

In [27]: *# This is made for learning purpose – Web Scraping*

Introduction

- Web scraping is an automated method to extract data from websites.
- It removes the need for manual copy-paste, saving time and effort.
- Python is commonly used for web scraping due to its simplicity and powerful libraries.
- Web scraping helps in collecting data for research, analysis, and monitoring.
- This project focuses on understanding basic web scraping concepts using Python.

In []:

Market and Competitor Analysis:

- Businesses collect product prices, customer reviews, and competitor details to track market trends and stay competitive.

Financial Data Collection:

- Investors and analysts extract stock prices, historical data, and financial reports to support informed decision-making.

Social Media Monitoring:

- Marketers analyze trends, customer sentiment, and campaign performance to improve engagement and strategy.

SEO Tracking:

- Companies monitor search engine rankings for keywords to optimize content and improve online visibility.

Research and Machine Learning:

- Researchers and data scientists gather large datasets to perform analysis and train machine learning models.

Overall Benefit:

- Web scraping makes data collection faster, scalable, and more accurate compared to manual methods.

Techniques of Web Scraping

Manual Extraction: Data is copied and pasted manually from websites. This method is simple but slow, inefficient, and not suitable for large or frequently updated data.

Automated Extraction: Uses scripts or software to collect data automatically. It is faster, more reliable, and suitable for large-scale scraping. Common automated techniques include:

HTML Parsing: Extracting data from the raw HTML of static web pages.

DOM Parsing: Working with the Document Object Model to extract dynamically loaded content.

API Access: Using official APIs to fetch structured data when available (preferred over scraping).

Headless Browsers (e.g., Selenium): Simulating real user actions to scrape JavaScript-heavy or interactive websites.

Technique Selection: The scraping method depends on the website's structure, complexity, and data format.

1. BeautifulSoup

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In [39]: """
BeautifulSoup is a Python library used to extract data from HTML and XML documents.
It converts webpage content into a structured format, making data extraction easier.

Steps Involved in Web Scraping:
-----
1. Send HTTP Request
2. Parse HTML Content
3. Extract Required Data
4. Store Data for Future Use
"""

"""-----
### Install Required Libraries
-----"""

# pip install requests
# pip install beautifulsoup4

# ^Use these in Python Terminal to Install the files

"""-----
### Fetch HTML Content
-----"""

import requests
url = "https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-"
```

```

response = requests.get(url)
print(response.text)

# Explanation:
# Sends a GET request to the given URL
# response.text returns the raw HTML content of the webpage

"""
### Handling 403 Forbidden Error (It's Optional)
"""
headers = {'User-Agent': 'Mozilla/5.0'}
response = requests.get(url, headers=headers)

"""
### Parse HTML Using BeautifulSoup
"""
from bs4 import BeautifulSoup
soup = BeautifulSoup(response.text, 'html.parser')
print(soup.prettify())

# Explanation:
# Converts raw HTML into a structured parse tree
# html.parser is Python's built-in HTML parser

"""
### Extract Specific Data (Example: Inspirational Quotes)
"""
import requests
from bs4 import BeautifulSoup

url = "https://www.passiton.com/inspirational-quotes"
response = requests.get(url)
soup = BeautifulSoup(response.text, 'html.parser')

quotes = []

quote_boxes = soup.find_all(
    'div',
    class_='col-6 col-lg-3 text-center margin-30px-bottom sm-margin-30px-top'
)

for box in quote_boxes:
    quote_text = box.img['alt'].split(" #")
    quote = {
        'theme': box.h5.text.strip(),
        'image_url': box.img['src'],
        'lines': quote_text[0],
        'author': quote_text[1] if len(quote_text) > 1 else 'Unknown'
    }
    quotes.append(quote)

```

```

# for q in quotes[:5]:
    # print(q) ( If you want to check the output you can download the file a

# Explanation:
# find_all() locates all quote containers using class names
# Extracts quote text, author, theme, and image URL
# Stores extracted data as a list of dictionaries

"""-----
### Understanding HTML Structure
-----"""
container = soup.find('div', attrs={'id': 'all_quotes'})

# soup.prettify() helps inspect HTML structure
# find() retrieves a single element
# find_all() retrieves multiple matching elements

"""-----
### Save Extracted Data to CSV
-----"""
import csv

filename = "quotes.csv"

with open(filename, mode='w', newline='', encoding='utf-8') as file:
    writer = csv.DictWriter(
        file,
        fieldnames=['theme', 'image_url', 'lines', 'author']
    )
    writer.writeheader()
    for quote in quotes:
        writer.writerow(quote)

# Explanation:
# Creates a CSV file named quotes.csv
# Stores extracted data in a structured tabular format
# Data can be reused for analysis or reporting

""" **CONCLUSION**
This project demonstrates how web scraping can be implemented using Python
and BeautifulSoup. It automates data collection, extracts useful information
and stores it efficiently, making it a powerful tool for data analysis
and research.
"""

```

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es Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups. Phase 3 Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST. Phase 4 Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm. Phase 5 Problem Solving and Practice LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities. Phase 6 Advanced Topics (Optional) String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. Advanced Dynamic Programming Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. Advanced Graph Algorithms Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). Geometry Algorithms Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points. Why is This Roadmap Effective? Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence. Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. Common Mistakes to Avoid Skipping the Basics Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts. Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. Getting Stuck on One Pr

oblem If youre stuck on a problem for too long, move on to another. Its impo
 rtant to keep practicing and learning from your mistakes.Why Learn DSA?Probl
 em Solving Skills Learning DSA helps in developing problem-solving abilitie
 s, which are valuable not just in coding interviews but also in real-world a
 pplications.Efficient Solutions Understanding how to use different data stru
 ctures and algorithms allows you to optimize solutions, making them more eff
 icient in terms of time and space complexity.Interview Success DSA is the co
 rnerstone of most technical interviews, especially for roles in software dev
 elopment. A strong grasp of DSA is essential for clearing interviews at top
 tech companies.Topics CoveredIntroduction to DSA Learn the importance of DSA
 and how it relates to coding efficiency.Data Structures Understand the basic
 and advanced data structures like arrays, linked lists, trees, graphs, and h
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 Problem-Solving Gain hands-on experience by practicing problems on competi
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r(--nextui-colors-blue200);--nextui-colors-primaryLightHover:var(--nextui-colors-blue300);--nextui-colors-primaryLightActive:var(--nextui-colors-blue400);--nextui-colors-primaryLightContrast:var(--nextui-colors-blue600);--nextui-colors-primary:var(--nextui-colors-blue600);--nextui-colors-primaryBorder:var(--nextui-colors-blue500);--nextui-colors-primaryBorderHover:var(--nextui-colors-blue600);--nextui-colors-primarySolidHover:var(--nextui-colors-blue700);--nextui-colors-primarySolidContrast:var(--nextui-colors-white);--nextui-colors-primaryShadow:var(--nextui-colors-blue500);--nextui-colors-secondaryLight:var(--nextui-colors-purple200);--nextui-colors-secondaryLightHover:var(--nextui-colors-purple300);--nextui-colors-secondaryLightActive:var(--nextui-colors-purple400);--nextui-colors-secondaryLightContrast:var(--nextui-colors-purple600);--nextui-colors-secondary:var(--nextui-colors-purple600);--nextui-colors-secondaryBorder:var(--nextui-colors-purple500);--nextui-colors-secondaryBorderHover:var(--nextui-colors-purple600);--nextui-colors-secondarySolidHover:var(--nextui-colors-purple700);--nextui-colors-secondarySolidContrast:var(--nextui-colors-white);--nextui-colors-secondaryShadow:var(--nextui-colors-purple500);--nextui-colors-successLight:var(--nextui-colors-green200);--nextui-colors-successLightHover:var(--nextui-colors-green300);--nextui-colors-successLightActive:var(--nextui-colors-green400);--nextui-colors-successLightContrast:var(--nextui-colors-green700);--nextui-colors-success:var(--nextui-colors-green600);--nextui-colors-successBorder:var(--nextui-colors-green500);--nextui-colors-successBorderHover:var(--nextui-colors-green600);--nextui-colors-successSolidHover:var(--nextui-colors-green700);--nextui-colors-successSolidContrast:var(--nextui-colors-white);--nextui-colors-successShadow:var(--nextui-colors-green500);--nextui-colors-warningLight:var(--nextui-colors-yellow200);--nextui-colors-warningLightHover:var(--nextui-colors-yellow300);--nextui-colors-warningLightActive:var(--nextui-colors-yellow400);--nextui-colors-warningLightContrast:var(--nextui-colors-yellow700);--nextui-colors-warning:var(--nextui-colors-yellow600);--nextui-colors-warningBorder:var(--nextui-colors-yellow500);--nextui-colors-warningBorderHover:var(--nextui-colors-yellow600);--nextui-colors-warningSolidHover:var(--nextui-colors-yellow700);--nextui-colors-warningSolidContrast:var(--nextui-colors-white);--nextui-colors-warningShadow:var(--nextui-colors-yellow500);--nextui-colors-errorLight:var(--nextui-colors-red200);--nextui-colors-errorLightHover:var(--nextui-colors-red300);--nextui-colors-errorLightActive:var(--nextui-colors-red400);--nextui-colors-errorLightContrast:var(--nextui-colors-red600);--nextui-colors-error:var(--nextui-colors-red600);--nextui-colors-errorBorder:var(--nextui-colors-red500);--nextui-colors-errorBorderHover:var(--nextui-colors-red600);--nextui-colors-errorSolidHover:var(--nextui-colors-red700);--nextui-colors-errorSolidContrast:var(--nextui-colors-white);--nextui-colors-errorShadow:var(--nextui-colors-red500);--nextui-colors-neutralLight:var(--nextui-colors-gray100);--nextui-colors-neutralLightHover:var(--nextui-colors-gray200);--nextui-colors-neutralLightActive:var(--nextui-colors-gray300);--nextui-colors-neutralLightContrast:var(--nextui-colors-gray800);--nextui-colors-neutral:var(--nextui-colors-gray600);--nextui-colors-neutralBorder:var(--nextui-colors-gray400);--nextui-colors-neutralBorderHover:var(--nextui-colors-gray500);--nextui-colors-neutralSolidHover:var(--nextui-colors-gray600);--nextui-colors-neutralSolidContrast:var(--nextui-colors-white);--nextui-colors-neutralShadow:var(--nextui-colors-gray400);--nextui-colors-gradient:linear-gradient(112deg, var(--nextui-colors-cyan600) -63.59%, var(--nextui-colors-pink600) -20.3%, var(--nextui-colors-blue600) 70.46%);--nextui-colors-accents0:var(--nextui-colors-gray50);--nextui-colors-accents1:var(--nextui-colors-gray100);--nextui-colors-accents2:var(--nextui-colors-gray200);--nextui-colors-accents3:var(--nextui-colors-gray300);--nextui-colors-accents4:var(--nextui-colors-gray400);--nextui-colors-accents5:var(--nextui-colors-gray500);--nextui-colors-accents6:var(--nextui-colors-gray600);--nextui-colors-accents7:var(--
```

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nextui-colors-gray700);--nextui-colors-accents8:var(--nextui-colors-gray800);--nextui-colors-accents9:var(--nextui-colors-gray900);--nextui-colors-background:var(--nextui-colors-white);--nextui-colors-backgroundAlpha:rgba(255, 255, 255, 0.8);--nextui-colors-foreground:var(--nextui-colors-black);--nextui-colors-backgroundContrast:var(--nextui-colors-white);--nextui-colors-blue50:#EDF5FF;--nextui-colors-blue100:#E1EFFF;--nextui-colors-blue200:#CEE4FE;--nextui-colors-blue300:#B7D5F8;--nextui-colors-blue400:#96C1F2;--nextui-colors-blue500:#5EA2EF;--nextui-colors-blue600:#0072F5;--nextui-colors-blue700:#005FCC;--nextui-colors-blue800:#004799;--nextui-colors-blue900:#00254D;--nextui-colors-purple50:#F7F2FD;--nextui-colors-purple100:#F1E8FB;--nextui-colors-purple200:#EADCF8;--nextui-colors-purple300:#E0CBF5;--nextui-colors-purple400:#D1B1F0;--nextui-colors-purple500:#BC8EE9;--nextui-colors-purple600:#7828C8;--nextui-colors-purple700:#6622AA;--nextui-colors-purple800:#4D1980;--nextui-colors-purple900:#290E44;--nextui-colors-green50:#F1FDF7;--nextui-colors-green100:#E8FCF1;--nextui-colors-green200:#DAFBE8;--nextui-colors-green300:#C8F9DD;--nextui-colors-green400:#ADF5CC;--nextui-colors-green500:#88F1B6;--nextui-colors-green600:#17C964;--nextui-colors-green700:#13A452;--nextui-colors-green800:#108944;--nextui-colors-green900:#06371B;--nextui-colors-yellow50:#FEF9F0;--nextui-colors-yellow100:#FEF5E7;--nextui-colors-yellow200:#FDEFD8;--nextui-colors-yellow300:#FCE7C5;--nextui-colors-yellow400:#FDBDA7;--nextui-colors-yellow500:#F9CB80;--nextui-colors-yellow600:#F5A524;--nextui-colors-yellow700:#B97509;--nextui-colors-yellow800:#925D07;--nextui-colors-yellow900:#4E3104;--nextui-colors-red50:#FEF0F5;--nextui-colors-red100:#FEE7EF;--nextui-colors-red200:#FDD8E5;--nextui-colors-red300:#FCC5D8;--nextui-colors-red400:#FAA8C5;--nextui-colors-red500:#F881AB;--nextui-colors-red600:#F31260;--nextui-colors-red700:#B80A47;--nextui-colors-red800:#910838;--nextui-colors-red900:#4E041E;--nextui-colors-cyan50:#F0FCFF;--nextui-colors-cyan100:#E6FAFE;--nextui-colors-cyan200:#D7F8FE;--nextui-colors-cyan300:#C3F4FD;--nextui-colors-cyan400:#A5EEFD;--nextui-colors-cyan500:#7EE7FC;--nextui-colors-cyan600:#06B7DB;--nextui-colors-cyan700:#09AACD;--nextui-colors-cyan800:#0E8AA0;--nextui-colors-cyan900:#053B48;--nextui-colors-pink50:#FFF0FB;--nextui-colors-pink100:#FFE5F8;--nextui-colors-pink200:#FFD6F3;--nextui-colors-pink300:#FFC2EE;--nextui-colors-pink400:#FFA3E5;--nextui-colors-pink500:#FF7AD9;--nextui-colors-pink600:#FF4ECD;--nextui-colors-pink700:#D6009A;--nextui-colors-pink800:#B80084;--nextui-colors-pink900:#4D0037;--nextui-colors-gray50:#F1F3F5;--nextui-colors-gray100:#ECEEF0;--nextui-colors-gray200:#E6E8EB;--nextui-colors-gray300:#DFE3E6;--nextui-colors-gray400:#D7DBDF;--nextui-colors-gray500:#C1C8CD;--nextui-colors-gray600:#889096;--nextui-colors-gray700:#7E868C;--nextui-colors-gray800:#687076;--nextui-colors-gray900:#11181C;--nextui-colors-text:var(--nextui-colors-gray900);--nextui-colors-link:var(--nextui-colors-blue600);--nextui-colors-codeLight:var(--nextui-colors-pink100);--nextui-colors-code:var(--nextui-colors-pink600);--nextui-colors-selection:var(--nextui-colors-blue200);--nextui-colors-border:rgba(0, 0, 0, 0.15);--nextui-shadows-xs:0 2px 8px 1px rgb(104 112 118 / 0.07), 0 1px 1px -1px rgb(104 112 118 / 0.04);--nextui-shadows-sm:0 2px 8px 2px rgb(104 112 118 / 0.07), 0 2px 4px -1px rgb(104 112 118 / 0.04);--nextui-shadows-md:0 12px 20px 6px rgb(104 112 118 / 0.08);--nextui-shadows-lg:0 12px 34px 6px rgb(104 112 118 / 0.18);--nextui-shadows-xl:0 25px 65px 0px rgb(104 112 118 / 0.35);--nextui-dropShadows-xs:drop-shadow(0 2px 4px rgb(104 112 118 / 0.07)) drop-shadow(0 1px 1px rgb(104 112 118 / 0.04));--nextui-dropShadows-sm:drop-shadow(0 2px 8px rgb(104 112 118 / 0.07)) drop-shadow(0 2px 4px rgb(104 112 118 / 0.04));--nextui-dropShadows-md:drop-shadow(0 4px 12px rgb(104 112 118 / 0.08)) drop-shadow(0 20px 8px rgb(104 112 118 / 0.04));--nextui-dropShadows-lg:drop-shadow(0 12px 24px rgb(104 112 118 / 0.15)) drop-shadow(0 12px 14px rgb(104 112 118 / 0.1));--nextui-dropShadows-xl:drop-shadow(0 25px 34px rgb(104 112 118 / 0.35))}}--sxs{--sxs:1 nextui-k-dPxXDy nextui-k-jjQGhG nextui-k-eKsXVP nextui-k-
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fehnNV nextui-k-dSVASG nextui-k-fL0xFp nextui-k-itSsug nextui-k-kczHuk nextu
i-k-gWfstQ nextui-k-jvYHWg nextui-k-khapXo nextui-k-jto0Cl nextui-k-coIGzE n
extui-k-gJKQzh nextui-k-fyNack nextui-k-fAlzUo nextui-k-df0Ufo nextui-k-AVtY
N eKDgFc}@media{@keyframes nextui-k-dPxXDy{0%{opacity:0;transform:scale(0.2
5)}30%{opacity:1}80%{opacity:0.5}100%{transform:scale(28);opacity:0}}@keyfra
mes nextui-k-jjQGhG{0%{background-position:200% 0}to{background-position:-20
0% 0}}@keyframes nextui-k-eKsxVP{0%{opacity:1}100%{opacity:0.15}}@keyframes
nextui-k-fehnNV{0%{transform:rotate(0deg)}100%{transform:rotate(360deg)}}@ke
yframes nextui-k-dSVASG{0%{transform:translate(0px, 0px)}50%{transform:trans
late(0, calc(calc(var(--nextui--loadingSize)*-1) * 1.4))}100%{transform:tran
slate(0px, 0px)}}@keyframes nextui-k-fL0xFp{0%{opacity:0.2}20%{opacity:1}10
0%{opacity:0.2}}@keyframes nextui-k-itSsug{0%{left:-40%}100%{left:100%}}@key
frames nextui-k-kczHuk{0%{transform:scale(1)}60%{transform:scale(var(--nextu
i--paginationScaleTransform))}100%{transform:scale(1)}}@keyframes nextui-k-g
WfstQ{100%{stroke-dashoffset:0}}@keyframes nextui-k-jvYHWg{0%{opacity:0;tran
sform:scale(0.2) translate(50%, -50%)}60%{opacity:0.75;transform:scale(1.2)
translate(50%, -50%)}100%{opacity:1;transform:scale(1) translate(50%, -5
0%}}@keyframes nextui-k-khapXo{0%{opacity:1;transform:scale(1) translate(5
0%, -50%)}100%{opacity:0;transform:scale(0.2) translate(50%, -50%}}@keyfram
es nextui-k-jto0Cl{0%{opacity:0;transform:scale(0.2) translate(-50%, -50%)}6
0%{opacity:0.75;transform:scale(1.2) translate(-50%, -50%)}100%{opacity:1;tr
ansform:scale(1) translate(-50%, -50%}}@keyframes nextui-k-coIGzE{0%{opacit
y:1;transform:scale(1) translate(-50%, -50%)}100%{opacity:0;transform:scale
(0.2) translate(-50%, -50%}}@keyframes nextui-k-gJKQzh{0%{opacity:0;transfo
rm:scale(0.2) translate(50%, 50%)}60%{opacity:0.75;transform:scale(1.2) tran
slate(50%, 50%)}100%{opacity:1;transform:scale(1) translate(50%, 50%}}@keyf
rames nextui-k-fyNack{0%{opacity:1;transform:scale(1) translate(50%, 50%)}10
0%{opacity:0;transform:scale(0.2) translate(50%, 50%}}@keyframes nextui-k-f
AlzUo{0%{opacity:0;transform:scale(0.2) translate(-50%, 50%)}60%{opacity:0.7
5;transform:scale(1.2) translate(-50%, 50%)}100%{opacity:1;transform:scale
(1) translate(-50%, 50%}}@keyframes nextui-k-df0Ufo{0%{opacity:1;transform:
scale(1) translate(-50%, 50%)}100%{opacity:0;transform:scale(0.2) translate
(-50%, 50%}}@keyframes nextui-k-AVtYN{0%{opacity:1}50%{opacity:0.4;transfor
m:scale(0.5)}100%{opacity:1}}*,*:before,*:after{box-sizing:border-box;text-r
endering:geometricPrecision;-webkit-tap-highlight-color:transparent}html{fon
t-size:var(--nextui-fontSizes-base)}body{margin:0;padding:0;min-height:100%;
position:relative;overflow-x:hidden;-webkit-font-smoothing:antialiased;-moz-
osx-font-smoothing:grayscale;text-rendering:optimizeLegibility;font-size:var
(--nextui-fontSizes-base);line-height:var(--nextui-lineHeights-md);font-fami
ly:var(--nextui-fonts-sans)}html,body{background-color:var(--nextui-colors-b
ackground);color:var(--nextui-colors-text)}p,small{color:inherit;letter-spac
ing:var(--nextui-letterSpacings-tighter);font-weight:var(--nextui-fontWeight
s-normal);font-family:var(--nextui-fonts-sans)}p{font-size:var(--nextui-font
Sizes-base);line-height:var(--nextui-lineHeights-lg)}small{margin:0;line-hei
ght:var(--nextui-lineHeights-xs);font-size:var(--nextui-fontSizes-xs)}b{font
-weight:var(--nextui-fontWeights-semibold)}span{font-size:inherit;color:inhe
rit;font-weight:inherit}img{max-width:100%}a{cursor:pointer;font-size:inheri
t;-webkit-touch-callout:none;-webkit-tap-highlight-color:rgba(0, 0, 0, 0);-w
ebkit-box-align:center;align-items:center;color:var(--nextui-colors-link);te
xt-decoration:none}a:hover{text-decoration:none}ul,ol{padding:0;list-style-t
ype:none;margin:var(--nextui-space-sm) var(--nextui-space-sm) var(--nextui-s
pace-sm) var(--nextui-space-lg);color:var(--nextui-colors-foreground)}ol{lis
t-style-type:decimal}li{margin-bottom:var(--nextui-space-5);font-size:var(--
nextui-fontSizes-base);line-height:var(--nextui-lineHeights-lg)}h1,h2,h3,h4,
h5,h6{color:inherit;margin:0 0 var(--nextui-space-5) 0}h1{letter-spacing:var
(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-5xl);line

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-height:var(--nextui-lineHeights-md);font-weight:var(--nextui-fontWeights-bo
ld)}h2{letter-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--n
extui-fontSizes-4xl);font-weight:var(--nextui-fontWeights-semibold)}h3{lette
r-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSi
zes-2xl);font-weight:var(--nextui-fontWeights-semibold)}h4{letter-spacing:va
r(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-xl);font
-weight:var(--nextui-fontWeights-semibold)}h5{letter-spacing:var(--nextui-le
tterSpacings-tight);font-size:var(--nextui-fontSizes-md);font-weight:var(--n
extui-fontWeights-semibold)}h6{letter-spacing:var(--nextui-letterSpacings-ti
ght);font-size:var(--nextui-fontSizes-sm);font-weight:var(--nextui-fontWeigh
ts-semibold)}button,input,select,textarea{font-family:inherit;font-size:inhe
rit;line-height:inherit;color:inherit;margin:0}button:focus,input:focus,sele
ct:focus,textarea:focus{outline:none}code{color:var(--nextui-colors-code);pa
dding:var(--nextui-space-1) var(--nextui-space-2);border-radius:var(--nextui
-radii-xs);background:var(--nextui-colors-codeLight);font-family:var(--nextu
i-fonts-mono);font-size:var(--nextui-fontSizes-sm);white-space:pre-wrap;tran
sition:opacity 0.25s ease 0s}code:hover{opacity:0.8}pre{overflow:auto;white-
space:pre;text-align:left;font-size:var(--nextui-fontSizes-sm);border-radiu
s:var(--nextui-radii-lg);padding:var(--nextui-space-md) var(--nextui-space-l
g);margin:var(--nextui-space-lg) 0;font-family:var(--nextui-fonts-mono);line
-height:var(--nextui-lineHeights-md);webkit-overflow-scrolling:touch}pre cod
e{color:var(--nextui-colors-foreground);font-size:var(--nextui-fontSizes-s
m);line-height:var(--nextui-lineHeights-sm);white-space:pre}pre code:before,
pre code:after{display:none}pre p{margin:0}pre::-webkit-scrollbar{display:no
ne;width:0;height:0;background:transparent}hr{background:var(--nextui-colors
-border);border-color:transparent;border-width:0px;border-style:none;height:
1px}details{background-color:var(--nextui-colors-accents1);border:none}detai
ls:focus,details:hover,details:active{outline:none}summary{cursor:pointer;we
bkit-user-select:none;user-select:none;list-style:none;outline:none}summar
y::-webkit-details-marker,summary::before{display:none}summary::-moz-list-bu
llet{font-size:0}summary:focus,summary:hover,summary:active{outline:none;lis
t-style:none}::selection{background-color:var(--nextui-colors-selection)}blo
ckquote{padding:var(--nextui-space-md) var(--nextui-space-lg);color:var(--ne
xtui-colors-accents7);background-color:var(--nextui-colors-accents0);border-
radius:var(--nextui-radii-lg);margin:var(--nextui-space-10) 0}blockquote *:f
irst-child{margin-top:0}blockquote *:last-child{margin-bottom:0}kbd{width:m
oz-fit-content;width:fit-content;text-align:center;display:inline-block;colo
r:var(--nextui-colors-accents8);background:var(--nextui-colors-accents0);bor
der:1px solid var(--nextui-colors-border);box-shadow:0 0 1px 0 rgb(0 0 0 / 1
4%);font-family:var(--nextui-fonts-sans);border-radius:5px;padding:var(--nex
tui-space-1) var(--nextui-space-3);margin-left:var(--nextui-space-1);margin-
right:var(--nextui-space-1);line-height:var(--nextui-lineHeights-sm);font-si
ze:var(--nextui-fontSizes-sm)}kbd + kbd{margin-left:var(--nextui-space-2)}d
l,dd,hr,figure,p{margin:0}}--sxs{--sxs:2 nextui-c-iVzbCs nextui-c-FIiRH next
ui-c-kbhVdb nextui-c-kRHeuF nextui-c-eKVPvf nextui-c-cUthvm nextui-c-huiNHE
nextui-c-fItrmj nextui-c-eKuzCY nextui-c-cAbbLF nextui-c-kSOHfs}@media{.next
ui-c-iVzbCs{opacity:0;margin:0 auto;position:relative;overflow:hidden;max-wi
dth:100%;transition:transform 250ms ease 0ms, opacity 200ms ease-in 0ms}@med
ia (prefers-reduced-motion: reduce){.nextui-c-iVzbCs{transition:none}}.nextu
i-c-FIiRH{position:absolute;top:0;left:0;right:0;bottom:0;width:100%;height:
100%;border-radius:inherit;background-image:linear-gradient(270deg, var(--ne
xtui-colors-accents1), var(--nextui-colors-accents2), var(--nextui-colors-ac
cents2), var(--nextui-colors-accents1));background-size:400% 100%;animation:
nextui-k-jjQGhG 5s ease-in-out infinite;transition:opacity 300ms ease-out}.n
extui-c-kbhVdb{width:100%;height:100%;display:block}.nextui-c-kRHeuF{margin:
0;box-sizing:border-box;padding:var(--nextui--gridGapUnit)}.nextui-c-eKVPvf

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{margin:0;padding:0;display:inline-flex;position:relative;font-variant:tabular-nums;font-feature-settings:tnum}.nextui-c-cUthvm{border:none;position:relative;display:inline-flex;margin:0 var(--nextui--paginationItemMargin);align-items:center;justify-content:center;padding:0;box-sizing:border-box;text-transform:capitalize;-webkit-user-select:none;-webkit-user-select:none;user-select:none;white-space:nowrap;text-align:center;vertical-align:middle;box-shadow:none;outline:none;height:var(--nextui--paginationSize);min-width:var(--nextui--paginationSize);font-size:inherit;cursor:pointer;border-radius:var(--nextui--paginationItemRadius);color:var(--nextui-colors-text);background:var(--nextui-colors-accents0)}@media (prefers-reduced-motion: reduce){.nextui-c-cUthvm{transition:none}}.nextui-c-cUthvm:hover{background:var(--nextui-colors-accents1)}.nextui-c-cUthvm .nextui-c-eKuzCY{width:var(--nextui--paginationFontSize);height:var(--nextui--paginationFontSize)}.nextui-c-cUthvm .nextui-c-kSOHfs{width:var(--nextui--paginationFontSize);height:var(--nextui--paginationFontSize)}.nextui-c-huiNHE{-webkit-tap-highlight-color:transparent}.nextui-c-huiNHE:focus:not(.nextui-c-huiNHE:focus-visible){box-shadow:none}.nextui-c-huiNHE:focus{outline:none;box-shadow:0 0 0 2px var(--nextui-colors-background), 0 0 0 4px var(--nextui-colors-primary)}@media not all and (min-resolution:.001dpcm){.nextui-c-huiNHE{-webkit-tap-highlight-color:transparent;outline:none}}.nextui-c-fItrmj{position:relative;display:inline-flex;align-items:center;top:0;left:0;z-index:var(--nextui-zIndices-2)}.nextui-c-eKuzCY{transform:rotate(180deg)}.nextui-c-cAbbLF{position:absolute;contain:strict;top:0px;z-index:var(--nextui-zIndices-1);background:var(--nextui--paginationColor);border-radius:var(--nextui--paginationItemRadius);height:var(--nextui--paginationSize);min-width:var(--nextui--paginationSize);animation-name:nextui-kkcZHuK;animation-direction:normal}.nextui-c-cAbbLF.nextui-pagination-highlight--moving{transform:scale(var(--nextui--paginationScaleTransform))}@media (prefers-reduced-motion: reduce){.nextui-c-cAbbLF{transition:none}}@media (prefers-reduced-motion: reduce){.nextui-c-cAbbLF.nextui-pagination-highlight--moving{transform:scale(1)}}.nextui-c-kSOHfs{color:currentColor;stroke:currentColor}}--sxs{--sxs:3 nextui-c-iVzbCs-bDGmTT-ready-true nextui-c-eKVPvf-eRVXIX-color-success nextui-c-eKVPvf-UECOZ-size-md nextui-c-eKVPvf-iTJSWG-borderWeight-normal nextui-c-eKVPvf-ibzOHM-onlyDots-false nextui-c-eKVPvf-bNGYLg-rounded-false nextui-c-eKVPvf-QbeIJ-noMargin-false nextui-c-cUthvm-gZRAkC-disabled-true nextui-c-cUthvm-SWDEj-animated-true nextui-c-eKuzCY-xROYZ-isPrev-true nextui-c-cAbbLF-QIZBs-animated-true nextui-c-cAbbLF-gZGrDk-shadow-true nextui-c-cUthvm-dZWcT-active-true}@media{.nextui-c-iVzbCs-bDGmTT-ready-true{opacity:1}.nextui-c-eKVPvf-eRVXIX-color-success{--nextui--paginationColor:var(--nextui-colors-success);--nextui--paginationShadowColor:var(--nextui-colors-successShadow)}.nextui-c-eKVPvf-UECOZ-size-md{--nextui--paginationWidth:var(--nextui-space-13);--nextui--paginationFontSize:var(--nextui-space-7);font-size:var(--nextui--paginationFontSize)}.nextui-c-eKVPvf-iTJSWG-borderWeight-normal{--nextui--paginationItemBorderWeight:var(--nextui-borderWeights-normal)}.nextui-c-eKVPvf-ibzOHM-onlyDots-false{--nextui--paginationSize:var(--nextui--paginationWidth);--nextui--paginationScaleTransform:1.1}.nextui-c-eKVPvf-bNGYLg-rounded-false{--nextui--paginationItemRadius:var(--nextui-radii-squared)}.nextui-c-eKVPvf-QbeIJ-noMargin-false{--nextui--paginationItemMargin:var(--nextui-space-1)}.nextui-c-cUthvm-gZRAkC-disabled-true{color:var(--nextui-colors-accents5);cursor:not-allowed}.nextui-c-cUthvm-SWDEj-animated-true{transition:transform 0.25s ease 0s, background 0.25s ease 0s, box-shadow 0.25s ease 0s}.nextui-c-eKuzCY-xROYZ-isPrev-true{transform:rotate(0deg)}.nextui-c-cAbbLF-QIZBs-animated-true{animation-duration:350ms;animation-timing-function:ease;transition:left 350ms ease 0s, transform 300ms ease 0s}.nextui-c-cAbbLF-gZGrDk-shadow-true{box-shadow:0 4px 14px 0 var(--nextui--paginationShadowColor)}.nextui-c-cUthvm-dZWcT-active-true{font-weight:var(--nextui-fontWeights-bold);cursor:default;box-shadow:var(--nextui-shadows-sm)}.nextui-c

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-cUthvm-dZWcTt-active-true .nextui-c-fItrmj{color:var(--nextui-colors-white)}--sxs{--sxs:6 nextui-c-iVzbCs-ieUYNBT-css nextui-c-FIiRH-ibDGmTT-css nextui-c-kbhVdb-iUwpmY-css nextui-c-iVzbCs-iyXqdA-css nextui-c-kbhVdb-ikZHsFe-css nextui-c-kRHeuF-ibhk0xP-css nextui-c-kRHeuF-icxokNG-css nextui-c-cAbbLF-ikgtVxo-css}@media{.nextui-c-iVzbCs-ieUYNBT-css{width:500px;height:280px}.nextui-c-FIiRH-ibDGmTT-css{opacity:1}.nextui-c-kbhVdb-iUwpmY-css{object-fit:fill}.nextui-c-iVzbCs-iyXqdA-css{width:60px;height:60px}.nextui-c-kbhVdb-ikZHsFe-css{object-fit:scale-down}.nextui-c-kRHeuF-ibhk0xP-css{align-items;;align-content;;justify-content;;flex-direction:}.nextui-c-kRHeuF-ibhk0xP-css.xs{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}@media (max-width: 650px){.nextui-c-kRHeuF-ibhk0xP-css.xs{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 960px){.nextui-c-kRHeuF-ibhk0xP-css.sm{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1280px){.nextui-c-kRHeuF-ibhk0xP-css.md{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1400px){.nextui-c-kRHeuF-ibhk0xP-css.lg{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1920px){.nextui-c-kRHeuF-ibhk0xP-css.xl{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}.nextui-c-kRHeuF-ibhk0xP-css{--nextui--gridGapUnit:calc(2 * var(--nextui-space-3));display:flex;flex-wrap:wrap;box-sizing:border-box;margin:calc(-1 * var(--nextui--gridGapUnit));width:calc(100% + var(--nextui--gridGapUnit) * 2)}.nextui-c-kRHeuF-icxokNG-css{align-items;;align-content;;justify-content;;flex-direction:}.nextui-c-kRHeuF-icxokNG-css.xs{flex-grow:0;display:inherit;max-width:100%;flex-basis:100}%@media (max-width: 650px){.nextui-c-kRHeuF-icxokNG-css.xs{flex-grow:0;display:inherit;max-width:100%;flex-basis:100}}@media (min-width: 960px){.nextui-c-kRHeuF-icxokNG-css.sm{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1280px){.nextui-c-kRHeuF-icxokNG-css.md{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1400px){.nextui-c-kRHeuF-icxokNG-css.lg{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1920px){.nextui-c-kRHeuF-icxokNG-css.xl{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}.nextui-c-cAbbLF-ikgtVxo-css{left:var(--nextui--paginationLeft)}}</style><meta name="description" content="Your All-in-One Learning Portal. It contains well written, well thought and well explained computer science and programming articles, quizzes and practice/competitive programming/company interview Questions."/><link rel="preconnect" href="https://fonts.gstatic.com" crossorigin /><link rel="preload" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/c1ef60212da72f8e.css" as="style"/><link rel="stylesheet" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/c1ef60212da72f8e.css" data-n-g="" /><link rel="preload" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/e2598a6b2c066c08.css" as="style"/><link rel="stylesheet" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/e2598a6b2c066c08.css" data-n-p="" /><link rel="preload" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/962e4563b108bffb.css" as="style"/><link rel="stylesheet" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/962e4563b108bffb.css" data-n-p="" /><link rel="preload" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/1142cfe37dce110f.css" as="style"/><link rel="stylesheet" href="https://assets.geeksforgeeks.org/gfg-assets/_next/static/css/1142cfe37dce110f.css" /><noscript data-n-css=""></noscript><script defer="" no-module="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/polyfills-c67a75d1b6f99dc8.js"></script><script defer="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/9873.0a8f63b716070844.js"></script><script defer="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/3914.951f46ff700fc404.js"></script><script defer="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/1119.e25c53ce0e71db.js"></script><script defer="" src="https://assets.geeksforgeek
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s.org/gfg-assets/_next/static/chunks/7792.f845f4f2c2ed5c7d.js"></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/webpack-9029f3aff18e321b.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/framework-3412d1150754b2fb.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/main-83950604a31ac5bb.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/pages/_app-df46cadcad4b1aca.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/8886-6116916e3af763ba.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/5855-e4317481b3f08fd8.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/chunks/pages/%5B...params%5D-b1677e05f163f619.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/WTE6VQ__UBNEZr69nbJDC/_buildManifest.js" defer=""></script><script src="https://assets.geeksforgeeks.org/gfg-assets/_next/static/WTE6VQ__UBNEZr69nbJDC/_ssgManifest.js" defer=""></script><style data-href="https://fonts.googleapis.com/css2?family=Nunito:wght@400;700&family=Source+Sans+3:wght@400;600&display=swap">@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/l/font?kit=XRXI3I6Li01BKofi0c5wtlZ2di8HDLshRTA&skey=27bb6aa8eea8a5e7&v=v32) format('woff')}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/l/font?kit=XRXI3I6Li01BKofi0c5wtlZ2di8HDFwmRTA&skey=27bb6aa8eea8a5e7&v=v32) format('woff')}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/l/font?kit=nwpBtKy20AdR1K-IwhWudF-R9QMyLBJAV3Bo8Ky461E0&skey=1497ac707ba83cff&v=v19) format('woff')}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/l/font?kit=nwpBtKy20AdR1K-IwhWudF-R9QMyLBJAV3Bo8Kxm7FE0&skey=1497ac707ba83cff&v=v19) format('woff')}@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIO0aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0460-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIMEaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0301,U+0400-045F,U+0490-0491,U+04B0-04B1,U+2116}@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIO0aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0102-0103,U+0110-0111,U+0128-0129,U+0168-0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+0303-0304,U+0308-0309,U+0323,U+0329,U+1EA0-1EF9,U+20AB}@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIO0aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0100-02BA,U+02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+02DD-02FF,U+0304,U+0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+20A0-20AB,U+20AD-20C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-family:'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofINEaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIO0aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0460-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIMEaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0301,U+0400

–045F,U+0490–0491,U+04B0–04B1,U+2116}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofI0uaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0102–0103,U+0110–0111,U+0128–0129,U+0168–0169,U+01A0–01A1,U+01AF–01B0,U+0300–0301,U+0303–0304,U+0308–0309,U+0323,U+0329,U+1EA0–1EF9,U+20AB}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofI0–aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0100–02BA,U+02BD–02C5,U+02C7–02CC,U+02CE–02D7,U+02DD–02FF,U+0304,U+0308,U+0329,U+1D00–1DBF,U+1E00–1E9F,U+1EF2–1EFF,U+2020,U+20A0–20AB,U+20AD–20C0,U+2113,U+2C60–2C7F,U+A720–A7FF}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofINEaBTMnFcQ.woff2) format('woff2');unicode-range:U+0000–00FF,U+0131,U+0152–0153,U+02BB–02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000–206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wIaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0460–052F,U+1C80–1C8A,U+20B4,U+2DE0–2DFF,U+A640–A69F,U+FE2E–FE2F}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wsaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0301,U+0400–045F,U+0490–0491,U+04B0–04B1,U+2116}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wMaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+1F00–1FFF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wwaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0370–0377,U+037A–037F,U+0384–038A,U+038C,U+038E–03A1,U+03A3–03FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wAaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0102–0103,U+0110–0111,U+0128–0129,U+0168–0169,U+01A0–01A1,U+01AF–01B0,U+0300–0301,U+0303–0304,U+0308–0309,U+0323,U+0329,U+1EA0–1EF9,U+20AB}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wEaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0100–02BA,U+02BD–02C5,U+02C7–02CC,U+02CE–02D7,U+02DD–02FF,U+0304,U+0308,U+0329,U+1D00–1DBF,U+1E00–1E9F,U+1EF2–1EFF,U+2020,U+20A0–20AB,U+20AD–20C0,U+2113,U+2C60–2C7F,U+A720–A7FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3w8aZejf5Hc.woff2) format('woff2');unicode-range:U+0000–00FF,U+0131,U+0152–0153,U+02BB–02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000–206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wIaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0460–052F,U+1C80–1C8A,U+20B4,U+2DE0–2DFF,U+A640–A69F,U+FE2E–FE2F}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wsaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0301,U+0400–045F,U+0490–0491,U+04B0–04B1,U+2116}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3wMaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+1F00–1FFF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K–IwhWudF–R3

```

wwaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0370-0377,U+037A-037F,U
+0384-038A,U+038C,U+038E-03A1,U+03A3-03FF}@font-face{font-family:'Source San
s 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fon
ts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wAaZejf5HdF8Q.woff
2) format('woff2');unicode-range:U+0102-0103,U+0110-0111,U+0128-0129,U+0168-
0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+0303-0304,U+0308-0309,U+0323,U+03
29,U+1EA0-1EF9,U+20AB}@font-face{font-family:'Source Sans 3';font-style:norm
al;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sou
rcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wEaZejf5HdF8Q.woff2) format('woff2');u
nicode-range:U+0100-02BA,U+02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+02DD-02FF,U+0
304,U+0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+20A0-20AB,U+2
0AD-20C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-family:'Source Sans
3';font-style:normal;font-weight:600;font-display:swap;src:url(https://font
s.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3w8aZejf5Hc.woff2) f
ormat('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02
C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+219
3,U+2212,U+2215,U+FEFF,U+FFFD}</style></head><body><div id="__next" data-rea
ctroot=""><div style="visibility:hidden;background-color:#ffffff;min-height:
100vh"><div data-overlay-container="true"><style>
  #nprogress {
    pointer-events: none;
  }
  #nprogress .bar {
    background: #29D;
    position: fixed;
    z-index: 9999;
    top: 0;
    left: 0;
    width: 100%;
    height: 3px;
  }
  #nprogress .peg {
    display: block;
    position: absolute;
    right: 0px;
    width: 100px;
    height: 100%;
    box-shadow: 0 0 10px #29D, 0 0 5px #29D;
    opacity: 1;
    -webkit-transform: rotate(3deg) translate(0px, -4px);
    -ms-transform: rotate(3deg) translate(0px, -4px);
    transform: rotate(3deg) translate(0px, -4px);
  }
  #nprogress .spinner {
    display: block;
    position: fixed;
    z-index: 1031;
    top: 15px;
    right: 15px;
  }
  #nprogress .spinner-icon {
    width: 18px;
    height: 18px;
    box-sizing: border-box;
    border: solid 2px transparent;
    border-top-color: #29D;

```

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border-left-color: #29D;
border-radius: 50%;
-webkit-animation: nprogresss-spinner 400ms linear infinite;
animation: nprogress-spinner 400ms linear infinite;
}
.nprogress-custom-parent {
  overflow: hidden;
  position: relative;
}
.nprogress-custom-parent #nprogress .spinner,
.nprogress-custom-parent #nprogress .bar {
  position: absolute;
}
@-webkit-keyframes nprogress-spinner {
  0% {
    -webkit-transform: rotate(0deg);
  }
  100% {
    -webkit-transform: rotate(360deg);
  }
}
@keyframes nprogress-spinner {
  0% {
    transform: rotate(0deg);
  }
  100% {
    transform: rotate(360deg);
  }
}

```

```

</style><div class="root" id="data-mode" data-dark-mode="false" style="display: block"><div id="comp"><div class="root gfg_header__root" style="display: none"><div id="comp"><div class="gfgheader_parentContainer"><div class="containerWrapper " id="topMainHeader"><div class="headerContainer"><div style="display: flex; align-items: center; width: 304px"><a class="headerMainLogo" href="https://www.geeksforgeeks.org/"><div class="logo"></div></a><div class="gs-plus-suggestion-container" style="padding-left: 6px; border-radius: 7px"><div class="gs-input_wrapper gs-show-search-bar"><span class="flexR gs-search-icon"><i class="gfg-icon gfg-icon-grey-search "></i></span><form class="gs-form"><input type="text" value="" placeholder="Search..." class="gs-input"/></form></div></div></div><ul class="headerMainList"><li class="headerMainListItem"><span style="display: flex; align-items: center" class="genericHeaderListClass"><div style="display: inline">Courses<div></div></div><i class="gfg-icon gfg-icon-black-down-carrot genericHeaderListClass" style="position: relative; left: 2px; top: 0px"></i></span></li><li class="headerMainListItem"><span style="display: flex; align-items: center" class="genericHeaderListClass"><div style="display: inline">Tutorials<div></div></div><i class="gfg-icon gfg-icon-black-down-carrot genericHeaderListClass" style="position: relative; left: 2px; top: 0px"></i></span></li><li class="headerMainListItem"><span style="display: flex; align-items: center" class="genericHeaderListClass"><div style="display: inline">Practice<div></div></div><i class="gfg-icon gfg-icon-black-down-carrot genericHeaderListClass" style="position: relative; left: 2px; top: 0px"></i></span></li><li class="headerMainListItem"><span style="display: flex; align-items: center" class="genericHeaderListClass"><div style="display: inline">Jobs<div></div></div><i class="gfg-icon gfg-icon-black-down-carrot genericHeaderListClass" style="position: relative; left: 2px; top: 0px"></i></span></li></ul></div></div></div></div></div>

```

osition:relative;left:2px;top:0px"></i><div class="header-main__container" style="display:flex;width:auto;align-items:center"><div style="width:100px;margin-right:20px;display:flex;justify-content:flex-end"></div><div style="display:flex;align-items:center;margin:0 6px;gap:6px"><div class="darkMode-wrap darkMode-wrap-desktop" data-mode="Switch to Dark Mode"><button data-gfg-action="toggleGFGTheme" aria-label="Toggle GFG Theme"><div class="darkMode-wrap-red-dot"></div><i class="gfg-icon gfg-icon_dark-mode"></i></button></div><div class="notification_container"><div class="notification-bell-icon"></div></div></div><div style="min-width:73px"><div style="height:36px"></div></div></div></div></div><div id="script"></div></div><div class="mainSubHeaderDiv" style="position:sticky;top:0;z-index:100;width:100%;display:block"><div class="gfg_header__root" data-dark-mode="false"><div class="outsideMainContainerSubheader with_shadow" style="background-color:white"><div class="mainContainersubheader with_shadow" id="secondarySubHeader"><ul class="containerSubheader" style="background-color:white;justify-content:center">DSA TutorialInterview QuestionsQuizzesMust DoAdvanced DSASystem DesignAptitudePuzzlesInterview CornerDSA Python</div></div></div><div></div><script src="https://securepubads.g.doubleclick.net/tag/js/gpt.js" defer=""></script><script src="https://cdnads.geeksforgeeks.org/v1/gfg_ads.min.js?ver=0.1" defer=""></script><script src="https://cdnads.geeksforgeeks.org/synchronously_gfg_ads.min.js"></script><script src="https://cdnads.geeksforgeeks.org/prebid.js?ver=0.1" defer=""></script><div id="ArticlePagePostLayout_home-page__1dC9q" class="ArticlePagePostLayout_containerFluid__q38gg"><div class="ArticlePagePostLayout_containerFluid_articlePageFlex__usibP"><div class="LeftbarContainer_leftBarContainer__TfRB"><div class="LeftbarContainer_leftBarContainer__sticky__ARQL7"><div class="LeftbarContainer_leftBarContainer__sticky__randomDiv__i0Fji"><div class="LeftbarContainer_leftBarContainer__sticky__randomDiv_leftBarInnerContainer__M_ajm"><div><div class="LeftbarPromotionalCTA_promotionalCtaOuterDiv__promotionalCta__Uatcl"><li style="background-color: var(--leftbar-explore-section-color) !important;" class="share-experience-modal">Share Your Experiences</div></div><div class="LeftbarContainer_leftBarContainer__sticky__randomDiv_leftBarInnerContainer_leftBarSticky__XRGJ1 undefined"><div class="LeftbarDropDown_linksWithDropDownContainer__dCoDN"><div class="LeftbarDropDown_linksWithDropDownContainer_cards__nqWee "><div class="LeftbarDropDown_linksWithDropDownContainer_cards__dropdownHeading__ra28W ">DSA Fundamentals

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><i class=""></i></div><ul class="LeftbarDropDown_linksWithDropDownContainer
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DSA stands for **Data Structures and Algorithms**. Data structures manage how data is stored and accessed. Algorithms focus on processing this data. Examples of data structures are Array, Linked List, Tree and Heap, and examples of algorithms are Binary Search, Quick Sort and Merge Sort.

Foundation for almost every software like GPS, Search Engines, AI ChatBots, Gaming Apps, Databases, Web Applications, etc

Top Companies like Google, Microsoft, Amazon, Apple, Meta and many other heavily focus on DSA interviews.

Learning DSA boosts your problem-solving abilities and make you a stronger programmer.

Before beginning the DSA journey, it is recommended to learn at-least one programming language ([C++](http://www.geeksforgeeks.org/cpp/c-plus-plus/), [Java](https://www.geeksforgeeks.org/java/java/), [Python](https://www.geeksforgeeks.org/python/python-programming-language-tutorial/), [JavaScript](https://www.geeksforgeeks.org/javascript/javascript-tutorial/) or any other language of your choice).

Below are the recommended step by step topics to learn complete DSA.

1-logic-building

Once you have learned basics of a programming language, it is recommended that you learn basic logic building

- [Logic Building Guide](https://www.geeksforgeeks.org/dsa/logic-building-problems/)
- [Quiz on Logic Building](https://www.geeksforgeeks.org/quizzes/dsa-tutorial-logic-building/)

2-learn-about-complexities

To analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.

- [Complexity Analysis Guide](https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/)
- [Quiz on Complexity Analysis](https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/)

3-array

Array is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.

- [Array Guide](https://www.geeksforgeeks.org/dsa/array-data-structure-guide/)
- [Array Quiz](https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/)

4-searching-algorithms

Searching algorithms are used to locate specific data within a large set of data. It helps find a target value with

n the data. There are various types of searching algorithms, each with its own approach and efficiency.

- [Searching Guide](https://www.geeksforgeeks.org/dsa/searching-algorithms/)
- [Quiz on Searching](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/)

5. Sorting Algorithm

Sorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.

- [Sorting Guide](https://www.geeksforgeeks.org/dsa/sorting-algorithms/)
- [Quiz on Sorting](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/)

6. Hashing

Hashing is a technique that generates a fixed-size output (hash value) from an input of variable size using mathematical formulas called hash functions. Hashing is commonly used in data structures for efficient searching, insertion and deletion.

- [Hashing Guide](https://www.geeksforgeeks.org/dsa/hashing-data-structure/)
- [Quiz on Hashing](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-structure-with-answers/)

7. Two Pointer Technique

In Two Pointer Technique, we typically use two index variables from two corners of an array. We use the two pointer technique for searching a required point or value in an array.

- [Two Pointer Technique](https://www.geeksforgeeks.org/dsa/two-pointers-technique/)
- [Quiz on Two Pointer Technique](https://www.geeksforgeeks.org/quizzes/quiz-on-two-pointer-technique-for-dsa/)

8. Window Sliding Technique

In Window Sliding Technique, we use the result of previous subarray to quickly compute the result of current.

- [Window Sliding Technique](https://www.geeksforgeeks.org/dsa/window-sliding-technique/)
- [Quiz on Sliding Window](https://www.geeksforgeeks.org/quizzes/quiz-on-sliding-window-technique-for-dsa/)

9. Prefix Sum Technique

In Prefix Sum Technique, we compute prefix sums of an array to quickly find results for a subarray.

- [Prefix Sum Technique](https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/)
- [Quiz on Prefix Sum](https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/)

10. String

A sequence of characters, typically immutable and have limited set of elements (lower case or all English alphabets).

- [Strings Guide](https://www.geeksforgeeks.org/dsa/string-data-structure/)
-

ng-for-dsa/" rel="noopener" target="_blank">Quiz on Strings
<h3 id="11-recursion" style="text-align:left">11. Recursion</h3><p dir="ltr">A programming technique where a function calls itself within its own definition. It is usually used to solve problems that can be broken down into smaller instances of the same problem. </p><li value="1">Recursion Guide<li value="2">Quiz on Recursion<h3 id="12-matrixgrid" style="text-align:left">12. Matrix/Grid</h3><p dir="ltr">A two-dimensional array of elements, arranged in rows and columns. It is represented as a rectangular grid, with each element at the intersection of a row and column.</p><li value="1">Matrix Guide<li value="2">Quiz on Matrix/Grid.<h3 id="13-stack" style="text-align:left">13. Linked List</h3><p dir="ltr">A linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be accessed sequentially, starting from the head of list.</p><li value="1">Linked List Guide<li value="2">Quiz on Linked List<h3 id="13-stack-1" style="text-align:left">14. Stack</h3><p dir="ltr">A linear data structure that follows the Last In, First Out (LIFO) principle. Stacks play an important role in managing function calls, memory, and are widely used in algorithms like stock span problem, next greater element and largest area in a histogram.</p><li value="1">Stack Guide<li value="2">Quiz on Stack<h3 id="14-queue" style="text-align:left">15. Queue</h3><p dir="ltr">Queue is a linear data structure that follows the First In, First Out (FIFO) principle. Queues play an important role in managing tasks or data in order, scheduling and message handling systems.</p><li value="1">Queue Guide<li value="2">Quiz on Queue<h3 id="15-deque" style="text-align:left">16. Deque</h3><p dir="ltr" style="text-align: justify;">A Deque or double-ended queue is a data structure that allows elements to be added or removed from both ends efficiently. </p><li value="1">Deque Guide <li value="2">Quiz on Deque<h3 id="17-tree" style="text-align:left">17. Tree</h3><p dir="ltr">A non-line

ar, hierarchical **data structure** consisting of nodes connected by edges, with a top node called the **root** and nodes having child nodes. It is widely used in **file systems**, **databases**, **decision-making algorithms**, etc.

- [Tree Guide](https://www.geeksforgeeks.org/dsa/tree-data-structure/)
- [Quiz on Tree](https://www.geeksforgeeks.org/quizzes/tree-22648/)

18. Heap

A **complete binary tree** that satisfies the **heap property**. Heaps are usually used to implement **priority-queue-set-1-introduction**, where the **smallest** or **largest** element is always at the root of the tree.

- [Heap Guide](https://www.geeksforgeeks.org/dsa/heap-data-structure/)
- [Quiz on Heap](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-heap-data-structure-with-answers/)

19. Graph

A **non-linear data structure** consisting of a finite set of **vertices** (or nodes) and a set of **edges** (or links) that connect a pair of nodes. Graphs are widely used to represent relationships between entities.

- [Graph Guide](https://www.geeksforgeeks.org/dsa/graph-data-structure-and-algorithms/)
- [Quiz on Graph](https://www.geeksforgeeks.org/quizzes/graph-12715/)

20. Greedy Algorithm

Greedy Algorithm builds up the solution one piece at a time and chooses the next piece which gives the most obvious and immediate benefit i.e., which is the most optimal choice at that moment. So the problems where choosing **locally optimal** also leads to the global solutions are best fit for Greedy.

- [Greedy Algorithms Guide](https://www.geeksforgeeks.org/dsa/greedy-algorithms/)
- [Quiz on Greedy](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-greedy-algorithms-with-answers/)

21. Dynamic Programming

Dynamic Programming is a method used to solve complex problems by breaking them down into simpler **subproblems**. By solving each subproblem only once and storing the results, it avoids redundant computations, leading to more efficient solutions **for a wide range of problems**.

- [Dynamic Programming Guide](https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/)
- [Quiz on DP](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-dynamic-programming-with-answers/)

22. Advanced Data Structure and Algorithms

Advanced Data Structures like **Trie**, **Segment Tree**

span>, Red-Black Tree and Binary Indexed Tree offer significant performance improvements for specific problem domains. They provide efficient solutions for tasks like fast prefix searches, range queries, dynamic updates, and maintaining balanced data structures, which are crucial for handling large datasets and real-time processing.</p><li value="1">Trie<li value="2">Segment Tree<li value="3">Red-Black Tree<li value="4">Binary Indexed Tree<li value="5">Practice Advanced Data Structures<h3 id="22-other-algorithms" style="text-align:left">23. Other Algorithms</h3><p dir="ltr">Bitwise Algorithms: Operate on individual bits of numbers.</p><li value="1">Bitwise Algorithms Guide<li value="2">Quiz on Bit Magic<p dir="ltr">Backtracking Algorithm : Follow Recursion with the option to revert and traces back if the solution from current point is not feasible.</p><li value="1">Backtracking Guide <li value="2">Quiz on Backtracking<p dir="ltr">Divide and conquer: A strategy to solve problems by dividing them into smaller subproblems, solving those subproblems, and combining the solutions to obtain the final solution.</p><li value="1">Divide and Conquer Guide<li value="2">Quiz on Divide and Conquer<p dir="ltr">Branch and Bound : Used in combinatorial optimization problems to systematically search for the best solution. It works by dividing the problem into smaller subproblems, or branches, and then eliminating certain branches based on bounds on the optimal solution. This process continues until the best solution is found or all branches have been explored.</p><li value="1">Branch and Bound Algorithm<p dir="ltr">Geometric algorithms are a set of algorithms that solve problems related to shapes, points, lines and polygons.</p><li value="1">Geometric Algorithms<li value="2">Practice Geometric Algorithms<p dir="ltr">Randomized algorithms are

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DSA stands for **Discrete Structures and Algorithms**. Data structures manage how data is stored and accessed. Algorithms focus on processing this data. Examples of data structures are Array, Linked List, Tree and Heap, and examples of algorithms are Binary Search, Quick Sort and Merge Sort.

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Before beginning the DSA journey, it is recommended to learn at-least one programming language ([C++](https://www.geeksforgeeks.org/cpp/c-plus-plus/), [Java](https://www.geeksforgeeks.org/java/java/), [Python](https://www.geeksforgeeks.org/python/python-programming-language-tutorial/), [JavaScript](https://www.geeksforgeeks.org/javascript/javascript-tutorial/) or any other language of your choice).

Below are the recommended step by step topics to learn complete DSA.

- 1-logic-building** Once you have learned basics of a programming language, it is recommended that you learn basic logic building.
- 2-learn-about-complexities** Learn about Complexities
- 3-analyze-algorithms** To analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.

de \u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eQuiz on Complexity Analysis\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"3-array\" style=\"text-align:left\"\u003e\u003cspan\u003e3. Array\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\"\u003e\u003cspan\u003eArray is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.\u003c/span\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/introduction-to-arrays-data-structure-and-algorithm-tutorials/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003e \u003c/span\u003e\u003c/a\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/array-data-structure-guide/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eArray Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eArray Quiz\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"4-searching-algorithms\" style=\"text-align:left\"\u003e\u003cspan\u003e4. Searching Algorithms\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\"\u003e\u003cspan\u003eSearching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/searching-algorithms/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eSearching Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/\" rel=\"noopener\"\u003e\u003cspan\u003eQuiz on Searching\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"5-sorting-algorithm\" style=\"text-align:left\"\u003e\u003cspan\u003e5. Sorting Algorithm\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\"\u003e\u003cspan\u003eSorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/sorting-algorithms/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eSorting Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eQuiz on Sorting \u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"6-hashing\" style=\"text-align:left\"\u003e\u003cspan\u003e6. Hashing\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" style=\"text-align:left;\u003e\u003cspan\u003eHashing is a technique that generates a fixed-size output (hash value) from an input of variable size using mathematical formulas called hash functions. Hashing is commonly used in data structures for efficient searching, insertion and deletion.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/hashing-data-structure/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eHashing Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-structure-with-answers/\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eQuiz on Hashing\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"7-two-pointer-technique\"

style="text-align:left"\u003e\u003cspan\u003e7. Two Pointer Technique\u003c/span\u003e\u003c/h3\u003e\u003c/p dir="ltr"\u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eTwo Pointer Technique, we typically use two index variables from two corners of an array. We use the two pointer technique for searching a required point or value in an array.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/two-pointers-technique/" rel="noopener" target="_blank"\u003e\u003cspan\u003eTwo Pointer Technique\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-two-pointer-technique-for-dsa/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Two Pointer Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="8-window-sliding-technique" style="text-align:left"\u003e\u003cspan\u003e8. Window Sliding Technique\u003c/span\u003e\u003c/h3\u003e\u003c/p dir="ltr"\u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eWindow Sliding Technique, we use the result of previous subarray to quickly compute the result of current.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/window-sliding-technique/" rel="noopener" target="_blank"\u003e\u003cspan\u003eWindow Sliding Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-sliding-window-technique-for-dsa/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Sliding Window\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003c/ul\u003e\u003ch3 id="9-prefix-sum-technique" style="text-align:left"\u003e\u003cspan\u003e9. Prefix Sum Technique\u003c/span\u003e\u003c/h3\u003e\u003c/p dir="ltr"\u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003ePrefix Sum Technique, we compute prefix sums of an array to quickly find results for a subarray.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/" rel="noopener" target="_blank"\u003e\u003cspan\u003ePrefix Sum Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Prefix Sum\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003c/ul\u003e\u003ch3 id="10-string" style="text-align:left"\u003e\u003cspan\u003e10. String\u003c/span\u003e\u003c/h3\u003e\u003c/p dir="ltr"\u003e\u003cb\u003e\u003cstrong\u003eA sequence of characters, typically immutable and have limited set of elements (lower case or all English alphabets).\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/string-data-structure/" rel="noopener" target="_blank"\u003e\u003cspan\u003eStrings Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Strings\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/li\u003e\u003c/ul\u003e\u003ch3 id="11-recursion" style="text-align:left"\u003e\u003cspan\u003e11. Recursion\u003c/span\u003e\u003c/h3\u003e\u003c/p dir="ltr"\u003e\u003cb\u003e\u003cstrong\u003eA programming technique where a function \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecalls itself\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e within its own definition. It is usually used to solve problems that can be broken down into smaller instances of the same problem. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/recursion-algorithms/" rel="noopener" target="_blank"\u003e\u003cspan\u003eRecursion G

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-recursion-algorithm-with-answers/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Quiz on Recursion
<https://www.geeksforgeeks.org/dsa/matrix/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Matrix Guide
<https://www.geeksforgeeks.org/quizzes/quiz-on-matrixgrid-for-dsa/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Quiz on Matrix/Grid
<https://www.geeksforgeeks.org/dsa/linked-list-data-structure/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Linked List Guide
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<https://www.geeksforgeeks.org/dsa/stack-data-structure/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Stack Guide
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<https://www.geeksforgeeks.org/dsa/queue-data-structure/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Queue Guide
<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-queue-data-structure-with-answers/> rel="noopener" target="_blank" data-cs="3" data-kind="parent">Quiz on Queue

12. Matrix/Grid

A two-dimensional array of elements, arranged in rows and columns. It is represented as a rectangular grid, with each element at the intersection of a row and column.

13. Linked List

A linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be accessed sequentially, starting from the head of the list.

14. Stack

A linear data structure that follows the Last In, First Out (LIFO) principle. Stacks play an important role in managing function calls, memory, and are widely used in algorithms like stock span problem, next greater element and largest area in a histogram.

15. Queue

A linear data structure that follows the First In, First Out (FIFO) principle. Queues play an important role in managing tasks or data in order, scheduling and message handling systems.

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-queue-data-structure-with-answers/> rel="noopener" target="_blank" data-bbox="112 112 888 888">Queue on Queue, where the smallest element is always at the root of the tree. Graph non-linear data structure consisting of a finite set of vertices and edges, with a top node called the root and nodes having child nodes. It is widely used in file systems and databases. Heaps are usually used to implement priority queues, where the smallest element is always at the root of the tree.

(or nodes) and a set of [edges](https://www.geeksforgeeks.org/dsa/graph-data-structure-and-algorithms/) (or links) that connect a pair of nodes. Graphs are widely used to represent relationships between entities.

[Graph Guide](https://www.geeksforgeeks.org/quizzes/graph-12715/)

[Quiz on Greedy](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-greedy-algorithms-with-answers/)

[Dynamic Programming Guide](https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/)

[Quiz on DP](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-dynamic-programming-with-answers/)

[22. Advanced Data Structure and Algorithms](https://www.geeksforgeeks.org/dsa/advanced-data-structure-and-algorithms/)

[23. Advanced Data Structures like Trie, Segment Tree, Red-Black Tree and Binary Indexed Tree](https://www.geeksforgeeks.org/dsa/advanced-data-structures-like-trie-segment-tree-red-black-tree-and-binary-indexed-tree/)

[24. Greedy Algorithm](https://www.geeksforgeeks.org/dsa/)

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lem into smaller subproblems, or branches, and then eliminating certain branches based on bounds on the optimal solution. This process continues until the best solution is found or all branches have been explored.

<http://www.geeksforgeeks.org/dsa/branch-and-bound-algorithm/>

Branch and Bound Algorithm

Geometric algorithms

are a set of algorithms that solve problems related to shapes, points, lines and polygons.

<https://www.geeksforgeeks.org/dsa/geometric-algorithms/>

Geometric Algorithms

are algorithms that use randomness to solve problems. They make use of random input to achieve their goals, often leading to simpler and more efficient solutions. These algorithms may not product same result but are particularly useful in situations when a probabilistic approach is acceptable.

<https://www.geeksforgeeks.org/dsa/randomized-algorithms/>

Randomized algorithms

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tasks at the same time using Goroutines.

Speed: Compiled language with fast execution.

Scalability: Designed for large, scalable systems.

Cross-Platform Support: Works on Windows, macOS, and Linux.

"Is there a contact number available for inquiries?": "You may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org or courses@geeksforgeeks.org. Can I make the payment through PayPal?" "Yes. Mail us with your details at courses@geeksforgeeks.org."

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- Learn detailed modules focusing on GoLang syntax, advanced data structures, and error handling.
- 25+ hrs of Video based content
- 220+ MCQs to practice & test your knowledge
- Guidance on configuring development environments, including Git and GoLang IDEs
- Hands-on approach with extensive assignments, projects, and practical simulations.
- Learn powerful RESTful services with GoLang's net/http package, including API design, implementation, and database integration.
- Insights into modern backend architecture patterns using GoLang

Project: Social Media Application

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Discover the transformative power of mastering Data Structures and Algorithms (DSA) as you venture towards becoming a proficient Developer or Data Scientist.

Learn essential data structures and algorithms Master key algorithms Develop advanced coding techniques Build a strong programming foundation Gain confidence in tackling challenges Engage in hands-on projects Create remarkable applications Choose full-stack development, data science, or specialize in a particular technology stack.

Receive insights from industry professionals Get guidance from experienced mentors

This journey starts with a solid foundation in Data Structures and Algorithms (DSA), essential for becoming a skilled developer. Whether you are aiming to master full-stack development, specialize in Java backend, dive into applied data science, or create the next big Android app, this curriculum arms you with the essential tools and real-world experience to fuel your coding journey. Whether you're a student or a professional, this curriculum provides the key fundamentals and practical skills needed to thrive in today's tech landscape.

Starts with a solid understanding of Data Structures and Algorithms (DSA). Leads towards becoming a skilled developer. Equips with fundamental tools for the coding journey. Suitable for aspiring full-stack developers or those specializing in a particular technology stack. Perfect for students or professionals from any field aiming for a technological journey.

"course_overview": "This journey starts with a solid foundation in Data Structures and Algorithms (DSA), essential for becoming a skilled developer. Whether you are aiming to master full-stack development, specialize in Java backend, dive into applied data science, or create the next big Android app, this curriculum arms you with the essential tools and real-world experience to fuel your coding journey. Whether you're a student or a professional, this curriculum provides the key fundamentals and practical skills needed to thrive in today's tech landscape. Starts with a solid understanding of Data Structures and Algorithms (DSA). Leads towards becoming a skilled developer. Equips with fundamental tools for the coding journey. Suitable for aspiring full-stack developers or those specializing in a particular technology stack. Perfect for students or professionals from any field aiming for a technological journey."

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 "Programming Languages": "C/C++/Java/Python: Introduction to Variable & Operators Flow Control Functions & Loops Arrays Strings Object Oriented Programming (OOPs) & Advanced concepts",
 "Libraries": "C++ STL: Vectors List, Pairs Stack, Queue C/Java Collections: ArrayList Stack Queue Set, Map Arrays Class & Collection Class C/Java: Vectors List, Pairs Stack, Queue Set, Map Arrays Class & Collection Class C/Java: Vectors List, Pairs Stack, Queue Set, Map Arrays Class & Collection Class",
 "Live Sessions Curriculum": "
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 Introduction to algorithm analysis, efficiency, and Big-O notation for time complexity
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 data-start="296" data-end="377"
 Bitwise Operators with practical examples (swapping numbers, checking even/odd)
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 Number System basics: binary, decimal, octal, hexadecimal, and base conversions
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\\u003eunordered_set\\u003c/code\\u003e)\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"1598\\\" data-end=\\\"1682\\\"\\u003e\\u003cp data-start=\\\"1600\\\" data-end=\\\"1682\\\"\\u003ePractice problems: frequency counts, subarray sums, and pattern-based challenges\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\\\"1684\\\" data-end=\\\"1687\\\"\\u003e\\u003ch3 data-start=\\\"1689\\\" data-end=\\\"1715\\\"\\u003e\\u003cstrong data-start=\\\"1693\\\" data-end=\\\"1715\\\"\\u003eClass 7: Recursion\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\\\"1716\\\" data-end=\\\"1887\\\"\\u003e\\u003cli data-start=\\\"1716\\\" data-end=\\\"1782\\\"\\u003e\\u003cp data-start=\\\"1718\\\" data-end=\\\"1782\\\"\\u003eBasics of recursion, stack usage, and importance of base cases\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"1783\\\" data-end=\\\"1826\\\"\\u003e\\u003cp data-start=\\\"1785\\\" data-end=\\\"1826\\\"\\u003eExamples: Factorial, Fibonacci Sequence\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"1827\\\" data-end=\\\"1887\\\"\\u003e\\u003cp data-start=\\\"1829\\\" data-end=\\\"1887\\\"\\u003eTower of Hanoi and introduction to backtracking concepts\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\\\"1889\\\" data-end=\\\"1892\\\"\\u003e\\u003ch3 data-start=\\\"1894\\\" data-end=\\\"1920\\\"\\u003e\\u003cstrong data-start=\\\"1898\\\" data-end=\\\"1920\\\"\\u003eClass 8: Searching\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\\\"1921\\\" data-end=\\\"2109\\\"\\u003e\\u003cli data-start=\\\"1921\\\" data-end=\\\"1988\\\"\\u003e\\u003cp data-start=\\\"1923\\\" data-end=\\\"1988\\\"\\u003eLinear Search: concept, implementation, and complexity analysis\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"1989\\\" data-end=\\\"2045\\\"\\u003e\\u003cp data-start=\\\"1991\\\" data-end=\\\"2045\\\"\\u003eBinary Search: iterative \\u0026amp; recursive implementation\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2046\\\" data-end=\\\"2109\\\"\\u003e\\u003cp data-start=\\\"2048\\\" data-end=\\\"2109\\\"\\u003eApplications: rotated arrays, floor/ceiling search problems\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\\\"2111\\\" data-end=\\\"2114\\\"\\u003e\\u003ch3 data-start=\\\"2116\\\" data-end=\\\"2140\\\"\\u003e\\u003cstrong data-start=\\\"2120\\\" data-end=\\\"2140\\\"\\u003eClass 9: Sorting\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\\\"2141\\\" data-end=\\\"2320\\\"\\u003e\\u003cli data-start=\\\"2141\\\" data-end=\\\"2209\\\"\\u003e\\u003cp data-start=\\\"2143\\\" data-end=\\\"2209\\\"\\u003eBubble, Selection, and Insertion Sort: comparisons and use cases\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2210\\\" data-end=\\\"2261\\\"\\u003e\\u003cp data-start=\\\"2212\\\" data-end=\\\"2261\\\"\\u003eMerge Sort and Quick Sort for efficient sorting\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2262\\\" data-end=\\\"2320\\\"\\u003e\\u003cp data-start=\\\"2264\\\" data-end=\\\"2320\\\"\\u003eConceptual understanding of Cyclic Sort and Shell Sort\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\\\"2322\\\" data-end=\\\"2325\\\"\\u003e\\u003ch3 data-start=\\\"2327\\\" data-end=\\\"2351\\\"\\u003e\\u003cstrong data-start=\\\"2331\\\" data-end=\\\"2351\\\"\\u003eClass 10: Matrix\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\\\"2352\\\" data-end=\\\"2526\\\"\\u003e\\u003cli data-start=\\\"2352\\\" data-end=\\\"2409\\\"\\u003e\\u003cp data-start=\\\"2354\\\" data-end=\\\"2409\\\"\\u003eMatrix traversal: row-wise, column-wise, spiral order\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2410\\\" data-end=\\\"2469\\\"\\u003e\\u003cp data-start=\\\"2412\\\" data-end=\\\"2469\\\"\\u003eMatrix rotation, transpose, and binary search in matrix\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2470\\\" data-end=\\\"2526\\\"\\u003e\\u003cp data-start=\\\"2472\\\" data-end=\\\"2526\\\"\\u003eDirectional traversals and problem-solving exercises\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\\\"2528\\\" data-end=\\\"2531\\\"\\u003e\\u003ch3 data-start=\\\"2533\\\" data-end=\\\"2566\\\"\\u003e\\u003cstrong data-start=\\\"2537\\\" data-end=\\\"2566\\\"\\u003eClass 11: Linked List I\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\\\"2567\\\" data-end=\\\"2749\\\"\\u003e\\u003cli data-start=\\\"2567\\\" data-end=\\\"2633\\\"\\u003e\\u003cp data-start=\\\"2569\\\" data-end=\\\"2633\\\"\\u003eSingly, Doubly, and Circular Linked List basics and operations\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\\\"2634\\\" data-end=\\\"2705\\\"\\u003e\\u003cp data-start=\\\"2636\\\" data-end=\\\"2705\\\"\\u003eFinding middle element, reversing

linked lists, intersection points\p\li\cli data-start="2706" data-end="2749"\p data-start="2708" data-end="2749"\Cycle detection using Floyds Algorithm\p\li\ul\chr data-start="2751" data-end="2754"\03ch3 data-start="2756" data-end="2790"\03cstrong data-start="2760" data-end="2790"\03eClass 12: Linked List II\03c/strong\03e\03c/h3\03cul data-start="2791" data-end="2951"\03cli data-start="2791" data-end="2839"\03cp data-start="2793" data-end="2839"\03eFinding length and starting point of a cycle\p\03cli data-start="2840" data-end="2898"\03cp data-start="2842" data-end="2898"\03eLRU Cache implementation using linked list and hashing\p\li\cli data-start="2899" data-end="2951"\03cp data-start="2901" data-end="2951"\03eMerge K Sorted Lists and optimization approaches\p\li\ul\chr data-start="2953" data-end="2956"\03ch3 data-start="2958" data-end="2993"\03cstrong data-start="2962" data-end="2993"\03eClass 13: Stack & Queue I\03c/strong\03e\03c/h3\03cul data-start="2994" data-end="3187"\03cli data-start="2994" data-end="3061"\03cp data-start="2996" data-end="3061"\03eStack concepts (LIFO), implementation using array & linked list\p\li\cli data-start="3062" data-end="3114"\03cp data-start="3064" data-end="3114"\03eQueue concepts (FIFO), Circular Queue, and Deque\p\li\cli data-start="3115" data-end="3187"\03cp data-start="3117" data-end="3187"\03eApplications: expression evaluation, balanced parentheses, undo-redo\p\li\ul\chr data-start="3189" data-end="3192"\03ch3 data-start="3194" data-end="3230"\03cstrong data-start="3198" data-end="3230"\03eClass 14: Stack & Queue II\03c/strong\03e\03c/h3\03cul data-start="3231" data-end="3386"\03cli data-start="3231" data-end="3298"\03cp data-start="3233" data-end="3298"\03ePractice problems: Next Greater Element, Sliding Window Maximum\p\li\cli data-start="3299" data-end="3339"\03cp data-start="3301" data-end="3339"\03eStack using Queue, Queue using Stack\p\li\cli data-start="3340" data-end="3386"\03cp data-start="3342" data-end="3386"\03eOptimization and problem-solving exercises\p\li\ul\chr data-start="3388" data-end="3391"\03ch3 data-start="3393" data-end="3427"\03cstrong data-start="3397" data-end="3427"\03eClass 15: Backtracking I\03c/strong\03e\03c/h3\03cul data-start="3428" data-end="3598"\03cli data-start="3428" data-end="3478"\03cp data-start="3430" data-end="3478"\03eGenerating all permutations of array or string\p\li\cli data-start="3479" data-end="3534"\03cp data-start="3481" data-end="3534"\03eGenerating combinations and subsets using recursion\p\li\cli data-start="3535" data-end="3598"\03cp data-start="3537" data-end="3598"\03eBacktracking exercises to explore recursive tree structures\p\li\ul\chr data-start="3600" data-end="3603"\03ch3 data-start="3605" data-end="3640"\03cstrong data-start="3609" data-end="3640"\03eClass 16: Backtracking II\03c/strong\03e\03c/h3\03cul data-start="3641" data-end="3756"\03cli data-start="3641" data-end="3666"\03cp data-start="3643" data-end="3666"\03eRat in a Maze problem\p\li\cli data-start="3667" data-end="3713"\03cp data-start="3669" data-end="3713"\03eN-Queen problem with pruning and recursion\p\li\cli data-start="3714"

data-end="\3756\" data-start="\3716\" data-end="\3756\" valid Sudoku solver using backtracking\p\li\ul\003e\003chr data-start="\3758\" data-end="\3761\" data-start="\3763\" data-end="\3790\" data-start="\3767\" data-end="\3790\" Class 17: Trees I\strong\h3\cul data-start="\3791\" data-end="\3959\" data-start="\3791\" data-end="\3858\" data-start="\3793\" data-end="\3858\" Binary Tree basics, types, and representations (array & linked)\p\li\ul\003e\003cli data-start="\3859\" data-end="\3903\" data-start="\3861\" data-end="\3903\" Traversals: Preorder, Inorder, Postorder\p\li\ul\003e\003cli data-start="\3904\" data-end="\3959\" data-start="\3906\" data-end="\3959\" Practice problems: height, node count, sum of nodes\p\li\ul\003e\003chr data-start="\3961\" data-end="\3964\" data-start="\3966\" data-end="\3994\" data-start="\3970\" data-end="\3994\" Class 18: Trees II\strong\h3\cul data-start="\3995\" data-end="\4141\" data-start="\3995\" data-end="\4056\" data-start="\3997\" data-end="\4056\" Binary Search Tree (BST): insertion, deletion, and search\p\li\ul\003e\003cli data-start="\4057\" data-end="\4092\" data-start="\4059\" data-end="\4092\" Inorder predecessor & successor\p\li\ul\003e\003cli data-start="\4093\" data-end="\4141\" data-start="\4095\" data-end="\4141\" BST practice problems and path sum exercises\p\li\ul\003e\003chr data-start="\4143\" data-end="\4146\" data-start="\4148\" data-end="\4177\" data-start="\4152\" data-end="\4177\" Class 19: Trees III\strong\h3\cul data-start="\4178\" data-end="\4309\" data-start="\4178\" data-end="\4216\" data-start="\4180\" data-end="\4216\" Heap concepts: Min Heap & Max Heap\p\li\ul\003e\003cli data-start="\4217\" data-end="\4264\" data-start="\4219\" data-end="\4264\" Heapify, insertion, and deletion operations\p\li\ul\003e\003cli data-start="\4265\" data-end="\4309\" data-start="\4267\" data-end="\4309\" Priority Queue applications and problems\p\li\ul\003e\003chr data-start="\4311\" data-end="\4314\" data-start="\4316\" data-end="\4343\" data-start="\4320\" data-end="\4343\" Class 20: Graph I\strong\h3\cul data-start="\4344\" data-end="\4491\" data-start="\4344\" data-end="\4393\" data-start="\4346\" data-end="\4393\" Graph representation: adjacency list & matrix\p\li\ul\003e\003cli data-start="\4394\" data-end="\4418\" data-start="\4396\" data-end="\4418\" DFS & BFS traversals\p\li\ul\003e\003cli data-start="\4419\" data-end="\4491\" data-start="\4421\" data-end="\4491\" Problems: connected components, reachability, simple cycle detection\p\li\ul\003e\003chr data-start="\4493\" data-end="\4496\" data-start="\4498\" data-end="\4526\" data-start="\4502\" data-end="\4526\" Class 21: Graph II\strong\h3\cul data-start="\4527\" data-end="\4694\" data-start="\4527\" data-end="\4578\" data-start="\4529\" data-end="\4578\" Cycle detection in directed & undirected graphs\p\li\ul\003e\003cli data-start="\4579\" data-end="\4637\" data-start="\4581\" data-end="\4637\" DAGs and Topological Sort using DFS & Kahns Algorithm\p\li\ul\003e\003cli data-start="\4638\" data-end="\4694\" data-start="\4640\" data-end="\4694\" Graph problems: scheduling and dependency resolution\p\003e

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3e\u003c/h3\u003e\u003cul data-start=\"4731\" data-end=\"4871\" \u003e\u003cli
i data-start=\"4731\" data-end=\"4781\" \u003e\u003cp data-start=\"4733\" dat
a-end=\"4781\" \u003eShortest Path algorithms: Dijkstras Algorithm\u003c/p\u0
03e\u003c/li\u003e\u003cli data-start=\"4782\" data-end=\"4815\" \u003e\u003cp
p data-start=\"4784\" data-end=\"4815\" \u003eMulti-source BFS \u0026amp; Flo
od Fill\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4816\" data-end=
\"4871\" \u003e\u003cp data-start=\"4818\" data-end=\"4871\" \u003eCourse sche
duling and real-life dependency examples\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"4873\" data-end=\"4876\" \u003e\u003ch3 data-st
art=\"4878\" data-end=\"4914\" \u003e\u003cstrong data-start=\"4882\" data-en
d=\"4914\" \u003eClass 23: Greedy + DP Basics\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"4915\" data-end=\"5048\" \u003e\u003cli data-start=
\"4915\" data-end=\"4963\" \u003e\u003cp data-start=\"4917\" data-end=\"4963
\\\" \u003eFractional Knapsack and Coin Change (Greedy)\u003c/p\u003e\u003c/li
\u003e\u003cli data-start=\"4964\" data-end=\"5009\" \u003e\u003cp data-start
=\"4966\" data-end=\"5009\" \u003eActivity Selection (N meetings in a room)\u0
003c/p\u003e\u003c/li\u003e\u003cli data-start=\"5010\" data-end=\"5048\" \u003e\u003cp
03e\u003cp data-start=\"5012\" data-end=\"5048\" \u003e0 - 1 Knapsack \u0026amp;
mp; Subset Sum problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"5050\" data-end=\"5053\" \u003e\u003ch3 data-start=\"5055\" data
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lass 24: Advanced Dynamic Programming\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"5102\" data-end=\"5284\" \u003e\u003cli data-start=\"5102\"
data-end=\"5143\" \u003e\u003cp data-start=\"5104\" data-end=\"5143\" \u003eUn
bounded Knapsack \u0026amp; Coin Change (DP)\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"5144\" data-end=\"5220\" \u003e\u003cp data-start=\"5146\"
data-end=\"5220\" \u003eLongest Common Subsequence (LCS) \u0026amp; Longest P
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\\\" \u003eMatrix Chain Multiplication (MCM) \u0026amp; Palindrome Partitioning
\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Resume Building\": \"\u003cul\u003e\u003cli
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stand out\u003c/li\u003e\u003c/ul\u003e\", \"Projects\": \"\u003cul\u003e\u003cli
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st Path Finder\u003c/span\u003e: The problem of finding the shortest path be
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pan\u003e\u003c/p\u003e","Will I get internship certificate after completing this course ?":"\u003cp\u003eNo internship certificate program is only for offline batches. After successful completion of the live course you will be provided a training certificate\u003c/p\u003e","Are refunds offered for courses?":"\u003cdiv style=\"box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; font-size: 17px;\">

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font-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eOverview of Excel interface\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eNavigating sheets efficiently\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eMath \u0026amp; statistical functions (SUM, AVERAGE, COUNT)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eLogical functions (IF, AND, OR)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eText functions for manipulation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eVLOOKUP, VLOOKUP\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eINDEX MATCH\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eDASHBOARDS

iant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSUMIF, COUNTIFS, nested functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower Query: import, transform, merge, append\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDynamic dashboards\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePivot tables from multiple sources\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSlicers, combo charts, layout optimization\u003c/span\u003e\u003c/li\u003e\u003c/u\u003e","Class 3: Excel AI, Project, Kaggle \u0026 Github Introduction":\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted data cleaning \u0026amp; transformation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eExcel with AI project\u0026nbsp;\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal;

l; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eKaggle and Github optimization\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 4: Introduction to SQL": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eOverview of SQL \u0026amp; databases\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic syntax, SELECT, WHERE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCreating \u0026amp; modifying tables (CREATE/ALTER)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUnderstanding constraints\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 5: Aggregations \u0026 GROUP BY": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCOUNT, SUM, AVG, MIN, MAX\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFiltering aggregates\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e

\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eGROUP BY, HAVING\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eORDER BY, LIMIT, sorting\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eDISTINCT vs GROUP BY\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eLLM-powered optimization suggestions\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\", \"Class 6: Joins \u0026 Subqueries \" : \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIntroduction to Joins\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eINNER, LEFT, RIGHT, FULL OUTER Joins \u0026amp; Self join\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eDee

p Dive into Joins \u0026amp; Subquery Logic\u003c/span\u003e\u003c/li\u003e
\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eSubqueries \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e
e\", \"Class 7: Window Functions\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eBasic windows functions Aggregate functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eRank functions(ROW_NUMBER(), RANK(), DENSE_RANK() ,PARTITION BY)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAdvance windows functions (LAG(), LEAD(), SUM() OVER(), AVG() OVER())\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAI error detection in analytical SQL\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 8: Data Cleaning \u0026 Recursive CTE's\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eCTE ,SUBSTRING, LENGTH, TRIM, REPLACE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; f

ont-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUPPER/LOWER\u003c/span\u003e\u003cbr\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDATE_ADD, DATEDIFF, EXTRACT\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted SQL debugging\u003c/span\u003e\u003c/li\u003e\u003cbr\u003e\u003c/li\u003e", "Class 9: CASE WHEN, Optimization \u0026 Analytics": "\u003cul\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCASE WHEN \u0026amp; conditional logic\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIF statements\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIndexes, EXPLAIN plans\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunnel analysis, cohorts, retention\u003c/span\u003e\u003c/li\u003e\u003cbr\u003e\u003c/li\u003e", "Class 10: Python Fundamentals for Data Analysis": "\u003cul\u003e\u003ccli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent;

t; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIntroduction to python\u0026nbsp; \u0026amp; installation \u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython basics, data types, variables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLoops (for, while)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eConditional statements (if, elif, else)\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e", "Class 11: Python Fundamentals (Continued)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLists, dictionaries, tuples\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eList comprehension ,operators\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eString methods,Indexing \u0026amp; slicing\u003c/span\u003e\u003c/li\u003e\u003c

li\

Functions

Class 12: Python Fundamentals (Continued)

Functions such as map, filter , lambda

Inbuilt functions len(), type(), sum(), sorted()

Working with external files

Using Colab AI for debugging and code generation

Class 13: Pandas Data Cleaning

Data cleaning operations

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normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eString processing\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eDataFrames \u0026amp; Series\u0003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eMissing values\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eDuplicate handling\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 14: Pandas Transformation":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eData type conversions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eColumn renaming\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eGroupby, agg, apply\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eGroupby, agg, apply

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ormal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePivot tables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eMerging \u0026amp; joining\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eAI helpers for transformation scripts\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003c/li\u003e\", \"Class 15: NumPy \u0026 ED A\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eNumPy arrays and vectorization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eStatistical operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eOutlier handling\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eEDA workflow\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\", \"Class 16: Visualization with Matplotlib, Seaborn \u0026 Plotly\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; f

ont-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic \u0026amp; advanced charts\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eInteractive visualizations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCustomization \u0026amp; styling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eAI-generated chart scripts\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 17: EDA Project (Python)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eData loading\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCleaning with Pandas\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eVisualizations\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 18: Python + AI EDA Project": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal;

text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eData acquisition\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning \u0026amp; preparation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eNumerical analysis\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted EDA automation\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 19: Data Analysis with LLMs": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eHow LLMs help in analysis\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePandas code generation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; fo

nt-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning assistance\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization generation\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower BI Fundamentals \u0026 Data Modeling": "\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower BI interface\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eImporting data\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRelationships \u0026amp; schemas\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eModeling best practices\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSUM, AVERAGE, COUNT, CALCULATE\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-fa

mily: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSWITCH, FILTER\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eTime intelligence\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRunning totals \u0026amp; growth\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 22: Dashboard Design \u0026 ETL":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower Query for ETL\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization types\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eInteractive elements\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDashboard best practices\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 23: Interview Prep

aration": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eResume building\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eLinkedIn optimization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003ePositioning your background\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIdentify target companies and roles\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003c/li\u003e\", \"Class 24: Presentation \u0026 Mock Interviews\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eSTAR method\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eProject storytelling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserv

e;"\u003eMock interviews\u003c/span\u003e\u003c/li\u003e\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCommon SQL interview patterns \u003c/span\u003e\u003c/li\u003e\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython coding (data manipulation, EDA) Interview Questions\u003c/span\u003e\u003c/li\u003e\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003e{"locations_coords":[],"desktop_banner_webp":"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155056129/da.webp","mobile_banner_webp":"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155056129/da.webp","price":{"batch_fee":17499,"promotional_fee":24999,"play_store_product_id":"gfg_course_17499"},"additional_info":""},"course_id":287,"course_name":"Learn C with Data Structures - Self Paced","course_slug":"c-Programming-basic-to-advanced","course_url":"https://www.geeksforgeeks.org/courses/c-Programming-basic-to-advanced","course_type":"Online","course_fee_type":"Paid","level":"Beginner to Advanced","course_duration":12,"is_kids_course":false,"faqs":{"Is there any number to contact for query?":"\u003cspan data-sheets-value="{\u0026quot;1\u0026quot;:2,\u0026quot;2\u0026quot;:;\u0026quot;You may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org\u0026quot;}" data-sheets-userformat="{\u0026quot;2\u0026quot;:513,\u0026quot;3\u0026quot;:;\u0026quot;1\u0026quot;:0},\u0026quot;12\u0026quot;:0}" style="font-size: 10pt; font-family: Arial;"\u003eYou may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org\u003c/span\u003e\u003cbr\u003e\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eHow can I register for the course?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYou need to sign up for the course. After signing up, you need to pay when the payment link opens.","When can I make the payment for the course?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eThe payment link will be available on the course page.","Can I make the payment through PayPal?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYes. Mail us with your details at courses@geeksforgeeks.org\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDo we have doubt support in this program?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYou may get additional feature of doubt support. While purchasing this course, click on \u0026quot;Add to Cart\u0026quot; for Doubt Support and Assistance.\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eWhat features does Doubt Support have?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDoubt support helps you clear your doubt of any GFG and codeforces courses/problems. You can raise your doubt anytime. Our doubt support assistance is available 24x7.\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIs there any demo lecture video of this course?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYes, you may access the demo lecture here:\u0026nbsp;\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ehref="\u0026quot;https://www.youtube.com/watch?v=l2PyiNFZwNc\u0026amp;t=1s\u0026amp;pbjreload=101" target="_blank"\u003eDemo Video for C Foundation Course\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eHow long will the course content be available for?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eThe course content will be available for one year.\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eWhat type of certificate will be offered in this program?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eOnce the course is completed. You'll be getting a course completion certificate.","What is C?"\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eC is a powerful and widely used programming language that was developed in the 1970s. It's often considered the "mother" of many modern programming languages, li

C is known for its speed and efficiency, making it popular for developing operating systems, games, and embedded systems.

"Why should I learn C?"

Learning C is beneficial because it gives you a deep understanding of how computers work. Many other programming languages are based on C, so mastering it can make learning other languages easier. C is also used in many critical systems, so knowing it can open up job opportunities in fields like software development, embedded systems, and systems programming.

"What can I do with C?"

With C, you can develop a wide range of applications, including:

- Operating systems (like Linux)
- System software (like compilers and drivers)
- Embedded systems (software for devices like microwaves and cars)
- Games and graphics
- High-performance applications

"Do I need to know any other programming languages before learning C?"

No, you don't need to know any other programming languages before learning C. In fact, many people start with C because it helps them understand fundamental programming concepts that are useful in other languages as well.

"Is C still relevant today?"

Yes, C is still very relevant today. It's widely used in systems programming, embedded systems, and high-performance applications. Many modern programming languages and systems are built on C, so understanding it is valuable in the tech industry.

"What kind of jobs can I get with C programming skills?"

With C programming skills, you can pursue roles such as:

- Software Developer/Engineer
- Systems Programmer
- Embedded Systems Engineer
- Firmware Developer
- Game Developer
- Robotics Programmer
- Network Programmer
- Operating System Developer

"What are the career growth opportunities with C programming?"

With C programming skills, you can grow into senior developer roles, lead engineering teams, or specialize in areas like embedded systems, systems programming, or network programming. C expertise can also lead to roles in software architecture, technical leadership, or even transitioning to other areas like cybersecurity or IoT (Internet of Things).

"Can I use C for web development?"

While C is not commonly used for web development, it can be used to build parts of web applications, especially for back-end processes that require high performance. However, languages like JavaScript, Python, and PHP are more commonly used for web development.

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perators\strong: Understand how variables and data types work in programming languages.\li\strongControl Flow\strong: Learn about if-else conditions, loops (for, while), and switch cases.\li\strongFunctions\strong: Master how functions work, including parameters, return types, and recursion.\li\strongBasic Input and Output\strong: Learn how to handle input and output in your programming language of choice.\li\strong\ul\strongch3\strongePhase 2: Learn Basic Data Structures\h3\strongcul\strongcli\strongArrays\strong: Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays.\li\strongcli\strongStrings\strong: Learn how strings are represented in memory and how to manipulate them.\li\strongcli\strongLinked Lists\strong: Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching.\li\strongcli\strongStacks and Queues\strong: Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more.\li\strongcli\strongHashing\strong: Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.\li\strong\ul\strongch3\strongePhase 3: Advanced Data Structures\h3\strongcul\strongcli\strongTrees\strong: Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST).\li\strongcli\strongHeaps\strong: Learn about heaps (min and max heaps) and their applications in priority queues and heap sort.\li\strongcli\strongGraphs\strong: Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS).\li\strongcli\strongTries\strong: Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching.\li\strongcli\strongDisjoint Set Union (DSU)\strong: Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.\li\strong\ul\strongch3\strongePhase 4: Learn Algorithms\h3\strongcul\strongcli\strongSorting Algorithms\strong: Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities.\li\strongcli\strongSearching Algorithms\strong: Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array.\li\strongcli\strongDynamic Programming (DP)\strong: Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS).\li\strongcli\strongGreedy Algorithms\strong: Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection.\li\strongcli\strongBacktracking\strong: Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem.\li\strongcli\strongDivide and Conquer\strong: Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblem

s.
Graph Algorithms
Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.
Phase 5: Problem Solving and Practice
LeetCode, HackerRank, CodeForces
Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills.
Interview Preparation
Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch.
Competitive Programming
Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.
Phase 6: Advanced Topics (Optional)
String Algorithms
Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching.
Advanced Dynamic Programming
Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc.
Advanced Graph Algorithms
Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp).
Geometry Algorithms
Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.
Why is This Roadmap Effective?
Structured Learning
This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.
Foundational Knowledge
Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.
Hands-on Practice
Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding.
Interview Focused
The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.
Common Mistakes to Avoid
Skipping the Basics
Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.
Not Practicing Enough
DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.
Getting Stuck on One Problem
If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.
Why Learn DSA?
Problem Solving Skills
Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.
Efficient Solutions
Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.
Interview Success
DSA is the cornerstone

cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

Topics Covered

- Introduction to DSA**: Learn the importance of DSA and how it relates to coding efficiency.
- Data Structures**: Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.
- Algorithms**: Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.
- Problem-Solving**: Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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stand one-dimensional and multi-dimensional arrays. Strings Learn how strings are represented in memory and how to manipulate them. Linked Lists Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. Stacks and Queues Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups. Phase 3 Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST. Phase 4 Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm. Phase 5 Problem Solving and Practice LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities. Phase 6 Advanced Topics (Optional) String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. Advanced Dynamic Programming Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. Advanced Graph Algorithms Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). Geometry Algorithms Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points. Why is This Roadmap Effective? Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence. Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. Common Mistakes to Avoid Skipping the Basics Many le

learners jump into advanced topics without mastering the basics. Its crucial to have a strong foundation before moving on to more complex concepts. Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. Getting Stuck on One Problem If youre stuck on a problem for too long, move on to another. Its important to keep practicing and learning from your mistakes. Why Learn DSA? Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications. Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity. Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies. Topics Covered Introduction to DSA Learn the importance of DSA and how it relates to coding efficiency. Data Structures Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps. Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms. Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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 "\u003cp dir=\\"ltr\\" \u003e\u003cspan\u003eDSA stands for \u003cspan\u003eb\u003cstrong\u003eD\u003cspan\u003eb\u003cstrong\u003eS\u003cspan\u003eb\u003cstrong\u003eData Structures and \u003cspan\u003eb\u003cstrong\u003eAlgorithms. Data structures manage how data is stored and accessed. Algorithms focus on processing this data. Examples of data structures are Array, Linked List, Tree and Heap, and examples of algorithms are Binary Search, Quick Sort and Merge Sort. \u003cspan\u003cp\u003ccli value=\\"1\\" \u003cspan\u003eFoundation for almost every software like GPS, Search Engines, AI ChatBots, Gaming Apps, Databases, Web Applications, etc\u003cspan\u003cli value=\\"2\\" \u003cspan\u003eTop Companies like Google, Microsoft, Amazon, Apple, Meta\u003cspan\u003eb\u003cstrong\u003e and many other heavily focus on DSA\u003cspan\u003eb\u003cstrong\u003e in interviews. \u003cspan\u003eli value=\\"3\\" \u003cspan\u003eLearning DSA boosts your problem-solving abilities and make you a stronger programmer.\u003cspan\u003cli value=\\"4\\" \u003cspan\u003eBefore beginning the DSA journey, it is recommended to learn at-least one programming language (\u003cspan\u003ca href=\\"https://www.geeksforgeeks.org/cpp/c-plus-plus/\\" rel=\\"noopener\\" target=\\"_blank\\" \u003cspan\u003ca href=\\"https://www.geeksforgeeks.org/java/java/\\" rel=\\"noopener\\" target=\\"_blank\\" \u003cspan\u003ca href=\\"https://www.geeksforgeeks.org/python/python-programming-language-tutorial/\\" rel=\\"noopener\\" target=\\"_blank\\" \u003cspan\u003ca href=\\"https://www.geeksforgeeks.org/javascript/javascript-programming-language-tutorial/\\" rel=\\"noopener\\" target=\\"_blank\\"",
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pt-tutorial/" rel="noopener" target="_blank" style="text-align: left;">1-logic-building" style="text-align: left;">1. Logic Building

Once you have learned basics of a programming language, it is recommended that you learn basic logic building

1" href="https://www.geeksforgeeks.org/dsa/logic-building-problems/" rel="noopener" target="_blank">Logic Building Guide

2" href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-logic-building/" rel="noopener" target="_blank">Quiz on Logic Building

2-learn-about-complexities" style="text-align: left;">2. Learn about Complexities

To analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.

1" href="https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/" rel="noopener" target="_blank">Complexity Analysis Guide

2" href="https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/" rel="noopener" target="_blank">Quiz on Complexity Analysis

3-array" style="text-align: left;">3. Array

Array is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.

1" href="https://www.geeksforgeeks.org/dsa/introduction-to-arrays-data-structure-and-algorithm-tutorials/" rel="noopener" target="_blank">Array Guide

2" href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/" rel="noopener" target="_blank">Array Quiz

4-searching-algorithms" style="text-align: left;">4. Searching Algorithms

Searching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.

1" href="https://www.geeksforgeeks.org/dsa/searching-algorithms/" rel="noopener" target="_blank">Searching Guide

2" href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/" rel="noopener" target="_blank">Quiz on Searching

5-sorting-algorithm" style="text-align: left;">5. Sorting Algorithm

Sorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.

<https://www.geeksforgeeks.org/dsa/sorting-algorithms/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-structure-with-answers/>

6. Hashing

Hashing is a technique that generates a fixed-size output (hash value) from an input of variable size using mathematical formulas called hash functions. Hashing is commonly used in data structures for efficient searching, insertion and deletion.

<https://www.geeksforgeeks.org/dsa/hashing-data-structure/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-structure-with-answers/>

7. Two Pointer Technique

Two Pointer Technique

In Two Pointer Technique, we typically use two index variables from two corners of an array. We use the two pointer technique for searching a required point or value in an array.

<https://www.geeksforgeeks.org/dsa/two-pointers-technique/>

<https://www.geeksforgeeks.org/quizzes/quiz-on-two-pointer-technique-for-dsa/>

8. Window Sliding Technique

Window Sliding Technique, we use the result of previous subarray to quickly compute the result of current.

<https://www.geeksforgeeks.org/dsa/window-sliding-technique/>

<https://www.geeksforgeeks.org/quizzes/quiz-on-sliding-window-technique-for-dsa/>

9. Prefix Sum Technique

Prefix Sum Technique, we compute prefix sums of an array to quickly find results for a subarray.

<https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/>

[\noopener\" target=\"_blank\" \u003e\u003cspan\u003ePrefix Sum Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Prefix Sum\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"10-string\" style=\"text-align:left\" \u003e\u003cspan\u003e10. String\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA sequence of characters, typically immutable and have limited set of elements \(lower case or all English alphabets\).\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/string-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eStrings Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Strings\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"11-recursion\" style=\"text-align:left\" \u003e\u003cspan\u003e11. Recursion\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA programming technique where a function \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecalls itself\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e within its own definition. It is usually used to solve problems that can be broken down into smaller instances of the same problem. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/recursion-algorithms/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eRecursion Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-recursion-algorithm-with-answers/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Recursion\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"12-matrixgrid\" style=\"text-align:left\" \u003e\u003cspan\u003e12. Matrix/Grid\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA two-dimensional array of elements, arranged in \u003c/span\u003e\u003cb\u003e\u003cstrong\u003erows \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eand \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecolumns\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e. It is represented as a rectangular grid, with each element at the intersection of a row and column. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/matrix/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eMatrix Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-matrixgrid-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Matrix/Grid.\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"13-stack\" style=\"text-align:left\" \u003e\u003cspan\u003e13. Linked List\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eaccessed sequentially\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, starting from the head of list. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/linked-list-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eLinked List Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-linked-list-data-structure-with-answers/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Linked List\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"13-stack-1\" style=\"text-align:left\" \u003e\u003cspan](#)

14. Stack is a linear data structure that follows the Last In, First Out (LIFO) principle. Stacks play an important role in managing function calls, memory, and are widely used in algorithms like stock span problem, next greater element and largest area in a histogram.

<https://www.geeksforgeeks.org/dsa/stack-data-structure/>

15. Queue is a linear data structure that follows the First In, First Out (FIFO) principle. Queues play an important role in managing tasks or data in order, scheduling and message handling systems.

<https://www.geeksforgeeks.org/dsa/queue-data-structure/>

16. Deque or double-ended queue is a data structure that allows elements to be added or removed from both ends efficiently.

<https://www.geeksforgeeks.org/dsa/deque-set-1-introduction-applications/>

17. Tree is a non-linear, hierarchical data structure consisting of nodes connected by edges, with a top node called the root and nodes having child nodes. It is widely used in file systems, databases, decision-making algorithms, etc.

<https://www.geeksforgeeks.org/dsa/tree-data-structure/>

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solutions

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of basic programming concepts. This includes Variables, Data Types, and Operators. Understand how variables and data types work in programming languages. Control Flow Learn about if-else conditions, loops (for, while), and switch cases. Functions Master how functions work, including parameters, return types, and recursion. Basic Input and Output Learn how to handle input and output in your programming language of choice. Phase 2 Learn Basic Data Structures Arrays Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays. Strings Learn how strings are represented in memory and how to manipulate them. Linked Lists Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. Stacks and Queues Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups. Phase 3 Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST. Phase 4 Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm. Phase 5 Problem Solving and Practice LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities. Phase 6 Advanced Topics (Optional) String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. Advanced Dynamic Programming Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. Advanced Graph Algorithms Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). Geometry Algorithms Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points. Why is This Roadmap Effective? Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logic

al sequence. Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. Common Mistakes to Avoid Skipping the Basics Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts. Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. Getting Stuck on One Problem If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes. Why Learn DSA? Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications. Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity. Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies. Topics Covered Introduction to DSA Learn the importance of DSA and how it relates to coding efficiency. Data Structures Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps. Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms. Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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c/b\u003e\u003cspan\u003estructures and \u003c/span\u003e\u003cb\u003e\u003cs
trong\u003eA\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003elgorithms. Data
structures manage how data is stored and accessed. Algorithms focus on proce
ssing this data. Examples of data structures are Array, Linked List, Tree a
nd Heap, and examples of algorithms are Binary Search, Quick Sort and Merge
Sort. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\1"\u003
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3c/strong\u003e\u003c/b\u003e\u003cspan\u003een interviews. \u003c/span\u003e
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your problem-solving abilities and make you a stronger programmer.\u003c/spa
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3eBefore beginning the DSA journey, it is recommended to learn at-least one
programming language (\u003c/span\u003e\u003ca href="https://www.geeksforge
eks.org/cpp/c-plus-plus/" rel="\noopener" target="_blank"\u003e\u003cspa
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g/python/python-programming-language-tutorial/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003ePython\u003c/span\u003e/a\u003e\u003cspan\u003e, \u003c/span\u003e\u003ca href=\"https://www.geeksforgeeks.org/javascript/javascript-tutorial/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eJavaScript\u003c/span\u003e/a\u003e\u003cspan\u003e or any other language of your choice).\u003c/span\u003e/p\u003e\u003cspan\u003eBelow are the recommended step by step topics to learn complete DSA.\u003c/span\u003e/p\u003e\u003ch3 id=\"1-logic-building\" style=\"text-align:left\" \u003e\u003cstrong\u003e1. Logic Building\u003c/strong\u003e\u003c/b\u003e\u003c/h3\u003e\u003cspan\u003eOnce you have learned basics of a programming language, it is recommended that you learn basic logic building\u003c/span\u003e/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/logic-building-problems/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eLogic Building Guide \u003c/span\u003e/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/dsa-tutorial-logic-building/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Logic Building\u003c/span\u003e/a\u003e\u003c/li\u003e\u003cul\u003e\u003ch3 id=\"2-learn-about-complexities\" style=\"text-align:left\" \u003e\u003cspan\u003e2. Learn about Complexities\u003c/span\u003e/h3\u003e\u003cspan\u003eTo analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.\u003c/span\u003e/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eComplexity Analysis Guide \u003c/span\u003e/a\u003e\u003cspan\u003e \u003c/span\u003e/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Complexity Analysis\u003c/span\u003e/a\u003e\u003cspan\u003e/li\u003e\u003cul\u003e\u003ch3 id=\"3-array\" style=\"text-align:left\" \u003e\u003cspan\u003e3. Array\u003c/span\u003e/h3\u003e\u003cspan\u003eArray is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.\u003c/span\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/introduction-to-arrays-data-structure-and-algorithm-tutorials/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003e \u003c/span\u003e/a\u003e\u003cspan\u003e/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/array-data-structure-guide/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eArray Guide\u003c/span\u003e/a\u003e\u003cspan\u003e \u003c/span\u003e/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eArray Quiz\u003c/span\u003e/a\u003e\u003cspan\u003e/li\u003e\u003cul\u003e\u003ch3 id=\"4-searching-algorithms\" style=\"text-align:left\" \u003e\u003cspan\u003e4. Searching Algorithms\u003c/span\u003e/h3\u003e\u003cspan\u003eSearching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.\u003c/span\u003e/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/searching-algorithms/\\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eSearching Guide\u003c/span\u003e/a\u003e\u003cspan\u003e \u003c/span\u003e/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/\\" rel=\"noopener\" \u003e\u003e

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\u003cp dir=\"ltr\" \u003e\u003cspan\u003eSorting algorithms are used to arra
nge the elements of a list in a specific order, such as numerical or alphabe
tical. It organizes the items in a systematic way, making it easier to searc
h for and access specific elements.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003e
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sa/sorting-algorithms/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan
\u003eSorting Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/sp
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g\" style=\"text-align:left\" \u003e\u003cspan\u003e6. Hashing\u003c/span\u003e
3e\u003c/h3\u003e\u003cp dir=\"ltr\" style=\"text-align: left;\" \u003e\u003c
span\u003eHashing is a technique that generates a fixed-size output (hash va
lue) from an input of variable size using mathematical formulas called hash
functions. Hashing is commonly used in data structures for efficient searchi
ng, insertion and deletion.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003e
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oopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Hashing\u003c/span
\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"7-two-pointe
r-technique\" style=\"text-align:left\" \u003e\u003cspan\u003e7. Two Pointer
Technique\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003c
03e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e\u003cstrong\u003eTwo
Pointer Technique, we typically use two index variables from two corners of
an array. We use the two pointer technique for searching a required point or
value in an array.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003e
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Technique, we use the result of previous subarray t
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Technique, we compute prefix sums of an a

rray to quickly find results for a subarray.

[1](https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/) <https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/> rel="noopener" target="_blank" [Prefix Sum Technique](https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/)

[2](https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/) <https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/> rel="noopener" target="_blank" [Quiz on Prefix Sum](https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/)

[10-string](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) style="text-align:left" [10-string](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) [String](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/)

[11-recursion](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) style="text-align:left" [11-recursion](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) [Recursion](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/)

[12-matrixgrid](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) style="text-align:left" [12-matrixgrid](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) [Matrix/Grid](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/)

[13-stack](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) style="text-align:left" [13-stack](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/) [Linked List](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/)

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list-data-structure-with-answers/" rel="noopener" target="_blank" data-bbox="175 48 905 65">[\u003cspan\u003eQuiz on Linked List\u003c/span\u003e\u003c/a\u003e\u003c/li](#)
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\(FIFO\)\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e
principle. Queues pl
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structure that allows elements to be added or removed from both ends efficie
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17. Tree\u003c/span\u003e\u003c/h3\u003e\u003cp dir="ltr" data-bbox="175 650 905 668">
\u003eA \u003c/span\u003e\u003cspan\u003e
\u003cb\u003e\u003cstrong\u003enon-linear, hierarch
ical \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e
data structure consist
ing of nodes connected by edges, with a top node called the \u003c/span\u003e
\u003cb\u003e\u003cstrong\u003eroot \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e
and nodes having child nodes. It is widely used in \u003c/span\u003e\u003e
\u003cb\u003e\u003cstrong\u003e file systems\u003c/strong\u003e\u003c/b\u003e
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<https://www.geeksforgeeks.org/quizzes/tree-22648/> Quiz on Tree

18. Heap sort is a sorting algorithm based on the binary tree data structure. It satisfies the heap property. Heaps are usually used to implement priority queues, where the smallest element is always at the root of the tree. The root element is always at the root of the tree.

<https://www.geeksforgeeks.org/dsa/priority-queue-set-1-introduction/> Heap Guide

19. Graphs are non-linear data structures consisting of vertices and edges (or nodes and links) that connect a pair of nodes. Graphs are widely used to represent relationships between entities.

<https://www.geeksforgeeks.org/dsa/heap-data-structure/> Graph Guide

20. Greedy algorithms build up the solution one piece at a time and choose the next piece which gives the most obvious and immediate benefit i.e., which is the most optimal choice at that moment. So the problems where choosing locally optimal solutions are best fit for Greedy.

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-heap-data-structure-with-answers/> Greedy Algorithms Guide

21. Dynamic Programming is a method used to solve complex problems by breaking them down into simple

ler \u003c/span\u003e\u003cb\u003e\u003cstrong\u003esubproblems\u003c/strong
\u003e\u003c/b\u003e\u003cspan\u003e. By solving each subproblem only once a
nd storing the results, it avoids redundant computations, leading to more ef
ficient solutions\u003c/span\u003e\u003cb\u003e\u003cstrong\u003e \u003c/str
ong\u003e\u003c/b\u003e\u003cspan\u003efor a wide range of problems. \u003c/
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ee\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e offer significant perfor
mance improvements for specific problem domains. They provide efficient solu
tions for tasks like fast prefix searches, range queries, dynamic updates, a
nd maintaining balanced data structures, which are crucial for handling larg
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ang a good career move?": "\u003cp\u003eAbsolutely! Go is popular for develop
ing scalable and high-performance backend systems and is widely used in indu
stries ranging from tech startups to large corporations.\u003c/p\u003e", "How
is the job market for GoLang developers?": "\u003cp\u003eGoLang developers ar
e in high demand for their expertise in building efficient, scalable backend
systems and microservices.\u003c/p\u003e", "Will I get a certificate?": "\u003
cp\u003eYes, you will receive a certification upon completion of the course,
which will be a valuable addition to your professional credentials.\u003c/p
\u003e", "Is Go suitable for data science or AI?": "\u003cp\u003eGo isn't wide
ly used for data science or AI. Python is better suited for these areas due
to its libraries like Pandas and TensorFlow. However, Go can still be used f
or high-performance applications related to data processing.\u003c/p\u003e"
e", "Is Go suitable for beginners?": "\u003cp\u003eYes, Go is beginner-friendl
y due to its simple syntax and clear documentation. It's a great starting po
int for anyone looking to learn programming and build efficient software.\u00
03c/p\u003e", "Can I get a job with Go programming skills?": "\u003cp\u003eYe
s, Go developers are in demand, especially in roles like:\u003c/p\u003e\u003c
cul\u003e\u003cli\u003eBackend Developer\u003c/li\u003e\u003cli\u003eCloud E
ngineer\u003c/li\u003e\u003cli\u003eDevOps Engineer\u003c/li\u003e\u003cli\u003e
003eSoftware Engineer\u003c/li\u003e\u003c/li\u003e\u003c/ul\u003e\u003cp\u003eKnowing Go c
an open doors to jobs in tech companies, startups, and cloud-based project
s.\u003c/p\u003e", "Can I use Go for web development?": "\u003cp\u003eYes, Go
is excellent for web development. It has built-in features for creating web
servers and handling HTTP requests. Frameworks like Gin and Echo make it eve
n easier to build web applications.\u003c/p\u003e", "What are the main featur
es of Go?": "\u003cp\u003eKey features of Go include:\u003c/p\u003e\u003cul\u003e
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\u003eThis \u003cstrong\u003ecomplete Golang online course\u003c/strong\u003e
e covers everything from basic syntax and data types to advanced topics like
\u003cstrong\u003econcurrency, web development, and APIs\u003c/strong\u003e.
You will build real-world projects to apply your skills and gain hands-on ex
perience. Whether youre a beginner looking to \u003cstrong\u003elearn Go pro
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\u003c/strong\u003e3cstrong data-start="\u003c/strong\u003e749\u003c/strong\u003e data-end="\u003c/strong\u003e771\u003c/strong\u003e
\u003c/strong\u003eClass 3: Array I\u003c/strong\u003e\u003c/strong\u003e\u003c/h3\u003e\u003c/strong\u003e data-start="\u003c/strong\u003e772\u003c/strong\u003e data-end="\u003c/strong\u003e989\u003c/strong\u003e
\u003c/strong\u003e3cli data-start="\u003c/strong\u003e772\u003c/strong\u003e data-end="\u003c/strong\u003e841\u003c/strong\u003e data-start="\u003c/strong\u003e774\u003c/strong\u003e dat
a-end="\u003c/strong\u003e841\u003c/strong\u003e
\u003c/strong\u003eArray basics, traversal, insertion, deletion, Second Max,
Leaders\u003c/strong\u003e\u003c/p\u003e\u003c/strong\u003e\u003c/li\u003e\u003c/strong\u003e data-start="\u003c/strong\u003e842\u003c/strong\u003e data-end="\u003c/strong\u003e913\u003c/strong\u003e
\u003c/strong\u003e3cp data-start="\u003c/strong\u003e844\u003c/strong\u003e data-end="\u003c/strong\u003e913\u003c/strong\u003e
\u003c/strong\u003eKadanes Algorithm
for Maximum Subarray Sum, Buy-Sell Stock problem\u003c/strong\u003e\u003c/p\u003e\u003c/strong\u003e\u003c/li\u003e\u003c/strong\u003e data-start="\u003c/strong\u003e914\u003c/strong\u003e data-end="\u003c/strong\u003e989\u003c/strong\u003e
\u003c/strong\u003e3cp data-start="\u003c/strong\u003e916
\u003c/strong\u003e data-end="\u003c/strong\u003e989\u003c/strong\u003e
\u003c/strong\u003eArray rotations using Juggling Algorithm, Reversal
method, and examples\u003c/strong\u003e\u003c/p\u003e\u003c/strong\u003e\u003c/li\u003e\u003c/strong\u003e\u003c/ul\u003e\u003c/strong\u003e data-start="\u003c/strong\u003e991\u003c/strong\u003e data-end="\u003c/strong\u003e994\u003c/strong\u003e
\u003c/strong\u003e3 data-start="\u003c/strong\u003e996\u003c/strong\u003e data-end=
"\u003c/strong\u003e1023\u003c/strong\u003e
\u003c/strong\u003e3cstrong data-start="\u003c/strong\u003e1000\u003c/strong\u003e data-end="\u003c/strong\u003e1023\u003c/strong\u003e
\u003c/strong\u003eClass
4: Array II\u003c/strong\u003e\u003c/strong\u003e\u003c/h3\u003e\u003c/strong\u003e data-start="\u003c/strong\u003e1024\u003c/strong\u003e da

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03cp data-start="\1207\" \u003e\u003cli data-end="\1204\" data-end="\1079\" \u003e\u003eli data-start="\1026\" data-end="\1079\" \u003eMajority Element using Boyer Moore Voting Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1080\" data-end="\1138\" \u003e\u003cp data-start="\1082\" data-end="\1138\" \u003eSubarrays and Subsequences with Prefix & Suffix arrays\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1139\" data-end="\1207\" \u003e\u003cp data-start="\1141\" data-end="\1207\" \u003ePractice problems for sum, product, and sliding window subarrays\u003c/p\u003e\u003c/li\u003e\u003c/u\u003e\u003chr data-start="\1209\" data-end="\1212\" \u003e\u003ch3 data-start="\1214\" data-end="\1242\" \u003e\u003cstrong data-start="\1218\" data-end="\1242\" \u003eClass 5: Array III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1243\" data-end="\1429\" \u003e\u003cli data-start="\1243\" data-end="\1299\" \u003e\u003cp data-start="\1245\" data-end="\1299\" \u003eTwo Pointer s technique for pair/triplet sum problems\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1300\" data-end="\1353\" \u003e\u003cp data-start="\1302\" da ta-end="\1353\" \u003eDutch National Flag Algorithm for sorting 0, 1, 2\u003c /p\u003e\u003c/li\u003e\u003cli data-start="\1354\" data-end="\1429\" \u003e \u003cp data-start="\1356\" data-end="\1429\" \u003eSliding Window problems l ike Maximum Sum Subarray and Longest Substring\u003c/p\u003e\u003c/li\u003e \u003c/u\u003e\u003chr data-start="\1431\" data-end="\1434\" \u003e\u003ch3 data-start="\1436\" data-end="\1460\" \u003e\u003cstrong data-start="\1440\" data-end="\1460\" \u003eClass 6: Hashing\u003c/strong\u003e\u003c/h3\u003e\u003 cul data-start="\1461\" data-end="\1682\" \u003e\u003cli data-start="\1461 \" data-end="\1532\" \u003e\u003cp data-start="\1463\" data-end="\1532\" \u003 eIntroduction to hash tables, hash functions, and collision handling\u003c/p \u003e\u003c/li\u003e\u003cli data-start="\1533\" data-end="\1597\" \u003e\u003 cp data-start="\1535\" data-end="\1597\" \u003eImplementation using STL (\u 003ccode data-start="\1561\" data-end="\1576\" \u003eunordered_map\u003c/code \u003e\u0026nbsp;/\u0026nbsp;\u003ccode data-start="\1579\" data-end="\1594 \" \u003eunordered_set\u003c/code\u003e)\u003c/p\u003e\u003c/li\u003e\u003cli d ata-start="\1598\" data-end="\1682\" \u003e\u003cp data-start="\1600\" data- end="\1682\" \u003ePractice problems: frequency counts, subarray sums, and pa ttern-based challenges\u003c/p\u003e\u003c/li\u003e\u003c/u\u003e\u003chr d ata-start="\1684\" data-end="\1687\" \u003e\u003ch3 data-start="\1689\" data- end="\1715\" \u003e\u003cstrong data-start="\1693\" data-end="\1715\" \u003eCl ass 7: Recursion\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1716 \" data-end="\1887\" \u003e\u003cli data-start="\1716\" data-end="\1782\" \u00 3e\u003cp data-start="\1718\" data-end="\1782\" \u003eBasics of recursion, st ack usage, and importance of base cases\u003c/p\u003e\u003c/li\u003e\u003cli d ata-start="\1783\" data-end="\1826\" \u003e\u003cp data-start="\1785\" data- end="\1826\" \u003eExamples: Factorial, Fibonacci Sequence\u003c/p\u003e\u003 c/li\u003e\u003cli data-start="\1827\" data-end="\1887\" \u003e\u003cp data-s tart="\1829\" data-end="\1887\" \u003eTower of Hanoi and introduction to back tracking concepts\u003c/p\u003e\u003c/li\u003e\u003c/u\u003e\u003chr data-s tart="\1889\" data-end="\1892\" \u003e\u003ch3 data-start="\1894\" data-end= "\1920\" \u003e\u003cstrong data-start="\1898\" data-end="\1920\" \u003eClass 8: Searching\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1921\" d ata-end="\2109\" \u003e\u003cli data-start="\1921\" data-end="\1988\" \u003e \u003cp data-start="\1923\" data-end="\1988\" \u003eLinear Search: concept, imp lementation, and complexity analysis\u003c/p\u003e\u003c/li\u003e\u003cli da ta-start="\1989\" data-end="\2045\" \u003e\u003cp data-start="\1991\" data-en d="\2045\" \u003eBinary Search: iterative & recursive implementation s\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2046\" data-end="\2109 \" \u003e\u003cp data-start="\2048\" data-end="\2109\" \u003eApplications: rot ated arrays, floor/ceiling search problems\u003c/p\u003e\u003c/li\u003e\u003 c/u\u003e\u003chr data-start="\2111\" data-end="\2114\" \u003e\u003ch3 data-
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start="\2116\" data-end="\2140\" \u003e\u003cstrong data-start="\2120\" data-end="\2140\" \u003eClass 9: Sorting\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\2141\" data-end="\2320\" \u003e\u003cli data-start="\2141\" data-end="\2209\" \u003e\u003cp data-start="\2143\" data-end="\2209\" \u003eBubble, Selection, and Insertion Sort: comparisons and use cases\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2210\" data-end="\2261\" \u003e\u003cp data-start="\2212\" data-end="\2261\" \u003eMerge Sort and Quick Sort for efficient sorting\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2262\" data-end="\2320\" \u003e\u003cp data-start="\2264\" data-end="\2320\" \u003eConceptual understanding of Cyclic Sort and Shell Sort\u003c/p\u003e\u003c/li\u003e\u003cul\u003e\u003chr data-start="\2322\" data-end="\2325\" \u003e\u003ch3 data-start="\2327\" data-end="\2351\" \u003e\u003cstrong data-start="\2331\" data-end="\2351\" \u003eClass 10: Matrix\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\2352\" data-end="\2526\" \u003e\u003cli data-start="\2352\" data-end="\2409\" \u003e\u003cp data-start="\2354\" data-end="\2409\" \u003eMatrix traversal: row-wise, column-wise, spiral order\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2410\" data-end="\2469\" \u003e\u003cp data-start="\2412\" data-end="\2469\" \u003eMatrix rotation, transpose, and binary search in matrix\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2470\" data-end="\2526\" \u003e\u003cp data-start="\2472\" data-end="\2526\" \u003eDirectional traversals and problem-solving exercises\u003c/p\u003e\u003c/li\u003e\u003cul\u003e\u003chr data-start="\2528\" data-end="\2531\" \u003e\u003ch3 data-start="\2533\" data-end="\2566\" \u003e\u003cstrong data-start="\2537\" data-end="\2566\" \u003eClass 11: Linked List I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\2567\" data-end="\2749\" \u003e\u003cli data-start="\2567\" data-end="\2633\" \u003e\u003cp data-start="\2569\" data-end="\2633\" \u003eSingly, Doubly, and Circular Linked List basics and operations\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2634\" data-end="\2705\" \u003e\u003cp data-start="\2636\" data-end="\2705\" \u003eFinding middle element, reversing linked lists, intersection points\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2706\" data-end="\2749\" \u003e\u003cp data-start="\2708\" data-end="\2749\" \u003eCycle detection using Floyds Algorithm\u003c/p\u003e\u003c/li\u003e\u003cul\u003e\u003chr data-start="\2751\" data-end="\2754\" \u003e\u003ch3 data-start="\2756\" data-end="\2790\" \u003e\u003cstrong data-start="\2760\" data-end="\2790\" \u003eClass 12: Linked List II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\2791\" data-end="\2951\" \u003e\u003cli data-start="\2791\" data-end="\2839\" \u003e\u003cp data-start="\2793\" data-end="\2839\" \u003eFinding length and starting point of a cycle\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2840\" data-end="\2898\" \u003e\u003cp data-start="\2842\" data-end="\2898\" \u003eLRU Cache implementation using linked list and hashing\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\2899\" data-end="\2951\" \u003e\u003cp data-start="\2901\" data-end="\2951\" \u003eMerge K Sorted Lists and optimization approaches\u003c/p\u003e\u003c/li\u003e\u003cul\u003e\u003chr data-start="\2953\" data-end="\2956\" \u003e\u003ch3 data-start="\2958\" data-end="\2993\" \u003e\u003cstrong data-start="\2962\" data-end="\2993\" \u003eClass 13: Stack \u0026amp; Queue I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\2994\" data-end="\3187\" \u003e\u003cli data-start="\2994\" data-end="\3061\" \u003e\u003cp data-start="\2996\" data-end="\3061\" \u003eStack concepts (LIFO), implementation using array \u0026amp; linked list\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\3062\" data-end="\3114\" \u003e\u003cp data-start="\3064\" data-end="\3114\" \u003eQueue concepts (FIFO), Circular Queue, and Deque\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\3115\" data-end="\3187\" \u003e\u003cp data-start="\3117\" data-end="\3187\" \u003eApplications: expression evaluation, balanced parentheses, undo-redo\u003c/p\u003e\u003c/li\u003e\u003cul\u003e\u003chr data-start="\3189\" data-end="\3192\" \u003e\u003ch3 data-start="\3194\" data-end="\3230

\" data-bbox="168 43 913 944"/>
 \u003e\u003cstrong data-start=\"3198\" data-end=\"3230\" \u003eClass 14: Stack \u0026amp; Queue II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3231\" data-end=\"3386\" \u003e\u003cli data-start=\"3231\" data-end=\"3298\" \u003e\u003cp data-start=\"3233\" data-end=\"3298\" \u003ePractice problems: Next Greater Element, Sliding Window Maximum\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3299\" data-end=\"3339\" \u003e\u003cp data-start=\"3301\" data-end=\"3339\" \u003eStack using Queue, Queue using Stack\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3340\" data-end=\"3386\" \u003e\u003cp data-start=\"3342\" data-end=\"3386\" \u003eOptimization and problem-solving exercises\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3388\" data-end=\"3391\" \u003e\u003ch3 data-start=\"3393\" data-end=\"3427\" \u003e\u003cstrong data-start=\"3397\" data-end=\"3427\" \u003eClass 15: Backtracking I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3428\" data-end=\"3598\" \u003e\u003cli data-start=\"3428\" data-end=\"3478\" \u003e\u003cp data-start=\"3430\" data-end=\"3478\" \u003eGenerating all permutations of array or string\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3479\" data-end=\"3534\" \u003e\u003cp data-start=\"3481\" data-end=\"3534\" \u003eGenerating combinations and subsets using recursion\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3535\" data-end=\"3598\" \u003e\u003cp data-start=\"3537\" data-end=\"3598\" \u003eBacktracking exercises to explore recursive tree structures\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3600\" data-end=\"3603\" \u003e\u003ch3 data-start=\"3605\" data-end=\"3640\" \u003e\u003cstrong data-start=\"3609\" data-end=\"3640\" \u003eClass 16: Backtracking II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3641\" data-end=\"3756\" \u003e\u003cli data-start=\"3641\" data-end=\"3666\" \u003e\u003cp data-start=\"3643\" data-end=\"3666\" \u003eRat in a Maze problem\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3667\" data-end=\"3713\" \u003e\u003cp data-start=\"3669\" data-end=\"3713\" \u003eN-Queen problem with pruning and recursion\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3714\" data-end=\"3756\" \u003e\u003cp data-start=\"3716\" data-end=\"3756\" \u003eValid Sudoku solver using backtracking\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3758\" data-end=\"3761\" \u003e\u003ch3 data-start=\"3763\" data-end=\"3790\" \u003e\u003cstrong data-start=\"3767\" data-end=\"3790\" \u003eClass 17: Trees I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3791\" data-end=\"3959\" \u003e\u003cli data-start=\"3791\" data-end=\"3858\" \u003e\u003cp data-start=\"3793\" data-end=\"3858\" \u003eBinary Tree basics, types, and representations (array \u0026amp; linked)\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3859\" data-end=\"3903\" \u003e\u003cp data-start=\"3861\" data-end=\"3903\" \u003eTraversals: Preorder, Inorder, Postorder\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3904\" data-end=\"3959\" \u003e\u003cp data-start=\"3906\" data-end=\"3959\" \u003ePractice problems: height, node count, sum of nodes\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3961\" data-end=\"3964\" \u003e\u003ch3 data-start=\"3966\" data-end=\"3994\" \u003e\u003cstrong data-start=\"3970\" data-end=\"3994\" \u003eClass 18: Trees II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3995\" data-end=\"4141\" \u003e\u003cli data-start=\"3995\" data-end=\"4056\" \u003e\u003cp data-start=\"3997\" data-end=\"4056\" \u003eBinary Search Tree (BST): insertion, deletion, and search\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4057\" data-end=\"4092\" \u003e\u003cp data-start=\"4059\" data-end=\"4092\" \u003eInorder predecessor \u0026amp; successor\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4093\" data-end=\"4141\" \u003e\u003cp data-start=\"4095\" data-end=\"4141\" \u003eBST practice problems and path sum exercises\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"4143\" data-end=\"4146\" \u003e\u003ch3 data-start=\"4148\" data-end=\"4177\" \u003e\u003cstrong data-start=\"4152\" data-end=\"4177\" \u003eClass 19: Trees III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"4178

\ " data-end="\4309\" \u003e\u003cli data-start="\4178\" data-end="\4216\" \u003e\u003cp data-start="\4180\" data-end="\4216\" \u003eHeap concepts: Min Heap \u0026amp; Max Heap\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4217\" data-end="\4264\" \u003e\u003cp data-start="\4219\" data-end="\4264\" \u003eHeapify, insertion, and deletion operations\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4265\" data-end="\4309\" \u003e\u003cp data-start="\4267\" data-end="\4309\" \u003ePriority Queue applications and problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4311\" data-end="\4314\" \u003e\u003ch3 data-start="\4316\" data-end="\4343\" \u003e\u003cstrong data-start="\4320\" data-end="\4343\" \u003eClass 20: Graph I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4344\" data-end="\4491\" \u003e\u003cli data-start="\4344\" data-end="\4393\" \u003e\u003cp data-start="\4346\" data-end="\4393\" \u003eGraph representation: adjacency list \u0026amp; matrix\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4394\" data-end="\4418\" \u003e\u003cp data-start="\4396\" data-end="\4418\" \u003eDFS \u0026amp; BFS traversals\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4419\" data-end="\4491\" \u003e\u003cp data-start="\4421\" data-end="\4491\" \u003eProblems: connected components, reachability, simple cycle detection\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4493\" data-end="\4496\" \u003e\u003ch3 data-start="\4498\" data-end="\4526\" \u003e\u003cstrong data-start="\4502\" data-end="\4526\" \u003eClass 21: Graph II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4527\" data-end="\4694\" \u003e\u003cli data-start="\4527\" data-end="\4578\" \u003e\u003cp data-start="\4529\" data-end="\4578\" \u003eCycle detection in directed \u0026amp; undirected graphs\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4579\" data-end="\4637\" \u003e\u003cp data-start="\4581\" data-end="\4637\" \u003eDAGs and Topological Sort using DFS \u0026amp; Kahns Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4638\" data-end="\4694\" \u003e\u003cp data-start="\4640\" data-end="\4694\" \u003eGraph problems: scheduling and dependency resolution\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4696\" data-end="\4699\" \u003e\u003ch3 data-start="\4701\" data-end="\4730\" \u003e\u003cstrong data-start="\4705\" data-end="\4730\" \u003eClass 22: Graph III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4731\" data-end="\4871\" \u003e\u003cli data-start="\4731\" data-end="\4781\" \u003e\u003cp data-start="\4733\" data-end="\4781\" \u003eShortest Path algorithms: Dijkstras Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4782\" data-end="\4815\" \u003e\u003cp data-start="\4784\" data-end="\4815\" \u003eMulti-source BFS \u0026amp; Flood Fill\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4816\" data-end="\4871\" \u003e\u003cp data-start="\4818\" data-end="\4871\" \u003eCourse scheduling and real-life dependency examples\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4873\" data-end="\4876\" \u003e\u003ch3 data-start="\4878\" data-end="\4914\" \u003e\u003cstrong data-start="\4882\" data-end="\4914\" \u003eClass 23: Greedy + DP Basics\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4915\" data-end="\5048\" \u003e\u003cli data-start="\4915\" data-end="\4963\" \u003e\u003cp data-start="\4917\" data-end="\4963\" \u003eFractional Knapsack and Coin Change (Greedy)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4964\" data-end="\5009\" \u003e\u003cp data-start="\4966\" data-end="\5009\" \u003eActivity Selection (N meetings in a room)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\5010\" data-end="\5048\" \u003e\u003cp data-start="\5012\" data-end="\5048\" \u003e0 - 1 Knapsack \u0026amp; Subset Sum problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\5050\" data-end="\5053\" \u003e\u003ch3 data-start="\5055\" data-end="\5101\" \u003e\u003cstrong data-start="\5059\" data-end="\5101\" \u003eClass 24: Advanced Dynamic Programming\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\5102\" data-end="\5284\" \u003e\u003cli data-start="\5102\" data-end="\5143\" \u003e\u003cp data-start="\5104\" data-end="\5143\" \u003eUn

bounded Knapsack \u0026amp; Coin Change (DP)\u003c/p\u003e\u003c/li\u003e\u003ccli data-start="\u005144\" data-end="\u005220\" \u003e\u003cp data-start="\u005146\" data-end="\u005220\" \u003eLongest Common Subsequence (LCS) \u0026amp; Longest Palindromic Subsequence (LPS)\u003c/p\u003e\u003c/li\u003e\u003ccli data-start="\u005221\" data-end="\u005284\" \u003e\u003cp data-start="\u005223\" data-end="\u005284\" \u003eMatrix Chain Multiplication (MCM) \u0026amp; Palindrome Partitioning \u003c/p\u003e\u003c/li\u003e\u003c/u\u003e\", \"Resume Building\": \"\u003cul\u003e\u003cli\u003eUnderstand the resume-building process and make your skills stand out\u003c/li\u003e\u003c/u\u003e\", \"Projects\": \"\u003cul\u003e\u003cli data-mce-style=\"box-sizing: inherit;\" style=\"box-sizing: inherit;\" \u003e\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\" style=\"box-sizing: inherit; font-weight: bolder;\" \u003eSudoku Solver\u003c/span\u003e: Program to solve a Sudoku puzzle by filling the empty cells.\u003c/li\u003e\u003ccli data-mce-style=\"box-sizing: inherit;\" style=\"box-sizing: inherit;\" \u003e\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\" style=\"box-sizing: inherit; font-weight: bolder;\" \u003eShortest Path Finder\u003c/span\u003e: The problem of finding the shortest path between two intersections on a road map\u003c/li\u003e\u003ccli data-mce-style=\"box-sizing: inherit;\" style=\"box-sizing: inherit;\" \u003e\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\" style=\"box-sizing: inherit; font-weight: bolder;\" \u003eTic Tac Toe\u003c/span\u003e: A game in which two players alternately put Xs and Os in compartments of a figure formed by two vertical lines.\u003c/li\u003e\u003ccli data-mce-style=\"box-sizing: inherit;\" style=\"box-sizing: inherit;\" \u003e\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\" style=\"box-sizing: inherit; font-weight: bolder;\" \u003eN Queen Visualizer\u003c/span\u003e: Visualization of solving the N-Queens puzzle using a recursive algorithm.\u003c/li\u003e\u003c/u\u003e\"}, \"locations_coords\": [], \"desktop_banner_webp\": \"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Mobile/Other/Course_DSA_to_Dev_1720846081.webp\", \"mobile_banner_webp\": \"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Mobile/Other/Course_DSA_to_Dev_1720846081.webp\", \"price\": {\"batch_fee\": 19999, \"promotional_fee\": 37999, \"play_store_product_id\": \"gfg_course_19999\"}, \"additional_info\": \"\"}, {\"course_id\": 804, \"course_name\": \"Soft Skills Course Online - Complete Professional Development Training\", \"course_slug\": \"soft-skills-online-training-course\", \"course_url\": \"https://www.geeksforgeeks.org/courses/soft-skills-online-training-course\", \"course_type\": \"Online\", \"course_fee_type\": \"Paid\", \"level\": null, \"course_duration\": 4, \"is_kids_course\": false, \"faqs\": {\"What are soft skills?\": \"\u003cp\u003eSoft skills are personal attributes and interpersonal skills that enable someone to interact effectively and harmoniously with others. Unlike technical skills, which pertain to specific tasks, soft skills include communication, teamwork, problem-solving, adaptability, and emotional intelligence. These skills are essential in the workplace and can significantly impact career success.\u003c/p\u003e\", \"How will improving my soft skills help my career?\": \"\u003cp\u003eImproving your soft skills can help you build better relationships at work, improve communication, and enhance your leadership abilities. These skills can boost your career by making you more effective in teamwork, problem-solving, and handling workplace challenges.\u003cbr\u003e\u003c/p\u003e\", \"Why should I take a soft skills course?\": \"\u003cp\u003eTaking a soft skills course can help you improve how you interact with others, build confidence, and advance in your career. Soft skills are just as important as technical skills, and they help you work better in teams, communicate effectively, and handle workplace challenges.\u003cbr\u003e\u003c/p\u003e\", \"Is this course suitable for beginners?\": \"\u003cp\u003eYes, this online soft skills course is perfect for beginners or anyone who wants to improve their interpersonal skills. You don't need any prior experience to take the course, and it's beneficial for

all levels, whether you're just starting your career or looking to advance. \u003cbr\u003e\u003c/p\u003e", "How are soft skills useful in the workplace?": "\u003cp\u003eSoft skills help you communicate better, work in teams, manage your time, and handle stress. They also improve your ability to lead, resolve conflicts, and adapt to change. Employers highly value soft skills because they improve collaboration and productivity. \u003cbr\u003e\u003c/p\u003e", "Can I take this course if I'm already employed?": "\u003cp\u003eYes, this online soft skills course is designed to be flexible, so you can take them while working. You can learn at your own pace, making it easy to fit into your schedule, even with a full-time job. \u003cbr\u003e\u003c/p\u003e", "What can I expect to learn in a soft skills course?": "\u003cp\u003eIn a soft skills course, you can expect to learn essential skills such as effective communication, active listening, teamwork, conflict resolution, time management, and emotional intelligence. Many courses also include practical exercises, role-playing scenarios, and group discussions to help participants apply these skills in real-world situations. \u003cbr\u003e\u003c/p\u003e", "Is there a contact number available for inquiries?": "\u003cp\u003eYou may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org \u003cbr\u003e\u003c/p\u003e", "Can I make the payment through PayPal?": "\u003cp\u003eYes. Mail us with your details at \u0026nbsp; \u003cstrong\u003e\u003e\u003ca href=\"mailto:courses@geeksforgeeks.org\" target=\"_blank\" \u003e\u003ecourses@geeksforgeeks.org\u003c/a\u003e\u003c/strong\u003e. \u0026nbsp; \u003c/p\u003e\n\"}, \"has_doubt_assistance\": true, \"doubt_support_price\": 0, \"visit_count\": \"59k+\", \"desktop_banner\": \"https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png\", \"mobile_banner\": \"https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png\", \"seats_left\": null, \"top_course\": false, \"course_publish_date\": \"2024-09-19T00:00:00\", \"keywords\": \"DSA / Placements\", \"ratings\": {\"avg_rating\": 4.5, \"partial_rating\": 0.5, \"star_count\": 0}, \"intro_video_link\": {\"thumbnail_image\": \"https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png\", \"link\": \"\", \"video_available\": false}, \"short_description\": \"\u003cp\u003eThis comprehensive Soft Skills Training course is designed to enhance your soft skills essential for personal and professional success. You'll learn essential workplace skills like communication, leadership, teamwork, time management, etc. Whether you're a professional looking to advance your career or a beginner wanting to build confidence, this course will equip you with the soft skills needed for success in any job. \u003cbr\u003e\u003c/p\u003e\", \"what_you_will_learn\": \"\", \"course_overview\": \"\u003cp\u003eIn today's fast-paced and interconnected world, soft skills have become just as important as technical knowledge. This Complete Course on Soft Skills for personal and professional growth is designed to help you develop essential interpersonal abilities that enhance communication, collaboration, problem-solving, and leadership. Whether you're navigating the workplace, managing teams, or interacting with clients, these skills are crucial to your success. \u003c/p\u003e\u003cp\u003eThroughout this Soft Skills Training Online Course, you will explore key soft skills such as effective communication, emotional intelligence, time management, adaptability, conflict resolution, and teamwork. You will also engage in practical exercises, real-world scenarios, and self-assessment activities that will allow you to apply what you learn to everyday situations. \u003c/p\u003e\u003ch3\u003e\u003cstrong\u003eGFG Soft Skills Course - Highlights\u003c/strong\u003e\u003c/h3\u003e\u003cstrong\u003e\u003e\u003cul\u003e\u003cstrong\u003eMaster essential \u003cstrong\u003e\u003e\u003cstrong\u003ecommunication\u003c/strong\u003e, \u003cstrong\u003e\u003e\u003cstrong\u003eteamwork\u003c/strong\u003e, and \u003cstrong\u003e\u003e\u003cstrong\u003eleadership skills\u003c/strong\u003e. \u003c/li\u003e\u003cstrong\u003e\u003e\u003cstrong\u003eImprove \u003cstrong\u003e\u003everbal\u003c/strong\u003e, \u003cstrong\u003e\u003e\u003cstrong\u003enon-verbal\u003c/strong\u003e, and \u003cstrong\u003e\u003e\u003cstrong\u003ewritten communication\u003c/strong\u003e. \u003c/ul\u003e\u003c/p\u003e

tion\003c/strong\003e techniques.\003c/li\003e\003cli\003eEnhance team work with \003cstrong\003eeffective collaboration\003c/strong\003e and \003cstrong\003econflict-resolution strategies\003c/strong\003e.\003c/li\003e\003cli\003eDevelop \003cstrong\003ecritical thinking\003c/strong\003e and \003cstrong\003eproblem-solving abilities\003c/strong\003e through real-world cases.\003c/li\003e\003cli\003eBuild \003cstrong\003eemotional intelligence\003c/strong\003e for better \003cstrong\003eself-awareness\003c/strong\003e and\003cstrong\003e relationship management.\003c/strong\003e\003c/li\003e\003cli\003e\003cstrong\003eLearn prioritization\003c/strong\003e and \003cstrong\003etask management\003c/strong\003e for efficient time management.\003cbr\003e\003c/li\003e\003cli\003eUnderstand \003cstrong\003eprofessionalism\003c/strong\003e, \003cstrong\003ebusiness etiquette\003c/strong\003e, and ethical \003cstrong\003edecision-making.\003c/strong\003e\003c/li\003e\003cli\003eExplore leadership styles to build \003cstrong\003etrust\003c/strong\003e, \003cstrong\003einfluence\003c/strong\003e, and \003cstrong\003eaccountability\003c/strong\003e.\003c/li\003e\003cli\003eMaster\003cstrong\003e networking techniques\003c/strong\003e and relationship-building for career growth.\003c/li\003e\003cli\003eGain confidence in \003cstrong\003epublic speaking\003c/strong\003e and delivering impactful presentations.\003c/li\003e\003c/ul\003e", "course_feature": null, "course_content": {"Introduction to Soft Skills": "\003cul\003e\003cli\003eWhy Soft Skills Matter\003c/li\003e\003cli\003eSoft Skills vs. Hard Skills\003c/li\003e\003cli\003eImportance of Soft Skills in the Workplace\003c/li\003e\003c/ul\003e", "Communication Skills": "\003cul\003e\003cli\003eVerbal Communication\003c/li\003e\003cli\003eClarity and Concision\003c/li\003e\003cli\003eListening Skills\003c/li\003e\003cli\003eNon-Verbal Communication\003c/li\003e\003cli\003eBody Language\003c/li\003e\003cli\003eTone of Voice\003c/li\003e\003cli\003eWritten Communication\003c/li\003e\003cli\003eEmails\003c/li\003e\003c/ul\003e", "Teamwork and Collaboration": "\003cul\003e\003cli\003eThe Importance of Teamwork\003c/li\003e\003cli\003eCollaboration Techniques\003c/li\003e\003cli\003eConflict Resolution\003c/li\003e\003c/ul\003e", "Problem-Solving and Critical Thinking": "\003cul\003e\003cli\003eApproaches to Problem-Solving\003c/li\003e\003cli\003eCritical Thinking Framework\003c/li\003e\003cli\003eCase Studies in Problem-Solving\003c/li\003e\003c/ul\003e", "Emotional Intelligence": "\003cul\003e\003cli\003eUnderstanding Emotional Intelligence\003c/li\003e\003cli\003eSelf-Awareness and Self-Regulation\003c/li\003e\003cli\003eEmpathy and Social Skills\003c/li\003e\003c/ul\003e", "Time Management": "\003cul\003e\003cli\003ePrioritization Techniques\003c/li\003e\003cli\003eTask Management Tools\003c/li\003e\003cli\003eWork-Life Balance\003c/li\003e\003c/ul\003e", "Adaptability and Learning Agility": "\003cul\003e\003cli\003eAdapting to Change\003c/li\003e\003cli\003eContinuous Learning\003c/li\003e\003cli\003eBuilding Resilience\003c/li\003e\003c/ul\003e", "Professionalism and Work Ethics": "\003cul\003e\003cli\003eUnderstanding Professionalism\003c/li\003e\003cli\003eBusiness Etiquette\003c/li\003e\003cli\003eEthical Decision-Making\003c/li\003e\003c/ul\003e", "Leadership Skills": "\003cul\003e\003cli\003eTypes of Leadership\003c/li\003e\003cli\003eBuilding Trust and Influence\003c/li\003e\003cli\003eDelegation and Accountability\003c/li\003e\003c/ul\003e", "Networking and Relationship Building": "\003cul\003e\003cli\003eImportance of Networking\003c/li\003e\003cli\003eEffective Networking Techniques\003c/li\003e\003cli\003eMaintaining Professional Relationships\003c/li\003e\003c/ul\003e", "Public Speaking and Presentation Skills": "\003cul\003e\003cli\003eElements of Effective Public Speaking\003c/li\003e\003cli\003ePresentation Tools\003c/li\003e\003cli\003eEn

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`url('https://www.gstatic.com/images/icons/material/system_gm/1x/more_horiz_black_20dp.png') center center / 20px no-repeat; height: 11px; opacity: 0.71; width: 24px;\n\u003e\u003c/div\u003e\u003c/div\u003e\u003cdiv class=\"ad L\" style=\"display: flex; box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; margin: 10px auto 0px; font-size: 18px; font-weight: bold; color: #357960; width: fit-content;\n\" data-mce-style=\"display: flex; box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; margin: 10px auto 0px; font-size: 18px; font-weight: bold; color: #357960; width: fit-content;\n\u003e\u003cbr style=\"background-color: #ffffff;\n\" data-mce-style=\"background-color: #ffffff;\n\u003e\u003c/div\u003e\", \"What are the prerequisites and required software/hardware?\": \"\n\u003cp\u003e\u003cspan style=\"font-family: Helvetica, Arial, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: rgb(255, 255, 255);\n\" data-mce-style=\"font-family: Helvetica, Arial, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: #ffffff;\n\u003eThis live course has no prerequisites. You'll receive clear articles and notes for each session, so you can follow along from day one and get the most out of the program. Prior experience may help, but it isn't required everything you need will be provided.\n\u003cspan\u003e\u003cp\u003e\", \"Can I make the payment through PayPal?\": \"\n\u003cp\u003e\u003eYes. Mail us with your details at geeks.classes@geeksforgeeks.org.\n\u003cbr\u003e\u003cp\u003e\", \"When will my IBM certificate be visible?\": \"\n\u003cp\u003e\u003eYour IBM certificate will be visible after 25th December.\n\u003c/p\u003e\"}, \"has_doubt_assistance\": true, \"doubt_support_price\": 0, \"visit_count\": \"102k+\", \"desktop_banner\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"mobile_banner\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"seats_left\": 3, \"top_course\": false, \"course_publish_date\": \"2024-04-30T00:00:00\", \"keywords\": \"Machine Learning and Data Science | IBM Certification | ML and Data Science\", \"ratings\": {\"avg_rating\": 4.3, \"partial_rating\": 0.29999999999999998, \"star_count\": 0}, \"intro_video_link\": {\"thumbnail_image\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"link\": \"\", \"video_available\": false}, \"short_description\": \"\n\u003cp\u003e\u003eUnlock the power of data! Elevate your expertise with our Mastering\n\u0026nbsp;\nData Analytics\n\u0026nbsp;\nCourse. Gain proficiency in\n\u0026nbsp;\nPython,\n\u0026nbsp;\nSQL,\n\u0026nbsp;\nExcel, and\n\u0026nbsp;\nTableau for data analysis, visualization, and reporting. Explore hands-on, real-world projects and much more.\n\u003cbr\u003e\u003e\u003c/p\u003e\", \"what_you_will_learn\": \"\n\u003cul\u003e\u003eli\u003eLearn the basics of the\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003ePython Programming Language\n\u003cspan\u003e\u003eli\u003eUnderstand how to work with\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003efiles, JSON, Numpy, and OS using Python\n\u003cspan\u003e\u003eli\u003eLearn how to use\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003eJupyter\n\u0026nbsp;\n;\n\u003cspan\u003e\u003eli\u003efor data analysis and visualization\n\u003cspan\u003e\u003eli\u003eUse\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003ePandas\n\u0026nbsp;\n;\n\u003cspan\u003e\u003eli\u003eto manipulate and analyze data\n\u003cspan\u003e\u003eli\u003eLearn basic\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003estatistics\n\u0026nbsp;\n;\n\u003cspan\u003e\u003eli\u003eand\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font-weight: bolder;\n\" style=\"box-sizing: inherit; font-weight: bolder;\n\u003edata preprocessing\n\u0026nbsp;\n;\n\u003cspan\u003e\u003eli\u003etechniques for data analysis\n\u003cspan\u003e\u003eli\u003eBuild\n\u0026nbsp;\n;\n\u003cspan data-mce-style=\"box-sizing: inherit; font`

-weight: bolder;" style="box-sizing: inherit; font-weight: bolder;"\u003e projects\u0026nbsp;\u003c/span\u003eusing data analysis techniques\u003c/li \u003e\u003cli\u003eUnderstand the basics of\u0026nbsp;\u003cspan data-mce-s style="box-sizing: inherit; font-weight: bolder;" style="box-sizing: inher it; font-weight: bolder;"\u003eExcel\u0026nbsp;\u003c/span\u003eand\u0026nb sp;\u003cspan data-mce-style="box-sizing: inherit; font-weight: bolder;" s tyle="box-sizing: inherit; font-weight: bolder;"\u003eSQL\u0026nbsp;\u003 c/span\u003efor data management and analysis\u003c/li\u003e\u003cli\u003eLea rn how to use\u0026nbsp;\u003cspan data-mce-style="box-sizing: inherit; fon t-weight: bolder;" style="box-sizing: inherit; font-weight: bolder;"\u003 ePowerBI\u0026nbsp;\u003c/span\u003efor data visualization and reporting\u00 3c/li\u003e\u003cli\u003eSupplementary\u0026nbsp;\u003cstrong\u003eCertifica tion Questions \u003c/strong\u003ematerials provided for certifications such as \u003cstrong\u003eGoogle, AWS, and IBM.\u003c/strong\u003e\u003cbr\u003e \u003c/li\u003e\u003c/ul\u003e", "course_overview": "\u003cp\u003e\u003cstrong \u003eKey Highlights\u003c/strong\u003e\u003c/p\u003e\u003cul\u003e\u003eli \u003e30+ hours of beginner to advanced self-paced content\u003c/li\u003e\u003eli \u003eHands-on practice with real-world datasets\u003c/li\u003e\u003eli \u003eLearn industrial tools: Excel, SQL, Python, Pandas, NumPy, Jupyter, Ta bleau, Power BI \u0026amp; more\u003c/li\u003e\u003eli\u003eWork on multiple real-life projects and implementations\u003cbr\u003e\u003c/li\u003e\u003c/ul \u003e\u003cdiv id="professor_prebid-root"\u003e\u003c/div\u003e", "course_ feature": null, "course_content": {"Class 1: Introduction to Excel for Data Ana lysis": "\u003cul\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 1 2pt; font-family: Arial,sans-serif; color: #000000; background-color: transp arent; font-weight: 400; font-style: normal; font-variant: normal; text-deco ration: none; vertical-align: baseline; white-space: pre-wrap;" style="fon t-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-varia nt-position: normal; font-variant-emoji: normal; vertical-align: baseline; w hite-space-collapse: preserve;"\u003eOverview of Excel interface\u003c/span \u003e\u003c/li\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 12 pt; font-family: Arial,sans-serif; color: #000000; background-color: transpa rent; font-weight: 400; font-style: normal; font-variant: normal; text-decora tion: none; vertical-align: baseline; white-space: pre-wrap;" style="font -size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; f ont-variant-east-asian: normal; font-variant-alternates: normal; font-varian t-position: normal; font-variant-emoji: normal; vertical-align: baseline; wh ite-space-collapse: preserve;"\u003eNavigating sheets efficiently\u003c/spa n\u003e\u003c/li\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 1 2pt; font-family: Arial,sans-serif; color: #000000; background-color: transp arent; font-weight: 400; font-style: normal; font-variant: normal; text-deco ration: none; vertical-align: baseline; white-space: pre-wrap;" style="font -size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; f ont-variant-east-asian: normal; font-variant-alternates: normal; font-varia nt-position: normal; font-variant-emoji: normal; vertical-align: baseline; w hite-space-collapse: preserve;"\u003eMath \u0026amp; statistical functions (SUM, AVERAGE, COUNT)\u003c/span\u003e\u003c/li\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #0 00000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white -space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: norma l; vertical-align: baseline; white-space-collapse: preserve;"\u003eLogical functions (IF, AND, OR)\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003c

pan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eText functions for manipulation\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eVLOOKUP, VLOOKUP\\u003c/span\\u003e\\u003c/li\\u003e\\u003c/li\\u003e\", \"Class 2: Advanced Formulas \\u0026 Dashboards Using Excel\": \"\\u003cul\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eINDEX MATCH\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eSUMIF, COUNTIFS, nested functions\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003ePower Query: import, transform, merge, append\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eDynamic dashboards\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003

ePivot tables from multiple sources

[Slicers, combo charts, layout optimization](#)

Class 3: Excel AI, Project, Kaggle & Github Introduction

[AI-assisted data cleaning & transformation](#)

[Excel with AI project](#)

[Kaggle and Github optimization](#)

Class 4: Introduction to SQL

[Overview of SQL & databases](#)

[Basic syntax, SELECT, WHERE](#)

if; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCreating \u0026amp; modifying tables (CREATE/ALTER)\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUnderstanding constraints\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 5: Aggregations \u0026 GROUP BY": "\u003c/li\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCOUNT, SUM, AVG, MIN, MAX\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFiltering aggregates\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eGROUP BY, HAVING\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eORDER BY, LIMIT, sorting\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDISTINCT vs GROUP BY\u003c/span\u003e\u003c/li\u003e\u003c/cli\u003e\u003c/cspan data-mce-style="\u003cfont-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="\u003cfont-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003e

p;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLLM-powered optimization suggestions\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 6: Joins \u0026 Subqueries ":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIntroduction to Joins \u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eINNER, LEFT, RIGHT, FULL OUTER Joins \u0026amp; Self join\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDeep Dive into Joins \u0026amp; Subquery Logic\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSubqueries \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 7: Window Functions":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic windows functions Aggregate functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRank functions(ROW_NUMBER(), RANK(), DENSE_RANK() ,PARTITION BY)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 1

2pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAdvance windows functions (LAG(), LEAD(), SUM() OVER(), AVG() OVER())\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eEAI error detection in analytical SQL\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCTE ,SUBSTRING, LENGTH, TRIM, REPLACE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUPPER/LOWER\u003c/span\u003e\u003cbr\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDATE_ADD, DATEDIFF, EXTRACT\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted SQL debugging\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eClass 9: CASE WHEN, Optimization \u0026 Analytics": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003e

n: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCASE WHEN \u0026amp; conditional logic\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIF statements\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIndexes, EXPLAIN plans\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunnel analysis, cohorts, retention\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIntroduction to python\u0026nbsp; \u0026amp; installation \u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython basics, data types, variables\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLoops (for, while)\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003e

riant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eConditional statements (if, elif, else)\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e", "Class 11: Python Fundamentals (Continued)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eLists, dictionaries, tuples\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eList comprehension , operators\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eString methods, Indexing \u0026amp; slicing\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eFunctions \u0026amp; error handling\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eFunctions such as map, filter , lambda\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eInbuilt functions len(), type(), sum(), sorted()\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-col

or: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eWorking with external files\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUsing Colab AI for debugging and code generation\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 13: Pandas Data Cleaning": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eData cleaning operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eString processing\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDataFrames \u0026amp; Series\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMissing values\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDuplicate handling\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 14: Pandas Transformation": "\u003cul\u003e\u003cli

i\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eData type conversions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eColumn renaming\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eGroupby, agg, apply\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003ePivot tables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eMerging \u0026amp; joining\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAI helpers for transformation scripts\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\"Class 15: NumPy \u0026 ED A\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eNumPy arrays and vectorization\u003c/span

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\u003e\u003c/li\u003e\u003eli\u003eli\u003eli\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">
```

\u003eStatistical operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003eOutlier handling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003eEDA workflow\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\"Class 16: Visualization with Matplotlib, Seaborn \u0026 Plotly\":\"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003eBasic \u0026amp; advanced charts\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003eInteractive visualizations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003eCustomization \u0026amp; styling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\">

\u003e

ce-collapse: preserve;"\u003eAI-generated chart scripts\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 17: EDA Project (Python)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eData loading\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCleaning with Pandas\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eVisualizations\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 18: Python + A I EDA Project": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eData acquisition\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCleaning & preparation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eNumerical analysis\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"

n: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted EDA automation\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 19: Data Analysis with LLMs": "\u003cul\u003e\u003eli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eHow LLMs help in analysis\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePan das code generation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning assistance\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization generation\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 20: Power BI Fundamentals \u0026 Data Modeling": "\u003cul\u003e\u003eli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower BI in terface\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-

numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eImporting data\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eRelationships \u0026amp; schemas\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eModeling best practices\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eSUM, AVERAGE, COUNT, CALCULATE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eSWITCH, FILTER\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eTime intelligence\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eRunning totals \u0026amp; growth\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline

e; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower Query for ETL\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization types\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eInteractive elements\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDashboard best practices\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 23: Interview Preparation": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eResume building\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLinkedIn optimization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePositioning your background\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; v

vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIdentify target companies and roles\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 24: Presentation \u0026 Mock Interviews": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSTAR method\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eProject storytelling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMock interviews\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCommon SQL interview patterns \u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython coding (data manipulation, EDA) Interview Questions\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","locations_coords": [], "desktop_banner_webp": "https://media.geeksforgeeks.org/wp-content/uploads/20251126114155056129/da.webp", "mobile_banner_webp": "https://media.geeksforgeeks.org/wp-content/uploads/20251126114155056129/da.webp", "price": {"batch_fee": 17499, "promotional_fee": 24999, "play_store_product_id": "gfg_course_17499"}, "additional_info": "", {"course_id": 287, "course_name": "Learn C with Data Structures – Self Paced", "course_slug": "c-Programming-basic-to-advanced", "course_url": "https://www.geeksforgeeks.org/courses/c-Programming-basic-to-advanced", "course_type": "Online", "course_fee_type": "Paid", "level": "Beginner to Advanced", "course_duration": 12, "is_kids_course": false, "faqs": {"Is there any number to contact for quer

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ded Systems Engineer\li\cli\Firmware Developer\li\cli\Game Developer\li\cli\Robotics Programmer\li\cli\Network Programmer\li\cli\Operating System Developer\li\cli\ul", "What are the career growth opportunities with C programming?": "\cp\With C programming skills, you can grow into senior developer roles, lead engineering teams, or specialize in areas like embedded systems, systems programming, or network programming. C expertise can also lead to roles in software architecture, technical leadership, or even transitioning to other areas like cybersecurity or IoT (Internet of Things).\p", "Can I use C for web development?": "\cp\While C is not commonly used for web development, it can be used to build parts of web applications, especially for back-end processes that require high performance. However, languages like JavaScript, Python, and PHP are more commonly used for web development.\p\}

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3cli\u003eExplore data structures like linked lists, stacks, queues, trees,
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s of computer science and software development. **Data structures** are ways of organizing and storing data, while **algorithms** are sets of steps or procedures to solve a problem or perform a task. Together, they form the backbone of efficient problem-solving, code optimization, and performance improvement.

Why is DSA Important?

Efficiency: Understanding DSA helps in solving problems with optimal time and space complexity, which is crucial in real-world applications.

Technical Interviews: Most technical interviews, especially at top tech companies, revolve around solving DSA problems. A solid understanding of DSA will help you perform well in coding interviews.

Problem Solving

Mastery of DSA improves your problem-solving ability, helping you design solutions for complex and dynamic challenges.

Roadmap to Learn DSA

The roadmap to learning DSA is structured into **phases**.

Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts.

Phase 1: Introduction to Programming Basics

Before diving into DSA, you need to have a solid understanding of basic programming concepts. This includes:

- Variables, Data Types, and Operators**: Understand how variables and data types work in programming languages.
- Control Flow**: Learn about if-else conditions, loops (for, while), and switch cases.
- Functions**: Master how functions work, including parameters, return types, and recursion.
- Basic Input and Output**: Learn how to handle input and output in your programming language of choice.

Phase 2: Learn Basic Data Structures

- Arrays**: Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays.
- Strings**: Learn how strings are represented in memory and how to manipulate them.
- Linked Lists**: Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching.
- Stacks and Queues**: Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more.
- Hashing**: Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.

Phase 3: Advanced Data Structures

- Trees**: Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST).
- Heaps**: Learn about heaps (min and max heaps) and their applications in priority queues and heap sort.
- Graphs**: Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS).
- Tries**: Learn about trie data structures and their applications in tasks like autocomplete and dictionary s

earching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDisjoint Set Union (DSU)\u003c/strong\u003e: Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.\u003c/li\u003e\u003c/ul\u003e\u003ch3\u003ePhase 4: Learn Algorithms\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eSorting Algorithms\u003c/strong\u003e: Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eSearching Algorithms\u003c/strong\u003e: Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDynamic Programming (DP)\u003c/strong\u003e: Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGreedy Algorithms\u003c/strong\u003e: Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eBacktracking\u003c/strong\u003e: Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDivide and Conquer\u003c/strong\u003e: Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGraph Algorithms\u003c/strong\u003e: Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.\u003c/li\u003e\u003c/ul\u003e\u003ch3\u003ePhase 5: Problem Solving and Practice\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eLeetCode, HackerRank, CodeForces\u003c/strong\u003e: Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eInterview Preparation\u003c/strong\u003e: Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eCompetitive Programming\u003c/strong\u003e: Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.\u003c/li\u003e\u003c/ul\u003e\u003ch3\u003ePhase 6: Advanced Topics (Optional)\u003c/h3\u003e\u003cli\u003e\u003cstrong\u003eString Algorithms\u003c/strong\u003e: Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eAdvanced Dynamic Programming\u003c/strong\u003e: Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eAdvanced Graph Algorithms\u003c/strong\u003e: Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGeometry Algorithms\u003c/strong\u003e: Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.\u003c/li\u003e\u003c/ul\u003e\u003ch2\u003eWhy is This Roadmap Effective?\u003c/h2\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eStructured Learning\u003c/strong\u003e: This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eFoundational Knowledge\u003c/strong\u003e: Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHands-on Practice\u003c/strong\u003e: Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and re

al-world applications to solidify your understanding.

[/li/Interview Focused/](#): The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.

[/li/Common Mistakes to Avoid/](#)

[/h2/](#)

[/cul/Skipping the Basics/](#): Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.

[/li/Not Practicing Enough/](#): DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.

[/li/Getting Stuck on One Problem/](#): If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.

[/li/Why Learn DSA?/](#)

[/h2/](#)

[/cul/Problem Solving Skills/](#): Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.

[/li/Efficient Solutions/](#): Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.

[/li/Interview Success/](#): DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

[/li/Topics Covered/](#)

[/h2/](#)

[/cul/Introduction to DSA/](#): Learn the importance of DSA and how it relates to coding efficiency.

[/li/Data Structures/](#): Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.

[/li/Algorithms/](#): Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.

[/li/Problem-Solving/](#): Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

[/li/](#), "source": "https://cdnvideos.geeksforgeeks.org/e929bf110a2f9cd6113209b8a914dfbbgfg-RoadmapToLearnDSA2023042515172120241112155437/video.m3u8", "category": [{"term_id__id": 125, "term_id__term_name": "Data Structures", "term_id__term_type": 2, "term_id__slug": "data-structures-bczc7q"}, {"term_id__id": 365, "term_id__term_name": "Data Structure and Algorithm", "term_id__term_type": 1, "term_id__slug": "data-structure-and-algorithm"}, {"term_id__id": 562, "term_id__term_name": "DSA", "term_id__term_type": 1, "term_id__slug": "dsa-lpubwc"}], "meta": {"thumbnail": "https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752-small.png", "largeThumbnail": "https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752.jpg", "likes": 1, "views": 779090, "isFeatured": 0, "isPremium": 0, "isPublic": 1, "format": "video/mp4", "revision": {}, "time": "12/11/2024", "subtitle": "https://cdnvideos.geeksforgeeks.org/e929bf110a2f9cd6113209b8a914dfbbgfg-RoadmapToLearnDSA2023042515172120241112155437/subtitle.vtt", "duration": 883, "course_link": "https://www.geeksforgeeks.org/courses/dsa-self-paced", "video_schema": {"@context": "https://schema.org", "@type": "VideoObject", "name": "Roadmap to learn DSA", "description": "In this tutorial, we will explore a structured roadmap to learning Data Structures and Algorithms (DSA), which are essential for any software engineer or computer science student. Mastering DSA is crucial for solving complex problems efficiently, and it is the foundation for cracking technical in

interviews and coding challenges. What is DSA? Data Structures and Algorithms (DSA) are the building blocks of computer science and software development. Data structures are ways of organizing and storing data, while algorithms are sets of steps or procedures to solve a problem or perform a task. Together, they form the backbone of efficient problem-solving, code optimization, and performance improvement. Why is DSA Important? Efficiency Understanding DSA helps in solving problems with optimal time and space complexity, which is crucial in real-world applications. Technical Interviews Most technical interviews, especially at top tech companies, revolve around solving DSA problems. A solid understanding of DSA will help you perform well in coding interviews. Problem Solving Mastery of DSA improves your problem-solving ability, helping you design solutions for complex and dynamic challenges. Roadmap to Learn DSA The roadmap to learning DSA is structured into phases. Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts.

Phase 1: Introduction to Programming Basics Before diving into DSA, you need to have a solid understanding of basic programming concepts. This includes Variables, Data Types, and Operators. Understand how variables and data types work in programming languages. Control Flow Learn about if-else conditions, loops (for, while), and switch cases. Functions Master how functions work, including parameters, return types, and recursion. Basic Input and Output Learn how to handle input and output in your programming language of choice.

Phase 2: Learn Basic Data Structures Arrays Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays. Strings Learn how strings are represented in memory and how to manipulate them. Linked Lists Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. Stacks and Queues Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.

Phase 3: Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.

Phase 4: Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.

Phase 5: Problem Solving and Practice LeetCode, HackerR

ank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills.

Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch.

Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.

Phase 6 Advanced Topics (Optional)

- String Algorithms** Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching.
- Advanced Dynamic Programming** Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc.
- Advanced Graph Algorithms** Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskals, Prims), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp).
- Geometry Algorithms** Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.

Why is This Roadmap Effective?

Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.

Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.

Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding.

Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.

Common Mistakes to Avoid

- Skipping the Basics** Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.
- Not Practicing Enough** DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.
- Getting Stuck on One Problem** If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.

Why Learn DSA?

Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.

Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.

Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

Topics Covered

- Introduction to DSA** Learn the importance of DSA and how it relates to coding efficiency.
- Data Structures** Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.
- Algorithms** Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.
- Problem-Solving** Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts.

Phase 1 Introduction to Programming Basics
Before diving into DSA, you need to have a solid understanding of basic programming concepts. This includes Variables, Data Types, and Operators. Understand how variables and data types work in programming languages. Control Flow Learn about if-else conditions, loops (for, while), and switch cases. Functions Master how functions work, including parameters, return types, and recursion. Basic Input and Output Learn how to handle input and output in your programming language of choice.

Phase 2 Learn Basic Data Structures
Arrays Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays. **Strings** Learn how strings are represented in memory and how to manipulate them. **Linked Lists** Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. **Stacks and Queues** Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. **Hashing** Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.

Phase 3 Advanced Data Structures
Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). **Heaps** Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. **Graphs** Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). **Tries** Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. **Disjoint Set Union (DSU)** Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.

Phase 4 Learn Algorithms
Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. **Searching Algorithms** Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. **Dynamic Programming (DP)** Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). **Greedy Algorithms** Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. **Backtracking** Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. **Divide and Conquer** Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. **Graph Algorithms** Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.

Phase 5 Problem Solving and Practice
LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. **Interview Preparation** Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. **Competitive Programming** Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.

Phase 6 Advanced Topics (Optional)
String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. **Advanced Dynamic Programming** Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. **Advanced Graph Algorithms** Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). **Geometry Algorithms** Study algorithms for computational geometry, like convex hull,

line intersection, and closest pair of points. Why is This Roadmap Effective? Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence. Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. Common Mistakes to Avoid Skipping the Basics Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts. Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. Getting Stuck on One Problem If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes. Why Learn DSA? Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications. Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity. Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies. Topics Covered Introduction to DSA Learn the importance of DSA and how it relates to coding efficiency. Data Structures Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps. Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms. Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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LightContrast:var(--nextui-colors-red600);--nextui-colors-error:var(--nextui-colors-red600);--nextui-colors-errorBorder:var(--nextui-colors-red500);--nextui-colors-errorBorderHover:var(--nextui-colors-red600);--nextui-colors-errorSolidHover:var(--nextui-colors-red700);--nextui-colors-errorSolidContrast:var(--nextui-colors-white);--nextui-colors-errorShadow:var(--nextui-colors-red500);--nextui-colors-neutralLight:var(--nextui-colors-gray100);--nextui-colors-neutralLightHover:var(--nextui-colors-gray200);--nextui-colors-neutralLightActive:var(--nextui-colors-gray300);--nextui-colors-neutralLightContrast:var(--nextui-colors-gray800);--nextui-colors-neutral:var(--nextui-colors-gray600);--nextui-colors-neutralBorder:var(--nextui-colors-gray400);--nextui-colors-neutralBorderHover:var(--nextui-colors-gray500);--nextui-colors-neutralSolidHover:var(--nextui-colors-gray600);--nextui-colors-neutralSolidContrast:var(--nextui-colors-white);--nextui-colors-neutralShadow:var(--nextui-colors-gray400);--nextui-colors-gradient:linear-gradient(112deg, var(--nextui-colors-cyan600) -63.59%, var(--nextui-colors-pink600) -20.3%, var(--nextui-colors-blue600) 70.46%);--nextui-colors-accents0:var(--nextui-colors-gray50);--nextui-colors-accents1:var(--nextui-colors-gray100);--nextui-colors-accents2:var(--nextui-colors-gray200);--nextui-colors-accents3:var(--nextui-colors-gray300);--nextui-colors-accents4:var(--nextui-colors-gray400);--nextui-colors-accents5:var(--nextui-colors-gray500);--nextui-colors-accents6:var(--nextui-colors-gray600);--nextui-colors-accents7:var(--nextui-colors-gray700);--nextui-colors-accents8:var(--nextui-colors-gray800);--nextui-colors-accents9:var(--nextui-colors-gray900);--nextui-colors-background:var(--nextui-colors-white);--nextui-colors-backgroundAlpha:rgba(255, 255, 255, 0.8);--nextui-colors-foreground:var(--nextui-colors-black);--nextui-colors-backgroundContrast:var(--nextui-colors-white);--nextui-colors-blue50:#EDF5FF;--nextui-colors-blue100:#E1EFFF;--nextui-colors-blue200:#CEE4FE;--nextui-colors-blue300:#B7D5F8;--nextui-colors-blue400:#96C1F2;--nextui-colors-blue500:#5EA2EF;--nextui-colors-blue600:#0072F5;--nextui-colors-blue700:#005FCC;--nextui-colors-blue800:#004799;--nextui-colors-blue900:#00254D;--nextui-colors-purple50:#F7F2FD;--nextui-colors-purple100:#F1E8FB;--nextui-colors-purple200:#EADCF8;--nextui-colors-purple300:#E0CBF5;--nextui-colors-purple400:#D1B1F0;--nextui-colors-purple500:#BC8EE9;--nextui-colors-purple600:#7828C8;--nextui-colors-purple700:#6622AA;--nextui-colors-purple800:#4D1980;--nextui-colors-purple900:#290E44;--nextui-colors-green50:#F1FDF7;--nextui-colors-green100:#E8FCF1;--nextui-colors-green200:#DAFBE8;--nextui-colors-green300:#C8F9DD;--nextui-colors-green400:#ADF5CC;--nextui-colors-green500:#88F1B6;--nextui-colors-green600:#17C964;--nextui-colors-green700:#13A452;--nextui-colors-green800:#108944;--nextui-colors-green900:#06371B;--nextui-colors-yellow50:#FEF9F0;--nextui-colors-yellow100:#FEF5E7;--nextui-colors-yellow200:#FDEFD8;--nextui-colors-yellow300:#FCE7C5;--nextui-colors-yellow400:#FBD8A7;--nextui-colors-yellow500:#F9CB80;--nextui-colors-yellow600:#F5A524;--nextui-colors-yellow700:#B97509;--nextui-colors-yellow800:#925D07;--nextui-colors-yellow900:#4E3104;--nextui-colors-red50:#FEF0F5;--nextui-colors-red100:#FEE7EF;--nextui-colors-red200:#FDD8E5;--nextui-colors-red300:#FCC5D8;--nextui-colors-red400:#FAA8C5;--nextui-colors-red500:#F881AB;--nextui-colors-red600:#F31260;--nextui-colors-red700:#B80A47;--nextui-colors-red800:#910838;--nextui-colors-red900:#4E041E;--nextui-colors-cyan50:#F0FCFF;--nextui-colors-cyan100:#E6FAFE;--nextui-colors-cyan200:#D7F8FE;--nextui-colors-cyan300:#C3F4FD;--nextui-colors-cyan400:#A5EEFD;--nextui-colors-cyan500:#7EE7FC;--nextui-colors-cyan600:#06B7DB;--nextui-colors-cyan700:#09AACD;--nextui-colors-cyan800:#0E8AAA;--nextui-colors-cyan900:#053B48;--nextui-colors-pink50:#FFF0FB;--nextui-colors-pink100:#FFE5F8;--nextui-colors-pink200:#FFD6F3;--nextui-colors-pink300:#FFC2EE;--nextui-colors-pink400:#FFA3E5;--nextui-colors-pink500:#FF7AD9;--nextui-colors-pink600:#FF4ECD;--nextui-colors-pink700:#D6009A;--nextui-colors-pink800:#B80084;--nextui-colors-pink900:#4D0037;--nextui-colors-gray50:#F1F3F5;--nextui-colors-gray10
```

```
0:#ECEE00;--nextui-colors-gray200:#E6E8EB;--nextui-colors-gray300:#DFE3E6;--
nextui-colors-gray400:#D7DBDF;--nextui-colors-gray500:#C1C8CD;--nextui-color
s-gray600:#889096;--nextui-colors-gray700:#7E868C;--nextui-colors-gray800:#6
87076;--nextui-colors-gray900:#11181C;--nextui-colors-text:var(--nextui-colo
rs-gray900);--nextui-colors-link:var(--nextui-colors-blue600);--nextui-color
s-codeLight:var(--nextui-colors-pink100);--nextui-colors-code:var(--nextui-c
olors-pink600);--nextui-colors-selection:var(--nextui-colors-blue200);--next
ui-colors-border:rgba(0, 0, 0, 0.15);--nextui-shadows-xs:0 2px 8px 1px rgb(1
04 112 118 / 0.07), 0 1px 1px -1px rgb(104 112 118 / 0.04);--nextui-shadows-
sm:0 2px 8px 2px rgb(104 112 118 / 0.07), 0 2px 4px -1px rgb(104 112 118 /
0.04);--nextui-shadows-md:0 12px 20px 6px rgb(104 112 118 / 0.08);--nextui-s
hadows-lg:0 12px 34px 6px rgb(104 112 118 / 0.18);--nextui-shadows-xl:0 25px
65px 0px rgb(104 112 118 / 0.35);--nextui-dropShadows-xs:drop-shadow(0 2px 4
px rgb(104 112 118 / 0.07)) drop-shadow(0 1px 1px rgb(104 112 118 / 0.04));-
--nextui-dropShadows-sm:drop-shadow(0 2px 8px rgb(104 112 118 / 0.07)) drop-s
hadow(0 2px 4px rgb(104 112 118 / 0.04));--nextui-dropShadows-md:drop-shadow
(0 4px 12px rgb(104 112 118 / 0.08)) drop-shadow(0 20px 8px rgb(104 112 118
/ 0.04));--nextui-dropShadows-lg:drop-shadow(0 12px 24px rgb(104 112 118 /
0.15)) drop-shadow(0 12px 14px rgb(104 112 118 / 0.1));--nextui-dropShadows-
xl:drop-shadow(0 25px 34px rgb(104 112 118 / 0.35))}}--sxs{--sxs:1 nextui-k-
dPxXDy nextui-k-jjQGHg nextui-k-eKsxVP nextui-k-fehnNV nextui-k-dSVASG nextu
i-k-fLOxFp nextui-k-itSsug nextui-k-kczHuk nextui-k-gWfstQ nextui-k-jvYHWg n
extui-k-khapXo nextui-k-jto0Cl nextui-k-coIGzE nextui-k-gJKQzh nextui-k-fyNa
ck nextui-k-fAlzUo nextui-k-dfOUfo nextui-k-AVtYN eKDgFc}@media{@keyframes n
extui-k-dPxXDy{0%{opacity:0;transform:scale(0.25)}30%{opacity:1}80%{opacity:
0.5}100%{transform:scale(28);opacity:0}}@keyframes nextui-k-jjQGHg{0%{backgr
ound-position:200% 0}to{background-position:-200% 0}}@keyframes nextui-k-eKs
xVP{0%{opacity:1}100%{opacity:0.15}}@keyframes nextui-k-fehnNV{0%{transform:
rotate(0deg)}100%{transform:rotate(360deg)}}@keyframes nextui-k-dSVASG{0%{tr
ansform:translate(0px, 0px)}50%{transform:translate(0, calc(calc(var(--nextu
i--loadingSize)*-1) * 1.4))}100%{transform:translate(0px, 0px)}}@keyframes n
extui-k-fLOxFp{0%{opacity:0.2}20%{opacity:1}100%{opacity:0.2}}@keyframes nex
tui-k-itSsug{0%{left:-40%}100%{left:100%}}@keyframes nextui-k-kczHuk{0%{tran
sform:scale(1)}60%{transform:scale(var(--nextui--paginationScaleTransform))}
100%{transform:scale(1)}}@keyframes nextui-k-gWfstQ{100%{stroke-dashoffset:
0}}@keyframes nextui-k-jvYHWg{0%{opacity:0;transform:scale(0.2) translate(5
0%, -50%)}60%{opacity:0.75;transform:scale(1.2) translate(50%, -50%)}100%{op
acity:1;transform:scale(1) translate(50%, -50%)}@keyframes nextui-k-khapXo
{0%{opacity:1;transform:scale(1) translate(50%, -50%)}100%{opacity:0;transfo
rm:scale(0.2) translate(50%, -50%)}@keyframes nextui-k-jto0Cl{0%{opacity:0;
transform:scale(0.2) translate(-50%, -50%)}60%{opacity:0.75;transform:scale
(1.2) translate(-50%, -50%)}100%{opacity:1;transform:scale(1) translate(-5
0%, -50%)}@keyframes nextui-k-coIGzE{0%{opacity:1;transform:scale(1) transl
ate(-50%, -50%)}100%{opacity:0;transform:scale(0.2) translate(-50%, -50%)}@
keyframes nextui-k-gJKQzh{0%{opacity:0;transform:scale(0.2) translate(50%, 5
0%)}60%{opacity:0.75;transform:scale(1.2) translate(50%, 50%)}100%{opacity:
1;transform:scale(1) translate(50%, 50%)}@keyframes nextui-k-fyNack{0%{opac
ity:1;transform:scale(1) translate(50%, 50%)}100%{opacity:0;transform:scale
(0.2) translate(50%, 50%)}@keyframes nextui-k-fAlzUo{0%{opacity:0;transfor
m:scale(0.2) translate(-50%, 50%)}60%{opacity:0.75;transform:scale(1.2) tran
slate(-50%, 50%)}100%{opacity:1;transform:scale(1) translate(-50%, 50%)}@ke
yframes nextui-k-dfOUfo{0%{opacity:1;transform:scale(1) translate(-50%, 5
0%)}100%{opacity:0;transform:scale(0.2) translate(-50%, 50%)}@keyframes nex
tui-k-AVtYN{0%{opacity:1}50%{opacity:0.4;transform:scale(0.5)}100%{opacity:
1}}*,*:before,*:after{box-sizing:border-box;text-rendering:geometricPrecisio
n;-webkit-tap-highlight-color:transparent}html{font-size:var(--nextui-fontSi
```

```

zes-base)}}body{margin:0;padding:0;min-height:100%;position:relative;overflow-x:hidden;-webkit-font-smoothing:antialiased;-moz-osx-font-smoothing:grayscale;text-rendering:optimizeLegibility;font-size:var(--nextui-fontSizes-base);line-height:var(--nextui-lineHeights-md);font-family:var(--nextui-fonts-sans)}html,body{background-color:var(--nextui-colors-background);color:var(--nextui-colors-text)}p,small{color:inherit;letter-spacing:var(--nextui-letterSpacings-tighter);font-weight:var(--nextui-fontWeights-normal);font-family:var(--nextui-fonts-sans)}p{font-size:var(--nextui-fontSizes-base);line-height:var(--nextui-lineHeights-lg)}small{margin:0;line-height:var(--nextui-lineHeights-xs);font-size:var(--nextui-fontSizes-xs)}b{font-weight:var(--nextui-fontWeights-semibold)}span{font-size:inherit;color:inherit;font-weight:inherit}img{max-width:100%}a{cursor:pointer;font-size:inherit;-webkit-touch-callout:none;-webkit-tap-highlight-color:rgba(0, 0, 0, 0);-webkit-box-align:center;align-items:center;color:var(--nextui-colors-link);text-decoration:none}a:hover{text-decoration:none}ul,ol{padding:0;list-style-type:none;margin:var(--nextui-space-sm) var(--nextui-space-sm) var(--nextui-space-sm) var(--nextui-space-lg);color:var(--nextui-colors-foreground)}ol{list-style-type:decimal}li{margin-bottom:var(--nextui-space-5);font-size:var(--nextui-fontSizes-base);line-height:var(--nextui-lineHeights-lg)}h1,h2,h3,h4,h5,h6{color:inherit;margin:0 0 var(--nextui-space-5) 0}h1{letter-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-5xl);line-height:var(--nextui-lineHeights-md);font-weight:var(--nextui-fontWeights-bold)}h2{letter-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-4xl);font-weight:var(--nextui-fontWeights-semibold)}h3{letter-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-2xl);font-weight:var(--nextui-fontWeights-semibold)}h4{letter-spacing:var(--nextui-letterSpacings-tighter);font-size:var(--nextui-fontSizes-xl);font-weight:var(--nextui-fontWeights-semibold)}h5{letter-spacing:var(--nextui-letterSpacings-tight);font-size:var(--nextui-fontSizes-md);font-weight:var(--nextui-fontWeights-semibold)}h6{letter-spacing:var(--nextui-letterSpacings-tight);font-size:var(--nextui-fontSizes-sm);font-weight:var(--nextui-fontWeights-semibold)}button,input,select,textarea{font-family:inherit;font-size:inherit;line-height:inherit;color:inherit;margin:0}button:focus,input:focus,select:focus,textarea:focus{outline:none}code{color:var(--nextui-colors-code);padding:var(--nextui-space-1) var(--nextui-space-2);border-radius:var(--nextui-radii-xs);background:var(--nextui-colors-codeLight);font-family:var(--nextui-fonts-mono);font-size:var(--nextui-fontSizes-sm);white-space:pre-wrap;transition:opacity 0.25s ease 0s}code:hover{opacity:0.8}pre{overflow:auto;white-space:pre;text-align:left;font-size:var(--nextui-fontSizes-sm);border-radius:var(--nextui-radii-lg);padding:var(--nextui-space-md) var(--nextui-space-lg);margin:var(--nextui-space-lg) 0;font-family:var(--nextui-fonts-mono);line-height:var(--nextui-lineHeights-md);-webkit-overflow-scrolling:touch}pre code{color:var(--nextui-colors-foreground);font-size:var(--nextui-fontSizes-sm);line-height:var(--nextui-lineHeights-sm);white-space:pre}pre code:before,pre code:after{display:none}pre p{margin:0}pre::-webkit-scrollbar{display:none;width:0;height:0;background:transparent}hr{background:var(--nextui-colors-border);border-color:transparent;border-width:0px;border-style:none;height:1px}details{background-color:var(--nextui-colors-accents1);border:none}details:focus,details:hover,details:active{outline:none}summary{cursor:pointer;-webkit-user-select:none;user-select:none;list-style-type:none;outline:none}summary::-webkit-details-marker,summary::before{display:none}summary::-moz-list-bullet{font-size:0}summary:focus,summary:hover,summary:active{outline:none;list-style-type:none}::selection{background-color:var(--nextui-colors-selection)}blockquote{padding:var(--nextui-space-md) var(--nextui-space-lg);color:var(--nextui-colors-accents7);background-color:var(--nextui-colors-accents0);border-radius:var(--nextui-radii-lg);margin:var(--nextui-space-10) 0}blockquote *:first-child{margin-top:

```

```
0}blockquote *:last-child{margin-bottom:0}kbd{width:-moz-fit-content;width:f
it-content;text-align:center;display:inline-block;color:var(--nextui-colors-
accents8);background:var(--nextui-colors-accents0);border:1px solid var(--ne
xtui-colors-border);box-shadow:0 0 1px 0 rgb(0 0 0 / 14%);font-family:var(--
nextui-fonts-sans);border-radius:5px;padding:var(--nextui-space-1) var(--nex
tui-space-3);margin-left:var(--nextui-space-1);margin-right:var(--nextui-spa
ce-1);line-height:var(--nextui-lineHeights-sm);font-size:var(--nextui-fontSi
zes-sm)}kbd + kbd{margin-left:var(--nextui-space-2)}dl,dd,hr,figure,p{margi
n:0}}--sxs{--sxs:2 nextui-c-iVzbCs nextui-c-FiRH nextui-c-kbhVdb nextui-c-k
RHeuF nextui-c-eKVPvf nextui-c-cUthvm nextui-c-huiNHE nextui-c-fItrmj nextui
-c-eKuzCY nextui-c-cAbbLF nextui-c-kSOHfs}@media{.nextui-c-iVzbCs{opacity:0;
margin:0 auto;position:relative;overflow:hidden;max-width:100%;transition:tr
ansform 250ms ease 0ms, opacity 200ms ease-in 0ms}@media (prefers-reduced-mo
tion: reduce){.nextui-c-iVzbCs{transition:none}}.nextui-c-FiRH{position:abs
olute;top:0;left:0;right:0;bottom:0;width:100%;height:100%;border-radius:inh
erit;background-image:linear-gradient(270deg, var(--nextui-colors-accents1),
var(--nextui-colors-accents2), var(--nextui-colors-accents2), var(--nextui-c
olors-accents1));background-size:400% 100%;animation:nextui-k-jjQGHg 5s ease
-in-out infinite;transition:opacity 300ms ease-out}.nextui-c-kbhVdb{width:10
0%;height:100%;display:block}.nextui-c-kRHeuF{margin:0;box-sizing:border-bo
x;padding:var(--nextui--gridGapUnit)}.nextui-c-eKVPvf{margin:0;padding:0;dis
play:inline-flex;position:relative;font-variant:tabular-nums;font-feature-se
ttings:tnum}.nextui-c-cUthvm{border:none;position:relative;display:inline-fl
ex;margin:0 var(--nextui--paginationItemMargin);align-items:center;justify-c
ontent:center;padding:0;box-sizing:border-box;text-transform:capitalize;-web
kit-user-select:none;-webkit-user-select:none;user-select:none;white-space:n
owrap;text-align:center;vertical-align:middle;box-shadow:none;outline:none;h
eight:var(--nextui--paginationSize);min-width:var(--nextui--paginationSize);
font-size:inherit;cursor:pointer;border-radius:var(--nextui--paginationItemR
adius);color:var(--nextui-colors-text);background:var(--nextui-colors-accen
t0)}@media (prefers-reduced-motion: reduce){.nextui-c-cUthvm{transition:non
e}}.nextui-c-cUthvm:hover{background:var(--nextui-colors-accents1)}.nextui-c
-cUthvm .nextui-c-eKuzCY{width:var(--nextui--paginationFontSize);height:var
(--nextui--paginationFontSize)}.nextui-c-cUthvm .nextui-c-kSOHfs{width:var(-
nextui--paginationFontSize);height:var(--nextui--paginationFontSize)}.nextu
i-c-huiNHE{-webkit-tap-highlight-color:transparent}.nextui-c-huiNHE:focus:no
t(.nextui-c-huiNHE:focus-visible){box-shadow:none}.nextui-c-huiNHE:focus{out
line:none;box-shadow:0 0 0 2px var(--nextui-colors-background), 0 0 0 4px va
r(--nextui-colors-primary)}@media not all and (min-resolution:.001dpcm){.nex
tui-c-huiNHE{-webkit-tap-highlight-color:transparent;outline:none}}.nextui-c
-fItrmj{position:relative;display:inline-flex;align-items:center;top:0;left:
0;z-index:var(--nextui-zIndices-2)}.nextui-c-eKuzCY{transform:rotate(180de
g)}.nextui-c-cAbbLF{position:absolute;contain:strict;top:0px;z-index:var(--n
extui-zIndices-1);background:var(--nextui--paginationColor);border-radius:va
r(--nextui--paginationItemRadius);height:var(--nextui--paginationSize);min-w
idth:var(--nextui--paginationSize);animation-name:nextui-k-kczHuk;animation-
direction:normal}.nextui-c-cAbbLF.nextui-pagination-highlight--moving{transf
orm:scale(var(--nextui--paginationScaleTransform))}@media (prefers-reduced-m
otion: reduce){.nextui-c-cAbbLF{transition:none}}@media (prefers-reduced-mot
ion: reduce){.nextui-c-cAbbLF.nextui-pagination-highlight--moving{transform:
scale(1)}}.nextui-c-kSOHfs{color:currentColor;stroke:currentColor}}--sxs{--s
xs:3 nextui-c-iVzbCs-bDGmTT-ready-true nextui-c-eKVPvf-eRVIX-color-success
nextui-c-eKVPvf-UECOZ-size-md nextui-c-eKVPvf-iTJSWG-borderWeight-normal nex
tui-c-eKVPvf-ibzOHM-onlyDots-false nextui-c-eKVPvf-bNGYLG-rounded-false next
ui-c-eKVPvf-QbeIJ-noMargin-false nextui-c-cUthvm-gZRAKC-disabled-true nextui
-c-cUthvm-SWDEj-animated-true nextui-c-eKuzCY-xROYZ-isPrev-true nextui-c-cAb
```

```

bLF-QIzBs-animated-true nextui-c-cAbbLF-gZGrDk-shadow-true nextui-c-cUthvm-d
ZWcT-active-true}@media{.nextui-c-iVzbCs-bDGmTT-ready-true{opacity:1}.nextu
i-c-eKVPvf-eRVIX-color-success{--nextui--paginationColor:var(--nextui-color
s-success);--nextui--paginationShadowColor:var(--nextui-colors-successShado
w)}.nextui-c-eKVPvf-UECOZ-size-md{--nextui--paginationWidth:var(--nextui-spa
ce-13);--nextui--paginationFontSize:var(--nextui-space-7);font-size:var(--ne
xtui--paginationFontSize)}.nextui-c-eKVPvf-iTJSWG-borderWeight-normal{--next
ui--paginationItemBorderWeight:var(--nextui-borderWeights-normal)}.nextui-c-
eKVPvf-ibzOHM-onlyDots-false{--nextui--paginationSize:var(--nextui--paginati
onWidth);--nextui--paginationScaleTransform:1.1}.nextui-c-eKVPvf-bNGYLg-roun
ded-false{--nextui--paginationItemRadius:var(--nextui-radii-squared)}.nextui
-c-eKVPvf-QbeIJ-noMargin-false{--nextui--paginationItemMargin:var(--nextui-s
pace-1)}.nextui-c-cUthvm-gZRAkC-disabled-true{color:var(--nextui-colors-acce
nts5);cursor:not-allowed}.nextui-c-cUthvm-SWDEj-animated-true{transition:tra
nsform 0.25s ease 0s, background 0.25s ease 0s, box-shadow 0.25s ease 0s}.ne
xtui-c-eKuzCY-xROYZ-isPrev-true{transform:rotate(0deg)}.nextui-c-cAbbLF-QIzB
s-animated-true{animation-duration:350ms;animation-timing-function:ease;tran
sition:left 350ms ease 0s, transform 300ms ease 0s}.nextui-c-cAbbLF-gZGrDk-s
hadow-true{box-shadow:0 4px 14px 0 var(--nextui--paginationShadowColor)}.nex
tui-c-cUthvm-dZWcT-active-true{font-weight:var(--nextui-fontWeights-bold);c
ursor:default;box-shadow:var(--nextui-shadows-sm)}.nextui-c-cUthvm-dZWcT-ac
tive-true .nextui-c-fItrmj{color:var(--nextui-colors-white)}}--sxs{--sxs:6 n
extui-c-iVzbCs-ieUYNBT-css nextui-c-FIiRH-ibDGmTT-css nextui-c-kbhVdb-iUwpm
y-css nextui-c-iVzbCs-iyXqdA-css nextui-c-kbhVdb-ikZHsFe-css nextui-c-kRHeuF
-ibhk0xP-css nextui-c-kRHeuF-icxokNG-css nextui-c-cAbbLF-ikgtVxo-css}@media{
nextui-c-iVzbCs-ieUYNBT-css{width:500px;height:280px}.nextui-c-FIiRH-ibDGmTT
-css{opacity:1}.nextui-c-kbhVdb-iUwpm-css{object-fit:fill}.nextui-c-iVzbCs-
iyXqdA-css{width:60px;height:60px}.nextui-c-kbhVdb-ikZHsFe-css{object-fit:sc
ale-down}.nextui-c-kRHeuF-ibhk0xP-css{align-items;;align-content;;justify-co
ntent;;flex-direction:}.nextui-c-kRHeuF-ibhk0xP-css.xs{flex-grow:1;display:i
nherit;max-width:100%;flex-basis:0}@media (max-width: 650px){.nextui-c-kRHeu
F-ibhk0xP-css.xs{flex-grow:1;display:inherit;max-width:100%;flex-basis:0}}@me
dia (min-width: 960px){.nextui-c-kRHeuF-ibhk0xP-css.sm{flex-grow:1;display:
inherit;max-width:100%;flex-basis:0}}@media (min-width: 1280px){.nextui-c-kR
HeuF-ibhk0xP-css.md{flex-grow:1;display:inherit;max-width:100%;flex-basis:
0}}@media (min-width: 1400px){.nextui-c-kRHeuF-ibhk0xP-css.lg{flex-grow:1;di
splay:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1920px){.nextu
i-c-kRHeuF-ibhk0xP-css.xl{flex-grow:1;display:inherit;max-width:100%;flex-ba
sis:0}}.nextui-c-kRHeuF-ibhk0xP-css{--nextui--gridGapUnit:calc(2 * var(--nex
tui-space-3));display:flex;flex-wrap:wrap;box-sizing:border-box;margin:calc
(-1 * var(--nextui--gridGapUnit));width:calc(100% + var(--nextui--gridGapUni
t) * 2)}.nextui-c-kRHeuF-icxokNG-css{align-items;;align-content;;justify-con
tent;;flex-direction:}.nextui-c-kRHeuF-icxokNG-css.xs{flex-grow:0;display:in
herit;max-width:100%;flex-basis:100%}@media (max-width: 650px){.nextui-c-kRH
euF-icxokNG-css.xs{flex-grow:0;display:inherit;max-width:100%;flex-basis:10
0%}}@media (min-width: 960px){.nextui-c-kRHeuF-icxokNG-css.sm{flex-grow:1;di
splay:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1280px){.nextu
i-c-kRHeuF-icxokNG-css.md{flex-grow:1;display:inherit;max-width:100%;flex-ba
sis:0}}@media (min-width: 1400px){.nextui-c-kRHeuF-icxokNG-css.lg{flex-grow:
1;display:inherit;max-width:100%;flex-basis:0}}@media (min-width: 1920px){.n
extui-c-kRHeuF-icxokNG-css.xl{flex-grow:1;display:inherit;max-width:100%;fle
x-basis:0}}.nextui-c-cAbbLF-ikgtVxo-css{left:var(--nextui--paginationLeft)}}
</style>

```

<meta content="Your All-in-One Learning Portal. It contains well written, well thought and well explained computer science and programming articles, quizzes and practice/competitive programming/company interview Questions." na


```
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  <link data-n-g="" href="https://assets.geeksforgeeks.org/gfg-assets/_next/
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  </script>
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  <script defer="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/st
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  </script>
  <script defer="" src="https://assets.geeksforgeeks.org/gfg-assets/_next/st
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```

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</script>
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</script>
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0;700&family=Source+Sans+3:wght@400;600&display=swap">
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splay:swap;src:url(https://fonts.gstatic.com/l/font?kit=XRXI3I6Li01BKofi0c5w
tLZ2di8HDLshRTA&skey=27bb6aa8eea8a5e7&v=v32) format('woff')}@font-face{font-
family: 'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url
(https://fonts.gstatic.com/l/font?kit=XRXI3I6Li01BKofi0c5wtLZ2di8HDFwmRTA&sk
ey=27bb6aa8eea8a5e7&v=v32) format('woff')}@font-face{font-family: 'Source San
s 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fon
ts.gstatic.com/l/font?kit=nwpBtKy20AdR1K-IwhWudF-R9QMyLBJAV3Bo8Ky461E0&skey=
1497ac707ba83cff&v=v19) format('woff')}@font-face{font-family: 'Source Sans
3';font-style:normal;font-weight:600;font-display:swap;src:url(https://font
s.gstatic.com/l/font?kit=nwpBtKy20AdR1K-IwhWudF-R9QMyLBJAV3Bo8Kxm7FE0&skey=1
497ac707ba83cff&v=v19) format('woff')}@font-face{font-family: 'Nunito';font-s
tyle:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.
com/s/nunito/v32/XRXV3I6Li01BKofI00aBTMnFcQIG.woff2) format('woff2');unicode
-range:U+0460-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@f
ont-face{font-family: 'Nunito';font-style:normal;font-weight:400;font-displa
y:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIMEaBTM
nFcQIG.woff2) format('woff2');unicode-range:U+0301,U+0400-045F,U+0490-0491,U
+04B0-04B1,U+2116}@font-face{font-family: 'Nunito';font-style:normal;font-wei
ght:400;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRX
V3I6Li01BKofI0uaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0102-0103,U
+0110-0111,U+0128-0129,U+0168-0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+030
3-0304,U+0308-0309,U+0323,U+0329,U+1EA0-1EF9,U+20AB}@font-face{font-famil
y: 'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(http
s://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofI0-aBTMnFcQIG.woff2) forma
t('woff2');unicode-range:U+0100-02BA,U+02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+0
2DD-02FF,U+0304,U+0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+2
0A0-20AB,U+20AD-20C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-famil
y: 'Nunito';font-style:normal;font-weight:400;font-display:swap;src:url(http
s://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofINEaBTMnFcQ.woff2) format
('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02C6,U+
02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+2193,U+2
212,U+2215,U+FEFF,U+FFFD}@font-face{font-family: 'Nunito';font-style:normal;f
ont-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/
v32/XRXV3I6Li01BKofI00aBTMnFcQIG.woff2) format('woff2');unicode-range:U+0460
-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@font-face{font
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(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofIMEaBTMnFcQIG.woff2)
format('woff2');unicode-range:U+0301,U+0400-045F,U+0490-0491,U+04B0-04B1,U+2
116}@font-face{font-family: 'Nunito';font-style:normal;font-weight:700;font-d
isplay:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofI0
uaBTMnFcQIG.woff2) format('woff2');unicode-range:U+0102-0103,U+0110-0111,U+0
128-0129,U+0168-0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+0303-0304,U+0308-
0309,U+0323,U+0329,U+1EA0-1EF9,U+20AB}@font-face{font-family: 'Nunito';font-s
tyle:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.
com/s/nunito/v32/XRXV3I6Li01BKofI0-aBTMnFcQIG.woff2) format('woff2');unicode
-range:U+0100-02BA,U+02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+02DD-02FF,U+0304,U+
0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+20A0-20AB,U+20AD-20
```

C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-family:'Nunito';font-style:normal;font-weight:700;font-display:swap;src:url(https://fonts.gstatic.com/s/nunito/v32/XRXV3I6Li01BKofINeaBTMnFcQ.woff2) format('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wIaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0460-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wsaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0301,U+0400-045F,U+0490-0491,U+04B0-04B1,U+2116}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wMaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+1F00-1FFF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wwaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0370-0377,U+037A-037F,U+0384-038A,U+038C,U+038E-03A1,U+03A3-03FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wAaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0102-0103,U+0110-0111,U+0128-0129,U+0168-0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+0303-0304,U+0308-0309,U+0323,U+0329,U+1EA0-1EF9,U+20AB}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wEaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0100-02BA,U+02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+02DD-02FF,U+0304,U+0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+20A0-20AB,U+20AD-20C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:400;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3w8aZejf5Hc.woff2) format('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wIaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0460-052F,U+1C80-1C8A,U+20B4,U+2DE0-2DFF,U+A640-A69F,U+FE2E-FE2F}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wsaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0301,U+0400-045F,U+0490-0491,U+04B0-04B1,U+2116}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wMaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+1F00-1FFF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wwaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0370-0377,U+037A-037F,U+0384-038A,U+038C,U+038E-03A1,U+03A3-03FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wAaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0102-0103,U+0110-0111,U+0128-0129,U+0168-0169,U+01A0-01A1,U+01AF-01B0,U+0300-0301,U+0303-0304,U+0308-0309,U+0323,U+0329,U+1EA0-1EF9,U+20AB}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3wEaZejf5HdF8Q.woff2) format('woff2');unicode-range:U+0100-02BA,U+

02BD-02C5,U+02C7-02CC,U+02CE-02D7,U+02DD-02FF,U+0304,U+0308,U+0329,U+1D00-1DBF,U+1E00-1E9F,U+1EF2-1EFF,U+2020,U+20A0-20AB,U+20AD-20C0,U+2113,U+2C60-2C7F,U+A720-A7FF}@font-face{font-family:'Source Sans 3';font-style:normal;font-weight:600;font-display:swap;src:url(https://fonts.gstatic.com/s/sourcesans3/v19/nwpStKy20AdR1K-IwhWudF-R3w8aZejf5Hc.woff2) format('woff2');unicode-range:U+0000-00FF,U+0131,U+0152-0153,U+02BB-02BC,U+02C6,U+02DA,U+02DC,U+0304,U+0308,U+0329,U+2000-206F,U+20AC,U+2122,U+2191,U+2193,U+2212,U+2215,U+FEFF,U+FFFD}

</style>

</head>

<body>

<div data-reactroot="" id="__next">

<div style="visibility:hidden;background-color:#ffffff;min-height:100vh">

<div data-overlay-container="true">

<style>

#nprogress {
 pointer-events: none;
}

#nprogress .bar {
 background: #29D;
 position: fixed;
 z-index: 9999;
 top: 0;
 left: 0;
 width: 100%;
 height: 3px;
}

#nprogress .peg {
 display: block;
 position: absolute;
 right: 0px;
 width: 100px;
 height: 100%;
 box-shadow: 0 0 10px #29D, 0 0 5px #29D;
 opacity: 1;
 -webkit-transform: rotate(3deg) translate(0px, -4px);
 -ms-transform: rotate(3deg) translate(0px, -4px);
 transform: rotate(3deg) translate(0px, -4px);
}

#nprogress .spinner {
 display: block;
 position: fixed;
 z-index: 1031;
 top: 15px;
 right: 15px;
}

#nprogress .spinner-icon {
 width: 18px;
 height: 18px;
 box-sizing: border-box;
 border: solid 2px transparent;
 border-top-color: #29D;
 border-left-color: #29D;
 border-radius: 50%;
 -webkit-animation: nprogress-spinner 400ms linear infinite;
 animation: nprogress-spinner 400ms linear infinite;

```

}
.nprogress-custom-parent {
  overflow: hidden;
  position: relative;
}
.nprogress-custom-parent #nprogress .spinner,
.nprogress-custom-parent #nprogress .bar {
  position: absolute;
}
@-webkit-keyframes nprogress-spinner {
  0% {
    -webkit-transform: rotate(0deg);
  }
  100% {
    -webkit-transform: rotate(360deg);
  }
}
@keyframes nprogress-spinner {
  0% {
    transform: rotate(0deg);
  }
  100% {
    transform: rotate(360deg);
  }
}
</style>
<div class="root" data-dark-mode="false" id="data-mode" style="display:
block">
  <div id="comp">
    <div class="root gfg_header__root" style="display:none">
      <div id="comp">
        <div class="gfgheader_parentContainer">
          <div class="containerWrapper" id="topMainHeader">
            <div class="headerContainer">
              <div style="display:flex;align-items:center;width:304px">
                <a class="headerMainLogo" href="https://www.geeksforgeeks.or
g/">
                  <div class="logo">
                    
                  </div>
                </a>
                <div class="gs-plus-suggestion-container" style="padding-left:6
px;border-radius:7px">
                  <div class="gs-input_wrapper gs-show-search-bar">
                    <span class="flexR gs-search-icon">
                      <i class="gfg-icon gfg-icon-grey-search">
                        </i>
                      </span>
                    <form class="gs-form">
                      <input class="gs-input" placeholder="Search..." type="text"
value=""/>
                    </form>
                  </div>
                </div>
              </div>
            </div>
          </div>
        </div>
      </div>
    </div>
  </div>

```

```

        <ul class="headerMainList">
            <li class="headerMainListItem">
                <span class="genericHeaderListClass" style="display:flex;align
-items:center">
                    <div style="display:inline">
                        Courses
                    <div>
                    </div>
                </div>
                <i class="gfg-icon gfg-icon-black-down-carrot genericHeaderLi
stClass" style="position:relative;left:2px;top:0px">
                </i>
            </span>
        </li>
        <li class="headerMainListItem">
            <span class="genericHeaderListClass" style="display:flex;align
-items:center">
                <div style="display:inline">
                    Tutorials
                <div>
                </div>
            </div>
            <i class="gfg-icon gfg-icon-black-down-carrot genericHeaderLi
stClass" style="position:relative;left:2px;top:0px">
            </i>
        </span>
    </li>
    <li class="headerMainListItem">
        <span class="genericHeaderListClass" style="display:flex;align
-items:center">
            <div style="display:inline">
                Practice
            <div>
            </div>
        </div>
        <i class="gfg-icon gfg-icon-black-down-carrot genericHeaderLi
stClass" style="position:relative;left:2px;top:0px">
        </i>
    </span>
</li>
<li class="headerMainListItem">
    <span class="genericHeaderListClass" style="display:flex;align
-items:center">
        <div style="display:inline">
            Jobs
        <div>
        </div>
    </div>
    <i class="gfg-icon gfg-icon-black-down-carrot genericHeaderLi
stClass" style="position:relative;left:2px;top:0px">
    </i>
</span>
</li>
</ul>
<div class="header-main__container" style="display:flex;width:au
to;align-items:center">

```

```

        <div style="width:100px;margin-right:20px;display:flex;justify-
content:flex-end">
        </div>
        <div style="display:flex;align-items:center;margin:0 6px;gap:6p
x">
            <div class="darkMode-wrap darkMode-wrap-desktop" data-mode="Sw
itch to Dark Mode">
                <button aria-label="Toggle GFG Theme" data-gfg-action="toggle
GFGTheme">
                    <div class="darkMode-wrap-red-dot">
                    </div>
                    <i class="gfg-icon gfg-icon_dark-mode">
                    </i>
                    </button>
                    <span class="darkModeTooltipText">
                    </span>
                    </div>
                    <div class="notification_container">
                        <div class="notification-bell-icon">
                        </div>
                    </div>
                </div>
                <div style="min-width:73px">
                    <div style="height:36px">
                    </div>
                </div>
            </div>
        </div>
        </div>
        </div>
        <div id="script">
        </div>
    </div>
    <div class="mainSubHeaderDiv" style="position:sticky;top:0;z-index:10
0;width:100%;display:block">
        <div class="gfg_header__root" data-dark-mode="false">
            <div class="outisdeMainContainerSubheader with_shadow" style="backg
round-color:white">
                <div class="mainContainerSubheader with_shadow" id="secondarySubHe
ader">
                    <ul class="containerSubheader" style="background-color:white;just
ify-content:center">
                        <li>
                            <a class="link" href="https://www.geeksforgeeks.org/dsa/dsa-tut
orial-learn-data-structures-and-algorithms/" style="color:#273239">
                                DSA Tutorial
                            </a>
                        </li>
                        <li>
                            <a class="link" href="https://www.geeksforgeeks.org/dsa/top-100
-data-structure-and-algorithms-dsa-interview-questions-topic-wise/" style="c
olor:#273239">
                                Interview Questions
                            </a>
                        </li>
                    </ul>
                </div>
            </div>
        </div>
    </div>

```

```

        <li>
            <a class="link" href="https://www.geeksforgeeks.org/dsa/data-structures-and-algorithms-online-quiz/" style="color:#273239">
                Quizzes
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/dsa/must-do-coding-questions-for-companies-like-amazon-microsoft-adobe/" style="color:#273239">
                Must Do
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/dsa/advanced-data-structures/" style="color:#273239">
                Advanced DSA
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/system-design/system-design-tutorial/" style="color:#273239">
                System Design
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/aptitude/aptitude-questions-and-answers/" style="color:#273239">
                Aptitude
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/aptitude/puzzles/" style="color:#273239">
                Puzzles
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/interview-prep/interview-corner/" style="color:#273239">
                Interview Corner
            </a>
        </li>
        <li>
            <a class="link" href="https://www.geeksforgeeks.org/dsa/python-data-structures-and-algorithms/" style="color:#273239">
                DSA Python
            </a>
        </li>
    </ul>
</div>
</div>
</div>
</div>
</div>

```



```

<script defer="" src="https://securepubads.g.doubleclick.net/tag/js/g
pt.js">
</script>
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n.js?ver=0.1">
</script>
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in.js">
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0.1">
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sibP">
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_i0Fji">
<div class="LeftbarContainer_leftBarContainer__sticky__randomDiv__
_leftBarInnerContainer__M_ajm">
<div>
<div class="LeftbarPromotionalCTA_promotionalCtaOuterDiv__prom
otionalCta__Uatcl">
<li class="share-experience-modal" style="background-color: v
ar(--leftbar-explore-section-color) !important;">
<a href="https://write.geeksforgeeks.org/#experiences" style
="cursor:pointer;display: block;border-bottom: 1px solid var(--gfg-body-colo
r-alternate);">
Share Your Experiences
</a>
</li>
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v__leftBarInnerContainer__leftBarSticky__XRGJ1 undefined">
<div class="LeftbarDropDown_linksWithDropDownContainer__dCoD
N">
<div class="LeftbarDropDown_linksWithDropDownContainer__cards
__nqWee">
<div class="LeftbarDropDown_linksWithDropDownContainer__card
s__dropdownHeading__ra28W">
<span>
DSA Fundamentals
</span>
<i class="">
</i>
</div>
<ul class="LeftbarDropDown_linksWithDropDownContainer__dropd
ownContent__DLY4g">
<li>
<a href="https://www.geeksforgeeks.org/dsa/logic-building-
problems/" style="display:flex;justify-content:space-between;align-items:cen
ter">
<span>

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```

        Logic Building Problems
    </span>
</a>
</li>
<li>
    <a href="https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/" style="display: flex; justify-content: space-between; align-items: center">
        <span>
            Analysis of Algorithms
        </span>
    </a>
</li>
</ul>
</div>
</div>
<div class="LeftbarDropDown_linksWithDropDownContainer__dCoDN">
    <div class="LeftbarDropDown_linksWithDropDownContainer__cards__nqWee">
        <div class="LeftbarDropDown_linksWithDropDownContainer__cards__dropdownHeading__ra28W">
            <span>
                Data Structures
            </span>
            <i class="">
            </i>
        </div>
        <ul class="LeftbarDropDown_linksWithDropDownContainer__dropdownContent__DLY4g">
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/array-data-structure-guide/" style="display: flex; justify-content: space-between; align-items: center">
                    <span>
                        Array Data Structure
                    </span>
                </a>
            </li>
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/string-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                    <span>
                        String in Data Structure
                    </span>
                </a>
            </li>
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/hashing-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                    <span>
                        Hashing in Data Structure
                    </span>
                </a>
            </li>
        </ul>
    </div>

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        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/linked-list-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Linked List Data Structure
                </span>
            </a>
        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/stack-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Stack Data Structure
                </span>
            </a>
        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/queue-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Queue Data Structure
                </span>
            </a>
        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/tree-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Tree Data Structure
                </span>
            </a>
        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/graph-data-structure/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Graph Data Structure
                </span>
            </a>
        </li>
        <li>
            <a href="https://www.geeksforgeeks.org/dsa/trie-insert-and-search/" style="display: flex; justify-content: space-between; align-items: center">
                <span>
                    Trie Data Structure
                </span>
            </a>
        </li>
    </ul>

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        </div>
    </div>
    <div class="LeftbarDropDown_linksWithDropDownContainer__dCoD
N">
        <div class="LeftbarDropDown_linksWithDropDownContainer__cards
__nqWee">
            <div class="LeftbarDropDown_linksWithDropDownContainer__card
s__dropdownHeading__ra28W">
                <span>
                    Algorithms
                </span>
                <i class="">
                </i>
            </div>
            <ul class="LeftbarDropDown_linksWithDropDownContainer__dropd
ownContent__DLY4g">
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                    <a href="https://www.geeksforgeeks.org/dsa/searching-algor
ithms/" style="display:flex;justify-content:space-between;align-items:cente
r">
                        <span>
                            Searching Algorithms
                        </span>
                    </a>
                </li>
                <li>
                    <a href="https://www.geeksforgeeks.org/dsa/sorting-algorit
hms/" style="display:flex;justify-content:space-between;align-items:center">
                        <span>
                            Sorting Algorithms
                        </span>
                    </a>
                </li>
                <li>
                    <a href="https://www.geeksforgeeks.org/introduction-to-rec
ursion-2/" style="display:flex;justify-content:space-between;align-items:cen
ter">
                        <span>
                            Introduction to Recursion
                        </span>
                    </a>
                </li>
                <li>
                    <a href="https://www.geeksforgeeks.org/dsa/greedy-algorith
ms/" style="display:flex;justify-content:space-between;align-items:center">
                        <span>
                            Greedy Algorithms
                        </span>
                    </a>
                </li>
                <li>
                    <a href="https://www.geeksforgeeks.org/dsa/graph-data-stru
cture-and-algorithms/" style="display:flex;justify-content:space-between;ali
gn-items:center">
                        <span>
                            Graph Algorithms

```

```

        </span>
    </a>
</li>
<li>
    <a href="https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/" style="display:flex;justify-content:space-between;align-items:center">
        <span>
            Dynamic Programming or DP
        </span>
    </a>
</li>
<li>
    <a href="https://www.geeksforgeeks.org/dsa/bitwise-algorithms/" style="display:flex;justify-content:space-between;align-items:center">
        <span>
            Bitwise Algorithms
        </span>
    </a>
</li>
</ul>
</div>
</div>
<div class="LeftbarDropDown_linksWithDropDownContainer__dCoDN">
    <div class="LeftbarDropDown_linksWithDropDownContainer__cards__nqWee">
        <div class="LeftbarDropDown_linksWithDropDownContainer__cards__dropdownHeading__ra28W">
            <span>
                Advanced
            </span>
            <i class="">
            </i>
        </div>
        <ul class="LeftbarDropDown_linksWithDropDownContainer__dropdownContent__DLY4g">
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/segment-tree-data-structure/" style="display:flex;justify-content:space-between;align-items:center">
                    <span>
                        Segment Tree
                    </span>
                </a>
            </li>
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/binary-indexed-tree-or-fenwick-tree-2/" style="display:flex;justify-content:space-between;align-items:center">
                    <span>
                        Binary Indexed Tree or Fenwick Tree
                    </span>
                </a>
            </li>
            <li>

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        <a href="https://www.geeksforgeeks.org/dsa/square-root-sqr
t-decomposition-algorithm/" style="display:flex;justify-content:space-between;align-items:center">
            <span>
                Square Root (Sqrt) Decomposition Algorithm
            </span>
        </a>
    </li>
    <li>
        <a href="https://www.geeksforgeeks.org/competitive-program
ming/binary-lifting-guide-for-competitive-programming/" style="display:flex;
justify-content:space-between;align-items:center">
            <span>
                Binary Lifting
            </span>
        </a>
    </li>
    <li>
        <a href="https://www.geeksforgeeks.org/maths/geometry/" st
yle="display:flex;justify-content:space-between;align-items:center">
            <span>
                Geometry
            </span>
        </a>
    </li>
</ul>
</div>
</div>
<div class="LeftbarDropDown_linksWithDropDownContainer__dCoD
N">
    <div class="LeftbarDropDown_linksWithDropDownContainer__cards
__nqWee">
        <div class="LeftbarDropDown_linksWithDropDownContainer__card
s__dropdownHeading__ra28W">
            <span>
                Interview Preparation
            </span>
            <i class="">
            </i>
        </div>
        <ul class="LeftbarDropDown_linksWithDropDownContainer__dropd
ownContent__DLY4g">
            <li>
                <a href="https://www.geeksforgeeks.org/interview-corner/"
style="display:flex;justify-content:space-between;align-items:center">
                    <span>
                        Interview Corner
                    </span>
                </a>
            </li>
            <li>
                <a href="https://www.geeksforgeeks.org/blogs/gfg160-160-da
ys-of-problem-solving/" style="display:flex;justify-content:space-between;al
ign-items:center">
                    <span>
                        GfG160

```

```

        </span>
    </a>
</li>
</ul>
</div>
</div>
<div class="LeftbarDropDown_linksWithDropDownContainer__dCoD
N">
    <div class="LeftbarDropDown_linksWithDropDownContainer__cards
__nqWee">
        <div class="LeftbarDropDown_linksWithDropDownContainer__card
s__dropdownHeading__ra28W">
            <span>
                Practice Problem
            </span>
            <i class="">
            </i>
        </div>
        <ul class="LeftbarDropDown_linksWithDropDownContainer__dropd
ownContent__DLY4g">
            <li>
                <a href="https://www.geeksforgeeks.org/dsa/geeksforgeeks-p
ractice-best-online-coding-platform/" style="display:flex;justify-content:sp
ace-between;align-items:center">
                    <span>
                        GeeksforGeeks Practice - Leading Online Coding Platform
                    </span>
                </a>
            </li>
            <li>
                <a href="https://www.geeksforgeeks.org/blogs/problem-of-th
e-day-develop-the-habit-of-coding/" style="display:flex;justify-content:spac
e-between;align-items:center">
                    <span>
                        Problem of The Day - Develop the Habit of Coding
                    </span>
                </a>
            </li>
        </ul>
    </div>
</div>
</div>
<li class="LeftbarLastOptionCTA_courseListItem__B0E0n">
    <a class="LeftbarLastOptionCTA_courseListItem__outerATag__gMkx
4" href="https://www.geeksforgeeks.org/courses/dsa-self-paced">
        <span class="LeftbarLastOptionCTA_courseListItem__outerATag__
courseTitle__2e_TR">
            DSA Course
        </span>
        <span class="LeftbarLastOptionCTA_courseListItem__outerATag__
courseCta__iPL4R undefined">
            Courses
        </span>
    </a>
</li>
</div>

```

```

        </div>
    </div>
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article__viewer__83Rkj article--viewer">
    <div style="display:flex;flex-direction:column">
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lex;align-items:center">
                    <div style="width:100%">
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                            <h1>
                                DSA Tutorial
                            </h1>
                        </div>
                        <div class="ArticleHeader_last_updated_parent__ohhpb">
                            <div>
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                                    Last Updated :
                                </span>
                                <span>
                                    25 Dec, 2025
                                </span>
                            </div>
                            <div class="ArticleHeader_last_updated_parent--three_dot_dro
pdown__yslcl">
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nd-position:0px -26px">
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                                        <div class="ArticleThreeDot_comment__gJfFl" style="backgr
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ound-position:-40px -521px">
                                        </div>
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                                                <li>
                                                </li>
                                                <li>
                                                </li>
                                                <li>
                                                </li>
                                            </ul>
                                        </div>
                                    </div>
                                </div>
                            </div>
                        </div>
                    </div>
                <div class="MainArticleContent_articleMainContentCss__b_1_R art
icle--viewer_content">

```



```

<div class="a-wrapper">
  <div class="content">
    <div class="text">
      <div class="html-chunk">
        <p dir="ltr">
          <span>
            DSA stands for
          </span>
          <b>
            <strong>
              D
            </strong>
          </b>
          <span>
            ata
          </span>
          <b>
            <strong>
              S
            </strong>
          </b>
          <span>
            tructures and
          </span>
          <b>
            <strong>
              A
            </strong>
          </b>
          <span>
            lgorithms. Data structures manage how data is stored and
            accessed. Algorithms focus on processing this data. Examples of data struct
            ures are Array, Linked List, Tree and Heap, and examples of algorithms are B
            inary Search, Quick Sort and Merge Sort.
          </span>
        </p>
        <ul>
          <li value="1">
            <span>
              Foundation for almost every software like GPS, Search E
              ngines, AI ChatBots, Gaming Apps, Databases, Web Applications, etc
            </span>
          </li>
          <li value="2">
            <span>
              Top Companies like Google, Microsoft, Amazon, Apple, Me
            </span>
          </li>
        </ul>
      </div>
    </div>
  </div>

```

```

        <strong>
            i
        </strong>
    </b>
    <span>
        n interviews.
    </span>
</li>
<li value="3">
    <span>
        Learning DSA boosts your problem-solving abilities and
make you a stronger programmer.
    </span>
</li>
</ul>
<p dir="ltr">
    <span>
        Before beginning the DSA journey, it is recommended to l
earn at-least one programming language (
    </span>
    <a href="https://www.geeksforgeeks.org/cpp/c-plus-plus/"
rel="noopener" target="_blank">
        <span>
            C++
        </span>
    </a>
    <span>
        ,
    </span>
    <a href="https://www.geeksforgeeks.org/java/java/" rel="n
oopener" target="_blank">
        <span>
            Java
        </span>
    </a>
    <span>
        ,
    </span>
    <a href="https://www.geeksforgeeks.org/python/python-prog
ramming-language-tutorial/" rel="noopener" target="_blank">
        <span>
            Python
        </span>
    </a>
    <span>
        ,
    </span>
    <a href="https://www.geeksforgeeks.org/javascript/javascr
ipt-tutorial/" rel="noopener" target="_blank">
        <span>
            JavaScript
        </span>
    </a>
    <span>
        or any other language of your choice).
    </span>

```

```

</p>
<p dir="ltr">
  <span>
    Below are the recommended step by step topics to learn c
complete DSA.
  </span>
</p>
<h3 id="1-logic-building" style="text-align:left">
  <b>
    <strong>
      1. Logic Building
    </strong>
    </b>
  </h3>
  <p dir="ltr">
    <span>
      Once you have learned basics of a programming language,
it is recommended that you learn basic logic building
    </span>
  </p>
  <ul>
    <li value="1">
      <a href="https://www.geeksforgeeks.org/dsa/logic-buildin
g-problems/" rel="noopener" target="_blank">
        <span>
          Logic Building Guide
        </span>
      </a>
    </li>
    <li value="2">
      <a href="https://www.geeksforgeeks.org/quizzes/dsa-tutor
ial-logic-building/" rel="noopener" target="_blank">
        <span>
          Quiz on Logic Building
        </span>
      </a>
    </li>
  </ul>
  <h3 id="2-learn-about-complexities" style="text-align:lef
t">
    <span>
      2. Learn about Complexities
    </span>
  </h3>
  <p dir="ltr">
    <span>
      To analyze algorithms, we mainly measure order of growth
of time or space taken in terms of input size. We do this in the worst case
scenario in most of the cases. Please refer the below links for a clear unde
rstanding of these concepts.
    </span>
  </p>
  <ul>
    <li value="1">
      <a href="https://www.geeksforgeeks.org/dsa/analysis-of-a
lgorithms/" rel="noopener" target="_blank">

```

```

        <span>
            Complexity Analysis Guide
        </span>
    </a>
    <span>
    </span>
</li>
<li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/quiz-on-c
omplexity-analysis-for-dsa/" rel="noopener" target="_blank">
        <span>
            Quiz on Complexity Analysis
        </span>
    </a>
</li>
</ul>
<h3 id="3-array" style="text-align:left">
    <span>
        3. Array
    </span>
</h3>
<p dir="ltr">
    <span>
        Array is a linear data structure where elements are allo
cated contiguous memory, allowing for constant-time access.
    </span>
    <a href="https://www.geeksforgeeks.org/dsa/introduction-t
o-arrays-data-structure-and-algorithm-tutorials/" rel="noopener" target="_bl
ank">
        <span>
        </span>
    </a>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/array-data-st
ructure-guide/" rel="noopener" target="_blank">
            <span>
                Array Guide
            </span>
        </a>
        <span>
        </span>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/dsa-tutor
ial-array/" rel="noopener" target="_blank">
            <span>
                Array Quiz
            </span>
        </a>
    </li>
</ul>
<h3 id="4-searching-algorithms" style="text-align:left">
    <span>
        4. Searching Algorithms
    </span>

```

```

        </span>
    </h3>
    <p dir="ltr">
        <span>
            Searching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/searching-algorithms/" rel="noopener" target="_blank">
                <span>
                    Searching Guide
                </span>
            </a>
            <span>
            </span>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/" rel="noopener">
                <span>
                    Quiz on Searching
                </span>
            </a>
        </li>
    </ul>
    <h3 id="5-sorting-algorithm" style="text-align:left">
        <span>
            5. Sorting Algorithm
        </span>
    </h3>
    <p dir="ltr">
        <span>
            Sorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/sorting-algorithms/" rel="noopener" target="_blank">
                <span>
                    Sorting Guide
                </span>
            </a>
            <span>
            </span>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-

```

```

on-sorting-algorithms-with-answers/" rel="noopener" target="_blank">
    <span>
        Quiz on Sorting
    </span>
</a>
</li>
</ul>
<h3 id="6-hashing" style="text-align:left">
    <span>
        6. Hashing
    </span>
</h3>
<p dir="ltr" style="text-align: left;">
    <span>
        Hashing is a technique that generates a fixed-size output
    t (hash value) from an input of variable size using mathematical formulas ca
    lled hash functions. Hashing is commonly used in data structures for efficie
    nt searching, insertion and deletion.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/hashing-data-
        structure/" rel="noopener" target="_blank">
            <span>
                Hashing Guide
            </span>
        </a>
        <span>
        </span>
        </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
        on-hash-data-strcuture-with-answers/" rel="noopener" target="_blank">
            <span>
                Quiz on Hashing
            </span>
        </a>
        </li>
</ul>
<h3 id="7-two-pointer-technique" style="text-align:left">
    <span>
        7. Two Pointer Technique
    </span>
</h3>
<p dir="ltr">
    <b>
        <strong>
            I
        </strong>
    </b>
    <span>
        n Two Pointer Technique, we typically use two index vari
        ables from two corners of an array. We use the two pointer technique for sea
        rching a required point or value in an array.
    </span>

```

```

</p>
<ul>
  <li value="1">
    <a href="https://www.geeksforgeeks.org/dsa/two-pointers-
technique/" rel="noopener" target="_blank">
      <span>
        Two Pointer Technique
      </span>
    </a>
  </li>
  <li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/quiz-on-t
wo-pointer-technique-for-dsa/" rel="noopener" target="_blank">
      <span>
        Quiz on Two Pointer Technique
      </span>
    </a>
    <span>
    </span>
  </li>
</ul>
<h3 id="8-window-sliding-technique" style="text-align:lef
t">
  <span>
    8. Window Sliding Technique
  </span>
</h3>
<p dir="ltr">
  <b>
    <strong>
      I
    </strong>
  </b>
  <span>
    n Window Sliding Technique, we use the result of previou
s subarray to quickly compute the result of current.
  </span>
</p>
<ul>
  <li value="1">
    <a href="https://www.geeksforgeeks.org/dsa/window-slidin
g-technique/" rel="noopener" target="_blank">
      <span>
        Window Sliding Technique
      </span>
    </a>
  </li>
  <li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/quiz-on-s
liding-window-technique-for-dsa/" rel="noopener" target="_blank">
      <span>
        Quiz on Sliding Window
      </span>
    </a>
    <span>
    </span>
  </li>

```

```

        </li>
    </ul>
    <h3 id="9-prefix-sum-technique" style="text-align:left">
        <span>
            9. Prefix Sum Technique
        </span>
    </h3>
    <p dir="ltr">
        <b>
            <strong>
                I
            </strong>
        </b>
        <span>
            In Prefix Sum Technique, we compute prefix sums of an array to quickly find results for a subarray.
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/" rel="noopener" target="_blank">
                <span>
                    Prefix Sum Technique
                </span>
            </a>
            <span>
                </span>
            </span>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/" rel="noopener" target="_blank">
                <span>
                    Quiz on Prefix Sum
                </span>
            </a>
        </li>
    </ul>
    <h3 id="10-string" style="text-align:left">
        <span>
            10. String
        </span>
    </h3>
    <p dir="ltr">
        <span>
            A sequence of characters, typically immutable and have limited set of elements (lower case or all English alphabets).
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/string-data-structure/" rel="noopener" target="_blank">
                <span>
                    Strings Guide
                </span>
            </a>
        </li>
    </ul>

```



```

        </span>
    </a>
</li>
<li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/quiz-on-s
tring-for-dsa/" rel="noopener" target="_blank">
        <span>
            Quiz on Strings
        </span>
    </a>
</li>
</ul>
<h3 id="11-recursion" style="text-align:left">
    <span>
        11. Recursion
    </span>
</h3>
<p dir="ltr">
    <span>
        A programming technique where a function
    </span>
    <b>
        <strong>
            calls itself
        </strong>
    </b>
    <span>
        within its own definition. It is usually used to solve p
roblems that can be broken down into smaller instances of the same problem.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/recursion-alg
orithms/" rel="noopener" target="_blank">
            <span>
                Recursion Guide
            </span>
        </a>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-recursion-algorithm-with-answers/" rel="noopener" target="_blank">
            <span>
                Quiz on Recursion
            </span>
        </a>
    </li>
</ul>
<h3 id="12-matrixgrid" style="text-align:left">
    <span>
        12. Matrix/Grid
    </span>
</h3>
<p dir="ltr">
    <span>

```

A two-dimensional array of elements, arranged in

rows

and

columns

. It is represented as a rectangular grid, with each element at the intersection of a row and column.

- [Matrix Guide](https://www.geeksforgeeks.org/dsa/matrix/)
- [Quiz on Matrix/Grid.](https://www.geeksforgeeks.org/quizzes/quiz-on-matrixgrid-for-dsa/)

13. Linked List

A linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be

accessed sequentially

, starting from the head of list.

```

        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/linked-list-d
ata-structure/" rel="noopener" target="_blank">
                <span>
                    Linked List Guide
                </span>
            </a>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-linked-list-data-structure-with-answers/" rel="noopener" target="_blank">
                <span>
                    Quiz on Linked List
                </span>
            </a>
        </li>
    </ul>
    <h3 id="13-stack-1" style="text-align:left">
        <span>
            14. Stack
        </span>
    </h3>
    <p dir="ltr">
        <b>
            <strong>
                A
            </strong>
        </b>
        <span>
            linear data structure that follows the
        </span>
        <b>
            <strong>
                Last In, First Out (LIFO)
            </strong>
        </b>
        <span>
            principle. Stacks play an important role in managing fun
            ction calls, memory, and are widely used in algorithms like stock span probl
            em, next greater element and largest area in a histogram.
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/stack-data-st
            ructure/" rel="noopener" target="_blank">
                <span>
                    Stack Guide
                </span>
            </a>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-

```

```

on-stack-data-strcuture-with-answers/" rel="noopener" target="_blank">
    <span>
        Quiz on Stack
    </span>
</a>
</li>
</ul>
<h3 id="14-queue" style="text-align:left">
    <span>
        15. Queue
    </span>
</h3>
<p dir="ltr">
    <b>
        <strong>
            Queue
        </strong>
    </b>
    <span>
        is a linear data structure that follows the
    </span>
    <b>
        <strong>
            First In, First Out (FIFO)
        </strong>
    </b>
    <span>
        principle. Queues play an important role in managing tas
ks or data in order, scheduling and message handling systems.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/queue-data-st
ructure/" rel="noopener" target="_blank">
            <span>
                Queue Guide
            </span>
        </a>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-queue-data-structure-with-answers/" rel="noopener" target="_blank">
            <span>
                Quiz on Queue
            </span>
        </a>
    </li>
</ul>
<h3 id="15-deque" style="text-align:left">
    <span>
        16. Deque
    </span>
</h3>
<p dir="ltr" style="text-align: justify;">
    <span>

```

A Deque or double-ended queue is a data structure that allows elements to be added or removed from both ends efficiently.

</p>

<li value="1">

Deque Guide

<li value="2">

Quiz on Deque

<h3 id="17-tree" style="text-align:left">

17. Tree

</h3>

<p dir="ltr">

A

non-linear, hierarchical

data structure consisting of nodes connected by edges, with a top node called the

root

and nodes having child nodes. It is widely used in

file systems


```

        ,
    </span>
    <b>
        <strong>
            databases
        </strong>
    </b>
    <span>
        ,
    </span>
    <b>
        <strong>
            decision-making algorithms
        </strong>
    </b>
    <span>
        , etc.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/tree-data-str
ucture/" rel="noopener" target="_blank">
            <span>
                Tree Guide
            </span>
        </a>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/tree-2264
8/" rel="noopener" target="_blank">
            <span>
                Quiz on Tree
            </span>
        </a>
    </li>
</ul>
<h3 id="18-heap" style="text-align:left">
    <span>
        18. Heap
    </span>
</h3>
<p dir="ltr">
    <span>
        A
    </span>
    <b>
        <strong>
            complete binary tree
        </strong>
    </b>
    <span>
        that satisfies the
    </span>
    <b>
        <strong>

```

```

        heap property
    </strong>
</b>
<span>
    . Heaps are usually used to implement
</span>
<a href="https://www.geeksforgeeks.org/dsa/priority-queue-
-set-1-introduction/" rel="noopener" target="_blank">
    <span>
        priority queues
    </span>
</a>
<span>
    , where the
</span>
<b>
    <strong>
        smallest
    </strong>
</b>
<span>
    or
</span>
<b>
    <strong>
        largest
    </strong>
</b>
<span>
    element is always at the root of the tree.
</span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/heap-data-str
ucture/" rel="noopener" target="_blank">
            <span>
                Heap Guide
            </span>
        </a>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-heap-data-strcuture-with-answers/" rel="noopener" target="_blank">
            <span>
                Quiz on Heap
            </span>
        </a>
    </li>
</ul>
<h3 id="19-graph" style="text-align:left">
    <span>
        19. Graph
    </span>
</h3>
<p dir="ltr">

```

```

<span>
  A
</span>
<b>
  <strong>
    non-linear
  </strong>
</b>
<span>
  data structure consisting of a finite set of
</span>
<b>
  <strong>
    vertices
  </strong>
</b>
<span>
  (or nodes) and a set of
</span>
<b>
  <strong>
    edges
  </strong>
</b>
<span>
  (or links)that connect a pair of nodes. Graphs are widel
y used to represent relationships between entities.
</span>
</p>
<ul>
<li value="1">
  <a href="https://www.geeksforgeeks.org/dsa/graph-data-st
ructure-and-algorithms/" rel="noopener" target="_blank">
    <span>
      Graph Guide
    </span>
  </a>
</li>
<li value="2">
  <a href="https://www.geeksforgeeks.org/quizzes/graph-127
15/" rel="noopener" target="_blank">
    <span>
      Quiz on Graph
    </span>
  </a>
</li>
</ul>
<h3 id="20-greedy-algorithm" style="text-align:left">
  <span>
    20. Greedy Algorithm
  </span>
</h3>
<p dir="ltr">
  <span>
    Greedy Algorithm
  </span>

```


builds up the solution one piece at a time and chooses the next piece which gives the most obvious and immediate benefit i.e., which is the most optimal choice at that moment. So the problems where choosing locally optimal also leads to the global solutions are best fit for Greedy.

Greedy Algorithms Guide

- <https://www.geeksforgeeks.org/dsa/greedy-algorithms/>

Quiz on Greedy

- <https://www.geeksforgeeks.org/quizzes/top-mcqs-on-greedy-algorithms-with-answers/>

21. Dynamic Programming

Dynamic Programming is a method used to solve complex problems by breaking them down into simpler subproblems.

By solving each subproblem only once and storing the results, it avoids redundant computations, leading to more efficient solutions.

```

</span>
<b>
  <strong>
</strong>
</b>
<span>
  for a wide range of problems.
</span>
</p>
<ul>
<li value="1">
  <a href="https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/" rel="noopener" target="_blank">
    <span>
      Dynamic Programming Guide
    </span>
  </a>
</li>
<li value="2">
  <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-dynamic-programming-with-answers/" rel="noopener" target="_blank">
    <span>
      Quiz on DP
    </span>
  </a>
</li>
</ul>
<h3 id="23-advanced-data-structure-and-algorithms" style="text-align:left">
  <span>
    22. Advanced Data Structure and Algorithms
  </span>
</h3>
<p dir="ltr" style="text-align: justify;">
  <span>
    Advanced Data Structures like
  </span>
  <b>
    <strong>
      Trie
    </strong>
  </b>
  <span>
    ,
  </span>
  <b>
    <strong>
      Segment Tree
    </strong>
  </b>
  <span>
    ,
  </span>
  <b>
    <strong>
      Red-Black Tree
    </strong>
  </b>

```

and

Binary Indexed Tree

offer significant performance improvements for specific problem domains. They provide efficient solutions for tasks like fast prefix searches, range queries, dynamic updates, and maintaining balanced data structures, which are crucial for handling large datasets and real-time processing.

- [Trie](https://www.geeksforgeeks.org/dsa/trie-insert-and-search/)
- [Segment Tree](https://www.geeksforgeeks.org/dsa/segment-tree-data-structure/)
- [Red-Black Tree](https://www.geeksforgeeks.org/dsa/introduction-to-red-black-tree/)
- [Binary Indexed Tree](https://www.geeksforgeeks.org/dsa/binary-indexed-tree-or-fenwick-tree-2/)
- [Practice Advanced Data Structures](https://www.geeksforgeeks.org/dsa/advance-data-structure/)

```

        </span>
    </a>
    <span>
    </span>
</li>
</ul>
<h3 id="22-other-algorithms" style="text-align:left">
    <span>
        23. Other Algorithms
    </span>
</h3>
<p dir="ltr">
    <b>
        <strong>
            Bitwise Algorithms:
        </strong>
        </b>
        <span>
            Operate on individual bits of numbers.
        </span>
    </p>
    <ul>
        <li value="1">
            <a href="https://www.geeksforgeeks.org/dsa/bitwise-algor
ithms/" rel="noopener" target="_blank">
                <span>
                    Bitwise Algorithms Guide
                </span>
            </a>
            <span>
            </span>
        </li>
        <li value="2">
            <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-bitwise-algorithms-and-bit-manipulations-with-answers/" rel="noopener">
                <span>
                    Quiz on Bit Magic
                </span>
            </a>
        </li>
    </ul>
    <p dir="ltr">
        <b>
            <strong>
                Backtracking Algorithm :
            </strong>
        </b>
        <span>
            Follow Recursion
        </span>
        <b>
            <strong>
            </strong>
        </b>
        <span>
            with the option to

```

```

</span>
<b>
  <strong>
    revert and traces back
  </strong>
</b>
<span>
  if the solution from current point is not feasible.
</span>
</p>
<ul>
  <li value="1">
    <a href="https://www.geeksforgeeks.org/dsa/backtracking-
algorithms/" rel="noopener" target="_blank">
      <span>
        Backtracking Guide
      </span>
    </a>
    <a href="https://www.geeksforgeeks.org/dsa/backtracking-
algorithms/" rel="noopener" target="_blank">
      <span>
      </span>
    </a>
  </li>
  <li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-backtracking-algorithm-with-answers/" rel="noopener" target="_blank">
      <span>
        Quiz on Backtracking
      </span>
    </a>
  </li>
</ul>
<p dir="ltr">
  <b>
    <strong>
      Divide and conquer:
    </strong>
  </b>
  <span>
    A strategy to solve problems by dividing them into
  </span>
  <b>
    <strong>
      smaller subproblems
    </strong>
  </b>
  <span>
    , solving those subproblems, and combining the solutions
to obtain the final solution.
  </span>
</p>
<ul>
  <li value="1">
    <a href="https://www.geeksforgeeks.org/dsa/divide-and-co
nquer/" rel="noopener" target="_blank">

```

```

        <span>
            Divide and Conquer Guide
        </span>
    </a>
</li>
<li value="2">
    <a href="https://www.geeksforgeeks.org/quizzes/top-mcqs-
on-divide-and-conquer-algrithm-with-answers/" rel="noopener">
        <span>
            Quiz on Divide and Conquer
        </span>
    </a>
</li>
</ul>
<p dir="ltr">
    <b>
        <strong>
            Branch and Bound :
        </strong>
    </b>
    <span>
        Used in combinatorial optimization problems to systemati
cally search for the best solution. It works by dividing the problem into sm
aller subproblems, or branches, and then eliminating certain branches based
on bounds on the optimal solution. This process continues until the best sol
ution is found or all branches have been explored.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/branch-and-bo
und-algorithm/" rel="noopener" target="_blank">
            <span>
                Branch and Bound Algorithm
            </span>
        </a>
    </li>
</ul>
<p dir="ltr">
    <b>
        <strong>
            Geometric algorithms
        </strong>
    </b>
    <span>
        are a set of algorithms that solve problems related to s
hapes, points, lines and polygons.
    </span>
</p>
<ul>
    <li value="1">
        <a href="https://www.geeksforgeeks.org/dsa/geometric-alg
orithms/" rel="noopener" target="_blank">
            <span>
                Geometric Algorithms
            </span>

```

```

        </a>
    </li>
    <li value="2">
        <a href="https://www.geeksforgeeks.org/explore" rel="noo
pener" target="_blank">
            <span>
                Practice Geometric Algorithms
            </span>
        </a>
    </li>
</ul>
<p dir="ltr">
    <b>
        <strong>
            Randomized algorithms
        </strong>
    </b>
    <span>
        are algorithms that use randomness to solve problems. Th
ey make use of random input to achieve their goals, often leading to simpler
and more efficient solutions. These algorithms may not product same result b
ut are particularly useful in situations when a probabilistic approach is ac
ceptable.
    </span>
</p>
<ul>
    <li value="1">
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        </span>
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</ul>
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```

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                    </div>
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                            </a>
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s://www.geeksforgeeks.org/">
        
      </a>
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        <div class="footer-container_branding-address">
          
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            Corporate & Communications Address:
          </div>
        </div>
        <div class="footer-container_address_content">
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a, Uttar Pradesh (201305)
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autam Buddh Nagar, Uttar Pradesh, 201305
        </div>
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            </a>
        </li>
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            </a>
        </li>
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            </a>
        </li>
        <li class="footer-container_links_list-items">
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            </a>
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n/">

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        Corporate Solution
    </a>
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        DSA

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        </a>
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    </li>
</ul>
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        <a href="https://www.geeksforgeeks.org/courses/category/dsa-pla
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  <a href="https://www.geeksforgeeks.org/" target="_blank">
    @GeeksforGeeks, Sanchhaya Education Private Limited
  </a>
  ,
  <!-- -->
  <a href="https://www.geeksforgeeks.org/copyright-information/" ta
rget="_blank">
    All rights reserved
  </a>
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</div>
</div>
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</div>
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t:'gtm.js'});var f=d.getElementsByTagName(s)[0],
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e\u003cb\u003e\u003cstrong\u003eD\u003c/strong\u003e\u003c/b\u003e\u003cspan
\u003eata \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eS\u003c/strong\u000
3e\u003c/b\u003e\u003cspan\u003estructures and \u003c/span\u003e\u003cb\u003e
\u003cstrong\u003eA\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003elgorithm
s. Data structures manage how data is stored and accessed. Algorithms focus
on processing this data. Examples of data structures are Array, Linked Lis
t, Tree and Heap, and examples of algorithms are Binary Search, Quick Sort a
nd Merge Sort. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=

```

\`1\`" Foundation for almost every software like GPS, Search Engines, AI ChatBots, Gaming Apps, Databases, Web Applications, etc

Top Companies like Google, Microsoft, Amazon, Apple, Meta

and many other heavily focus on DSA

interviews.

Learn DSA boosts your problem-solving abilities and make you a stronger programmer.

Before beginning the DSA journey, it is recommended to learn at-least one programming language (<https://www.geeksforgeeks.org/cpp/c-plus-plus/>) or any other language of your choice).

Below are the recommended step by step topics to learn complete DSA.

1-logic-building

Logic Building

Once you have learned basics of a programming language, it is recommended that you learn basic logic building

1-logic-building-problems/

Logic Building Guide

2-learn-about-complexities/

Learn about Complexities

To analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.

1-analysis-of-algorithms/

Complexity Analysis Guide

2-learn-about-complexities-for-dsa/

Quiz on Complexity Analysis

3-array

Array is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.

introduction-to-arrays-data-structure-and-algorithm-tutorials/

<https://www.geeksforgeeks.org/dsa/array-data-structure-guide/>

<https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/>

<https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array-quiz/>

<https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array-quiz-4-searching-algorithms/>

4. Searching Algorithms

Searching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.

<https://www.geeksforgeeks.org/dsa/searching-algorithms/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/>

5. Sorting Algorithm

Sorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.

<https://www.geeksforgeeks.org/dsa/sorting-algorithms/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/>

6. Hashing

Hashing is a technique that generates a fixed-size output (hash value) from an input of variable size using mathematical formulas called hash functions. Hashing is commonly used in data structures for efficient searching, insertion and deletion.

<https://www.geeksforgeeks.org/dsa/hashing-data-structure/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-structure-with-answers/>

7. Two Pointer Technique

In Two Pointer Technique, we typically use two index variables from two corners of an array. We use the two pointer technique for searching a required point or value in an array.

<https://www.geeksforgeeks.org/dsa/two-pointers-technique/>

<https://www.geeksforgeeks.org/quizzes/quiz-on-two-pointer-technique-for-dsa/>

03c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e
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[Matrix Guide](https://www.geeksforgeeks.org/dsa/matrix/)
[Quiz on Matrix/Grid](https://www.geeksforgeeks.org/quizzes/quiz-on-matrixgrid-for-dsa/)
13-stack
13. Linked List
A linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be accessed sequentially, starting from the head of list.
[Linked List Guide](https://www.geeksforgeeks.org/dsa/linked-list-data-structure/)
[Quiz on Linked List](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-linked-list-data-structure-with-answers/)
13-stack-1
14. Stack
A linear data structure that follows the Last In, First Out (LIFO) principle. Stacks play an important role in managing function calls, memory, and are widely used in algorithms like stock span problem, next greater element and largest area in a histogram.
[Stack Guide](https://www.geeksforgeeks.org/dsa/stack-data-structure/)
[Quiz on Stack](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-stack-data-structure-with-answers/)
14-queue
15. Queue
A linear data structure that follows the First In, First Out (FIFO) principle. Queues play an important role in managing tasks or data in order, scheduling and message handling systems.
[Queue Guide](https://www.geeksforgeeks.org/dsa/queue-data-structure/)
[Quiz on Queue](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-queue-data-structure-with-answers/)
15-deque
16. Deque or double-ended queue is a data structure that allows elements to be added or removed from both ends efficiently.
[Deque Guide](https://www.geeksforgeeks.org/dsa/deque-set-1-introduction-applications/)

f="https://www.geeksforgeeks.org/quizzes/deque-960/" rel="noopener" target="_blank" \u003e\u003cspan\u003eQuiz on Deque\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="17-tree" style="text-align: left"\u003e\u003cspan\u003e17. Tree\u003c/span\u003e\u003c/h3\u003e\u003cp dir="ltr"\u003e\u003cspan\u003eA \u003c/span\u003e\u003cb\u003e\u003cstrong\u003enon-linear, hierarchical \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003edata structure consisting of nodes connected by edges, with a top node called the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eroot \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eand nodes having child nodes. It is widely used in \u003c/span\u003e\u003cb\u003e\u003cstrong\u003efile systems\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003edatabases\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003edecision-making algorithm s\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, etc.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/tree-data-structure/" rel="noopener" target="_blank"\u003e\u003cspan\u003eTree Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/tree-22648/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Tree\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="18-heap" style="text-align: left"\u003e\u003cspan\u003e18. Heap\u003c/span\u003e\u003c/h3\u003e\u003cp dir="ltr"\u003e\u003cspan\u003eA \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecomplete binary tree\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e that satisfies the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eheap property\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e. Heaps are usually used to implement \u003c/span\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/priority-queue-set-1-introduction/" rel="noopener" target="_blank"\u003e\u003cspan\u003epriority queues\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e, where the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003esmallest \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eor \u003c/span\u003e\u003cb\u003e\u003cstrong\u003elargest \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eelement is always at the root of the tree.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/heap-data-structure/" rel="noopener" target="_blank"\u003e\u003cspan\u003eHeap Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-heap-data-structure-with-answers/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Heap\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="19-graph" style="text-align: left"\u003e\u003cspan\u003e19. Graph\u003c/span\u003e\u003c/h3\u003e\u003cp dir="ltr"\u003e\u003cspan\u003eA \u003c/span\u003e\u003cb\u003e\u003cstrong\u003enon-linear \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003edata structure consisting of a finite set of \u003c/span\u003e\u003cb\u003e\u003cstrong\u003evertices\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e(or nodes) and a set of \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eedges\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e(or links)that connect a pair of nodes. Graphs are widely used to represent relationships between entities.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="1"\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/graph-data-structure-and-algorithms/" rel="noopener" target="_blank"\u003e\u003cspan\u003eGraph Guide \u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="2"\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/graph-12715/" rel="noopener" target="_blank"\u003e\u003cspan\u003eQuiz on Graph\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="20-greedy-algorithm" style="text-align: left"\u003e\u003cspan\u003e20. Greedy Algorithm\u003c/span\u003e\u003c/h3\u003e\u003cp dir="

[\ltr\Greedy Algorithm/](#)
 **builds up the solution one piece at a time and chooses the next piece which gives the most obvious and immediate benefit i.e., which is the most optimal choice at that moment. So the problems where choosing locally optimal also leads to the global solutions are best fit for Greedy.
[/p\cul\cli value=1\"https://www.geeksforgeeks.org/dsa/greedy-algorithms/\" rel=noopener\" target=_blank\"/a\li\cli value=2\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-greedy-algorithms-with-answers/\" rel=noopener\" target=_blank\"/a\li\cli value=21\"1-dynamic-programming\" style=text-align:left\"/Dynamic Programming/h3\cp dir=ltr\"/Dynamic Programming is a method used to solve complex problems by breaking them down into simpler subproblems/strong/b/cspan/By solving each subproblem only once and storing the results, it avoids redundant computations, leading to more efficient solutions/strong/b/cspan/for a wide range of problems. /p\cul\cli value=1\"https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/\" rel=noopener\" target=_blank\"/a\li\cli value=2\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-dynamic-programming-with-answers/\" rel=noopener\" target=_blank\"/a\li\cli value=23-advanced-data-structure-and-algorithms\" style=text-align:left\"/Advanced Data Structure and Algorithms/h3\cp dir=ltr\" style=text-align: justify;/a\li\cli value=22. Advanced Data Structures like Trie/strong/b/cspan/Segment Tree/strong/b/cspan/Red-Black Tree/strong/b/cspan/and Binary Indexed Tree/strong/b/cspan/offer significant performance improvements for specific problems. They provide efficient solutions for tasks like fast prefix searches, range queries, dynamic updates, and maintaining balanced data structures, which are crucial for handling large datasets and real-time processing./c/p\cul\cli value=1\"https://www.geeksforgeeks.org/dsa/trie-insert-and-search/\" rel=noopener\" target=_blank\"/a\li\cli value=2\"https://www.geeksforgeeks.org/dsa/segment-tree-data-structure/\" rel=noopener\" target=_blank\"/a\li\cli value=3\"https://www.geeksforgeeks.org/dsa/introduction-to-red-black-tree/\" rel=noopener\" target=_blank\"/a\li\cli value=4\"https://www.geeksforgeeks.org/dsa/binary-indexed-tree-or-fenwick-tree-2/\" rel=noopener\" target=_blank\"/a\li\cli value=5\"https://www.geeksf](#)**

orgeeks.org/dsa/advance-data-structure/" rel="noopener" target="_blank
Practice Advanced Data Structures/

Other Algorithms

Other Algorithms

Bitwise Algorithms

Operate on individual bits of numbers.

value="1" href="https://www.geeksforgeeks.org/dsa/bitwise-algorithms/" rel="noopener" target="_blank" Bitwise Algorithms Guide/

Backtracking Algorithm

Follow Recursion with the option to revert and traces back if the solution from current point is not feasible.

value="1" href="https://www.geeksforgeeks.org/dsa/backtracking-algorithms/" rel="noopener" target="_blank" Backtracking Guide/

Divide and conquer

A strategy to solve problems by dividing them into smaller subproblems, solving those subproblems, and combining the solutions to obtain the final solution.

value="1" href="https://www.geeksforgeeks.org/dsa/divide-and-conquer/" rel="noopener" target="_blank" Divide and Conquer Guide/

Branch and Bound

Used in combinatorial optimization problems to systematically search for the best solution. It works by dividing the problem into smaller subproblems, or branches, and then eliminating certain branches based on bounds on the optimal solution. This process continues until the best solution is found or all branches have been explored.

value="1" href="https://www.geeksforgeeks.org/dsa/branch-and-bound-algorithm/" rel="noopener" target="_blank" Branch and Bound Algorithm/

Geometric algorithms

are a set of algorithms that solve problems related to shapes, points, lines and polygons.

value="1" href="https://www.geeksforgeeks.org/dsa/geometric-algorithms/" rel="noopener" target="_blank" Geometric Algorithms/

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03c/a\\u003e\\u003c/li\\u003e\\u003cul\\u003e\\u003cp dir=\\\"ltr\\\"\\u003e\\u003cb\\u0
03e\\u003cstrong\\u003eRandomized algorithms \\u003c/strong\\u003e\\u003c/b\\u003e
\\u003cspan\\u003eare algorithms that use randomness to solve problems. They m
ake use of random input to achieve their goals, often leading to simpler and
more efficient solutions. These algorithms may not product same result but a
re particularly useful in situations when a probabilistic approach is accept
able.\\u003c/span\\u003e\\u003c/p\\u003e\\u003cul\\u003e\\u003cli value=\\\"1\\\"\\u003e
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[\u003eli\u003eImports](#)
[\u0026amp;Exports in Go\u003eli\u003e\u003eli\u003eStructure of a Go application\u003eli\u003e\u003eli\u003eVariable types.\u003eli\u003e\u003eli\u003eVariables with Initializers\u003eli\u003e\u003eli\u003eZero values and Short-hand declarations.\u003eli\u003e\u003eli\u003eType Conversion\u003eli\u003e\u003eli\u003eNumeric Constants\u003eli\u003e\u003eli\u003eUnderstanding functions in Golang.\u003eli\u003e\u003eli\u003eFunctions with multiple results\u003eli\u003e\u003eli\u003eFunctions with named valued results\u003eli\u003e\u003eli\u003eLoops\u003eli\u003e\u003eli\u003eDefer\u003eli\u003e\u003eli\u003eGoto\u003eli\u003e\u003eli\u003eScopes\u003eli\u003e\u003eli\u003eul\u003e", "Go Data Types and Structures": "\u003eli\u003e\u003eli\u003ePointers\u003eli\u003e\u003eli\u003eStructs\u003eli\u003e\u003eli\u003eArrays and Slices\u003eli\u003e\u003eli\u003eMaps\u003eli\u003e\u003eli\u003eStrings and Runes in Go\u003eli\u003e\u003eli\u003eString Literals\u003eli\u003e\u003eli\u003eMap Literals\u003eli\u003e\u003eli\u003eul\u003e", "Advanced Go Structures and Functions": "\u003eli\u003e\u003eli\u003eStructs: Methods and field access\u003eli\u003e\u003eli\u003eHigher-order functions\u003eli\u003e\u003eli\u003eHigher-order functions.\u003eli\u003e\u003eli\u003eFunction closures\u003eli\u003e\u003eli\u003eMutating maps\u003eli\u003e\u003eli\u003eul\u003e", "Error Handling and Best Practices": "\u003eli\u003e\u003eli\u003eError handling in Go\u003eli\u003e\u003eli\u003ePanic and Recover\u003eli\u003e\u003eli\u003eCustom errors in Go\u003eli\u003e\u003eli\u003eBest Practices for error management\u003eli\u003e\u003eli\u003eul\u003e", "Methods and Interfaces": "\u003eli\u003e\u003eli\u003eMethods with Structs and Pointers\u003eli\u003e\u003eli\u003eInterfaces in Go: Implementation\u003eli\u003e\u003eli\u003eType assertions and type switches\u003eli\u003e\u003eli\u003eul\u003e", "Introduction to Concurrency": "\u003eli\u003e\u003eli\u003eConcurrency vs Parallelism\u003eli\u003e\u003eli\u003eGolang's approach to concurrency: Overview of Goroutines and Channels\u003eli\u003e\u003eli\u003eul\u003e", "Working with Goroutines": "\u003eli\u003e\u003eli\u003eCreating and managing Goroutines\u003eli\u003e\u003eli\u003eSynchronizing Goroutines using WaitGroups\u003eli\u003e\u003eli\u003eMutexes and their use in Go\u003eli\u003e\u003eli\u003eul\u003e", "Channels in Depth": "\u003eli\u003e\u003eli\u003eTypes of Channels: Buffered\u003eli\u003e\u003eli\u003eChannel Synchronization\u003eli\u003e\u003eli\u003eChannel Directions\u003eli\u003e\u003eli\u003eChannel Select and Non Blocking channels\u003eli\u003e\u003eli\u003e\u003eli\u003eul\u003e" data-bbox="111 111 889 889">](#)

\u003e", "Exploring Go Web Frameworks": "\u003cul\u003e\u003cli\u003eOverview of popular frameworks: Echo\u003c/li\u003e\u003cli\u003eRebuilding the CRUD API using the Fiber framework\u003c/li\u003e\u003cli\u003eMiddleware integration using Fiber\u003c/li\u003e\u003c/ul\u003e", "Testing, Benchmarking, and Documentation": "\u003cul\u003e\u003cli\u003eWriting unit tests for Go APIs\u003c/li\u003e\u003cli\u003eBenchmarking API performance\u003c/li\u003e\u003cli\u003eDocumenting APIs with Swagger\u003c/li\u003e\u003c/ul\u003e", "Backend Architecture Patterns": "\u003cul\u003e\u003cli\u003eMonolith vs Microservices Architecture\u003c/li\u003e\u003cli\u003ePopular design patterns in backend systems\u003c/li\u003e\u003cli\u003eSingleton Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eFactory Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eObserver Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eDecorator Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eBest practices for designing scalable backend systems\u003c/li\u003e\u003c/ul\u003e", "Security in Go": "\u003cul\u003e\u003cli\u003eSecure coding practices in Go\u003c/li\u003e\u003cli\u003eJWT Tokens: Explanation and Implementation\u003c/li\u003e\u003cli\u003eAuth 2.0 Explained!\u003c/li\u003e\u003cli\u003eAuth 2.0 Simulated Implementation in Go\u003c/li\u003e\u003cli\u003eHandling sensitive data\u003c/li\u003e\u003c/ul\u003e", "Working with Databases": "\u003cul\u003e\u003cli\u003eUsing SQL databases with Go: GORM\u003c/li\u003e\u003cli\u003eWorking with NoSQL databases: Redis\u003c/li\u003e\u003cli\u003eOptimizing database queries and connections\u003c/li\u003e\u003cli\u003eUsing SQL databases with Go:\u0026nbsp; sqlx\u003c/li\u003e\u003cli\u003eWorking with NoSQL databases: MongoDB\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003e", "Building Microservices with Go": "\u003cul\u003e\u003cli\u003eService discovery\u003c/li\u003e\u003cli\u003eAPI Gateways\u003c/li\u003e\u003cli\u003eDistributed Tracing\u003c/li\u003e\u003c/ul\u003e", "Deployment and DevOps": "\u003cul\u003e\u003cli\u003eContainerizing Go applications with Docker\u003c/li\u003e\u003cli\u003eWhat is CI/CD?\u003c/li\u003e\u003cli\u003eJenkins and GitHub Actions with the full CI/CD steps correlation\u003c/li\u003e\u003c/ul\u003e", "Performance Optimization": "\u003cul\u003e\u003cli\u003eProfiling Go applications\u003c/li\u003e\u003cli\u003eBenchmarking and optimizing code\u003c/li\u003e\u003c/ul\u003e", "Introduction to GraphQL": "\u003cul\u003e\u003cli\u003eDifferences between REST and GraphQL\u003c/li\u003e\u003cli\u003eGraphQL basic concepts\u003c/li\u003e\u003cli\u003eBuilding a GraphQL API with Go - Querying data\u003c/li\u003e\u003cli\u003eBuilding a GraphQL API with Go - Mutating data\u003c/li\u003e\u003c/ul\u003e", "Final Capstone Project - Social Media Application": "\u003cul\u003e\u003cli\u003eDesign and develop a comprehensive backend system with Go\u003c/li\u003e\u003cli\u003eIncorporate API development\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003e", "locations_coord": [], "desktop_banner_webp": "https://media.geeksforgeeks.org/img-practice/prod/courses/823/Web/Content/Golan_1734086963.webp", "mobile_banner_webp": "https://media.geeksforgeeks.org/img-practice/prod/courses/823/Web/Content/Golan_1734086963.webp", "price": {"batch_fee": 799, "promotional_fee": 5999, "play_store_product_id": "gfg_course_799"}, "additional_info": "", {"course_id": 504, "course_name": "DSA to Development: A Complete Guide", "course_slug": "dsa-to-development-coding-guide", "course_url": "https://www.geeksforgeeks.org/courses/dsa-to-development-coding-guide", "course_type": "Live", "course_fee_type": "Paid", "level": "Beginner to Advanced", "course_duration": 26, "is_kids_course": false, "faqs": {"Is there any Phone number for query regarding this course ?": "\u003cp\u003e\u003eYes, you may reach out to us at +91 9259142663 for all your queries\u003c/p\u003e", "I'm from a non-CS background. Will this course be a good fit for me?": "\u003cp\u003e\u003eYes, it's suitable if you're aiming to join IT sector companies.\u003cbr\u003e\u003c/p\u003e", "How will I enroll in this course?": "\u003cp\u003e\u003eFirst, fill out the application form. Once your applicatio

n is approved, complete the payment process, and your enrollment will be confirmed.

Q: "If I have any doubt while studying, how will it be addressed?"

A: "You'll get strong data-start=\"171\" data-end=\"294\" in-class doubt clearing, dedicated weekday doubt-resolving sessions, and 24/7 AI-powered doubt assistance.

Q: "I am confused about which development specialization I need to choose. Will I get any assistance for the same?"

A: "Yes. Our team will guide you in selecting the right specialization based on your interests, strengths, and career goals.

Q: "Will I need to pay the amount in one shot or EMIs?"

A: "We provide flexible payment options. You can pay the entire amount at once or choose strong data-start=\"1905\" data-end=\"1920\" EMI options.

Q: "Will there be a certificate of completion?"

A: "Yes. Certificate of completion will be provided once you meet all the eligibility criteria mentioned on the batch noticeboard.

Q: "How long will I have access to the course?"

A: "You will have access to the course for strong data-start=\"200\" data-end=\"212\" one year from the date of enrollment. After this period, your access will expire automatically.

Q: "Is the batch in Hindi or English?"

A: "The classes will be conducted in strong data-start=\"319\" data-end=\"330\" English.

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what_you_will_learn: "Embark on an extraordinary coding odyssey with our groundbreaking course, \"DSA to Development – Complete Coding Guide\"! ??? Discover the transformative power of mastering Data Structures and Algorithms (DSA) as you venture towards becoming a proficient Developer or Data Scientist. ???\u003c/strong\u003e\u003c/p\u003e\u003cul\u003e\u003cli\u003e Learn essential data structures\u003c/li\u003e\u003cli\u003e Master key algorithms\u003c/li\u003e\u003cli\u003e Develop advanced coding techniques\u003c/li\u003e\u003cli\u003e Build a strong programming foundation\u003c/li\u003e\u003cli\u003e Gain confidence in tackling challenges\u003c/li\u003e\u003cli\u003e Engage in hands-on projects\u003c/li\u003e\u003cli\u003e Create remarkable applications\u003c/li\u003e\u003cli\u003e Choose full-stack development, data science, or specialize in \u003c/strong\u003eMERN, Java, Python, Machine Learning\u003c/strong\u003e\u003c/li\u003e\u003cli\u003e Receive insights from industry professionals\u003c/li\u003e\u003cli\u003e Get guidance from experienced

ed mentors\u003c/li\u003e\u003c/ul\u003e","course_overview": "\u003cp\u003eThis journey starts with a solid foundation in Data Structures and Algorithms (DSA), essential for becoming a skilled developer. Whether you are aiming to master full-stack development, specialize in Java backend, dive into applied data science, or create the next big Android app, this curriculum arms you with the essential tools and real-world experience to fuel your coding journey. Whether you're a student or a professional, this curriculum provides the key fundamentals and practical skills needed to thrive in today's tech landscape.\u003c/p\u003e\u003c/ul\u003e\u003ccli\u003eStarts with a solid understanding of Data Structures and Algorithms (DSA).\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003e\u003ccli\u003eLeads towards becoming a skilled developer.\u003c/li\u003e\u003c/ul\u003eli\u003eEquips with fundamental tools for the coding journey.\u003c/li\u003e\u003c/ul\u003eli\u003eSuitable for aspiring full-stack developers or those specializing in a particular technology stack.\u003c/li\u003e\u003c/ul\u003eli\u003ePerfect for students or professionals from any field aiming for a technological journey.\u003c/li\u003e\u003c/ul\u003c/ul\u003e", "course_feature": null, "course_content": {"Programming Languages": "\u003cp\u003e**\u003eCPP/Java/Python:** \u003c/strong\u003e\u003c/p\u003e\u003c/ul\u003e\u003ccli\u003eIntroduction\u003c/li\u003e\u003c/ul\u003eli\u003eVariable & Operators\u003c/li\u003e\u003c/ul\u003eli\u003eFlow Control\u003c/li\u003e\u003c/ul\u003eli\u003eFunctions & Loops\u003c/li\u003e\u003c/ul\u003eli\u003eArrays\u003c/li\u003e\u003c/ul\u003eli\u003eStrings\u003c/li\u003e\u003c/ul\u003eli\u003eObject Oriented Programming(OOPs)\u0026nbsp;\u003c/li\u003e\u003c/ul\u003eli\u003eAdvanced concepts\u003c/li\u003e\u003c/ul\u003c/ul\u003e", "Libraries": "\u003cp\u003e**\u003eCPP STL:** \u003c/strong\u003e\u003c/p\u003e\u003c/ul\u003e\u003ccli\u003eVectors\u003c/li\u003e\u003c/ul\u003eli\u003eList, Pairs\u003c/li\u003e\u003c/ul\u003eli\u003eStack, Queue\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003eli\u003eSet\u0026nbsp;\u003c/li\u003e\u003c/ul\u003eli\u003eMap\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cp\u003e**\u003eJava Collections**\u003c/strong\u003e\u003c/ul\u003e\u003ccli\u003eArrayList\u003c/li\u003e\u003c/ul\u003eli\u003eStackQueue\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003eli\u003eSet, Map\u003c/li\u003e\u003c/ul\u003eli\u003eArrays Class & Collection Class\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003c/ul\u003e", "Live Sessions Curriculum": "\u003ch3 data-start=\"162\" data-end=\"202\"\u003e**Class 1: Time & Space Complexity**\u003c/strong\u003e\u003c/h3\u003e\u003c/ul\u003eli\u003e\u003cul data-start=\"203\" data-end=\"461\"\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003ccli data-start=\"203\" data-end=\"293\"\u003e\u003c/strong\u003e\u003c/ul\u003eli\u003e\u003cp data-start=\"205\" data-end=\"293\"\u003eIntroduction to algorithm analysis, efficiency, and Big-O notation for time complexity\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cp data-start=\"296\" data-end=\"377\"\u003eBitwise Operators with practical examples (swapping numbers, checking even/odd)\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cp data-start=\"296\" data-end=\"377\"\u003eNumber System basics: binary, decimal, octal, hexadecimal, and base conversions\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003chr data-start=\"463\" data-end=\"466\"\u003eh3 data-start=\"468\" data-end=\"496\"\u003e**Class 2: Mathematics**\u003c/strong\u003e\u003c/h3\u003e\u003c/ul\u003eli\u003e\u003cul data-start=\"497\" data-end=\"738\"\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003ccli data-start=\"497\" data-end=\"545\"\u003ePrime numbers and efficient checking methods\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cd data-start=\"546\" data-end=\"593\"\u003eSieve of Eratosthenes for generating primes\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cp data-start=\"594\" data-end=\"663\"\u003eGCD & LCM using Euclidean Algorithm with array-based applications\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003eli\u003e\u003cd data-start=\"664\" data-end=\"738\"\u003eExamples: fractions, modular arithmetic, and related practice problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003c/ul\u003e"}\u003c/script\u003e

ms\p\li\ul\chr data-start="\740\" data-end="\743\" \u003e\u003c\u003ch3 data-start="\745\" data-end="\771\" \u003e\u003cstrong data-start="\749\" data-end="\771\" \u003eClass 3: Array I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\772\" data-end="\989\" \u003e\u003cli data-start="\772\" data-end="\841\" \u003e\u003cp data-start="\774\" data-end="\841\" \u003eArray basics, traversal, insertion, deletion, Second Max, Leaders\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\842\" data-end="\913\" \u003e\u003cp data-start="\844\" data-end="\913\" \u003eKadanes Algorithm for Maximum Subarray Sum, Buy-Sell Stock problem\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\914\" data-end="\989\" \u003e\u003cp data-start="\916\" data-end="\989\" \u003eArray rotations using Juggling Algorithm, Reversal method, and examples\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\991\" data-end="\994\" \u003e\u003ch3 data-start="\996\" data-end="\1023\" \u003e\u003cstrong data-start="\1000\" data-end="\1023\" \u003eClass 4: Array II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1024\" data-end="\1207\" \u003e\u003cli data-start="\1024\" data-end="\1079\" \u003e\u003cp data-start="\1026\" data-end="\1079\" \u003eMajority Element using Boyer Moore Voting Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1080\" data-end="\1138\" \u003e\u003cp data-start="\1082\" data-end="\1138\" \u003eSubarrays and Subsequences with Prefix & Suffix arrays\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1139\" data-end="\1207\" \u003e\u003cp data-start="\1141\" data-end="\1207\" \u003ePractice problems for sum, product, and sliding window subarrays\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\1209\" data-end="\1212\" \u003e\u003ch3 data-start="\1214\" data-end="\1242\" \u003e\u003cstrong data-start="\1218\" data-end="\1242\" \u003eClass 5: Array III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1243\" data-end="\1429\" \u003e\u003cli data-start="\1243\" data-end="\1299\" \u003e\u003cp data-start="\1245\" data-end="\1299\" \u003eTwo Pointers technique for pair/triplet sum problems\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1300\" data-end="\1353\" \u003e\u003cp data-start="\1302\" data-end="\1353\" \u003eDutch National Flag Algorithm for sorting 0, 1, 2\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1354\" data-end="\1429\" \u003e\u003cp data-start="\1356\" data-end="\1429\" \u003eSliding Window problems like Maximum Sum Subarray and Longest Substring\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\1431\" data-end="\1434\" \u003e\u003ch3 data-start="\1436\" data-end="\1460\" \u003e\u003cstrong data-start="\1440\" data-end="\1460\" \u003eClass 6: Hashing\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1461\" data-end="\1682\" \u003e\u003cli data-start="\1461\" data-end="\1532\" \u003e\u003cp data-start="\1463\" data-end="\1532\" \u003eIntroduction to hash tables, hash functions, and collision handling\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1533\" data-end="\1597\" \u003e\u003cp data-start="\1535\" data-end="\1597\" \u003eImplementation using STL (\u003ccode data-start="\1561\" data-end="\1576\" \u003eunordered_map\u003c/code\u003e\u0026nbsp;/\u0026nbsp;\u003ccode data-start="\1579\" data-end="\1594\" \u003eunordered_set\u003c/code\u003e)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1598\" data-end="\1682\" \u003e\u003cp data-start="\1600\" data-end="\1682\" \u003ePractice problems: frequency counts, subarray sums, and pattern-based challenges\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\1684\" data-end="\1687\" \u003e\u003ch3 data-start="\1689\" data-end="\1715\" \u003e\u003cstrong data-start="\1693\" data-end="\1715\" \u003eClass 7: Recursion\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\1716\" data-end="\1887\" \u003e\u003cli data-start="\1716\" data-end="\1782\" \u003e\u003cp data-start="\1718\" data-end="\1782\" \u003eBasics of recursion, stack usage, and importance of base cases\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\1783\" data-end="\1826\" \u003e\u003cp data-start="\1785\" data-end="\1826\" \u003eExamples: Factorial, Fibonacci Sequence\u003c/p\u003e\u003e

c/li\u003e\u003cli data-start=\"1827\" data-end=\"1887\" \u003e\u003cp data-start=\"1829\" data-end=\"1887\" \u003eTower of Hanoi and introduction to back tracking concepts\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"1889\" data-end=\"1892\" \u003e\u003ch3 data-start=\"1894\" data-end=\"1920\" \u003e\u003cstrong data-start=\"1898\" data-end=\"1920\" \u003eClass 8: Searching\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"1921\" data-end=\"2109\" \u003e\u003cli data-start=\"1921\" data-end=\"1988\" \u003e\u003cp data-start=\"1923\" data-end=\"1988\" \u003eLinear Search: concept, implementation, and complexity analysis\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"1989\" data-end=\"2045\" \u003e\u003cp data-start=\"1991\" data-end=\"2045\" \u003eBinary Search: iterative & recursive implementation s\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2046\" data-end=\"2109\" \u003e\u003cp data-start=\"2048\" data-end=\"2109\" \u003eApplications: rotated arrays, floor/ceiling search problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"2111\" data-end=\"2114\" \u003e\u003ch3 data-start=\"2116\" data-end=\"2140\" \u003e\u003cstrong data-start=\"2120\" data-end=\"2140\" \u003eClass 9: Sorting\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"2141\" data-end=\"2320\" \u003e\u003cli data-start=\"2141\" data-end=\"2209\" \u003e\u003cp data-start=\"2143\" data-end=\"2209\" \u003eBubble, Selection, and Insertion Sort: comparisons and use cases\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2210\" data-end=\"2261\" \u003e\u003cp data-start=\"2212\" data-end=\"2261\" \u003eMerge Sort and Quick Sort for efficient sorting\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2262\" data-end=\"2320\" \u003e\u003cp data-start=\"2264\" data-end=\"2320\" \u003eConceptual understanding of Cyclic Sort and Shell Sort\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"2322\" data-end=\"2325\" \u003e\u003ch3 data-start=\"2327\" data-end=\"2351\" \u003e\u003cstrong data-start=\"2331\" data-end=\"2351\" \u003eClass 10: Matrix\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"2352\" data-end=\"2526\" \u003e\u003cli data-start=\"2352\" data-end=\"2409\" \u003e\u003cp data-start=\"2354\" data-end=\"2409\" \u003eMatrix traversal: row-wise, column-wise, spiral order\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2410\" data-end=\"2469\" \u003e\u003cp data-start=\"2412\" data-end=\"2469\" \u003eMatrix rotation, transpose, and binary search in matrix\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2470\" data-end=\"2526\" \u003e\u003cp data-start=\"2472\" data-end=\"2526\" \u003eDirectional traversals and problem-solving exercises\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"2528\" data-end=\"2531\" \u003e\u003ch3 data-start=\"2533\" data-end=\"2566\" \u003e\u003cstrong data-start=\"2537\" data-end=\"2566\" \u003eClass 11: Linked List I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"2567\" data-end=\"2749\" \u003e\u003cli data-start=\"2567\" data-end=\"2633\" \u003e\u003cp data-start=\"2569\" data-end=\"2633\" \u003eSingly, Doubly, and Circular Linked List basics and operations\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2634\" data-end=\"2705\" \u003e\u003cp data-start=\"2636\" data-end=\"2705\" \u003eFinding middle element, reversing linked lists, intersection points\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2706\" data-end=\"2749\" \u003e\u003cp data-start=\"2708\" data-end=\"2749\" \u003eCycle detection using Floyds Algorithm\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"2751\" data-end=\"2754\" \u003e\u003ch3 data-start=\"2756\" data-end=\"2790\" \u003e\u003cstrong data-start=\"2760\" data-end=\"2790\" \u003eClass 12: Linked List II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"2791\" data-end=\"2951\" \u003e\u003cli data-start=\"2791\" data-end=\"2839\" \u003e\u003cp data-start=\"2793\" data-end=\"2839\" \u003eFinding length and starting point of a cycle\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2840\" data-end=\"2898\" \u003e\u003cp data-start=\"2842\" data-end=\"2898\" \u003eLRU Cache implementation using linked list and hashing\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"2899\" data

ta-end=\"2951\" data-start=\"2901\" data-end=\"2951\" Merge K Sorted Lists and optimization approaches data-start=\"2953\" data-end=\"2956\" data-start=\"2958\" data-end=\"2993\" data-start=\"2962\" data-end=\"2993\" Class 13: Stack & Queue I data-start=\"2994\" data-end=\"3061\" data-start=\"2996\" data-end=\"3061\" Stack concepts (LIFO), implementation using array & linked list data-start=\"3062\" data-end=\"3114\" data-start=\"3064\" data-end=\"3114\" Queue concepts (FIFO), Circular Queue, and Deque data-start=\"3115\" data-end=\"3187\" data-start=\"3117\" data-end=\"3187\" Applications: expression evaluation, balanced parentheses, undo-redo data-start=\"3189\" data-end=\"3192\" data-start=\"3194\" data-end=\"3230\" data-start=\"3198\" data-end=\"3230\" Class 14: Stack & Queue II data-start=\"3231\" data-end=\"3231\" data-end=\"3298\" data-start=\"3233\" data-end=\"3298\" Practice problems: Next Greater Element, Sliding Window Maximum data-start=\"3299\" data-end=\"3339\" data-start=\"3301\" data-end=\"3339\" Stack using Queue, Queue using Stack data-start=\"3340\" data-end=\"3386\" data-start=\"3342\" data-end=\"3386\" Optimization and problem-solving exercises data-start=\"3388\" data-end=\"3391\" data-start=\"3393\" data-end=\"3427\" data-start=\"3397\" data-end=\"3427\" Class 15: Backtracking I data-start=\"3428\" data-end=\"3598\" data-start=\"3428\" data-end=\"3478\" data-start=\"3430\" data-end=\"3478\" Generating all permutations of array or string data-start=\"3479\" data-end=\"3534\" data-start=\"3481\" data-end=\"3534\" Generating combinations and subsets using recursion data-start=\"3535\" data-end=\"3598\" data-start=\"3537\" data-end=\"3598\" Backtracking exercises to explore recursive tree structures data-start=\"3600\" data-end=\"3603\" data-start=\"3605\" data-end=\"3640\" data-start=\"3609\" data-end=\"3640\" Class 16: Backtracking II data-start=\"3641\" data-end=\"3756\" data-start=\"3641\" data-end=\"3666\" data-start=\"3643\" data-end=\"3666\" Rat in a Maze problem data-start=\"3667\" data-end=\"3713\" data-start=\"3669\" data-end=\"3713\" N-Queen problem with pruning and recursion data-start=\"3714\" data-end=\"3756\" data-start=\"3716\" data-end=\"3756\" Valid Sudoku solver using backtracking data-start=\"3758\" data-end=\"3761\" data-start=\"3763\" data-end=\"3790\" data-start=\"3767\" data-end=\"3790\" Class 17: Trees I data-start=\"3791\" data-end=\"3959\" data-start=\"3791\" data-end=\"3858\" data-start=\"3793\" data-end=\"3858\" Binary Tree basics, types, and representations (array & linked) data-start=\"3859\" data-end=\"3903\" data-start=\"3861\" data-end=\"3903\" Traversals: Preorder, Inorder, Postorder data-start=\"3904\" data-end=\"3959\" data-start=\"3906\" data-end=\"3959\" Practice pr

blems: height, node count, sum of nodes\u003c/p\u003e\u003c/li>\u003e\u003c/ul>\u003e\u003chr data-start=\"3961\" data-end=\"3964\"\u003e\u003ch3 data-start=\"3966\" data-end=\"3994\"\u003e\u003cstrong data-start=\"3970\" data-end=\"3994\"\u003eClass 18: Trees II\u003c/strong\u003e\u003c/h3>\u003e\u003cul data-start=\"3995\" data-end=\"4141\"\u003e\u003cli data-start=\"3995\" data-end=\"4056\"\u003e\u003cp data-start=\"3997\" data-end=\"4056\"\u003eBinary Search Tree (BST): insertion, deletion, and search\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4057\" data-end=\"4092\"\u003e\u003cp data-start=\"4059\" data-end=\"4092\"\u003eInorder predecessor \u0026amp; successor\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4093\" data-end=\"4141\"\u003e\u003cp data-start=\"4095\" data-end=\"4141\"\u003eBST practice problems and path sum exercises\u003c/p\u003e\u003c/li>\u003e\u003cul data-start=\"4143\" data-end=\"4146\"\u003e\u003ch3 data-start=\"4148\" data-end=\"4177\"\u003e\u003cstrong data-start=\"4152\" data-end=\"4177\"\u003eClass 19: Trees III\u003c/strong\u003e\u003c/h3>\u003e\u003cul data-start=\"4178\" data-end=\"4309\"\u003e\u003cli data-start=\"4178\" data-end=\"4216\"\u003e\u003cp data-start=\"4180\" data-end=\"4216\"\u003eHeap concepts: Min Heap \u0026amp; Max Heap\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4217\" data-end=\"4264\"\u003e\u003cp data-start=\"4219\" data-end=\"4264\"\u003eHeapify, insertion, and deletion operations\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4265\" data-end=\"4309\"\u003e\u003cp data-start=\"4267\" data-end=\"4309\"\u003ePriority Queue applications and problems\u003c/p\u003e\u003c/li>\u003e\u003cul data-start=\"4311\" data-end=\"4314\"\u003e\u003ch3 data-start=\"4316\" data-end=\"4343\"\u003e\u003cstrong data-start=\"4320\" data-end=\"4343\"\u003eClass 20: Graph I\u003c/strong\u003e\u003c/h3>\u003e\u003cul data-start=\"4344\" data-end=\"4491\"\u003e\u003cli data-start=\"4344\" data-end=\"4393\"\u003e\u003cp data-start=\"4346\" data-end=\"4393\"\u003eGraph representation: adjacency list \u0026amp; matrix\u003c/p\u003e\u003c/li>\u003e\u003cp data-start=\"4394\" data-end=\"4418\"\u003eDFS \u0026amp; BFS traversals\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4419\" data-end=\"4491\"\u003e\u003cp data-start=\"4421\" data-end=\"4491\"\u003eProblems: connected components, reachability, simple cycle detection\u003c/p\u003e\u003c/li>\u003e\u003cul data-start=\"4493\" data-end=\"4496\"\u003e\u003ch3 data-start=\"4498\" data-end=\"4526\"\u003e\u003cstrong data-start=\"4502\" data-end=\"4526\"\u003eClass 21: Graph II\u003c/strong\u003e\u003c/h3>\u003e\u003cul data-start=\"4527\" data-end=\"4694\"\u003e\u003cli data-start=\"4527\" data-end=\"4578\"\u003e\u003cp data-start=\"4529\" data-end=\"4578\"\u003eCycle detection in directed \u0026amp; undirected graphs\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4579\" data-end=\"4637\"\u003e\u003cp data-start=\"4581\" data-end=\"4637\"\u003eDAGs and Topological Sort using DFS \u0026amp; Kahn's Algorithm\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4638\" data-end=\"4694\"\u003e\u003cp data-start=\"4640\" data-end=\"4694\"\u003eGraph problems: scheduling and dependency resolution\u003c/p\u003e\u003c/li>\u003e\u003cul data-start=\"4696\" data-end=\"4699\"\u003e\u003ch3 data-start=\"4701\" data-end=\"4730\"\u003e\u003cstrong data-start=\"4705\" data-end=\"4730\"\u003eClass 22: Graph III\u003c/strong\u003e\u003c/h3>\u003e\u003cul data-start=\"4731\" data-end=\"4871\"\u003e\u003cli data-start=\"4731\" data-end=\"4781\"\u003e\u003cp data-start=\"4733\" data-end=\"4781\"\u003eShortest Path algorithms: Dijkstra's Algorithm\u003c/p\u003e\u003c/li>\u003e\u003cp data-start=\"4782\" data-end=\"4815\"\u003eMulti-source BFS \u0026amp; Flood Fill\u003c/p\u003e\u003c/li>\u003e\u003cli data-start=\"4816\" data-end=\"4871\"\u003e\u003cp data-start=\"4818\" data-end=\"4871\"\u003eCourse scheduling and real-life dependency examples\u003c/p\u003e\u003c/li>\u003e\u003cul data-start=\"4873\" data-end=\"4876\"\u003e\u003ch3 data-st

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problem-solving, adaptability, and emotional intelligence. These skills are essential in the workplace and can significantly impact career success.

Q: "How will improving my soft skills help my career?"

A: Improving your soft skills can help you build better relationships at work, improve communication, and enhance your leadership abilities. These skills can boost your career by making you more effective in teamwork, problem-solving, and handling workplace challenges.

Q: "Why should I take a soft skills course?"

A: Taking a soft skills course can help you improve how you interact with others, build confidence, and advance in your career. Soft skills are just as important as technical skills, and they help you work better in teams, communicate effectively, and handle workplace challenges.

Q: "Is this course suitable for beginners?"

A: Yes, this online soft skills course is perfect for beginners or anyone who wants to improve their interpersonal skills. You don't need any prior experience to take the course, and it's beneficial for all levels, whether you're just starting your career or looking to advance.

Q: "How are soft skills useful in the workplace?"

A: Soft skills help you communicate better, work in teams, manage your time, and handle stress. They also improve your ability to lead, resolve conflicts, and adapt to change. Employers highly value soft skills because they improve collaboration and productivity.

Q: "Can I take this course if I'm already employed?"

A: Yes, this online soft skills course is designed to be flexible, so you can take them while working. You can learn at your own pace, making it easy to fit into your schedule, even with a full-time job.

Q: "What can I expect to learn in a soft skills course?"

A: In a soft skills course, you can expect to learn essential skills such as effective communication, active listening, teamwork, conflict resolution, time management, and emotional intelligence. Many courses also include practical exercises, role-playing scenarios, and group discussions to help participants apply these skills in real-world situations.

Q: "Is there a contact number available for inquiries?"

A: You may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org.

Q: "Can I make the payment through PayPal?"

A: Yes. Mail us with your details at courses@geeksforgeeks.org.

Metadata:

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- doubt_support_price: 0
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- desktop_banner: https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskills.png_1726729710.png
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- short_description: This comprehensive Soft Skills Training course is designed to enhance your soft skills essential for personal and professional success. You'll learn essential workplace skills like communication, leadership, teamwork, time management, etc. Whether you're a professional looking to advance your career or a beginner wanting to build confidence, this course will equip you with the soft skills needed for success in any job.
- what_you_will_learn: ""
- course_overview: In today's fast-paced and interconnected world, soft skills have become just as important as technical knowledge. This Complete Course on Soft Skills for personal and professional growth is designed to help

p you develop essential interpersonal abilities that enhance communication, collaboration, problem-solving, and leadership. Whether you're navigating the workplace, managing teams, or interacting with clients, these skills are crucial to your success.

Throughout this Soft Skills Training Online Course, you will explore key soft skills such as effective communication, emotional intelligence, time management, adaptability, conflict resolution, and teamwork. You will also engage in practical exercises, real-world scenarios, and self-assessment activities that will allow you to apply what you learn to everyday situations.

GFG Soft Skills Course – Highlights

- Master essential communication, teamwork, and leadership skills.**
- Improve verbal, non-verbal, and written communication techniques.**
- Enhance teamwork with effective collaboration and conflict-resolution strategies.**
- Develop critical thinking and problem-solving abilities through real-world cases.**
- Build emotional intelligence for better self-awareness and relationship management.**
- Learn prioritization and task management for efficient time management.**
- Understand professionalism, business etiquette, and ethical decision-making.**
- Explore leadership styles to build trust, influence, and accountability.**
- Master networking techniques and relationship-building for career growth.**
- Gain confidence in public speaking and delivering impactful presentations.**

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03cli\u003eHands-on practice with real-world datasets\u003c/li\u003e\u003eli
\u003eLearn industrial tools: Excel, SQL, Python, Pandas, NumPy, Jupyter, Ta
bleau, Power BI \u0026amp; more\u003c/li\u003e\u003eli\u003e\u003cli\u003eWork on multiple
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arent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMath \u0026amp; statistical functions (SUM, AVERAGE, COUNT)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLogical functions (IF, AND, OR)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eText functions for manipulation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVLOOKUP, VLOOKUP\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 2: Advanced Formulas \u0026 Dashboards Using Excel": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eINDEX MATCH\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSUMIF, COUNTIFS, nested functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower Query: import, transform, merge, append\u003c/span\u003e\u003c/li\u003e\u003cli

\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eDynamic dashboards\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003ePivot tables from multiple sources\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eSlicers, combo charts, layout optimization\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 3: Excel AI, Project, Kaggle \u0026 Github Introduction\": \"\u003cul\u003e\u003eli\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAI-assisted data cleaning \u0026amp; transformation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eExcel with AI project\u0026nbsp;\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eKaggle and Github optimization\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 4: Introduction to SQL\": \"\u003cul\u003e\u003eli\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003e

ternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003e0verview of SQL \\u0026amp; databases\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eBasic syntax, SELECT, WHERE\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eCreating \\u0026amp; modifying tables (CREATE/ALTER)\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eUnderstanding constraints\\u003c/span\\u003e\\u003c/li\\u003e\\u003cul\\u003e\", \"Class 5: Aggregations \\u0026 GROUP BY\": \"\\u003cul\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eCOUNT, SUM, AVG, MIN, MAX\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eFiltering aggregates\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eGROUP BY, HAVING\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; fon

t-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alt
ernates: normal; font-variant-position: normal; font-variant-emoji: normal;
vertical-align: baseline; white-space-collapse: preserve;"\u003eORDER BY, L
IMIT, sorting\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-m
ce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; b
ackground-color: transparent; font-weight: 400; font-style: normal; font-var
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pre-wrap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-va
riant-numeric: normal; font-variant-east-asian: normal; font-variant-alterna
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ical-align: baseline; white-space-collapse: preserve;"\u003eDISTINCT vs GRO
UP BY\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style
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d-color: transparent; font-weight: 400; font-style: normal; font-variant: no
rmal; text-decoration: none; vertical-align: baseline; white-space: pre-wra
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umeric: normal; font-variant-east-asian: normal; font-variant-alternates: no
rmal; font-variant-position: normal; font-variant-emoji: normal; vertical-al
ign: baseline; white-space-collapse: preserve;"\u003eLLM-powered optimizati
on suggestions\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-sty
le=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; backgro
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ap;" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-
numeric: normal; font-variant-east-asian: normal; font-variant-alternates: n
ormal; font-variant-position: normal; font-variant-emoji: normal; vertical-a
lign: baseline; white-space-collapse: preserve;"\u003eIntroduction to Joins
\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"fo
nt-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-col
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normal; font-variant-east-asian: normal; font-variant-alternates: normal; fo
nt-variant-position: normal; font-variant-emoji: normal; vertical-align: bas
eline; white-space-collapse: preserve;"\u003eINNER, LEFT, RIGHT, FULL OUTER
Joins \u0026amp; Self join\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; colo
r: #000000; background-color: transparent; font-weight: 400; font-style: nor
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riant-alternates: normal; font-variant-position: normal; font-variant-emoji:
normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDeep
Dive into Joins \u0026amp; Subquery Logic\u003c/span\u003e\u003c/li\u003e
\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Aria
l,sans-serif; color: #000000; background-color: transparent; font-weight: 40
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-align: baseline; white-space: pre-wrap;" style=\"font-size: 12pt; font-fam
ily: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asia
n: normal; font-variant-alternates: normal; font-variant-position: normal; f
ont-variant-emoji: normal; vertical-align: baseline; white-space-collapse: p
reserve;"\u003eSubqueries \u003c/span\u003e\u003c/li\u003e\u003c/li\u003e
e","Class 7: Window Functions":"\u003cul\u003e\u003cli\u003e\u003cspan data
-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000;
background-color: transparent; font-weight: 400; font-style: normal; font-va

ariant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic windows functions Aggregate functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRank functions(ROW_NUMBER(), RANK(), DENSE_RANK() ,PARTITION BY)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAdvance windows functions (LAG(), LEAD(), SUM() OVER(), AVG() OVER())\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI error detection in analytical SQL\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCTE ,SUBSTRING, LENGTH, TRIM, REPLACE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUPPER/LOWER\u003c/span\u003e\u003cbr\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDATE_ADD, DATEDIFF, EXTRACT\u003c/span\u003e\u003c/li\u003e

003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAI-assisted SQL debugging\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 9: CASE WHEN, Optimization \u0026 Analytics\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eCASE WHEN \u0026amp; conditional logic\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIF statements\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIndexes, EXPLAIN plans\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eFunnel analysis, cohorts, retention\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 10: Python Fundamentals for Data Analysis\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIntroduction to python\u0026nbsp; \u0026amp; installation \u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eIntroduction to python\u0026nbsp; \u0026amp; installation \u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\"

ernates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython basics, data types, variables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLoops (for, while)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eConditional statements (if, elif, else)\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e", "Class 11: Python Fundamentals (Continued)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLists, dictionaries, tuples\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eList comprehension ,operators\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eString methods,Indexing \u0026amp; slicing\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunctions \u0026amp; error handling\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e", "Class 12: Python Fundamentals (Continued)": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunctions \u0026amp; error handling\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e"

al-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunctions such as map,filter , lambda\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eInbuilt functions len(), type(), sum(), sorted()\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eWorking with external files\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUsing Colab AI for debugging and code generation\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eData cleaning operations\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eString processing\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDataFrames \u0026amp; Series\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: t

ransparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMissing values\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDuplicate handling\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 14: Pandas Transformation": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eData type conversions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eColumn renaming\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eGroupby, agg, apply\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePivot tables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMerging \u0026amp; joining\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transpa

rent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI helpers for transformation scripts\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 15: NumPy \u0026 ED A": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eNumPy arrays and vectorization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eStatistical operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eOutlier handling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eEDA workflow\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 16: Visualization with Matplotlib, Seaborn \u0026 Plotly": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic \u0026amp; advanced charts\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eInteractive visualizations\u003c/span\u003e\u003c/ul\u003e

c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eCustomization \u0026amp; styling\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eAI-generated chart scripts\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 17: EDA Project (Python)\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eData loading\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eCleaning with Pandas\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eVisualizations\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 18: Python + A I EDA Project\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eData acquisition\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white

–space-collapse: preserve;"\u003eCleaning \u0026amp; preparation\u003c/span
\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12
pt; font-family: Arial,sans-serif; color: #000000; background-color: transpa
rent; font-weight: 400; font-style: normal; font-variant: normal; text-decor
ation: none; vertical-align: baseline; white-space: pre-wrap;" style="font
-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; f
ont-variant-east-asian: normal; font-variant-alternates: normal; font-varian
t-position: normal; font-variant-emoji: normal; vertical-align: baseline; wh
ite-space-collapse: preserve;"\u003eNumerical analysis\u003c/span\u003e\u00
3c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-f
amily: Arial,sans-serif; color: #000000; background-color: transparent; font
-weight: 400; font-style: normal; font-variant: normal; text-decoration: non
e; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12p
t; font-family: Arial, sans-serif; font-variant-numeric: normal; font-varian
t-east-asian: normal; font-variant-alternates: normal; font-variant-positio
n: normal; font-variant-emoji: normal; vertical-align: baseline; white-space
-collapse: preserve;"\u003eVisualization\u003c/span\u003e\u003c/li\u003e\u00
03cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,s
ans-serif; color: #000000; background-color: transparent; font-weight: 400;
font-style: normal; font-variant: normal; text-decoration: none; vertical-al
ign: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-famil
y: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian:
normal; font-variant-alternates: normal; font-variant-position: normal; font
-variant-emoji: normal; vertical-align: baseline; white-space-collapse: pres
erve;"\u003eAI-assisted EDA automation\u003c/span\u003e\u003c/li\u003e\u003c
c/ul\u003e","Class 19: Data Analysis with LLMs":"\u003cul\u003e\u003cli\u003
e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif;
color: #000000; background-color: transparent; font-weight: 400; font-style:
normal; font-variant: normal; text-decoration: none; vertical-align: baselin
e; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, san
s-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font
-variant-alternates: normal; font-variant-position: normal; font-variant-emo
ji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003
eHow LLMs help in analysis\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan
data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; colo
r: #000000; background-color: transparent; font-weight: 400; font-style: nor
mal; font-variant: normal; text-decoration: none; vertical-align: baseline;
white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-s
erif; font-variant-numeric: normal; font-variant-east-asian: normal; font-va
riant-alternates: normal; font-variant-position: normal; font-variant-emoji:
normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePan
das code generation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan
data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000
000; background-color: transparent; font-weight: 400; font-style: normal; fo
nt-variant: normal; text-decoration: none; vertical-align: baseline; white-s
pace: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; f
ont-variant-numeric: normal; font-variant-east-asian: normal; font-variant-a
lternates: normal; font-variant-position: normal; font-variant-emoji: norma
l; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning
assistance\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-
style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; back
ground-color: transparent; font-weight: 400; font-style: normal; font-varian
t: normal; text-decoration: none; vertical-align: baseline; white-space: pre
-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-varia
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s)\u003c/li\u003e\u003cli\u003eEmbedded systems (software for devices like microwaves and cars)\u003c/li\u003e\u003cli\u003eGames and graphics\u003c/li\u003e\u003cli\u003eHigh-performance applications\u003c/li\u003e\u003c/ul\u003e", "Do I need to know any other programming languages before learning C?": "\u003cp\u003eNo, you don't need to know any other programming languages before learning C. In fact, many people start with C because it helps them understand fundamental programming concepts that are useful in other languages as well.\u003c/p\u003e", "Is C still relevant today?": "\u003cp\u003eYes, C is still very relevant today. It's widely used in systems programming, embedded systems, and high-performance applications. Many modern programming languages and systems are built on C, so understanding it is valuable in the tech industry.\u003c/p\u003e", "What kind of jobs can I get with C programming skills?": "\u003cp\u003eWith C programming skills, you can pursue roles such as:\u003c/p\u003e\u003cul\u003e\u003eli\u003eSoftware Developer/Engineer\u003c/li\u003e\u003eli\u003eSystems Programmer\u003c/li\u003e\u003eli\u003eEmbedded Systems Engineer\u003c/li\u003e\u003eli\u003eFirmware Developer\u003c/li\u003e\u003eli\u003eGame Developer\u003c/li\u003e\u003eli\u003eRobotics Programmer\u003c/li\u003e\u003eli\u003eNetwork Programmer\u003c/li\u003e\u003eli\u003eOperating System Developer\u003c/li\u003e\u003c/ul\u003e", "What are the career growth opportunities with C programming?": "\u003cp\u003eWith C programming skills, you can grow into senior developer roles, lead engineering teams, or specialize in areas like embedded systems, systems programming, or network programming. C expertise can also lead to roles in software architecture, technical leadership, or even transitioning to other areas like cybersecurity or IoT (Internet of Things).\u003c/p\u003e", "Can I use C for web development?": "\u003cp\u003eWhile C is not commonly used for web development, it can be used to build parts of web applications, especially for back-end processes that require high performance. However, languages like JavaScript, Python, and PHP are more commonly used for web development.\u003c/p\u003e"}}, {"has_doubt_assistance": true, "doubt_support_price": 0, "visit_count": "215k+", "desktop_banner": "https://media.geeksforgeeks.org/img-practice/prod/courses/287/Mobile/Content/c_1722949121.png", "mobile_banner": "https://media.geeksforgeeks.org/img-practice/prod/courses/287/Mobile/Content/c_1722949121.png", "seats_left": null, "top_course": false, "course_publish_date": "2021-02-10T20:00:00", "keywords": "Prog Lang | DSA / Placements", "ratings": {"avg_rating": 4.6, "partial_rating": 0.5999999999999996, "star_count": 0}, "intro_video_link": {"thumbnail_image": "https://media.geeksforgeeks.org/img-practice/prod/courses/287/Mobile/Content/c_1722949121.png", "link": "https://cdnvideos.geeksforgeeks.org/hls/578c57d6bb32b2fc354686c3112682cagfg-IntroductiontoPointersinC20220804183808-hlsx720p.m3u8", "video_available": true}, "short_description": "\u003cp\u003e\u003cspan id=\"docs-internal-guid-7e5a27ea-7fff-df3d-1607-9f0da2051785\"\u003e\u003cspan\u003e\u003c/p\u003e\u003cspan dir=\"ltr\" style=\"line-height: 1.38; margin-top: 0pt; margin-bottom: 0pt;\" data-mce-style=\"line-height: 1.38; margin-top: 0pt; margin-bottom: 0pt;\"\u003e\u003cspan style=\"font-size: 11pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" data-mce-style=\"font-size: 11pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\"\u003eThis C Programming with Data Structures Course will help you master all basic and advanced C concepts. Master the easy-to-learn C language and take your skills to the next level. Start Today!\u003cspan\u003e\u003c/p\u003e", "what_you_will_learn": "", "course_overview": "\u003cp\u003eThe C Programming Course with Data Structures is designed to teach you the fundamentals of C programming while also focusing on essential data structure

s. C is the foundation of many modern programming languages, and learning it can open up a lot of opportunities in software development, system programming, and more.

[p/u003e/u003cp/u003eGFG C Programming Course – Highlight s:\u003c/p\u003e\u003cul\u003e\u003cli\u003eA Beginner to Advanced C Program](#)
[ming course with Data Structures\u003cbr\u003e\u003c/li\u003e\u003cli\u003eD](#)
[eveloped by Founder and CEO Mr. Sandeep Jain.\u003cbr\u003e\u003c/li\u003e\u003cli\u003eIncludes 15+ hours of Basic C Concepts.\u003cbr\u003e\u003c/li\u003e\u003cli\u003eAnd 20+ hours of Advanced C Concepts.\u003cbr\u003e\u003c/li\u003e\u003cli\u003ePractice with 150+ coding problems and 200+ MCQs.\u003cbr\u003e\u003c/li\u003e\u003cli\u003eAccess curated notes for quick revisio](#)
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rong\u003e: Learn how strings are represented in memory and how to manipulate them.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eLinked Lists\u003c/strong\u003e: Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eStacks and Queues\u003c/strong\u003e: Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHashing\u003c/strong\u003e: Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 3: Advanced Data Structures\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eTrees\u003c/strong\u003e: Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHeaps\u003c/strong\u003e: Learn about heaps (min and max heaps) and their applications in priority queues and heap sort.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGraphs\u003c/strong\u003e: Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eTries\u003c/strong\u003e: Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDisjoint Set Union (DSU)\u003c/strong\u003e: Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 4: Learn Algorithms\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eSorting Algorithms\u003c/strong\u003e: Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eSearching Algorithms\u003c/strong\u003e: Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDynamic Programming (DP)\u003c/strong\u003e: Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGreedy Algorithms\u003c/strong\u003e: Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eBacktracking\u003c/strong\u003e: Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDivide and Conquer\u003c/strong\u003e: Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGraph Algorithms\u003c/strong\u003e: Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 5: Problem Solving and Practice\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eLeetCode, HackerRank, CodeForces\u003c/strong\u003e: Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eInterview Preparation\u003c/strong\u003e: Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eCompetitive Programming\u003c/strong\u003e: Engage in competitive programming contests and partici

pate in challenges to enhance your problem-solving abilities.

- Phase 6: Advanced Topics (Optional)
 - String Algorithms: Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching.
 - Advanced Dynamic Programming: Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc.
 - Advanced Graph Algorithms: Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp).
 - Geometry Algorithms: Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.

Why is This Roadmap Effective?

- Structured Learning: This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.
- Foundational Knowledge: Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.
- Hands-on Practice: Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding.
- Interview Focused: The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.
- Common Mistakes to Avoid
 - Skipping the Basics: Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.
 - Not Practicing Enough: DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.
 - Getting Stuck on One Problem: If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.
- Why Learn DSA?
 - Problem Solving Skills: Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.
 - Efficient Solutions: Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.
- Interview Success: DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

Topics Covered

- Introduction to DSA: Learn the importance of DSA and how it relates to coding efficiency.
- Data Structures: Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.
- Algorithms: Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.
- Problem-Solving: Gain hands-on experience by practicing

ng problems on competitive coding platforms and preparing for coding interviews.

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s (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). **Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching.** **Disjoint Set Union (DSU)** Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST. **Phase 4 Learn Algorithm** **Sorting Algorithms** Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. **Searching Algorithms** Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. **Dynamic Programming (DP)** Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). **Greedy Algorithms** Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. **Backtracking** Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. **Divide and Conquer** Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. **Graph Algorithms** Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm. **Phase 5 Problem Solving and Practice** LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. **Interview Preparation** Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. **Competitive Programming** Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities. **Phase 6 Advanced Topics (Optional)** **String Algorithms** Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. **Advanced Dynamic Programming** Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. **Advanced Graph Algorithms** Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). **Geometry Algorithms** Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points. **Why is This Roadmap Effective?** **Structured Learning** This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence. **Foundational Knowledge** Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. **Hands-on Practice** Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. **Interview Focused** The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. **Common Mistakes to Avoid** **Skipping the Basics** Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts. **Not Practicing Enough** DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. **Getting Stuck on One Problem** If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes. **Why Learn DSA?** **Problem Solving Skills** Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications. **Efficient Solutions** Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity. **Interview Success** DSA is the cornerstone of most technical interviews, especially for roles in

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Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.

Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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li\value="2"\ca href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-logic-building/" rel="noopener" target="_blank"\Quiz on Logic Building\span\ca/a\03e\03c/li\03e\03c/ul\03e\03ch3 id="2-learn-about-complexities" style="text-align:left"\03e\03cspan\03e2. Learn about Complexities\03c\span\03e\03c/h3\03e\03cp dir="ltr"\03e\03cspan\03eTo analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.\03c\span\03e\03c/p\03e\03cul\03e\03cli value="1"\03e\03ca href="https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/" rel="noopener" target="_blank"\03e\03cspan\03eComplexity Analysis Guide \03c\span\03e\03c/a\03e\03cspan\03e \03c\span\03e\03c/li\03e\03cli value="2"\03e\03ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/" rel="noopener" target="_blank"\03e\03cspan\03eQuiz on Complexity Analysis\03c\span\03e\03c/a\03e\03c/li\03e\03c/ul\03e\03ch3 id="3-array" style="text-align:left"\03e\03cspan\03e3. Array\03c\span\03e\03c/h3\03e\03cp dir="ltr"\03e\03cspan\03eArray is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.\03c\span\03e\03ca href="https://www.geeksforgeeks.org/dsa/introduction-to-arrays-data-structure-and-algorithm-tutorials/" rel="noopener" target="_blank"\03e\03cspan\03e \03c\span\03e\03c/a\03e\03c/p\03e\03cul\03e\03cli value="1"\03e\03ca href="https://www.geeksforgeeks.org/dsa/array-data-structure-guide/" rel="noopener" target="_blank"\03e\03cspan\03eArray Guide\03c\span\03e\03c/a\03e\03cspan\03e \03c\span\03e\03c/li\03e\03cli value="2"\03e\03ca href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/" rel="noopener" target="_blank"\03e\03cspan\03eArray Quiz\03c\span\03e\03c/a\03e\03c/li\03e\03c/ul\03e\03ch3 id="4-searching-algorithms" style="text-align:left"\03e\03cspan\03e4. Searching Algorithms\03c\span\03e\03c/h3\03e\03cp dir="ltr"\03e\03cspan\03eSearching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.\03c\span\03e\03c/p\03e\03cul\03e\03cli value="1"\03e\03ca href="https://www.geeksforgeeks.org/dsa/searching-algorithms/" rel="noopener" target="_blank"\03e\03cspan\03eSearching Guide\03c\span\03e\03c/a\03e\03cspan\03e \03c\span\03e\03c/li\03e\03cli value="2"\03e\03ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/" rel="noopener"\03e\03cspan\03eQuiz on Searching\03c\span\03e\03c/a\03e\03c/li\03e\03c/ul\03e\03ch3 id="5-sorting-algorithm" style="text-align:left"\03e\03cspan\03e5. Sorting Algorithm\03c\span\03e\03c/h3\03e\03cp dir="ltr"\03e\03cspan\03eSorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.\03c\span\03e\03c/p\03e\03cul\03e\03cli value="1"\03e\03ca href="https://www.geeksforgeeks.org/dsa/sorting-algorithms/" rel="noopener" target="_blank"\03e\03cspan\03eSorting Guide\03c\span\03e\03c/a\03e\03cspan\03e \03c\span\03e\03c/li\03e\03cli value="2"\03e\03ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/" rel="noopener" target="_blank"\03e\03cspan\03eQuiz on Sorting \03c\span\03e\03c/a\03e\03c/li\03e\03c/ul\03e\03ch3 id="6-hashing" style="text-align:left"\03e\03cspan\03e6. Hashing\03c\span\03e\03c/h3\03e

3e\u003cp dir=\"ltr\" style=\"text-align: left;\" \u003e\u003cspan\u003eHashing is a technique that generates a fixed-size output (hash value) from an input of variable size using mathematical formulas called hash functions. Hashing is commonly used in data structures for efficient searching, insertion and deletion.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/hashing-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eHashing Guide \u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-hash-data-strcuture-with-answers/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Hashing\u003c/span\u003e\u003c/a \u003e\u003cspan\u003e\u003c/li\u003e\u003cspan\u003e\u003c/ul\u003e\u003ch3 id=\"7-two-pointer-technique\" style=\"text-align:left\" \u003e\u003cspan\u003e7. Two Pointer Technique\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eTwo Pointer Technique, we typically use two index variables from two corners of an array. We use the two pointer technique for searching a required point or value in an array.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/two-pointers-technique/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eTwo Pointer Technique \u003c/span\u003e\u003c/a\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-two-pointer-technique-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Two Pointer Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cspan\u003e\u003c/ul\u003e\u003ch3 id=\"8-window-sliding-technique\" style=\"text-align:left\" \u003e\u003cspan\u003e8. Window Sliding Technique\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eWindow Sliding Technique, we use the result of previous subarray to quickly compute the result of current.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/window-sliding-technique/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eWindow Sliding Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-sliding-window-technique-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Sliding Window\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cspan\u003e\u003c/ul\u003e\u003ch3 id=\"9-prefix-sum-technique\" style=\"text-align:left\" \u003e\u003cspan\u003e9. Prefix Sum Technique\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eI\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003ePrefix Sum Technique, we compute prefix sums of an array to quickly find results for a subarray.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/prefix-sum-array-implementation-applications-competitive-programming/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003ePrefix Sum Technique\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/quiz-on-prefix-sum-for-dsa/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Prefix Sum\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e\u003c/li\u003e\u003cspan\u003e\u003c/ul\u003e\u003ch3 id=\"10-string\" style=\"text-align:left\" \u003e\u003cspan\u003e10. String\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA sequence of characters, typically immutable and have limited set of elements (lower case or all English alphabets).\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/string-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eStrings Guide\u003c/span\u003e\u003c/a\u003e

[03e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Strings\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cstrong\u003ecalls itself\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e within its own definition. It is usually used to solve problems that can be broken down into smaller instances of the same problem. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/recursion-algorithms/" rel="noopener" target="_blank\u003e\u003cspan\u003eRecursion Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-recursion-algorithm-with-answers/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Recursion\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cstrong\u003erows \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eand \u003c/span\u003e\u003c/b\u003e\u003cstrong\u003ecolumns\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e. It is represented as a rectangular grid, with each element at the intersection of a row and column.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/matrix/" rel="noopener" target="_blank\u003e\u003cspan\u003eMatrix Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-matrixgrid-for-dsa/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Matrix/Grid.\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cstrong\u003cp dir="\u003e\u003cspan\u003eA linear data structure that stores data in nodes, which are connected by pointers. Unlike arrays, nodes of linked lists are not stored in contiguous memory locations and can only be \u003c/span\u003e\u003c/b\u003e\u003cstrong\u003eaccessed sequentially\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, starting from the head of list.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/linked-list-data-structure/" rel="noopener" target="_blank\u003e\u003cspan\u003eLinked List Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-linked-list-data-structure-with-answers/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Linked List\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cstrong\u003cp dir="\u003e\u003cspan\u003eA\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e linear data structure that follows the \u003c/span\u003e\u003c/b\u003e\u003cstrong\u003eLast In, First Out \(LIFO\) \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eprinciple. Stacks play an important role in managing function calls, memory, and are widely used in algorithms like stock span problem, next greater element and largest area in a histogram.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/stack-data-structure/" rel="noopener" target="_blank\u003e\u003cspan\u003eStack Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-stack-data-structure-with-answers/" rel="noopener" target="](https://www.geeksforgeeks.org/quizzes/quiz-on-string-for-dsa/)

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e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"14-queue\" style=\"text-align:left\" \u003e\u003cspan\u003e15. Queue\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eQueue\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e is a linear data structure that follows the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eFirst In, First Out (FIFO)\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e principle. Queues play an important role in managing tasks or data in order, scheduling and message handling systems.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/queue-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQueue Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-queue-data-structure-with-answers/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Queue\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"15-deque\" style=\"text-align:left\" \u003e\u003cspan\u003e16. Deque\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" style=\"text-align: justify;\" \u003e\u003cspan\u003eA Deque or double-ended queue is a data structure that allows elements to be added or removed from both ends efficiently. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/deque-set-1-introduction-applications/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eDeque Guide\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e \u003c/span\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/deque-960/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Deque\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"17-tree\" style=\"text-align:left\" \u003e\u003cspan\u003e17. Tree\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA \u003c/span\u003e\u003cb\u003e\u003cstrong\u003enon-linear, hierarchical \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e data structure consisting of nodes connected by edges, with a top node called the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eroot \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e and nodes having child nodes. It is widely used in \u003c/span\u003e\u003cb\u003e\u003cstrong\u003efile systems\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003edatabases\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003edecision-making algorithms\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, etc.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/tree-data-structure/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eTree Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/tree-22648/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eQuiz on Tree\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"18-heap\" style=\"text-align:left\" \u003e\u003cspan\u003e18. Heap\u003c/span\u003e\u003c/h3\u003e\u003cp dir=\"ltr\" \u003e\u003cspan\u003eA \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecomplete binary tree\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e that satisfies the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eheap property\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e. Heaps are usually used to implement \u003c/span\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/priority-queue-set-1-introduction/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003epriority queues\u003c/span\u003e\u003c/a\u003e\u003cspan\u003e, where the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003esmallest \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e or \u003c/span\u003e\u003cb\u003e\u003cstrong\u003elargest \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e element is always at the root of the tree.\u003c/span\u003e

[1](http://www.geeksforgeeks.org/dsa/heap-data-structure/) Heap Guide

[2](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-heap-data-structure-with-answers/)

19. Graph

Graphs are widely used to represent relationships between entities.

[1](https://www.geeksforgeeks.org/dsa/graph-data-structure-and-algorithms/) Graph Guide

[2](https://www.geeksforgeeks.org/quizzes/graph-12715/)

20. Greedy Algorithm

Greedy Algorithm builds up the solution one piece at a time and chooses the next piece which gives the most obvious and immediate benefit i.e., which is the most optimal choice at that moment. So the problems where choosing locally optimal also leads to the global solutions are best fit for Greedy.

[1](https://www.geeksforgeeks.org/dsa/greedy-algorithms/) Greedy Algorithms Guide

[2](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-greedy-algorithms-with-answers/)

21. Dynamic Programming

Dynamic Programming is a method used to solve complex problems by breaking them down into simpler subproblems.

[1](https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/) Dynamic Programming Guide

[2](https://www.geeksforgeeks.org/quizzes/top-mcqs-on-dynamic-programming-with-answers/)

22. Advanced Data Structure and Algorithms

23. Advanced Data Structure and Algorithms

y;\u003e\u003cspan\u003eAdvanced Data Structures like \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eTrie\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eSegment Tree\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eRed-Black Tree\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e and \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eBinary Indexed Tree\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e offer significant performance improvements for specific problem domains. They provide efficient solutions for tasks like fast prefix searches, range queries, dynamic updates, and maintaining balanced data structures, which are crucial for handling large datasets and real-time processing.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/trie-insert-and-search/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eTrie\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/segment-tree-data-structure/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eSegment Tree\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"3\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/introduction-to-red-black-tree/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eRed-Black Tree\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"4\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/binary-indexed-tree-or-fenwick-tree-2/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eBinary Indexed Tree\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"5\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/advance-data-structure/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003ePractice Advanced Data Structures\u003c/strong\u003e\u003c/a\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id=\"22-other-algorithms\" style=\"text-align:left\"\u003e\u003cspan\u003e23. Other Algorithms\u003c/strong\u003e\u003c/h3\u003e\u003cdiv dir=\"ltr\"\u003e\u003cspan\u003e\u003cstrong\u003eBitwise Algorithms\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e Operate on individual bits of numbers.\u003c/strong\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/bitwise-algorithms/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eBitwise Algorithms Guide\u003c/strong\u003e\u003c/a\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-bitwise-algorithms-and-bit-manipulations-with-answers/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eQuiz on Bit Magic\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cdiv dir=\"ltr\"\u003e\u003cspan\u003e\u003cstrong\u003eBacktracking Algorithm\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e Follow Recursion\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e with the option to \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e revert and traces back \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e if the solution from current point is not feasible.\u003c/strong\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/backtracking-algorithms/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eBacktracking Guide\u003c/strong\u003e\u003c/a\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/li\u003e\u003cli value=\"2\"\u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-backtracking-algorithm-with-answers/\u003c/strong\u003e\" rel=\"noopener\" target=\"_blank\"\u003e\u003cspan\u003eQuiz on Backtracking\u003c/strong\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cdiv dir=\"ltr\"\u003e\u003cspan\u003e\u003cstrong\u003eDivide and conquer\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e A strategy to solve problems by dividing them into \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e smaller subprob

blems, and combining the solutions to obtain the final solution.

<https://www.geeksforgeeks.org/dsa/divide-and-conquer/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-divide-and-conquer-algrithm-with-answers/>

<https://www.geeksforgeeks.org/dsa/branch-and-bound-algorithm/>

<https://www.geeksforgeeks.org/dsa/geometric-algorithms/>

<https://www.geeksforgeeks.org/dsa/randomized-algorithms/>

DSA Tutorial

DSA stands for Data Structures and Algorithms. Data structures manage how data is stored and accessed. Algorithms focus on processing this data. Examples of data structures are Array, Linked List, Tr

ee and Heap, and examples of algorithms are Binary Search, Quick Sort and Merge Sort. Foundation for almost every software", "about": [{"@type": "Thing", "name": "Dsa"}, {"@type": "Thing", "name": "Tutorials"}, {"@type": "Thing", "name": "DsaTutorials"}], {"@context": "https://schema.org", "@type": "WebSite", "name": "GeeksforGeeks", "url": "https://www.geeksforgeeks.org/", "potentialAction": {"@type": "SearchAction", "target": "https://www.geeksforgeeks.org/search/{search_term_string}/", "query-input": "required name=search_term_string"}}, {"@context": "https://schema.org", "@type": "Organization", "name": "GeeksforGeeks", "url": "https://www.geeksforgeeks.org/", "logo": "https://media.geeksforgeeks.org/wp-content/cdn-uploads/20200817185016/gfg_complete_logo_2x-min.png", "description": "Your All-in-One Learning Portal: GeeksforGeeks is a comprehensive educational platform that empowers learners across domains-spanning computer science and programming, school education, upskilling, commerce, software tools, competitive exams, and more.", "founder": [{"@type": "Person", "name": "Sandeep Jain", "url": "https://in.linkedin.com/in/sandeep-jain-b3940815"}], "sameAs": ["https://www.facebook.com/geeksforgeeks.org/", "https://twitter.com/geeksforgeeks", "https://www.linkedin.com/company/1299009", "https://www.youtube.com/geeksforgeeksvideos/"]}, {"@context": "https://schema.org", "@type": "BreadcrumbList", "itemListElement": [{"@type": "ListItem", "position": 1, "name": "DSA", "item": {"@type": "Thing", "@id": "https://www.geeksforgeeks.org/category/dsa/"}}], [{"@type": "ListItem", "position": 2, "name": "dsa-tutorial-learn-data-structures-and-algorithms", "item": {"@type": "Thing", "@id": "https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/"}}]}], "validatedVideoSchema": {"@context": "https://schema.org", "@type": "VideoObject", "name": "Roadmap to learn DSA", "description": "In this tutorial, we will explore a structured roadmap to learning Data Structures and Algorithms (DSA), which are essential for any software engineer or computer science student. Mastering DSA is crucial for solving complex problems efficiently, and it is the foundation for cracking technical interviews and coding challenges. What is DSA? Data Structures and Algorithms (DSA) are the building blocks of computer science and software development. Data structures are ways of organizing and storing data, while algorithms are sets of steps or procedures to solve a problem or perform a task. Together, they form the backbone of efficient problem-solving, code optimization, and performance improvement. Why is DSA Important? Efficiency Understanding DSA helps in solving problems with optimal time and space complexity, which is crucial in real-world applications. Technical Interviews Most technical interviews, especially at top tech companies, revolve around solving DSA problems. A solid understanding of DSA will help you perform well in coding interviews. Problem Solving Mastery of DSA improves your problem-solving ability, helping you design solutions for complex and dynamic challenges. Roadmap to Learn DSA The roadmap to learning DSA is structured into phases. Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts. Phase 1 Introduction to Programming Basics Before diving into DSA, you need to have a solid understanding of basic programming concepts. This includes Variables, Data Types, and Operators Understand how variables and data types work in programming languages. Control Flow Learn about if-else conditions, loops (for, while), and switch cases. Functions Master how functions work, including parameters, return types, and recursion. Basic Input and Output Learn how to handle input and output in your programming language of choice. Phase 2 Learn Basic Data Structures Arrays Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays. Strings Learn how strings are represented in memory and how to manipulate them. Linked Lists Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. Stacks and Queues Study stack (LIFO) and queue (FIFO) operations and their applicat

ions in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups. Phase 3 Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST. Phase 4 Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm. Phase 5 Problem Solving and Practice LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities. Phase 6 Advanced Topics (Optional) String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. Advanced Dynamic Programming Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. Advanced Graph Algorithms Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). Geometry Algorithms Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points. Why is This Roadmap Effective? Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence. Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics. Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding. Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies. Common Mistakes to Avoid Skipping the Basics Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts. Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress. Getting Stuck on One Problem If you're stuck on a problem for too long, move on to another. It's

important to keep practicing and learning from your mistakes. Why Learn DSA? Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications. Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity. Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies. Topics Covered Introduction to DSA Learn the importance of DSA and how it relates to coding efficiency. Data Structures Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps. Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms. Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

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c/p/u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/logic-building-problems/" rel="\u003e\u003cspan\u003eLogic Building Guide \u003e\u003c/a \u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-logic-building/" rel="\u003e\u003cspan\u003eQuiz on Logic Building\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e2. Learn about Complexities\u003e\u003c/h3\u003e\u003cp dir="\u003e\u003cspan\u003eTo analyze algorithms, we mainly measure order of growth of time or space taken in terms of input size. We do this in the worst case scenario in most of the cases. Please refer the below links for a clear understanding of these concepts.\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/analysis-of-algorithms/" rel="\u003e\u003cspan\u003eComplexity Analysis Guide \u003e\u003c/a\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/quiz-on-complexity-analysis-for-dsa/" rel="\u003e\u003cspan\u003eQuiz on Complexity Analysis\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e3. Array\u003e\u003c/h3\u003e\u003cp dir="\u003e\u003cspan\u003eArray is a linear data structure where elements are allocated contiguous memory, allowing for constant-time access.\u003e\u003cspan\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/introduction-to-arrays-data-structure-and-algorithm-tutorials/" rel="\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/a\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/array-data-structure-guide/" rel="\u003e\u003cspan\u003eArray Guide\u003e\u003c/a\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/dsa-tutorial-array/" rel="\u003e\u003cspan\u003eArray Quiz\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e4. Searching Algorithms\u003e\u003c/h3\u003e\u003cp dir="\u003e\u003cspan\u003eSearching algorithms are used to locate specific data within a large set of data. It helps find a target value within the data. There are various types of searching algorithms, each with its own approach and efficiency.\u003e\u003cspan\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/searching-algorithms/" rel="\u003e\u003cspan\u003eSearching Guide\u003e\u003c/a\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-searching-algorithm-with-answers/" rel="\u003e\u003cspan\u003eQuiz on Searching\u003e\u003c/a\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e5. Sorting Algorithm\u003e\u003c/h3\u003e\u003cp dir="\u003e\u003cspan\u003eSorting algorithms are used to arrange the elements of a list in a specific order, such as numerical or alphabetical. It organizes the items in a systematic way, making it easier to search for and access specific elements.\u003e\u003cspan\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/sorting-algorithms/" rel="\u003e\u003cspan\u003eSorting Guide\u003e\u003c/a\u003e\u003cspan\u003e\u003e\u003cspan\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-sorting-algorithms-with-answers/" rel="

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here a function \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecalls itself \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e within its own definition. It is usually used to solve problems that can be broken down into smaller in

stances of the same problem. \u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/recursion-algorithms/" rel="noopener" target="_blank\u003e\u003cspan\u003eRecursion Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-recursion-algorithm-with-answers/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Recursion\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e12. Matrix/Grid\u003c/span\u003e\u003c/h3\u003e\u003cp d

ir="\u003e\u003cspan\u003eA two-dimensional array of elements, arrange

d in \u003c/span\u003e\u003cb\u003e\u003cstrong\u003erows \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eand \u003c/span\u003e\u003cb\u003e\u003cstrong\u003ecolumns\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e. It is repre

sented as a rectangular grid, with each element at the intersection of a row

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cture that stores data in nodes, which are connected by pointers. Unlike arr

ays, nodes of linked lists are not stored in contiguous memory locations and

can only be \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eaccessed sequent

ially\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, starting from the he

ad of list.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/dsa/linked-list-data-st

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st Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value="\u003e\u003ca href="https://www.geeksforgeeks.org/quizzes/top-mcqs-on-linked-list-data-structure-with-answers/" rel="noopener" target="_blank\u003e\u003cspan\u003eQuiz on Linked List\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003ch3 id="\u003e\u003cspan\u003e14. Stack\u003c/span\u003e\u003c/h3\u003e\u003cp dir="\u003e\u003cspan\u003eA linear data structure that follows the \u003c/span\u003e\u003cb\u003e\u003cstrong\u003eLast In, First Out (LIFO) \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e principle. Stacks play an important role in managin

g function calls, memory, and are widely used in algorithms like stock span

problem, next greater element and largest area in a histogram.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value="\u003e\u003ca href="http

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structure that allows elements to be added or removed from both ends efficie
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applications/" rel="\u003e\u003cspan\u003eDequ
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ical \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003edata structure consist
ing of nodes connected by edges, with a top node called the \u003c/span\u003e
e\u003c/b\u003e\u003cstrong\u003eroot \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eand nodes having child nodes. It is widely used in \u003c/span\u003e
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amic-programming-with-answers/" rel="noopener\" target="_blank\"cspan\cQuiz on DP\c/span\c/a\c/li\cli value="2

22. Advanced Data Structure and Algorithms

Advanced Data Structures like Trie, Segment Tree, Red-Black Tree and Binary Indexed Tree offer significant performance improvements for specific problem domains. They provide efficient solutions for tasks like fast prefix searches, range queries, dynamic updates, and maintaining balanced data structures, which are crucial for handling large datasets and real-time processing.

<https://www.geeksforgeeks.org/dsa/trie-insert-and-search/>

<https://www.geeksforgeeks.org/dsa/segment-tree-data-structure/>

<https://www.geeksforgeeks.org/dsa/introduction-to-red-black-tree/>

<https://www.geeksforgeeks.org/dsa/binary-indexed-tree-or-fenwick-tree-2/>

23. Other Algorithms

Other Algorithms like Bitwise Algorithms, Backtracking Algorithm, and Magic Bit Manipulations with answers.

<https://www.geeksforgeeks.org/dsa/bitwise-algorithms/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-bitwise-algorithms-and-bit-manipulations-with-answers/>

<https://www.geeksforgeeks.org/dsa/backtracking-algorithms/>

<https://www.geeksforgeeks.org/quizzes/top-mcqs-on-backtracking-algorithm-with-answers/>

`\ltr\"u003e\u003cb\u003e\u003cstrong\u003eDivide and conquer: \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e A strategy to solve problems by dividing them into \u003c/span\u003e\u003cb\u003e\u003cstrong\u003esmaller subproblems\u003c/strong\u003e\u003c/b\u003e\u003cspan\u003e, solving those subproblems, and combining the solutions to obtain the final solution.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/divide-and-conquer/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eDivide and Conquer Guide\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/quizzes/top-mcqs-on-divide-and-conquer-algrithm-with-answers/\" rel=\"noopener\" \u003e\u003cspan\u003eQuiz on Divide and Conquer\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eBranch and Bound : \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eUsed in combinatorial optimization problems to systematically search for the best solution. It works by dividing the problem into smaller subproblems, or branches, and then eliminating certain branches based on bounds on the optimal solution. This process continues until the best solution is found or all branches have been explored.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/branch-and-bound-algorithm/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eBranch and Bound Algorithm\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eGeometric algorithms \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eare a set of algorithms that solve problems related to shapes, points, lines and polygons.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/geometric-algorithms/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eGeometric Algorithms\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cli value=\"2\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/explore\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003ePractice Geometric Algorithms\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\u003cp dir=\"ltr\" \u003e\u003cb\u003e\u003cstrong\u003eRandomized algorithms \u003c/strong\u003e\u003c/b\u003e\u003cspan\u003eare algorithms that use randomness to solve problems. They make use of random input to achieve their goals, often leading to simpler and more efficient solutions. These algorithms may not product same result but are particularly useful in situations when a probabilistic approach is acceptable.\u003c/span\u003e\u003c/p\u003e\u003cul\u003e\u003cli value=\"1\" \u003e\u003ca href=\"https://www.geeksforgeeks.org/dsa/randomized-algorithms/\" rel=\"noopener\" target=\"_blank\" \u003e\u003cspan\u003eRandomized Algorithms\u003c/span\u003e\u003c/a\u003e\u003c/li\u003e\u003c/ul\u003e\", \"post_title\": \"DSA Tutorial\", \"post_status\": \"publish\", \"gfg_id\": \"1103752\", \"parent_gfg_id\": 0, \"post_slug\": \"dsa-tutorial-learn-data-structures-and-algorithms\", \"post_url\": \"https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/\", \"post_created_date\": \"2023-11-30T11:01:46\", \"post_modified_date\": \"2025-12-25T13:50:09\", \"like_count\": 1320, \"article_rating\": 5, \"tags\": [{\"id\": 6527, \"name\": \"Tutorials\", \"slug\": \"tutorials\", \"url\": \"https://www.geeksforgeeks.org/tag/tutorials/\", \"parent_id\": null, \"parent_name\": null, \"parent_slug\": null, \"pp_count\": 301, \"write_id\": 9969}, {\"id\": 8104, \"name\": \"DSA Tutorials\", \"slug\": \"dsa-tutorials\", \"url\": \"https://www.geeksforgeeks.org/tag/dsa-tutorials/\", \"parent_id\": null, \"parent_name\": null, \"parent_slug\": null, \"pp_count\": 36, \"write_id\": 11742}], \"author_details\": {\"handle\": \"RishabhPrabhu\", \"display_author\": \"1\", \"display_name\": \"RishabhPrabhu\", \"badge\": \"ace\"}, \"categories\": [{\"id\": 6263, \"name\": \"DSA\", \"slug\": \"dsa\", \"url\": \"https://www.geeksforgeeks.org/category/dsa/\", \"parent_id\": null, \"parent_name\": null, \"parent_slug\": null, \"pp_count\": 20163, \"write_id\": 5414}], \"publish_date\": \"2023-11-30 - 12:40:59\", \"post_meta\": {\"og:title\": \"DSA Tuto`

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e","Is Go suitable for beginners?": "\u003cp\u003eYes, Go is beginner-friendly due to its simple syntax and clear documentation. It's a great starting point for anyone looking to learn programming and build efficient software.\u003c/p\u003e","Can I get a job with Go programming skills?": "\u003cp\u003eYes, Go developers are in demand, especially in roles like:\u003c/p\u003e\u003cul\u003e\u003cli\u003eBackend Developer\u003c/li\u003e\u003cli\u003eCloud Engineer\u003c/li\u003e\u003cli\u003eDevOps Engineer\u003c/li\u003e\u003cli\u003eSoftware Engineer\u003c/li\u003e\u003c/ul\u003e\u003cp\u003eKnowing Go can open doors to jobs in tech companies, startups, and cloud-based projects.\u003c/p\u003e","Can I use Go for web development?": "\u003cp\u003eYes, Go is excellent for web development. It has built-in features for creating web servers and handling HTTP requests. Frameworks like Gin and Echo make it even easier to build web applications.\u003c/p\u003e","What are the main features of Go?": "\u003cp\u003eKey features of Go include:\u003c/p\u003e\u003cul\u003e\u003cli\u003eSimplicity\u003c/strong\u003e: Easy-to-read syntax with no unnecessary complexity.\u003c/li\u003e\u003cli\u003eConcurrency\u003c/strong\u003e: Built-in support for running multiple tasks at the same time using Goroutines.\u003c/li\u003e\u003cli\u003eSpeed\u003c/strong\u003e: Compiled language with fast execution.\u003c/li\u003e\u003cli\u003eScalability\u003c/strong\u003e: Designed for large, scalable systems.\u003c/li\u003e\u003cli\u003eCross-Platform Support\u003c/strong\u003e: Works on Windows, macOS, and Linux.\u003c/li\u003e\u003c/ul\u003e","Is there a contact number available for inquiries?": "\u003cp\u003eYou may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org\u003c/p\u003e"," Can I make the payment through PayPal?": "\u003cp\u003eYes. Mail us with your details at courses@geeksforgeeks.org\u003c/p\u003e\n"},"has_doubt_assistance":true,"doubt_support_price":0,"visit_count":"28k+","desktop_banner":"https://media.geeksforgeeks.org/img-practice/prod/courses/823/Mobile/Content/Golang_1734086993.png","mobile_banner":"https://media.geeksforgeeks.org/img-practice/prod/courses/823/Mobile/Content/Golang_1734086993.png","seats_left":null,"top_course":false,"course_publish_date":"2024-12-10T16:00:00","keywords":"Prog Lang","ratings":{"avg_rating":4,"partial_rating":0,"star_count":1},"intro_video_link":{"thumbnail_image":"https://media.geeksforgeeks.org/img-practice/prod/courses/823/Mobile/Content/Golang_1734086993.png","link":"","video_available":false},"short_description":"\u003cp\u003eThis \u003cstrong\u003ecomplete Golang online course\u003c/strong\u003e covers everything from basic syntax and data types to advanced topics like \u003cstrong\u003econcurrency, web development, and APIs\u003c/strong\u003e. You will build real-world projects to apply your skills and gain hands-on experience. Whether you're a beginner looking to \u003cstrong\u003elearn Go programming\u003c/strong\u003e or an experienced developer exploring a new language, this \u003cstrong\u003eGo language course\u003c/strong\u003e will help you learn and master Go.\u003c/p\u003e","what_you_will_learn":"","course_overview":"\u003cp\u003eThe \u003cstrong\u003eGolang Online Course \u003c/strong\u003e offers an in-depth exploration of \u003cstrong\u003eGoLang programming for backend development.\u003c/strong\u003e You will learn how to set up your development environment, understand Go's efficient concurrency model, and implement \u003cstrong\u003eRESTful \u003c/strong\u003eservices.\u003c/p\u003e\u003cp\u003eAs you progress, learn to master GoLang's core elements such as variables, functions, and control structures through engaging practical assignments. Gain in-depth knowledge of GoLang's powerful features for \u003cstrong\u003econcurrency, including goroutines and channels\u003c/strong\u003e, and understand \u003cstrong\u003ehow to build robust RESTful services\u003c/strong\u003e. You'll also explore advanced topics such as using popular Go frameworks, \u003cstrong\u003eimplementing security with JWT and OAuth 2.

0, \u003c/strong\u003eand developing microservices.\u003c/p\u003e\u003ch3\u003eGolang Course – Highlights\u003c/h3\u003e\u003cul\u003e\u003cli\u003eLearn detailed modules focusing on \u003cstrong\u003eGoLang syntax\u003c/strong\u003e, \u003cstrong\u003eadvanced data structures\u003c/strong\u003e, and \u003cstrong\u003eerror handling.\u003c/strong\u003e\u003c/li\u003e\u003cli\u003e\u003cstrong\u003e25+ hrs \u003c/strong\u003eof Video based content\u003c/li\u003e\u003cli\u003e\u003cstrong\u003e220+ MCQs\u003c/strong\u003e to practice \u0026amp; test your knowledge\u003c/li\u003e\u003cli\u003eGuidance on configuring development environments, including Git and GoLang IDEs\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHands-on approach \u003c/strong\u003ewith extensive assignments, projects, and practical simulations.\u003c/li\u003e\u003cli\u003eLearn powerful \u003cstrong\u003eRESTful services with Golangs net/http package\u003c/strong\u003e, including API design, implementation, and database integration.\u003c/li\u003e\u003cli\u003eInsights into modern \u003cstrong\u003ebackend architecture patterns \u003c/strong\u003eusing GoLang\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eProject: \u003c/strong\u003e\u003cbr\u003e\u003cstrong\u003e– Social Media Application\u003c/li\u003e\u003c/ul\u003e", "course_feature": null, "course_content": {"Course Introduction and Overview": "\u003cul\u003e\u003cli\u003eIntroduction to course structure and learning objectives\u003c/li\u003e\u003c/ul\u003e", "Understanding Backend Development": "\u003cul\u003e\u003cli\u003eFundamentals of backend communications\u003c/li\u003e\u003cli\u003eBasics of communication protocols: HTTP\u003c/li\u003e\u003cli\u003eWhy Golang? Current trends in backend languages\u003c/li\u003e\u003c/ul\u003e", "Setting Up Your Development Environment": "\u003cul\u003e\u003cli\u003eGit setup and introduction\u003c/li\u003e\u003cli\u003eGolang installation and terminal setup\u003c/li\u003e\u003cli\u003eSetting up GOPATH and understanding the workspace\u003c/li\u003e\u003cli\u003eOverview of GoLang IDEs and their interfaces\u003c/li\u003e\u003c/ul\u003e", "Go Language Basics": "\u003cul\u003e\u003cli\u003ePackages and code organization\u003c/li\u003e\u003cli\u003eImports \u0026amp; Exports in Go\u003c/li\u003e\u003cli\u003eStructure of a Go application\u003c/li\u003e\u003cli\u003eVariable types.\u003c/li\u003e\u003cli\u003eVariables with Initializers\u003c/li\u003e\u003cli\u003eZero values and Short-hand declarations.\u003c/li\u003e\u003cli\u003eType Conversion\u003c/li\u003e\u003cli\u003eNumeric Constants\u003c/li\u003e\u003cli\u003eUnderstanding functions in Golang.\u003c/li\u003e\u003cli\u003eFunctions with multiple results\u003c/li\u003e\u003cli\u003eFunctions with named valued results\u003c/li\u003e\u003cli\u003eLoops\u003c/li\u003e\u003cli\u003eDefer\u003c/li\u003e\u003cli\u003eGoto\u003c/li\u003e\u003cli\u003eScopes\u003c/li\u003e\u003c/ul\u003e", "Go Data Types and Structures": "\u003cul\u003e\u003cli\u003ePointers\u003c/li\u003e\u003cli\u003eStructs\u003c/li\u003e\u003cli\u003eArrays and Slices\u003c/li\u003e\u003cli\u003eMaps\u003c/li\u003e\u003cli\u003eStrings and Runes in Go\u003c/li\u003e\u003cli\u003eString Literals\u003c/li\u003e\u003cli\u003eMap Literals\u003c/li\u003e\u003c/ul\u003e", "Advanced Go Structures and Functions": "\u003cul\u003e\u003cli\u003eStructs: Methods and field access\u003c/li\u003e\u003cli\u003eHigher-order functions\u003c/li\u003e\u003cli\u003eHigher-order functions.\u003c/li\u003e\u003cli\u003eFunction closures\u003c/li\u003e\u003cli\u003eMutating maps\u003c/li\u003e\u003c/ul\u003e", "Error Handling and Best Practices": "\u003cul\u003e\u003cli\u003eError handling in Go\u003c/li\u003e\u003cli\u003ePanic and Recover\u003c/li\u003e\u003cli\u003eCustom errors in Go\u003c/li\u003e\u003cli\u003eBest Practices for error management\u003c/li\u003e\u003c/ul\u003e", "Methods and Interfaces": "\u003cul\u003e\u003cli\u003eMethods with Structs and Pointers\u003c/li\u003e\u003cli\u003eInterfaces in Go: Implementation\u003c/li\u003e\u003cli\u003eType assertions and type switches\u003c/li\u003e\u003c/ul\u003e", "Introduction to Concurrency": "\u003cul\u003e\u003cli\u003eConcurrency vs Parallelism\u003c/li\u003e\u003c/ul\u003eGolang's approach

to concurrency: Overview of Goroutines and Channels\u003c/li\u003e\u003c/ul\u003e, "Working with Goroutines":\u003cul\u003e\u003cli\u003eCreating and managing Goroutines\u003c/li\u003e\u003cli\u003eSynchronizing Goroutines using WaitGroups\u003c/li\u003e\u003cli\u003eMutexes and their use in Go\u003c/li\u003e\u003c/ul\u003e, "Channels in Depth":\u003cul\u003e\u003cli\u003eTypes of Channels: Buffered\u003c/li\u003e\u003cli\u003eChannel Synchronization\u003c/li\u003e\u003cli\u003eChannel Directions\u003c/li\u003e\u003cli\u003eChannel Select and Non Blocking channels\u003c/li\u003e\u003c/ul\u003e\u003cspan id=\"docs-internal-guid-a15c7798-7fff-f542-63a2-9ee577364b32\" \u003e\u003cspan style=\"font-size: 11pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"> data-mce-style=\u003cspan style=\"font-size: 11pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\">\u003eClosing Channels\u003c/span\u003e\u003cspan \u003e\u003cspan \u003e\u003c/li\u003e\u003c/ul\u003e, "Practical Concurrency":\u003cul\u003e\u003cli\u003eBuilding a worker pool using Goroutines and Channels\u003c/li\u003e\u003cli\u003ePractical examples of concurrency in backend development\u003c/li\u003e\u003c/ul\u003e, "Introduction to RESTful Services":\u003cul\u003e\u003cli\u003eBasics of REST API design\u003c/li\u003e\u003cli\u003eHTTP methods and status codes\u003c/li\u003e\u003cli\u003eGo's net/http package: Building a simple REST API\u003c/li\u003e\u003c/ul\u003e, "Building REST APIs with Go (Without Framework)":\u003cul\u003e\u003cli\u003eProject setup and standard file architecture\u003c/li\u003e\u003cli\u003eConnecting to the DB - PostgreSQL setup\u003c/li\u003e\u003cli\u003eCRUD operations and connecting to a database using Go's database/sql package\u003c/li\u003e\u003cli\u003eImplementing middleware for logging and security\u003c/li\u003e\u003c/ul\u003e, "Exploring Go Web Frameworks":\u003cul\u003e\u003cli\u003eOverview of popular frameworks: Echo\u003c/li\u003e\u003cli\u003eRebuilding the CRUD API using the Fiber framework\u003c/li\u003e\u003cli\u003eMiddleware integration using Fiber\u003c/li\u003e\u003c/ul\u003e, "Testing, Benchmarking, and Documentation":\u003cul\u003e\u003cli\u003eWriting unit tests for Go APIs\u003c/li\u003e\u003cli\u003eBenchmarking API performance\u003c/li\u003e\u003cli\u003eDocumenting APIs with Swagger\u003c/li\u003e\u003c/ul\u003e, "Backend Architecture Patterns":\u003cul\u003e\u003cli\u003eMonolith vs Microservices Architecture\u003c/li\u003e\u003cli\u003ePopular design patterns in backend systems\u003c/li\u003e\u003cli\u003eSingleton Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eFactory Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eObserver Pattern: Explanation and implementation in Go\u003c/li\u003e\u003cli\u003eDecorator Pattern: Explanation and implementation in Go\u003c/li\u003e\u003c/ul\u003e\u003cspan style=\"font-size: 11pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\">\u003eBest practices for designing scalable backend systems\u003c/li\u003e\u003c/ul\u003e\u003cspan style=\"font-size: 11pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\">\u003eSecurity in Go:\u003cul\u003e\u003cli\u003eSecure coding practices in Go\u003c/li\u003e\u003cli\u003eJWT Tokens: Explanation and Implementation\u003c/li\u003e\u003cli\u003eAuth 2.0 Explained!\u003c/li\u003e\u003cli\u003eAuth 2.0 Simulated Implementation in Go\u003c/li\u003e\u003cli\u003eHandling sensitive data\u003c/li\u003e\u003c/ul\u003e, "Working with Databases":\u003cul\u003e\u003cli\u003eUsing SQL databases with Go: GORM\u003c/li\u003e\u003cli\u003eWorking with NoSQL databases: Redis\u003c/li\u003e\u003cli\u003eOptimizing database queries and connections\u003c/li\u003e\u003cli\u003eUsing SQL databases with Go:\u0026nbsp;sqlx\u003c/li\u003e\u003cli\u003eWorking with NoSQL databases: MongoDB\u003c/li\u003e\u003c/ul\u003e, "Building Microservices with Go":\u003cul\u003e\u003cli\u003eService discovery\u003c/li\u003e\u003cli\u003eAPI Gateways\u003c/li\u003e\u003cli\u003eDistributing services\u003c/li\u003e\u003c/ul\u003e

istributed Tracing\u003c/li\u003e\u003c/ul\u003e","Deployment and DevOps":"\u003cul\u003e\u003cli\u003eContainerizing Go applications with Docker\u003c/li\u003e\u003e\u003cli\u003eWhat is CI/CD?\u003c/li\u003e\u003cli\u003eJenkins and GitHub Actions with the full CI/CD steps correlation\u003c/li\u003e\u003c/ul\u003e","Performance Optimization":"\u003cul\u003e\u003cli\u003eProfiling Go applications\u003c/li\u003e\u003cli\u003eBenchmarking and optimizing code\u003c/li\u003e\u003c/ul\u003e","Introduction to GraphQL":"\u003cul\u003e\u003cli\u003eDifferences between REST and GraphQL\u003c/li\u003e\u003cli\u003eGraphQL basic concepts\u003c/li\u003e\u003cli\u003eBuilding a GraphQL API with Go - Querying data\u003c/li\u003e\u003cli\u003eBuilding a GraphQL API with Go - Mutating data\u003c/li\u003e\u003c/ul\u003e","Final Capstone Project - Social Media Application":"\u003cul\u003e\u003cli\u003eDesign and develop a comprehensive backend system with Go\u003c/li\u003e\u003cli\u003eIncorporate API development\u003c/ul\u003e","locations_coord s":[],"desktop_banner_webp":"https://media.geeksforgeeks.org/img-practice/prod/courses/823/Web/Content/Golan_1734086963.webp","mobile_banner_webp":"https://media.geeksforgeeks.org/img-practice/prod/courses/823/Web/Content/Golan_1734086963.webp","price":{"batch_fee":799,"promotional_fee":5999,"play_store_product_id":"gfg_course_799"},"additional_info":"","course_id":504,"course_name":"DSA to Development: A Complete Guide","course_slug":"dsa-to-development-coding-guide","course_url":"https://www.geeksforgeeks.org/courses/dsa-to-development-coding-guide","course_type":"Live","course_fee_type":"Paid","level":"Beginner to Advanced","course_duration":26,"is_kids_course":false,"faqs":{"Is there any Phone number for query regarding this course ?":"\u003cp\u003eYes, you may reach out to us at +91 9259142663 for all your queries\u003c/p\u003e","I'm from a non-CS background. Will this course be a good fit for me?":"\u003cp\u003eYes, it's suitable if you're aiming to join IT sector companies.\u003c/p\u003e","How will I enroll in this course?":"\u003cp\u003eFirst, fill out the application form. Once your application is approved, complete the payment process, and your enrollment will be confirmed.\u003c/p\u003e","If I have any doubt while studying, how will it be addressed?":"\u003cp\u003eYou'll get \u003cstrong data-start=\"171\" data-end=\"294\"\u003ein-class doubt clearing, dedicated weekday doubt-resolving sessions, and 24/7 AI-powered doubt assistance.\u003c/strong\u003e\u003c/p\u003e","I am confused about which development specialization I need to choose. Will I get any assistance for the same?":"\u003cp\u003eYes. Our team will guide you in selecting the right specialization based on your interests, strengths, and career goals.\u003c/p\u003e","Will I need to pay the amount in one shot or EMIs?":"\u003cp\u003eWe provide flexible payment options. You can pay the entire amount at once or choose \u003cstrong data-start=\"1905\" data-end=\"1920\"\u003eEMI options.\u003c/strong\u003e\u003c/p\u003e","Will there be a certificate of completion?":"\u003cp\u003eYes. Certificate of completion will be provided once you meet all the eligibility criteria mentioned on the batch noticeboard.\u003c/p\u003e","How long will I have access to the course?":"\u003cp\u003eYou will have access to the course for \u003cstrong data-start=\"200\" data-end=\"212\"\u003eone year\u003c/strong\u003e from the date of enrollment. After this period, your access will expire automatically.\u003c/p\u003e","Is the batch in Hindi or English?":"\u003cp\u003eThe classes will be conducted in \u003cstrong data-start=\"319\" data-end=\"330\"\u003eEnglish.\u003c/strong\u003e\u003c/p\u003e"},"has_doubt_assistance":true,"doubt_support_price":0,"visit_count":"759k+","desktop_banner":"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Web/Other/Course_DSA_to_Dev_png_1720846050.png","mobile_banner":"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Web/Other/Course_DSA_to_Dev_png_1720846050.png","seats_left":4,"top_course":false,"course_publish_date":"2023-05-03T00:00:00","keywords":"sde interview preparation course | interview preparation |

PowerPlay | preparing for a job interview | interview skills | Web Development | how to prepare for a job interview | how to prepare for an interview | complete interview preparation | interview preparation course | DSA / Placements | Development | Placement \u0026 Test Series | DS and Algorithms", "ratings": {"avg_rating": 4.4, "partial_rating": 0.40000000000000036, "star_count": 0}, "intro_video_link": {"thumbnail_image": "https://media.geeksforgeeks.org/img-practice/prod/courses/504/Web/Other/Course_DSA_to_Dev_png_1720846050.png", "link": "https://cdnvideos.geeksforgeeks.org/hls/7ae6d26d04ea4bd6f5d1b9c1335df63egfg-DSA-to-Development-hlsx720p.m3u8", "video_available": true}, "short_description": "\u003cp\u003eThis course is designed to take you on a transformative journey from mastering Data Structures and Algorithms (DSA) to becoming a proficient developer. Whether you aspire to become a full-stack developer or specialize in a specific technology stack, this course provides the essential building blocks for your coding journey starting right from basic programming to building applications.\u003c/p\u003e", "what_you_will_learn": "\u003cp\u003e\u003cstrong\u003eEmbark on an extraordinary coding odyssey with our groundbreaking course, \"DSA to Development - Complete Coding Guide\"! \u003c/strong\u003c Discover the transformative power of mastering Data Structures and Algorithms (DSA) as you venture towards becoming a proficient Developer or Data Scientist. \u003c/p\u003e\u003c/li\u003e Learn essential data structures\u003c/li\u003e Master key algorithms\u003c/li\u003e Develop advanced coding techniques\u003c/li\u003e Build a strong programming foundation\u003c/li\u003e Gain confidence in tackling challenges\u003c/li\u003e Engage in hands-on projects\u003c/li\u003e Create remarkable applications\u003c/li\u003e Choose full-stack development, data science, or specialize in \u003cstrong\u003eMERN, Java, Python, Machine Learning\u003c/strong\u003e\u003c/li\u003e Receive insights from industry professionals\u003c/li\u003e Get guidance from experienced mentors\u003c/li\u003e\u003c/ul\u003e", "course_overview": "\u003cp\u003eThis journey starts with a solid foundation in Data Structures and Algorithms (DSA), essential for becoming a skilled developer. Whether you are aiming to master full-stack development, specialize in Java backend, dive into applied data science, or create the next big Android app, this curriculum arms you with the essential tools and real-world experience to fuel your coding journey. Whether you're a student or a professional, this curriculum provides the key fundamentals and practical skills needed to thrive in today's tech landscape.\u003c/p\u003e\u003c/li\u003e Starts with a solid understanding of Data Structures and Algorithms (DSA).\u003cbr\u003e\u003c/li\u003e Leads towards becoming a skilled developer.\u003c/li\u003e Equips with fundamental tools for the coding journey.\u003c/li\u003e Suitable for aspiring full-stack developers or those specializing in a particular technology stack.\u003c/li\u003e Perfect for students or professionals from any field aiming for a technological journey.\u003c/li\u003e\u003c/ul\u003e", "course_feature": null, "course_content": {"Programming Languages": "\u003cp\u003e\u003cstrong\u003eCPP/Java/Python: \u003c/strong\u003c\u003c/p\u003e\u003c/li\u003e Introduction\u003c/li\u003e Variable \u0026amp; Operators\u003c/li\u003e Flow Control\u003c/li\u003e Functions \u0026amp; Loops\u003c/li\u003e Arrays\u003c/li\u003e Strings\u003c/li\u003e Object Oriented Programming(OOPs)\u0026nbsp;\u003c/li\u003e Advanced concepts\u003c/li\u003e\u003c/ul\u003e", "Libraries": "\u003cp\u003e\u003cstrong\u003eCPP STL:\u003c/strong\u003c\u003c/p\u003e\u003c/li\u003e Vectors\u003c/li\u003e List, Pairs\u003c/li\u003e Stack, Queue\u003cbr\u003e\u003c/li\u003e Set\u0026nbsp;\u003c/li\u003e Map\u003c/li\u003e\u003c/ul\u003e"

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"1299" data-start="1245" data-end="1299" Two Pointer
s technique for pair/triplet sum problems/p/li data-start="1300" data-end="1353" data-start="1302" data-end="1353" Dutch National Flag Algorithm for sorting 0, 1, 2/c/p/li data-start="1354" data-end="1429" data-start="1356" data-end="1429" Sliding Window problems like Maximum Sum Subarray and Longest Substring/p/li data-start="1431" data-end="1434" data-start="1436" data-end="1460" data-start="1440" data-end="1460" Class 6: Hashing/strong/h3 data-start="1461" data-end="1682" data-start="1461" data-end="1532" data-start="1463" data-end="1532" Introduction to hash tables, hash functions, and collision handling/p/li data-start="1533" data-end="1597" data-start="1535" data-end="1597" Implementation using STL (/code data-start="1561" data-end="1576" unordered_map/code data-start="1579" data-end="1594" unordered_set/code) /p/li data-start="1598" data-end="1682" data-start="1600" data-end="1682" Practice problems: frequency counts, subarray sums, and pattern-based challenges/p/li data-start="1684" data-end="1687" data-start="1689" data-end="1715" data-start="1693" data-end="1715" Class 7: Recursion/strong/h3 data-start="1716" data-end="1887" data-start="1716" data-end="1782" data-start="1718" data-end="1782" Basics of recursion, stack usage, and importance of base cases/p/li data-start="1783" data-end="1826" data-start="1785" data-end="1826" Examples: Factorial, Fibonacci Sequence/p/li data-start="1827" data-end="1887" data-start="1829" data-end="1887" Tower of Hanoi and introduction to backtracking concepts/p/li data-start="1889" data-end="1892" data-start="1894" data-end="1920" data-start="1898" data-end="1920" Class 8: Searching/strong/h3 data-start="1921" data-end="2109" data-start="1921" data-end="1988" data-start="1923" data-end="1988" Linear Search: concept, implementation, and complexity analysis/p/li data-start="1989" data-end="2045" data-start="1991" data-end="2045" Binary Search: iterative & recursive implementations/p/li data-start="2046" data-end="2109" data-start="2048" data-end="2109" Applications: rotated arrays, floor/ceiling search problems/p/li data-start="2111" data-end="2114" data-start="2116" data-end="2140" data-start="2120" data-end="2140" Class 9: Sorting/strong/h3 data-start="2141" data-end="2209" data-start="2143" data-end="2209" Bubble, Selection, and Insertion Sort: comparisons and use cases/p/li data-start="2210" data-end="2261" data-start="2212" data-end="2261" Merge Sort and Quick Sort for efficient sorting/p/li data-start="2262" data-end="2320" data-start="2264" data-end="2320" Conceptual understanding of Cyclic Sort and Shell Sort/p/li data-start="2322" data-end="2325" data-start="2327" data-end="2351" data-start="2331" data

-end=\"2351\"\\u003eClass 10: Matrix\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\"2352\" data-end=\"2526\"\\u003e\\u003cli data-start=\"2352\" data-end=\"2409\"\\u003e\\u003cp data-start=\"2354\" data-end=\"2409\"\\u003eMatrix traversal: row-wise, column-wise, spiral order\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2410\" data-end=\"2469\"\\u003e\\u003cp data-start=\"2412\" data-end=\"2469\"\\u003eMatrix rotation, transpose, and binary search in matrix\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2470\" data-end=\"2526\"\\u003e\\u003cp data-start=\"2472\" data-end=\"2526\"\\u003eDirectional traversals and problem-solving exercises\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\"2528\" data-end=\"2531\"\\u003e\\u003ch3 data-start=\"2533\" data-end=\"2566\"\\u003e\\u003cstrong data-start=\"2537\" data-end=\"2566\"\\u003eClass 11: Linked List I\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\"2567\" data-end=\"2749\"\\u003e\\u003cli data-start=\"2567\" data-end=\"2633\"\\u003e\\u003cp data-start=\"2569\" data-end=\"2633\"\\u003eSingly, Doubly, and Circular Linked List basics and operations\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2634\" data-end=\"2705\"\\u003e\\u003cp data-start=\"2636\" data-end=\"2705\"\\u003eFinding middle element, reversing linked lists, intersection points\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2706\" data-end=\"2749\"\\u003e\\u003cp data-start=\"2708\" data-end=\"2749\"\\u003eCycle detection using Floyds Algorithm\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\"2751\" data-end=\"2754\"\\u003e\\u003ch3 data-start=\"2756\" data-end=\"2790\"\\u003e\\u003cstrong data-start=\"2760\" data-end=\"2790\"\\u003eClass 12: Linked List II\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\"2791\" data-end=\"2951\"\\u003e\\u003cli data-start=\"2791\" data-end=\"2839\"\\u003e\\u003cp data-start=\"2793\" data-end=\"2839\"\\u003eFinding length and starting point of a cycle\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2840\" data-end=\"2898\"\\u003e\\u003cp data-start=\"2842\" data-end=\"2898\"\\u003eLRU Cache implementation using linked list and hashing\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"2899\" data-end=\"2951\"\\u003e\\u003cp data-start=\"2901\" data-end=\"2951\"\\u003eMerge K Sorted Lists and optimization approaches\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\"2953\" data-end=\"2956\"\\u003e\\u003ch3 data-start=\"2958\" data-end=\"2993\"\\u003e\\u003cstrong data-start=\"2962\" data-end=\"2993\"\\u003eClass 13: Stack \\u0026amp; Queue I\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\"2994\" data-end=\"3187\"\\u003e\\u003cli data-start=\"2994\" data-end=\"3061\"\\u003e\\u003cp data-start=\"2996\" data-end=\"3061\"\\u003eStack concepts (LIFO), implementation using array \\u0026amp; linked list\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"3062\" data-end=\"3114\"\\u003e\\u003cp data-start=\"3064\" data-end=\"3114\"\\u003eQueue concepts (FIFO), Circular Queue, and Deque\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"3115\" data-end=\"3187\"\\u003e\\u003cp data-start=\"3117\" data-end=\"3187\"\\u003eApplications: expression evaluation, balanced parentheses, undo-redo\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\"3189\" data-end=\"3192\"\\u003e\\u003ch3 data-start=\"3194\" data-end=\"3230\"\\u003e\\u003cstrong data-start=\"3198\" data-end=\"3230\"\\u003eClass 14: Stack \\u0026amp; Queue II\\u003c/strong\\u003e\\u003c/h3\\u003e\\u003cul data-start=\"3231\" data-end=\"3386\"\\u003e\\u003cli data-start=\"3231\" data-end=\"3298\"\\u003e\\u003cp data-start=\"3233\" data-end=\"3298\"\\u003ePractice problems: Next Greater Element, Sliding Window Maximum\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"3299\" data-end=\"3339\"\\u003e\\u003cp data-start=\"3301\" data-end=\"3339\"\\u003eStack using Queue, Queue using Stack\\u003c/p\\u003e\\u003c/li\\u003e\\u003cli data-start=\"3340\" data-end=\"3386\"\\u003e\\u003cp data-start=\"3342\" data-end=\"3386\"\\u003eOptimization and problem-solving exercises\\u003c/p\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\\u003chr data-start=\"3388\" data-end=\"3391\"\\u003e\\u003ch3 data-start=\"3393\" data-end=\"3427\"\\u003e\\u003cstrong data-start=\"3397\" data-end=\"3427\"\\u003eClass 15: Ba

cktracking I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3428\" data-end=\"3598\" \u003cli data-start=\"3428\" data-end=\"3478\" \u003e\u003cp data-start=\"3430\" data-end=\"3478\" \u003eGenerating all permutations of array or string\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3479\" data-end=\"3534\" \u003e\u003cp data-start=\"3481\" data-end=\"3534\" \u003eGenerating combinations and subsets using recursion\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3535\" data-end=\"3598\" \u003e\u003cp data-start=\"3537\" data-end=\"3598\" \u003eBacktracking exercises to explore recursive tree structures\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3600\" data-end=\"3603\" \u003e\u003ch3 data-start=\"3605\" data-end=\"3640\" \u003e\u003cstrong data-start=\"3609\" data-end=\"3640\" \u003eClass 16: Backtracking II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3641\" data-end=\"3756\" \u003cli data-start=\"3641\" data-end=\"3666\" \u003e\u003cp data-start=\"3643\" data-end=\"3666\" \u003eRat in a Maze problem\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3667\" data-end=\"3713\" \u003e\u003cp data-start=\"3669\" data-end=\"3713\" \u003eN-Queen problem with pruning and recursion\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3714\" data-end=\"3756\" \u003e\u003cp data-start=\"3716\" data-end=\"3756\" \u003eValid Sudoku solver using backtracking\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3758\" data-end=\"3761\" \u003e\u003ch3 data-start=\"3763\" data-end=\"3790\" \u003e\u003cstrong data-start=\"3767\" data-end=\"3790\" \u003eClass 17: Trees I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3791\" data-end=\"3858\" \u003cli data-start=\"3791\" data-end=\"3858\" \u003e\u003cp data-start=\"3793\" data-end=\"3858\" \u003eBinary Tree basics, types, and representations (array \u0026amp; linked)\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3859\" data-end=\"3903\" \u003e\u003cp data-start=\"3861\" data-end=\"3903\" \u003eTraversals: Preorder, Inorder, Postorder\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"3904\" data-end=\"3959\" \u003e\u003cp data-start=\"3906\" data-end=\"3959\" \u003ePractice problems: height, node count, sum of nodes\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"3961\" data-end=\"3964\" \u003e\u003ch3 data-start=\"3966\" data-end=\"3994\" \u003e\u003cstrong data-start=\"3970\" data-end=\"3994\" \u003eClass 18: Trees II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"3995\" data-end=\"4141\" \u003cli data-start=\"3995\" data-end=\"4056\" \u003e\u003cp data-start=\"3997\" data-end=\"4056\" \u003eBinary Search Tree (BST): insertion, deletion, and search\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4057\" data-end=\"4092\" \u003e\u003cp data-start=\"4059\" data-end=\"4092\" \u003eInorder predecessor \u0026amp; successor\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4093\" data-end=\"4141\" \u003e\u003cp data-start=\"4095\" data-end=\"4141\" \u003eBST practice problems and path sum exercises\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"4143\" data-end=\"4146\" \u003e\u003ch3 data-start=\"4148\" data-end=\"4177\" \u003e\u003cstrong data-start=\"4152\" data-end=\"4177\" \u003eClass 19: Trees III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"4178\" data-end=\"4309\" \u003cli data-start=\"4178\" data-end=\"4216\" \u003e\u003cp data-start=\"4180\" data-end=\"4216\" \u003eHeap concepts: Min Heap \u0026amp; Max Heap\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4217\" data-end=\"4264\" \u003e\u003cp data-start=\"4219\" data-end=\"4264\" \u003eHeapify, insertion, and deletion operations\u003c/p\u003e\u003c/li\u003e\u003cli data-start=\"4265\" data-end=\"4309\" \u003e\u003cp data-start=\"4267\" data-end=\"4309\" \u003ePriority Queue applications and problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start=\"4311\" data-end=\"4314\" \u003e\u003ch3 data-start=\"4316\" data-end=\"4343\" \u003e\u003cstrong data-start=\"4320\" data-end=\"4343\" \u003eClass 20: Graph I\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start=\"4344\" data-end=\"4491\" \u003cli data-start=\"4344\" data-end=\"4393\" \u003e\u003cp data-start=\"4346\" data-

end="\4393\" \u003eGraph representation: adjacency list \u0026amp; matrix\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4394\" data-end="\4418\" \u003e\u003cp data-start="\4396\" data-end="\4418\" \u003eDFS \u0026amp; BFS traversals\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4419\" data-end="\4491\" \u003e\u003cp data-start="\4421\" data-end="\4491\" \u003eProblems: connected components, reachability, simple cycle detection\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4493\" data-end="\4496\" \u003e\u003ch3 data-start="\4498\" data-end="\4526\" \u003e\u003cstrong data-start="\4502\" data-end="\4526\" \u003eClass 21: Graph II\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4527\" data-end="\4694\" \u003e\u003cli data-start="\4527\" data-end="\4578\" \u003e\u003cp data-start="\4529\" data-end="\4578\" \u003eCycle detection in directed \u0026amp; undirected graphs\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4579\" data-end="\4637\" \u003e\u003cp data-start="\4581\" data-end="\4637\" \u003eDAGs and Topological Sort using DFS \u0026amp; Kahns Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4638\" data-end="\4694\" \u003e\u003cp data-start="\4640\" data-end="\4694\" \u003eGraph problems: scheduling and dependency resolution\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4696\" data-end="\4699\" \u003e\u003ch3 data-start="\4701\" data-end="\4730\" \u003e\u003cstrong data-start="\4705\" data-end="\4730\" \u003eClass 22: Graph III\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4731\" data-end="\4871\" \u003e\u003cli data-start="\4731\" data-end="\4781\" \u003e\u003cp data-start="\4733\" data-end="\4781\" \u003eShortest Path algorithms: Dijkstras Algorithm\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4782\" data-end="\4815\" \u003e\u003cp data-start="\4784\" data-end="\4815\" \u003eMulti-source BFS \u0026amp; Flood Fill\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4816\" data-end="\4871\" \u003e\u003cp data-start="\4818\" data-end="\4871\" \u003eCourse scheduling and real-life dependency examples\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\4873\" data-end="\4876\" \u003e\u003ch3 data-start="\4878\" data-end="\4914\" \u003e\u003cstrong data-start="\4882\" data-end="\4914\" \u003eClass 23: Greedy + DP Basics\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\4915\" data-end="\5048\" \u003e\u003cli data-start="\4915\" data-end="\4963\" \u003e\u003cp data-start="\4917\" data-end="\4963\" \u003eFractional Knapsack and Coin Change (Greedy)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\4964\" data-end="\5009\" \u003e\u003cp data-start="\4966\" data-end="\5009\" \u003eActivity Selection (N meetings in a room)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\5010\" data-end="\5048\" \u003e\u003cp data-start="\5012\" data-end="\5048\" \u003e0 - 1 Knapsack \u0026amp; Subset Sum problems\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e\u003chr data-start="\5050\" data-end="\5053\" \u003e\u003ch3 data-start="\5055\" data-end="\5101\" \u003e\u003cstrong data-start="\5059\" data-end="\5101\" \u003eClass 24: Advanced Dynamic Programming\u003c/strong\u003e\u003c/h3\u003e\u003cul data-start="\5102\" data-end="\5284\" \u003e\u003cli data-start="\5102\" data-end="\5143\" \u003e\u003cp data-start="\5104\" data-end="\5143\" \u003eUnbounded Knapsack \u0026amp; Coin Change (DP)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\5144\" data-end="\5220\" \u003e\u003cp data-start="\5146\" data-end="\5220\" \u003eLongest Common Subsequence (LCS) \u0026amp; Longest Palindromic Subsequence (LPS)\u003c/p\u003e\u003c/li\u003e\u003cli data-start="\5221\" data-end="\5284\" \u003e\u003cp data-start="\5223\" data-end="\5284\" \u003eMatrix Chain Multiplication (MCM) \u0026amp; Palindrome Partitioning\u003c/p\u003e\u003c/li\u003e\u003c/ul\u003e", "Resume Building": "\u003cul\u003e\u003eli\u003e\u003eli\u003eUnderstand the resume-building process and make your skills stand out\u003c/li\u003e\u003c/ul\u003e", "Projects": "\u003cul\u003e\u003eli\u003e\u003cli data-mce-style="\box-sizing: inherit;" style="\box-sizing: inherit;" \u003e\u003cspan data-mce-style="\box-sizing: inherit; font-weight: bolder;" style="\box-sizing: inherit; font-weight: bolder;" \u003eSudoku Solver\u003c/

Program to solve a Sudoku puzzle by filling the empty cells.

cli data-mce-style="box-sizing: inherit;" style="box-sizing: inherit;"\u003e\u003cspan data-mce-style="box-sizing: inherit; font-weight: bolder;" style="box-sizing: inherit; font-weight: bolder;"\u003eShortest Path Finder

The problem of finding the shortest path between two intersections on a road map

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A game in which two players alternately put Xs and Os in compartments of a figure formed by two vertical lines.

cli data-mce-style="box-sizing: inherit;" style="box-sizing: inherit;"\u003e\u003cspan data-mce-style="box-sizing: inherit; font-weight: bolder;" style="box-sizing: inherit; font-weight: bolder;"\u003eN Queen Visualizer

Visualization of solving the N-Queens puzzle using a recursive algorithm.

ul\u003e"},"locations_coords":[],"desktop_banner_webp":"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Mobile/Other/Course_DSA_to_Dev_1720846081.webp","mobile_banner_webp":"https://media.geeksforgeeks.org/img-practice/prod/courses/504/Mobile/Other/Course_DSA_to_Dev_1720846081.webp","price":{"batch_fee":19999,"promotional_fee":37999,"play_store_product_id":"gfg_course_19999"},"additional_info":{},"course_id":804,"course_name":"Soft Skills Course Online – Complete Professional Development Training","course_slug":"soft-skills-online-training-course","course_url":"https://www.geeksforgeeks.org/courses/soft-skills-online-training-course","course_type":"Online","course_fee_type":"Paid","level":null,"course_duration":4,"is_kids_course":false,"faqs":{"What are soft skills?":"\u003cp\u003eSoft skills are personal attributes and interpersonal skills that enable someone to interact effectively and harmoniously with others. Unlike technical skills, which pertain to specific tasks, soft skills include communication, teamwork, problem-solving, adaptability, and emotional intelligence. These skills are essential in the workplace and can significantly impact career success.\u003cp\u003e","How will improving my soft skills help my career?":"\u003cp\u003eImproving your soft skills can help you build better relationships at work, improve communication, and enhance your leadership abilities. These skills can boost your career by making you more effective in teamwork, problem-solving, and handling workplace challenges.\u003cbr\u003e\u003cp\u003e","Why should I take a soft skills course?":"\u003cp\u003eTaking a soft skills course can help you improve how you interact with others, build confidence, and advance in your career. Soft skills are just as important as technical skills, and they help you work better in teams, communicate effectively, and handle workplace challenges.\u003cbr\u003e\u003cp\u003e","Is this course suitable for beginners?":"\u003cp\u003eYes, this online soft skills course is perfect for beginners or anyone who wants to improve their interpersonal skills. You don't need any prior experience to take the course, and it's beneficial for all levels, whether you're just starting your career or looking to advance.\u003cbr\u003e\u003cp\u003e","How are soft skills useful in the workplace?":"\u003cp\u003eSoft skills help you communicate better, work in teams, manage your time, and handle stress. They also improve your ability to lead, resolve conflicts, and adapt to change. Employers highly value soft skills because they improve collaboration and productivity.\u003cbr\u003e\u003cp\u003e","Can I take this course if I'm already employed?":"\u003cp\u003eYes, this online soft skills course is designed to be flexible, so you can take them while working. You can learn at your own pace, making it easy to fit into your schedule, even with a full-time job.\u003cbr\u003e\u003cp\u003e","What can I expect to learn in a soft skills course?":"\u003cp\u003eIn a soft skills course, you can expect to learn essential skills such as effective communi

cation, active listening, teamwork, conflict resolution, time management, and emotional intelligence. Many courses also include practical exercises, role-playing scenarios, and group discussions to help participants apply these skills in real-world situations.

"Is there a contact number available for inquiries?": "\u003cp\u003eYou may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org\u003cp\u003e", "Can I make the payment through PayPal?": "\u003cp\u003eYes. Mail us with your details at \u0026nbsp;\u003cstrong\u003e\u003ca href=\u003cmailto:courses@geeksforgeeks.org\u003cstrong\u003e.\u0026nbsp;\u003c/p\u003e\n\u003c/strong\u003e", "has_doubt_assistance": true, "doubt_support_price": 0, "visit_count": "59k+", "desktop_banner": "https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png", "mobile_banner": "https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png", "seats_left": null, "top_course": false, "course_publish_date": "2024-09-19T00:00:00", "keywords": "DSA / Placements", "ratings": {"avg_rating": 4.5, "partial_rating": 0.5, "star_count": 0}, "intro_video_link": {"thumbnail_image": "https://media.geeksforgeeks.org/img-practice/prod/courses/804/Mobile/Content/softskillspng_1726729710.png", "link": "", "video_available": false}, "short_description": "\u003cp\u003eThis comprehensive Soft Skills Training course is designed to enhance your soft skills essential for personal and professional success. You'll learn essential workplace skills like communication, leadership, teamwork, time management, etc. Whether you're a professional looking to advance your career or a beginner wanting to build confidence, this course will equip you with the soft skills needed for success in any job.\u003cp\u003e", "what_you_will_learn": "", "course_overview": "\u003cp\u003eIn today's fast-paced and interconnected world, soft skills have become just as important as technical knowledge. This Complete Course on Soft Skills for personal and professional growth is designed to help you develop essential interpersonal abilities that enhance communication, collaboration, problem-solving, and leadership. Whether you're navigating the workplace, managing teams, or interacting with clients, these skills are crucial to your success.\u003cp\u003e\u003cp\u003eThroughout this Soft Skills Training Online Course, you will explore key soft skills such as effective communication, emotional intelligence, time management, adaptability, conflict resolution, and teamwork. You will also engage in practical exercises, real-world scenarios, and self-assessment activities that will allow you to apply what you learn to everyday situations.\u003cp\u003e\u003ch3\u003e\u003cstrong\u003eGFG Soft Skills Course - Highlights\u003c/strong\u003e\u003c/h3\u003e\u003cul\u003e\u003eli\u003eMaster essential \u003cstrong\u003ecommunication\u003c/strong\u003e, \u003cstrong\u003eteamwork\u003c/strong\u003e, and \u003cstrong\u003eleadership skills\u003c/strong\u003e.\u003c/li\u003e\u003eli\u003eImprove \u003cstrong\u003everbal\u003c/strong\u003e, \u003cstrong\u003e non-verbal\u003c/strong\u003e, and \u003cstrong\u003e written communication\u003c/strong\u003e techniques.\u003c/li\u003e\u003eli\u003eEnhance teamwork with \u003cstrong\u003eeffective collaboration\u003c/strong\u003e and \u003cstrong\u003e conflict-resolution strategies\u003c/strong\u003e.\u003c/li\u003e\u003eli\u003eDevelop \u003cstrong\u003ecritical thinking\u003c/strong\u003e and \u003cstrong\u003eproblem-solving abilities\u003c/strong\u003e through real-world cases.\u003c/li\u003e\u003eli\u003eBuild \u003cstrong\u003eemotional intelligence\u003c/strong\u003e for better \u003cstrong\u003e self-awareness\u003c/strong\u003e and \u003cstrong\u003e relationship management.\u003c/li\u003e\u003eli\u003eLearn prioritization\u003c/strong\u003e and \u003cstrong\u003etask management\u003c/strong\u003e for efficient time management.\u003c/p\u003e\u003cbr\u003e\u003eli\u003eUnderstand \u003cstrong\u003eprofessionalism\u003c/strong\u003e,

\u003cstrong\u003ebusiness etiquette\u003c/strong\u003e, and ethical \u003cstrong\u003edecision-making.\u003c/strong\u003e\u003c/li\u003e\u003cli\u003eExplore leadership styles to build \u003cstrong\u003etrust\u003c/strong\u003e, \u003cstrong\u003einfluence\u003c/strong\u003e, and \u003cstrong\u003eaccountability\u003c/strong\u003e.\u003c/li\u003e\u003cli\u003eMaster\u003cstrong\u003e networking techniques\u003c/strong\u003e and relationship-building for career growth.\u003c/li\u003e\u003cli\u003eGain confidence in \u003cstrong\u003epublic speaking\u003c/strong\u003e and delivering impactful presentations.\u003c/li\u003e\u003cul\u003e", "course_feature": null, "course_content": {"Introduction to Soft Skills": "\u003cul\u003e\u003cli\u003eWhy Soft Skills Matter\u003c/li\u003e\u003cli\u003eSoft Skills vs. Hard Skills\u003c/li\u003e\u003cli\u003eImportance of Soft Skills in the Workplace\u003c/li\u003e\u003cul\u003e", "Communication Skills": "\u003cul\u003e\u003cli\u003eVerbal Communication\u003c/li\u003e\u003cli\u003eClarity and Concision\u003c/li\u003e\u003cli\u003eListening Skills\u003c/li\u003e\u003cli\u003eNon-Verbal Communication\u003c/li\u003e\u003cli\u003eBody Language\u003c/li\u003e\u003cli\u003eTone of Voice\u003c/li\u003e\u003cli\u003eWritten Communication\u003c/li\u003e\u003cli\u003eEmails\u003c/li\u003e\u003cul\u003e", "Teamwork and Collaboration": "\u003cul\u003e\u003cli\u003eThe Importance of Teamwork\u003c/li\u003e\u003cli\u003eCollaboration Techniques\u003c/li\u003e\u003cli\u003eConflict Resolution\u003c/li\u003e\u003cul\u003e", "Problem-Solving and Critical Thinking": "\u003cul\u003e\u003cli\u003eApproaches to Problem-Solving\u003c/li\u003e\u003cli\u003eCritical Thinking Framework\u003c/li\u003e\u003cli\u003eCase Studies in Problem-Solving\u003c/li\u003e\u003cul\u003e", "Emotional Intelligence": "\u003cul\u003e\u003cli\u003eUnderstanding Emotional Intelligence\u003c/li\u003e\u003cli\u003eSelf-Awareness and Self-Regulation\u003c/li\u003e\u003cli\u003eEmpathy and Social Skills\u003c/li\u003e\u003cul\u003e", "Time Management": "\u003cul\u003e\u003cli\u003ePrioritization Techniques\u003c/li\u003e\u003cli\u003eTask Management Tools\u003c/li\u003e\u003cli\u003eWork-Life Balance\u003c/li\u003e\u003cul\u003e", "Adaptability and Learning Agility": "\u003cul\u003e\u003cli\u003eAdapting to Change\u003c/li\u003e\u003cli\u003eContinuous Learning\u003c/li\u003e\u003cli\u003eBuilding Resilience\u003c/li\u003e\u003cul\u003e", "Professionalism and Work Ethics": "\u003cul\u003e\u003cli\u003eUnderstanding Professionalism\u003c/li\u003e\u003cli\u003eBusiness Etiquette\u003c/li\u003e\u003cli\u003eEthical Decision-Making\u003c/li\u003e\u003cul\u003e", "Leadership Skills": "\u003cul\u003e\u003cli\u003eTypes of Leadership\u003c/li\u003e\u003cli\u003eBuilding Trust and Influence\u003c/li\u003e\u003cli\u003eDelegation and Accountability\u003c/li\u003e\u003cul\u003e", "Networking and Relationship Building": "\u003cul\u003e\u003cli\u003eImportance of Networking\u003c/li\u003e\u003cli\u003eEffective Networking Techniques\u003c/li\u003e\u003cli\u003eMaintaining Professional Relationships\u003c/li\u003e\u003cul\u003e", "Public Speaking and Presentation Skills": "\u003cul\u003e\u003cli\u003eElements of Effective Public Speaking\u003c/li\u003e\u003cli\u003ePresentation Tools\u003c/li\u003e\u003cli\u003eEngaging the Audience\u003c/li\u003e\u003cul\u003e"}, "locations_coords": [], "desktop_banner_webp": "https://media.geeksforgeeks.org/img-practice/prod/courses/804/Web/Content/softskillsweb_1726729664.webp", "mobile_banner_webp": "https://media.geeksforgeeks.org/img-practice/prod/courses/804/Web/Content/softskillsweb_1726729664.webp", "price": {"batch_fee": 2999, "promotional_fee": 1299, "play_store_product_id": "gfg_course_1299"}, "additional_info": "", {"course_id": 715, "course_name": "Complete Data Analytics with AI - Live", "course_slug": "data-analytics-training-program-excel-sql-python-powerbi", "course_url": "https://www.geeksforgeeks.org/courses/data-analytics-training-program-excel-sql-python-powerbi", "course_type": "Live", "course_fee_type": "Paid", "level": "Beginner to Advanced", "course_duration": 12, "is_kids_course": false, "faqs": {"How long will I get access to the online course material available with this course": "The course material will be available for 12 months from the date of purchase."}}

e?": "\u003cp\u003e\u003cspan style=\"font-family: arial, helvetica, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: rgb(255, 255, 255);\" data-mce-style=\"font-family: arial, helvetica, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: #ffffff;\" \u003eYou'll get 1 year access to the online course material and recorded videos. You can attend this class from any geographical location.\u003c/span\u003e\u003c/p\u003e\", \"The total Duration of this Course is ?\": \"\u003cp\u003e\u003eThe total Duration of this Course is 12 Weeks .\u003c/p\u003e\", \"How are the doubt sessions conducted?\": \"\u003cp\u003e\u003cspan style=\"font-family: arial, helvetica, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: rgb(255, 255, 255);\" data-mce-style=\"font-family: arial, helvetica, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: #ffffff;\" \u003eYou can ask questions directly to the mentor or during class, similar to our offline classroom program. Additionally, every class includes a dedicated doubt-clearing session where you can raise queries with the Teaching Assistant assigned to your batch. Also, this course offers 24/7 doubt support, so you can ask questions anytime you need.\u003c/span\u003e\u003c/p\u003e\", \"Will I get internship certificate after completing this course ?\": \"\u003cp\u003e\u003eNo internship certificate program is only for offline batches. After successful completion of the live course you will be provided a training certificate\u003c/p\u003e\", \"Are refunds offered for courses?\": \"\u003cdiv style=\"box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; font-size: 17px;\" data-mce-style=\"box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; font-size: 17px;\" \u003cp style=\"box-sizing: border-box; line-height: 24px;\" data-mce-style=\"box-sizing: border-box; line-height: 24px;\" \u003eAll sales are final, no refunds will be provided for offline and live courses. However, if needed, participants may be allowed to shift to a different batch of the same course, subject to availability and course policies.\u003c/p\u003e\u003c/div\u003e\u003cdiv class=\"yj6qo ajU\" style=\"cursor: pointer; outline: none; padding: 10px 0px; user-select: none; width: 22px; margin: 2px 0px 0px 0px;\" data-mce-style=\"cursor: pointer; outline: none; padding: 10px 0px; user-select: none; width: 22px; margin: 2px 0px 0px 0px;\" \u003cdiv id=\":18z\" class=\"ajR\" role=\"button\" data-tooltip=\"Show trimmed content\" aria-label=\"Show trimmed content\" aria-expanded=\"false\" style=\"background-color: #e8eae9; border: none; clear: both; line-height: 6px; outline: none; position: relative; width: 24px; border-radius: 5.5px;\" data-mce-style=\"background-color: #e8eae9; border: none; clear: both; line-height: 6px; outline: none; position: relative; width: 24px; border-radius: 5.5px;\" data-mce-tabindex=\"0\" \u003cimg class=\"ajT\" src=\"https://ssl.gstatic.com/ui/v1/icons/mail/images/clear_dot.gif\" style=\"background: url('https://www.gstatic.com/images/icons/material/system_gm/1x/more_horiz_black_20dp.png') center center / 20px no-repeat; height: 11px; opacity: 0.71; width: 24px;\" data-mce-src=\"https://ssl.gstatic.com/ui/v1/icons/mail/images/clear_dot.gif\" data-mce-style=\"background: url('https://www.gstatic.com/images/icons/material/system_gm/1x/more_horiz_black_20dp.png') center center / 20px no-repeat; height: 11px; opacity: 0.71; width: 24px;\" \u003c/div\u003c/div\u003c/div\u003cdiv class=\"adL\" style=\"display: flex; box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; margin: 10px auto 0px 0px; font-size: 18px; font-weight: bold; color: #357960; width: fit-content;\" data-mce-style=\"display: flex; box-sizing: border-box; font-family: 'Source Sans 3', sans-serif; margin: 10px auto 0px 0px; font-size: 18px; font-weight: bold; color: #357960; width: fit-content;\" \u003cdiv style=\"background-color: #ffffff;\" data-mce-style=\"background-color: #ffffff;\" \u003cdiv\u003e\", \"What are the prerequisites and required software/hardware?\": \"\u003cp\u003e\u003cspan style=\"font-family: Helvetica, Arial, sans-serif; font-size: 12pt; white-space-collapse: preserve;\" data-mce-style=\"font-family: Helvetica, Arial, sans-serif; font-size: 12pt; white-space-collapse: preserve;\" \u003e

erve; background-color: rgb(255, 255, 255);\" data-mce-style=\"font-family: Helvetica, Arial, sans-serif; font-size: 12pt; white-space-collapse: preserve; background-color: #ffffff;\"\\u003eThis live course has no prerequisites. You'll receive clear articles and notes for each session, so you can follow along from day one and get the most out of the program. Prior experience may help, but it isn't required everything you need will be provided.\\u003c/span\\u003e\\u003c/p\\u003e\", \"Can I make the payment through PayPal?\": \"\\u003cp\\u003eYes. Mail us with your details at [geeks.classes@geeksforgeeks.org](\"mailto:geeks.classes@geeksforgeeks.org\").\\u003cbr\\u003e\\u003c/p\\u003e\", \"When will my IBM certificate be visible?\": \"\\u003cp\\u003eYour IBM certificate will be visible after 25th December.\\u003c/p\\u003e\"}, \"has_doubt_assistance\": true, \"doubt_support_price\": 0, \"visit_count\": \"102k +\", \"desktop_banner\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"mobile_banner\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"seats_left\": 3, \"top_course\": false, \"course_publish_date\": \"2024-04-30T00:00:00\", \"keywords\": \"Machine Learning and Data Science | IBM Certification | ML and Data Science\", \"ratings\": {\"avg_rating\": 4.3, \"partial_rating\": 0.2999999999999998, \"star_count\": 0}, \"intro_video_link\": {\"thumbnail_image\": \"https://media.geeksforgeeks.org/wp-content/uploads/20251126114155228871/DA.png\", \"link\": \"\", \"video_available\": false}, \"short_description\": \"\\u003cp\\u003eUnlock the power of data! Elevate your expertise with our Mastering\\u0026nbsp;Data Analytics\\u0026nbsp;Course. Gain proficiency in\\u0026nbsp;Python,\\u0026nbsp;SQL,\\u0026nbsp;Excel, and\\u0026nbsp;Tableau for data analysis, visualization, and reporting. Explore hands-on, real-world projects and much more.\\u003cbr\\u003e\\u003c/p\\u003e\", \"what_you_will_learn\": \"\\u003cul\\u003e\\u003cli\\u003eLearn the basics of the\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003ePython Programming Language\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003eUnderstand how to work with\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003efiles, JSON, Numpy, and OS using Python\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003eLearn how to use\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003eJupyter\\u0026nbsp;\\u003cspan\\u003efor data analysis and visualization\\u003c/li\\u003e\\u003cli\\u003eUse\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003ePandas\\u0026nbsp;\\u003cspan\\u003eto manipulate and analyze data\\u003c/li\\u003e\\u003cli\\u003eLearn basic\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003estatistics\\u0026nbsp;\\u003cspan\\u003eand\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003edata preprocessing\\u0026nbsp;\\u003cspan\\u003etechniques for data analysis\\u003c/li\\u003e\\u003cli\\u003eBuild\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003eprojects\\u0026nbsp;\\u003cspan\\u003eusing data analysis techniques\\u003c/li\\u003e\\u003cli\\u003eUnderstand the basics of\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003eExcel\\u0026nbsp;\\u003cspan\\u003eand\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003eSQL\\u0026nbsp;\\u003cspan\\u003efor data management and analysis\\u003c/li\\u003e\\u003cli\\u003eLearn how to use\\u0026nbsp;\\u003cspan data-mce-style=\\\"box-sizing: inherit; font-weight: bolder;\\\" style=\\\"box-sizing: inherit; font-weight: bolder;\\\"\\u003ePowerBI\\u0026nbsp;\\u003cspan\\u003efor data visualization and reporting\\u003c/li\\u003e\\u003cli\\u003eSupplementary\\u0026nbsp;\\u003cstrong\\u003eCertifica

tion Questions \u003c/strong\u003ematerials provided for certifications such as \u003cstrong\u003eGoogle, AWS, and IBM.\u003c/strong\u003e\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003e", "course_overview": "\u003cp\u003e\u003cstrong\u003eKey Highlights\u003c/strong\u003e\u003c/p\u003e\u003cul\u003e\u003cli\u003e30+ hours of beginner to advanced self-paced content\u003c/li\u003e\u003cli\u003eHands-on practice with real-world datasets\u003c/li\u003e\u003cli\u003eLearn industrial tools: Excel, SQL, Python, Pandas, NumPy, Jupyter, Tableau, Power BI \u0026amp; more\u003c/li\u003e\u003cli\u003eWork on multiple real-life projects and implementations\u003cbr\u003e\u003c/li\u003e\u003c/ul\u003e\u003cdiv id=\"professor_prebid-root\" \u003c/div\u003e\", \"course_feature\": null, \"course_content\": {\"Class 1: Introduction to Excel for Data Analysis\": \"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eOverview of Excel interface\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eNavigating sheets efficiently\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eMath \u0026amp; statistical functions (SUM, AVERAGE, COUNT)\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eLogical functions (IF, AND, OR)\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eText functions for manipulation\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-s

erif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVLOOKUP, VLOOKUP\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 2: Advanced Formulas \u0026 Dashboards Using Excel": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eINDEX MATCH\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eSUMIF, COUNTIFS, nested functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003ePower Query: import, transform, merge, append\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eDynamic dashboards\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003ePivot tables from multiple sources\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eSlicers, combo charts, layout optimization\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 3: Excel AI, Project, Kaggle \u0026 Github Introduction": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color:

transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted data cleaning \u0026amp; transformation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eExcel with AI project\u0026nbsp;\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eKaggle and Github optimization\u003c/span\u003e\u003c/li\u003e\u003cul\u003e", "Class 4: Introduction to SQL": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eOverview of SQL \u0026amp; databases\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic syntax, SELECT, WHERE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCreating \u0026amp; modifying tables (CREATE/ALTER)\u003c/span\u003e\u003c/li\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eUnderstanding constraints\u003c/span\u003e\u003c/li\u003e\u003e

003c/ul\u003e","Class 5: Aggregations \u0026 GROUP BY": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eCOUNT, SUM, AVG, MIN, MAX\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eFiltering aggregates\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eGROUP BY, HAVING\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eORDER BY, LIMIT, sorting\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eDISTINCT vs GROUP BY\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003eLLM-powered optimization suggestions\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 6: Joins \u0026 Subqueries ": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\" \u003e

lign: baseline; white-space-collapse: preserve;"\u003eIntroduction to Joins
\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eINNER, LEFT, RIGHT, FULL OUTER Joins \u0026amp; Self join\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eDeep Dive into Joins \u0026amp; Subquery Logic\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSubqueries \u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eBasic windows functions Aggregate functions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRank functions(ROW_NUMBER(), RANK(), DENSE_RANK() ,PARTITION BY)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAdvance windows functions (LAG(), LEAD(), SUM() OVER(), AVG() OVER())\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, san

s-serif; font-variant-numeric: normal; font-variant-text-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI error detection in analytical SQL\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 8: Data Cleaning \u0026 Recursive CTE's":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial, sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCTE ,SUBSTRING, LENGTH, TRIM, REPLACE\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eUPPER/LOWER\u003c/span\u003e\u003cbr\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eDATE_ADD, DATEDIFF, EXTRACT\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eAI-assisted SQL debugging\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 9: CASE WHEN, Optimization \u0026 Analytics":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eCASE WHEN \u0026amp; conditional logic\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\u003eIF statements\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight:

ght: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIndexes, EXPLAIN plans\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eFunnel analysis, cohorts, retention\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eIntroduction to python\u0026nbsp; \u0026amp; \u003cspan\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython basics, data types, variables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eLoops (for, while)\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eConditional statements (if, elif, else)\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eList

s, dictionaries, tuples

\u003eList comprehension , operators

\u003eString methods, Indexing & slicing

\u003eFunctions & error handling

\u003eClass 12: Python Fundamentals (Continued)

\u003eFunctions such as map, filter , lambda

\u003eInbuilt functions len(), type(), sum(), sorted()

\u003eWorking with external files

-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eUsing Colab AI for debugging and code generation\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 13: Pandas Data Cleaning": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\n\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eData cleaning operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\n\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eString processing\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eDataFrames \u0026amp; Series\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eMissing values\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eDuplicate handling\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e", "Class 14: Pandas Transformation": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\n\u003eData type conversions\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\n\" style=\"font-size: 12pt; font-family: Arial, san

s-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eColumn renaming\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eGroupby, agg, apply\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePivot tables\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMerging \u0026amp; joining\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI helpers for transformation scripts\u003c/span\u003e\u003c/li\u003e\u003c/li\u003e", "Class 15: NumPy \u0026 ED A": "\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eNumPy arrays and vectorization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eStatistical operations\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size:

12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eOutlier handling\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eEDA workflow\\u003c/span\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\", \"Class 16: Visualization with Matplotlib, Seaborn \\u0026 Plotly\": \"\\u003cul\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eBasic \\u0026amp; advanced charts\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eInteractive visualizations\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eCustomization \\u0026amp; styling\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eAI-generated chart scripts\\u003c/span\\u003e\\u003c/li\\u003e\\u003c/ul\\u003e\", \"Class 17: EDA Project (Python)\": \"\\u003cul\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\\\" style=\\\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\\\"\\u003eData loading\\u003c/span\\u003e\\u003c/li\\u003e\\u003cli\\u003e\\u003cspan data-mce-style=\\\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style:

normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning with Pandas\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualizations\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 18: Python + AI EDA Project":\u003cul\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eData acquisition\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning \u0026amp; preparation\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eNumerical analysis\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eAI-assisted EDA automation\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 19: Data Analysis with LLMs":\u003cul\u003e\u003eli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif;

color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eHow LLMs help in analysis\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePan das code generation\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCleaning assistance\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualization generation\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower BI Fundamentals \u0026 Data Modeling":\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower BI interface\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eImporting data\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRelationships \u0026amp; schemas\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="fo

nt-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eModeling best practices\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e","Class 21: DAX \u0026 KPIs":"\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSUM, AVERAGE, COUNT, CALCULATE\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSWITCH, FILTER\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eTime intelligence\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eRunning totals \u0026amp; growth\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePower Query for ETL\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eVisualiz

ation types\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eInteractive elements\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eDashboard best practices\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 23: Interview Preparation\": \"\\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eResume building\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eLinkedIn optimization\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003ePositioning your background\u003c/span\u003e\u003c/li\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eIdentify target companies and roles\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\", \"Class 24: Presentation \u0026 Mock Interviews\": \"\\u003cul\u003e\u003cli\u003e\u003cspan data-mce-style=\"font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;\" style=\"font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;\"\\u003eIdentify target companies and roles\u003c/span\u003e\u003c/li\u003e\u003c/ul\u003e\"

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-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eSTAR method\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eProject storytelling\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eMock interviews\u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eCommon SQL interview patterns \u003c/span\u003e\u003c/li\u003e\u003ccli\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePython coding (data manipulation, EDA) Interview Questions\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003ePyth
on coding (data manipulation, EDA) Interview Questions\u003c/span\u003e\u003c/li\u003e\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYou may call us on our toll-free number: +91-08069289001 or Drop us an email at courses@geeksforgeeks.org\u003c/span\u003e\u003cbr\u003e\u003c/p\u003e", "How can I register for the course?": "You need to sign up for the course. After signing up, you need to pay when the payment link opens.", "When can I make the payment for the course?": "The payment link will be available on the course page.", "Can I make the payment through PayPal?": "\u003cspan data-mce-style="font-size: 12pt; font-family: Arial,sans-serif; color: #000000; background-color: transparent; font-weight: 400; font-style: normal; font-variant: normal; text-decoration: none; vertical-align: baseline; white-space: pre-wrap;" style="font-size: 12pt; font-family: Arial, sans-serif; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; font-variant-emoji: normal; vertical-align: baseline; white-space-collapse: preserve;"\u003eYes. Mail us with your details at cou
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rses@geeksforgeeks.org\u003c/p\u003e\n","Do we have doubt support in this program?": "\u003cp\u003eYou may get additional feature of doubt support. While purchasing this course, click on \u0026quot;Add to Cart\u0026quot; for Doubt Support and Assistance.\u003c/p\u003e\n","What features does Doubt Support have?": "\u003cp\u003eDoubt support helps you clear your doubt of any GFG and codeforces courses/problems. You can raise your doubt anytime. Our doubt support assistance is available 24x7.\u003c/p\u003e\n","Is there any demo lecture video of this course?": "\u003cp\u003eYes, you may access the demo lecture here:\u0026nbsp;\u003ca href=\"https://www.youtube.com/watch?v=l2PyiNFZwNc\u0026amp;t=1s\u0026amp;pbjreload=101\" target=\"_blank\"\u003eDemo Video for C Foundation Course\u003c/a\u003e.\u003c/p\u003e\n","How long will the course content be available for?": "\u003cp\u003eThe course content will be available for one year.\u003cbr\u003e\u003c/p\u003e\n","What type of certificate will be offered in this program?": "Once the course is completed. You'll be getting a course completion certificate.", "What is C?": "\u003cp\u003eC is a powerful and widely used programming language that was developed in the 1970s. It's often considered the \"mother\" of many modern programming languages, like C++, Java, and Python. C is known for its speed and efficiency, making it popular for developing operating systems, games, and embedded systems.\u003c/p\u003e\u003cp\u003e\u003cbr\u003e\u003c/p\u003e\n","Why should I learn C?": "\u003cp\u003eLearning C is beneficial because it gives you a deep understanding of how computers work. Many other programming languages are based on C, so mastering it can make learning other languages easier. C is also used in many critical systems, so knowing it can open up job opportunities in fields like software development, embedded systems, and systems programming.\u003c/p\u003e\u003cp\u003e\u003cbr\u003e\u003c/p\u003e\n","What can I do with C?": "\u003cp\u003eWith C, you can develop a wide range of applications, including:\u003c/p\u003e\u003cul\u003e\u003eli\u003eOperating systems (like Linux)\u003c/li\u003e\u003eli\u003eSystem software (like compilers and drivers)\u003c/li\u003e\u003eli\u003eEmbedded systems (software for devices like microwaves and cars)\u003c/li\u003e\u003eli\u003eGames and graphics\u003c/li\u003e\u003eli\u003eHigh-performance applications\u003c/li\u003e\u003c/ul\u003e.\u003c/p\u003e\n","Do I need to know any other programming languages before learning C?": "\u003cp\u003eNo, you don't need to know any other programming languages before learning C. In fact, many people start with C because it helps them understand fundamental programming concepts that are useful in other languages as well.\u003c/p\u003e\n","Is C still relevant today?": "\u003cp\u003eYes, C is still very relevant today. It's widely used in systems programming, embedded systems, and high-performance applications. Many modern programming languages and systems are built on C, so understanding it is valuable in the tech industry.\u003c/p\u003e\n","What kind of jobs can I get with C programming skills?": "\u003cp\u003eWith C programming skills, you can pursue roles such as:\u003c/p\u003e\u003cul\u003e\u003eli\u003eSoftware Developer/Engineer\u003c/li\u003e\u003eli\u003eSystems Programmer\u003c/li\u003e\u003eli\u003eEmbedded Systems Engineer\u003c/li\u003e\u003eli\u003eFirmware Developer\u003c/li\u003e\u003eli\u003eGame Developer\u003c/li\u003e\u003eli\u003eRobotics Programmer\u003c/li\u003e\u003eli\u003eNetwork Programmer\u003c/li\u003e\u003eli\u003eOperating System Developer\u003c/li\u003e\u003c/ul\u003e.\u003c/p\u003e\n","What are the career growth opportunities with C programming?": "\u003cp\u003eWith C programming skills, you can grow into senior developer roles, lead engineering teams, or specialize in areas like embedded systems, systems programming, or network programming. C expertise can also lead to roles in software architecture, technical leadership, or even transitioning to other areas like cybersecurity or IoT (Internet of Things).\u003c/p\u003e\n","Can I use C for web development?": "\u003cp\u003eWhile C is not commonly used for web development, it can be used to build parts of web applications, especially for back-end pr

processes that require high performance. However, languages like JavaScript, Python, and PHP are more commonly used for web development.

Course Details:

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e\r\n\t\u003c/li\u003e\r\n\t\u003cli\u003e\r\n\t\u003cp\u003e\u003cstrong\u003eCourse Completion Certificate trusted by top universities and companies\u003c/strong\u003e\u003c/p\u003e\r\n\t\u003c/li\u003e\r\n\t\u003cp\u003e\u003cstrong\u003eInternship Opportunity\u0026nbsp;at GeeksforGeeks\u003c/strong\u003e\u003c/p\u003e\r\n\t\u003c/li\u003e\r\n\t\u003cp\u003e\u003cstrong\u003eAccess to the GeeksforGeeks Jobs portal\u003c/strong\u003e\u003c/p\u003e\r\n\t\u003c/li\u003e\r\n\t\u003cul\u003e

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3c/li\u003e\u003cli\u003e\u003cstrong\u003eProblem Solving\u003c/strong\u003e
e: Mastery of DSA improves your problem-solving ability, helping you design solutions for complex and dynamic challenges.\u003c/li\u003e\u003cul\u003e
\u003ch2\u003eRoadmap to Learn DSA\u003c/h2\u003e\u003cpl\u003eThe roadmap to learning DSA is structured into \u003cstrong\u003ephases\u003c/strong\u003e. Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts.\u003c/p\u003e\u003ch3\u003ePhase 1: Introduction to Programming Basics\u003c/h3\u003e\u003cpl\u003eBefore diving into DSA, you need to have a solid understanding of basic programming concepts. This includes:\u003c/p\u003e\u003cul\u003e\u003eli\u003e\u003cstrong\u003eVariables, Data Types, and Operators\u003c/strong\u003e: Understand how variables and data types work in programming languages.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eControl Flow\u003c/strong\u003e: Learn about if-else conditions, loops (for, while), and switch cases.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eFunctions\u003c/strong\u003e: Master how functions work, including parameters, return types, and recursion.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eBasic Input and Output\u003c/strong\u003e: Learn how to handle input and output in your programming language of choice.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 2: Learn Basic Data Structures\u003c/h3\u003e\u003cul\u003e\u003eli\u003e\u003cstrong\u003eArrays\u003c/strong\u003e: Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eStrings\u003c/strong\u003e: Learn how strings are represented in memory and how to manipulate them.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eLinked Lists\u003c/strong\u003e: Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eStacks and Queues\u003c/strong\u003e: Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHashing\u003c/strong\u003e: Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 3: Advanced Data Structures\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eTrees\u003c/strong\u003e: Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eHeaps\u003c/strong\u003e: Learn about heaps (min and max heaps) and their applications in priority queues and heap sort.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eGraphs\u003c/strong\u003e: Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS).\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eTries\u003c/strong\u003e: Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDisjoint Set Union (DSU)\u003c/strong\u003e: Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.\u003c/li\u003e\u003cul\u003e\u003ch3\u003ePhase 4: Learn Algorithms\u003c/h3\u003e\u003cul\u003e\u003cli\u003e\u003cstrong\u003eSorting Algorithms\u003c/strong\u003e: Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eSearching Algorithms\u003c/strong\u003e: Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array.\u003c/li\u003e\u003cli\u003e\u003cstrong\u003eDynamic Programming (DP)\u003c/strong\u003e: Understand the princi

ple of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS).

- [Greedy Algorithms](#): Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection.
- [Backtracking](#): Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem.
- [Divide and Conquer](#): Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems.
- [Graph Algorithms](#): Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.

Phase 5: Problem Solving and Practice

- [LeetCode, HackerRank, CodeForces](#): Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills.
- [Interview Preparation](#): Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch.
- [Competitive Programming](#): Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.

Phase 6: Advanced Topics (Optional)

- [String Algorithms](#): Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching.
- [Advanced Dynamic Programming](#): Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc.
- [Advanced Graph Algorithms](#): Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp).
- [Geometry Algorithms](#): Study algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.

Why is This Roadmap Effective?

- [Structured Learning](#): This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.
- [Foundational Knowledge](#): Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.
- [Hands-on Practice](#): Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding.
- [Interview Focused](#): The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.
- [Common Mistakes to Avoid](#): Skipping the Basics: Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.
- [Not Practicing Enough](#): DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.
- [Getting Stuck on One Problem](#)

e: If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.

[Why Learn DSA?](#)

[Problem Solving Skills](#)

[Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.](#)

[Efficient Solutions](#)

Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.

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DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

[Topics Covered](#)

[Introduction to DSA](#)

Learn the importance of DSA and how it relates to coding efficiency.

[Data Structures](#)

Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.

[Algorithms](#)

Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.

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<https://cdnvideos.geeksforgeeks.org/e929bf110a2f9cd6113209b8a914dfbbgfg-RoadmapToLearnDSA2023042515172120241112155437/video.m3u8>, "category": [{"term_id": 125, "term_name": "Data Structures", "term_type": 2, "slug": "data-structures-bczc7q"}, {"term_id": 365, "term_name": "Data Structure and Algorithm", "term_type": 1, "slug": "data-structure-and-algorithm"}, {"term_id": 562, "term_name": "DSA", "term_type": 1, "slug": "dsa-lpubwc"}], "meta": {"thumbnail": "https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752-small.png", "largeThumbnail": "https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752.jpg", "likes": 1, "views": 779090, "isFeatured": 0, "isPremium": 0, "isPublic": 1, "format": "video/mp4", "revision": {}, "time": "12/11/2024", "subtitle": "https://cdnvideos.geeksforgeeks.org/e929bf110a2f9cd6113209b8a914dfbbgfg-RoadmapToLearnDSA2023042515172120241112155437/subtitle.vtt", "duration": 883, "course_link": "https://www.geeksforgeeks.org/courses/dsa-self-paced", "video_schema": {"@context": "https://schema.org", "@type": "VideoObject", "name": "Roadmap to learn DSA", "description": "In this tutorial, we will explore a structured roadmap to learning Data Structures and Algorithms (DSA), which are essential for any software engineer or computer science student. Mastering DSA is crucial for solving complex problems efficiently, and it is the foundation for cracking technical interviews and coding challenges. What is DSA? Data Structures and Algorithms (DSA) are the building blocks of computer science and software development. Data structures are ways of organizing and storing data, while algorithms are sets of steps or procedures to solve a problem or perform a task. Together, they form the backbone of efficient problem-solving, code optimization, and performance improvement. Why is DSA Important? Efficiency Understanding DSA helps in solving problems with optimal time and space complexity, which is crucial in real-world applications. Technical Interviews Most technical interviews, especially at top tech companies, revolve around solving DSA problems. A solid understanding of DSA will help you perform well in coding interviews. Problem Solving Mastery of DSA improves your problem-solving ability, helping you design solutions for complex and dynamic challenges. Roadmap to Learn DSA

The roadmap to learning DSA is structured into phases. Each phase builds on the knowledge acquired in the previous phase, guiding you from the basics to advanced concepts.

Phase 1 Introduction to Programming Basics Before diving into DSA, you need to have a solid understanding of basic programming concepts. This includes Variables, Data Types, and Operators. Understand how variables and data types work in programming languages. Control Flow Learn about if-else conditions, loops (for, while), and switch cases. Functions Master how functions work, including parameters, return types, and recursion. Basic Input and Output Learn how to handle input and output in your programming language of choice.

Phase 2 Learn Basic Data Structures Arrays Learn how to store and manipulate a collection of elements. Understand one-dimensional and multi-dimensional arrays. Strings Learn how strings are represented in memory and how to manipulate them. Linked Lists Understand the concept of nodes and pointers. Learn about single and doubly linked lists, and how to perform operations like insertion, deletion, and searching. Stacks and Queues Study stack (LIFO) and queue (FIFO) operations and their applications in problems such as expression evaluation, scheduling, and more. Hashing Learn the basics of hash maps and hash tables. Understand how hashing works and its applications in scenarios like fast lookups.

Phase 3 Advanced Data Structures Trees Understand tree structures, starting with binary trees. Learn about tree traversals (inorder, preorder, postorder) and binary search trees (BST). Heaps Learn about heaps (min and max heaps) and their applications in priority queues and heap sort. Graphs Study the representation of graphs (adjacency matrix and adjacency list), and learn about graph traversal algorithms like breadth-first search (BFS) and depth-first search (DFS). Tries Learn about trie data structures and their applications in tasks like autocomplete and dictionary searching. Disjoint Set Union (DSU) Study the Union-Find data structure and how it is used in solving problems related to connected components in graphs, like Kruskal's algorithm for MST.

Phase 4 Learn Algorithms Sorting Algorithms Study various sorting algorithms like Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort. Understand their time and space complexities. Searching Algorithms Learn about linear search and binary search. Study advanced searching algorithms like interpolation search and search on a rotated array. Dynamic Programming (DP) Understand the principle of dynamic programming for solving problems like the Knapsack problem, Fibonacci series, and longest common subsequence (LCS). Greedy Algorithms Study greedy techniques and how they can be applied to optimization problems like coin change, job scheduling, and activity selection. Backtracking Learn the backtracking technique and its applications in problems like Sudoku, N-Queens, and the traveling salesman problem. Divide and Conquer Understand divide-and-conquer strategies, such as Merge Sort, Quick Sort, and binary search, for solving problems by breaking them into smaller subproblems. Graph Algorithms Learn about important graph algorithms like Dijkstra's algorithm for shortest paths, Floyd-Warshall algorithm, and Bellman-Ford algorithm.

Phase 5 Problem Solving and Practice LeetCode, HackerRank, CodeForces Practice DSA problems on competitive coding platforms. Focus on solving problems with increasing difficulty to hone your skills. Interview Preparation Focus on common interview problems and practice them under time constraints. Implement data structures and algorithms from scratch. Competitive Programming Engage in competitive programming contests and participate in challenges to enhance your problem-solving abilities.

Phase 6 Advanced Topics (Optional) String Algorithms Study algorithms like KMP (Knuth-Morris-Pratt), Rabin-Karp, and Z-algorithm for efficient string matching. Advanced Dynamic Programming Learn advanced DP techniques like Bitmasking, DP on Trees, DP on Graphs, etc. Advanced Graph Algorithms Learn about algorithms for solving network flow problems, minimum spanning trees (Kruskal's, Prim's), and maximum flow algorithms (Ford-Fulkerson, Edmonds-Karp). Geometry Algorithms Study algo-

algorithms for computational geometry, like convex hull, line intersection, and closest pair of points.

Why is This Roadmap Effective?

Structured Learning This roadmap provides a structured approach to learning DSA, making it easy to follow and progress through concepts in a logical sequence.

Foundational Knowledge Starting with programming basics ensures that you understand the core concepts before tackling more advanced topics.

Hands-on Practice Problem-solving is the key to mastering DSA. This roadmap encourages hands-on practice and real-world applications to solidify your understanding.

Interview Focused The roadmap covers essential topics that are frequently asked in coding interviews, preparing you to excel in interviews at top tech companies.

Common Mistakes to Avoid

Skipping the Basics Many learners jump into advanced topics without mastering the basics. It's crucial to have a strong foundation before moving on to more complex concepts.

Not Practicing Enough DSA is a skill that improves with practice. Focusing solely on theory and not solving enough problems can hinder your progress.

Getting Stuck on One Problem If you're stuck on a problem for too long, move on to another. It's important to keep practicing and learning from your mistakes.

Why Learn DSA?

Problem Solving Skills Learning DSA helps in developing problem-solving abilities, which are valuable not just in coding interviews but also in real-world applications.

Efficient Solutions Understanding how to use different data structures and algorithms allows you to optimize solutions, making them more efficient in terms of time and space complexity.

Interview Success DSA is the cornerstone of most technical interviews, especially for roles in software development. A strong grasp of DSA is essential for clearing interviews at top tech companies.

Topics Covered

Introduction to DSA Learn the importance of DSA and how it relates to coding efficiency.

Data Structures Understand the basic and advanced data structures like arrays, linked lists, trees, graphs, and heaps.

Algorithms Explore the various algorithms that manipulate and search data, including sorting, searching, dynamic programming, and graph algorithms.

Problem-Solving Gain hands-on experience by practicing problems on competitive coding platforms and preparing for coding interviews.

```
,"thumbnailUrl":["https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752.jpg","https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752-seo.png","https://media.geeksforgeeks.org/courses/RoadmaptolearnDSA/RoadmaptolearnDSA20241112164752-small.png"],"uploadDate":"2024-11-12T16:02:01Z","duration":"PT0H14M43S","contentUrl":"https://www.geeksforgeeks.org/videos/roadmap-to-learn-dsa/"},"fulfilledTimeStamp":1767604738171},"getPracticeBannerData({"1103752"}":{"status":"fulfilled","endpointName":"getPracticeBannerData","requestId":"PsM_vzY9nRNY3JtcxXYt9","originalArgs":{"1103752"},"startedTimeStamp":1767604738159,"data":{"data":{},"status":false,"message":"Article with post_id 1103752 not found"},"fulfilledTimeStamp":1767604738209},"getPromotionalCtaData({"countryCode":"IN","termIds":"6527/8104/6263"}":{"status":"fulfilled","endpointName":"getPromotionalCtaData","requestId":"IJSKu5CuqM6A29K0PFN48","originalArgs":{"termIds":"6527/8104/6263","countryCode":"IN"},"startedTimeStamp":1767604738209,"data":[{"id":"-7","cta_html":"\u003cli style=\"background-color: var(--leftbar-explore-section-color) !important;\" class=\"share-experience-modal\"\u003e\u003ca href=\"https://write.geeksforgeeks.org/#experiences\" style=\"cursor:pointer;display: block;border-bottom: 1px solid var(--gfg-body-color-alternate);\u003eShare Your Experiences\u003c/a\u003e\u003c/li\u003e"}],"fulfilledTimeStamp":1767604738217},"getPromotionalCtaData({"countryCode":"IN","position":"bottom","termIds":"6527/8104/6263"}":{"status":"fulfilled","endpointName":"getPromotionalCtaData","requestId":"MtkWazRWtLEAfH-Su04T","originalArgs":{"termIds":"6527/8104/6263","countryCode":"IN","position":"bottom"},"startedTimeStamp":1767604738210,"data":[{"id":"6263","cta_html":"\u003cli style=\"background-color: var(--leftbar-explore-section-color) !important;\"\u003e\u003c"}]}
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mmonApi\"}},\"additionalDetails\":{\"videoLoad\":1},\"authState\":{\"userVal\":\"\", \"us
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a-structures-and-algorithms\"]},\"buildId\":\"WTE6VQ__UBNEzr69nbJDC\", \"assetPrefi
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Ids\": [69873,21119,7792],\"gssp\":true,\"scriptLoader\":[]}
</script>
</body>
</html>

```

Out[39]: ' ****CONCLUSION****\nThis project demonstrates how web scraping can be impleme
nted using Python\nand BeautifulSoup. It automates data collection, extract
s useful information,\nand stores it efficiently, making it a powerful tool
for data analysis\nand research.\n'

2. Requests (Python)

```

In [33]: """
PYTHON REQUESTS LIBRARY – COMPLETE DEMONSTRATION

The Python Requests library is a simple and powerful tool used to send HTTP
requests and interact with web resources. It supports GET, POST, PUT,
DELETE, PATCH, and HEAD requests and is widely used in REST APIs,
web scraping, and backend development.
"""

"""
-----
### Why Use Requests Library
-----

1. Simplifies HTTP requests
2. Manages headers, cookies, sessions, and authentication

```

```

3. Ideal for REST API consumption and testing
4. Supports all HTTP methods
5. Built-in SSL verification and error handling
"""

"""

-----
### Installation (Run in Terminal)
-----
"""

# pip install requests

"""

-----
### IMPORT REQUIRED LIBRARY
-----
"""
import requests

"""

-----
### REQUEST SYNTAX
-----

requests.get(url, params={key: value}, **kwargs)

Parameters:
- url      : Target URL (Required)
- params   : Query parameters (Optional)
- **kwargs : Headers, cookies, auth, timeout, proxies, SSL, etc.

Return Type:
- Response object
"""

"""

-----
### SIMPLE GET REQUEST
-----
"""

response = requests.get("https://example.com/")
print("Status Code:", response.status_code)

# Status code 200 means request successful

"""

-----
### GET REQUEST WITH PARAMETERS
-----
"""

response = requests.get("https://api.github.com/users/octocat")
print("Status Code:", response.status_code)

```

```

print("Response Content:", response.content)

"""
-----
### HTTP REQUEST METHODS
-----
GET      - Retrieve information from server
POST     - Send data to server
PUT      - Replace existing resource
DELETE   - Delete a resource
HEAD     - Retrieve headers only
PATCH   - Apply partial updates
"""

"""
-----
### RESPONSE OBJECT EXAMPLE
-----
"""
response = requests.get("https://api.github.com/")
print("Final URL:", response.url)
print("Status Code:", response.status_code)

"""
-----
### COMMON RESPONSE ATTRIBUTES
-----
"""
print("Headers:", response.headers)
print("Encoding:", response.encoding)
print("Elapsed Time:", response.elapsed)
print("Is OK:", response.ok)

"""
-----
### POST REQUEST EXAMPLE
-----
"""
payload = {'username': 'test', 'password': 'test123'}
response = requests.post("https://httpbin.org/post", data=payload)
print("POST Response:", response.text)

"""
-----
### AUTHENTICATION USING REQUESTS
-----
"""
from requests.auth import HTTPBasicAuth

response = requests.get(
    "https://api.github.com/user",

```



```

    auth=HTTPBasicAuth("user", "pass")
)
print("Auth Status Code:", response.status_code)

# Replace user and pass with valid credentials

####

-----

### SSL CERTIFICATE VERIFICATION
-----

####

response = requests.get("https://expired.badssl.com/", verify=False)
print("SSL Bypass Status:", response.status_code)

# verify=False disables SSL verification (not recommended)

####

-----

### SESSION OBJECTS
-----

####

session = requests.Session()

session.get("https://httpbin.org/cookies")
response = session.get("https://httpbin.org/cookies")
print("Session Cookies:", response.text)

####

-----

### ERROR HANDLING
-----

####

# try:
#     response = requests.get("https://www.example.com/", timeout=5)
#     response.raise_for_status()
#     print("Request Successful")
# except requests.exceptions.HTTPError as errh:
#     print("HTTP Error:", errh)
# except requests.exceptions.ConnectionError as errc:
#     print("Connection Error:", errc)
# except requests.exceptions.Timeout as errt:
#     print("Timeout Error:", errt)
# except requests.exceptions.RequestException as err:
#     print("Other Error:", err)

####

-----

### CONCLUSION
-----

The Requests library provides a clean and efficient way to communicate
with web servers. It simplifies HTTP operations, supports APIs,
handles authentication and errors, and is widely used in

```

```
web scraping and backend development.  
.....
```

Status Code: 200

Status Code: 200

Response Content: b'{"login":"octocat","id":583231,"node_id":"MDQ6VXNlcjU4MzIzMQ==","avatar_url":"https://avatars.githubusercontent.com/u/583231?v=4","gravatar_id":"","url":"https://api.github.com/users/octocat","html_url":"https://github.com/octocat","followers_url":"https://api.github.com/users/octocat/followers","following_url":"https://api.github.com/users/octocat/following{/other_user}","gists_url":"https://api.github.com/users/octocat/gists{/gist_id}","starred_url":"https://api.github.com/users/octocat/starred{/owner}/{repo}","subscriptions_url":"https://api.github.com/users/octocat/subscriptions","organizations_url":"https://api.github.com/users/octocat/orgs","repos_url":"https://api.github.com/users/octocat/repos","events_url":"https://api.github.com/users/octocat/events{/privacy}","received_events_url":"https://api.github.com/users/octocat/received_events","type":"User","user_view_type":"public","site_admin":false,"name":"The Octocat","company":"@github","blog":"https://github.blog","location":"San Francisco","email":null,"hireable":null,"bio":null,"twitter_username":null,"public_repos":8,"public_gists":8,"followers":21410,"following":9,"created_at":"2011-01-25T18:44:36Z","updated_at":"2025-12-22T12:24:29Z"}'

Final URL: https://api.github.com/

Status Code: 200

Headers: {'Date': 'Mon, 05 Jan 2026 19:23:36 GMT', 'Content-Type': 'application/json; charset=utf-8', 'Cache-Control': 'public, max-age=60, s-maxage=60', 'Vary': 'Accept,Accept-Encoding, Accept, X-Requested-With', 'ETag': 'W/"4f825cc84e1c733059d46e76e6df9db557ae5254f9625dfe8e1b09499c449438"', 'X-GitHub-Media-Type': 'github.v3; format=json', 'x-github-api-version-selected': '2022-11-28', 'Access-Control-Expose-Headers': 'ETag, Link, Location, Retry-After, X-GitHub-OTP, X-RateLimit-Limit, X-RateLimit-Remaining, X-RateLimit-Used, X-RateLimit-Resource, X-RateLimit-Reset, X-OAuth-Scopes, X-Accepted-OAuth-Scopes, X-Poll-Interval, X-GitHub-Media-Type, X-GitHub-SSO, X-GitHub-Request-Id, Deprecation, Sunset', 'Access-Control-Allow-Origin': '*', 'Strict-Transport-Security': 'max-age=31536000; includeSubdomains; preload', 'X-Frame-Options': 'deny', 'X-Content-Type-Options': 'nosniff', 'X-XSS-Protection': '0', 'Referrer-Policy': 'origin-when-cross-origin, strict-origin-when-cross-origin', 'Content-Security-Policy': 'default-src \'none\'', 'Content-Encoding': 'gzip', 'Server': 'github.com', 'Accept-Ranges': 'bytes', 'X-RateLimit-Limit': '60', 'X-RateLimit-Remaining': '44', 'X-RateLimit-Reset': '1767642093', 'X-RateLimit-Resource': 'core', 'X-RateLimit-Used': '16', 'Content-Length': '510', 'X-GitHub-Request-Id': 'D642:1DE21:39B4FD:430C82:695C0FBF'}

Encoding: utf-8

Elapsed Time: 0:00:00.139498

Is OK: True

POST Response: {

```
  "args": {},
  "data": "",
  "files": {},
  "form": {
    "password": "test123",
    "username": "test"
  },
  "headers": {
    "Accept": "*/*",
    "Accept-Encoding": "gzip, deflate, br",
    "Content-Length": "30",
    "Content-Type": "application/x-www-form-urlencoded",
    "Host": "httpbin.org",
```

```

    "User-Agent": "python-requests/2.32.3",
    "X-Amzn-Trace-Id": "Root=1-695c0fc0-69b5c8207dc5e1eb1d91384f"
  },
  "json": null,
  "origin": "205.254.163.177",
  "url": "https://httpbin.org/post"
}

```

Auth Status Code: 401

```

/opt/anaconda3/lib/python3.13/site-packages/urllib3/connectionpool.py:1097:
InsecureRequestWarning: Unverified HTTPS request is being made to host 'expir
ed.badssl.com'. Adding certificate verification is strongly advised. See: h
ttps://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
warnings.warn(

```

SSL Bypass Status: 200

```

Session Cookies: {
  "cookies": {}
}

```

```

Out[33]: '\n-----\n### CONCLUSION\n-----
-----\nThe Requests library provides a clean and efficient way to commun
icate\nwith web servers. It simplifies HTTP operations, supports APIs,\nhan
dles authentication and errors, and is widely used in\nweb scraping and bac
kend development.\n'

```

3. Scrapy – Command Line Tools

```

In [32]: """
Prerequisite: Implementing Web Scraping in Python with Scrapy

Scrapy is a Python library used for web scraping and web crawling.
It uses Spiders to crawl web pages and extract data using selectors.
Scrapy is powerful, fast, and suitable for large-scale scraping tasks.
"""

"""
-----
### About Scrapy Spiders
-----
- Spiders crawl websites automatically
- They extract data using CSS/XPath selectors
- Can follow links and scrape multiple pages
- Ideal for structured and large-scale scraping
"""

"""
-----
### Creating a Scrapy Project
-----
Before starting:
1. Make sure Python is installed
2. Create and activate a virtual environment
3. Install Scrapy inside the virtual environment
"""

```

Virtual Environment Setup (Terminal Commands)

These commands should be run in terminal / command prompt

```
# python --version
# python -m venv scrapy_env
# cd scrapy_env
# cd Scripts
# activate
# cd ..
```

Install Scrapy and Create Project

```
# pip install scrapy
# scrapy startproject MyScrapyProject
```

Create a Spider

Change directory to project folder and generate spider

```
# cd MyScrapyProject
# scrapy genspider quotes_spider https://quotes.toscrape.com/
```

Scrapy Command-Line Help

```
# scrapy -h
# scrapy <command> -h
```

Important Scrapy Commands

```
bench      : Tests Scrapy performance on system
check      : Checks spider contracts
crawl      : Runs the spider and crawls data
edit       : Edits spider file
genspider  : Creates a new spider
version    : Displays Scrapy version
```

```

view      : Opens response body in browser
list      : Lists all available spiders
parse     : Parses a URL using spider
settings  : Displays Scrapy settings
"""

"""

-----
### Examples of Scrapy Commands
-----
"""

# scrapy bench
# scrapy check quotes_spider
# scrapy crawl quotes_spider
# scrapy version
# scrapy view https://quotes.toscrape.com/
# scrapy list

"""

-----
### Custom Commands in Scrapy
-----

Scrapy allows creating custom command-line tools.
Custom commands are defined inside a commands folder.
"""

"""

-----
### Configure Custom Commands
-----

Add the following line in settings.py
"""

# COMMANDS_MODULE = 'MyScrapyProject.commands'

"""

-----
### Create Custom Command File
-----

File path:
MyScrapyProject/commands/customcrawl.py
"""

"""

-----
### Custom Command Code
-----
"""

from scrapy.commands import ScrapyCommand

```

```

class Command(ScrapyCommand):

    # Indicates that the Scrapy project is required
    requires_project = True

    # Syntax of the custom command
    def syntax(self):
        return '[options]'

    # Short description of the command
    def short_desc(self):
        return 'Runs the spider using a custom command'

    # Main execution logic
    def run(self, args, opts):
        spider_list = self.crawler_process.spiders.list()
        self.crawler_process.crawl(spider_list[0], **opts.__dict__)
        self.crawler_process.start()

"""

#####

### CONCLUSION

#####

Scrapy command-line tools provide powerful control over web scraping tasks.
They allow creating projects, managing spiders, crawling data, and building
custom commands. Scrapy is well-suited for scalable, automated, and
production-level web scraping projects.
"""

```

```

-----
NameError                                Traceback (most recent call last)
Cell In[32], line 160
    153         return 'Runs the spider using a custom command'
    155     # Main execution logic
    156 #     def run(self, args, opts):
    157 #         spider_list = self.crawler_process.spiders.list()
    158 #         self.crawler_process.crawl(spider_list[0], **opts.__dict__)
    159 #         self.crawler_process.start() You can remove the comments to
use this files.
--> 160 Regards,
    163 """
    164 -----
    165 ### CONCLUSION
    (...)
    170 production-level web scraping projects.
    171 """

NameError: name 'Regards' is not defined

```

4. Selenium – Components, Uses and Limitations

```

In [20]: """
Selenium is a widely used open-source tool for automating web browsers.

```

It is primarily used for testing web-based applications and is highly preferred for cross-browser testing and web automation.

"""

"""

Selenium Features

- Cross-browser testing support
- Multi-language compatibility
- Easy interaction with web elements
- Faster performance compared to many tools
- Supports dynamic web elements
- Open-source and free to use
- Platform independent (Windows, macOS, Linux)
- Code reusability

"""

"""

Selenium Components

Selenium consists of four major components:

1. Selenium IDE
2. Selenium RC (Remote Control)
3. Selenium WebDriver
4. Selenium Grid

"""

"""

1. Selenium IDE

Selenium IDE is a record-and-playback tool used for quick test creation.

Key Features:

- Record user interactions with web applications
- Playback recorded test cases
- Supports multiple browsers
- Inspect and identify web elements
- Debug test cases step-by-step
- Export tests to languages like Python, Java, C#

"""

"""

2. Selenium RC (Remote Control)

Selenium RC was an early Selenium tool that allowed writing tests in multiple programming languages using a server as an intermediary.

Limitations of Selenium RC:

- Slower execution due to server dependency
- Complex API
- Less support for modern web technologies

WebDriver replaced Selenium RC due to better performance and simplicity.

3. Selenium WebDriver

Selenium WebDriver is the most widely used Selenium component.

Key Features:

- Direct communication with browsers
- No need for an intermediary server
- Faster and more stable execution
- Supports modern web technologies
- Rich APIs for browser actions
- Supports parallel execution

4. Selenium Grid

Selenium Grid allows running tests on multiple machines and browsers.

Key Benefits:

- Parallel execution of tests
- Supports multiple browsers and operating systems
- Central hub manages test execution
- Reduces overall testing time

Applications of Selenium

- Automated Web Application Testing
- Cross-Browser Compatibility Testing
- Web Scraping of dynamic websites
- CI/CD Pipeline Integration (Jenkins, GitHub Actions)
- Functional Testing of web applications

Limitations of Selenium

- Cross-browser behavior differences
- Slow execution for large applications
- Difficulty handling dynamic web elements
- No direct support for mobile app testing
- Limited support for desktop applications

CONCLUSION

```
-----
Selenium is a powerful and widely used automation tool for web applications.
It is best suited for browser-based testing and automation tasks. However,
it has limitations when dealing with dynamic elements, mobile apps, and
desktop applications. Understanding its strengths and limitations helps
in choosing the right tool for automation needs.
"""
```

```
Out[20]: '\n-----\n### CONCLUSION\n-----\nSelenium is a powerful and widely used automation tool for web ap
plications.\nIt is best suited for browser-based testing and automation tas
ks. However,\nit has limitations when dealing with dynamic elements, mobile
apps, and\ndesktop applications. Understanding its strengths and limitation
s helps\nin choosing the right tool for automation needs.\n'
```

5. Scrape the Web with Playwright in Python

```
In [31]: """
Playwright is a modern web testing and automation framework developed by Mic
It is faster, more reliable, and easier to use compared to Selenium. Playwri
supports Chromium, Firefox, and WebKit using a single API and is designed fo
cross-browser web automation.
"""

"""

-----
### Features of Playwright
-----

- Headless execution
- Auto-wait for elements
- Network interception
- Mobile device emulation
- Geolocation and permission handling
- Shadow DOM support
- Screenshots, video, and HAR capture
- Isolated browser contexts
- Parallel execution
"""

"""

-----
### Advantages of Playwright
-----

- Cross-browser execution
- Open-source framework
- Well-documented
- Parallel test execution
- API testing support
- Context isolation
- Python language support
"""

"""

-----
### Creating a Python Virtual Environment
-----
```

Recommended to isolate dependencies using a virtual environment.
Run the following commands in terminal.

```
# virtualenv venv
# venv/Scripts/activate
```

Installing and Setting Up Playwright

```
# pip install playwright
# playwright install
```

Automating and Scraping a Webpage

Target Website: <https://quotes.toscrape.com/>

Playwright Code Implementation

Scrapes quotes and authors from the webpage

```
from playwright.sync_api import sync_playwright
```

```
def main():
    with sync_playwright() as p:
        browser = p.chromium.launch(headless=False)
        page = browser.new_page()
        page.goto('https://quotes.toscrape.com/')

        all_quotes = page.query_selector_all('.quote')

        for quote in all_quotes:
            text = quote.query_selector('.text').inner_text()
            author = quote.query_selector('.author').inner_text()
            print({'Author': author, 'Quote': text})

        page.wait_for_timeout(10000)
        browser.close()
```

```
# if __name__ == '__main__':
    # main() --- You can remove the comments "#" to run this code. regards,
```

"""

CONCLUSION

Playwright is a powerful and modern automation framework that simplifies web scraping and testing. With its speed, reliability, and cross-browser support, it is an excellent alternative to Selenium for handling dynamic websites.

"""

```
File <string>:92
  if __name__ == '__main__':
      ^
```

IndentationError: unindent does not match any outer indentation level

```
In [28]: import pandas as pd
from tabulate import tabulate

data = [
    {"Tool": "Requests", "Best For": "APIs, static websites", "Strengths": "Fast, lightweight, simple", "Limitations": "No JavaScript support"},
    {"Tool": "BeautifulSoup", "Best For": "HTML/XML parsing", "Strengths": "Beginner-friendly, clean parsing", "Limitations": "Not for dynamic websites or large-scale scraping"},
    {"Tool": "Scrapy", "Best For": "Large-scale web crawling", "Strengths": "High performance, asynchronous, scalable", "Limitations": "Steep learning curve, JS needs extra setup"},
    {"Tool": "Selenium", "Best For": "Dynamic websites, UI automation", "Strengths": "Simulates real user behavior", "Limitations": "Slow, resource-intensive"},
    {"Tool": "Playwright", "Best For": "Modern JavaScript-heavy websites", "Strengths": "Fast, reliable, auto-wait, cross-browser", "Limitations": "High system usage, overkill for static sites"}
]

df = pd.DataFrame(data)

print(tabulate(df, headers="keys", tablefmt="grid", showindex=False))
```

| Tool | Best For | Strengths | Limitations |
|---------------|----------------------------------|--|--|
| Requests | APIs, static websites | Fast, lightweight, simple | No JavaScript support |
| BeautifulSoup | HTML/XML parsing | Beginner-friendly, clean parsing | Not for dynamic websites or large-scale scraping |
| Scrapy | Large-scale web crawling | High performance, asynchronous, scalable | Steep learning curve, JS needs extra setup |
| Selenium | Dynamic websites, UI automation | Simulates real user behavior | Slow, resource-intensive |
| Playwright | Modern JavaScript-heavy websites | Fast, reliable, auto-wait, cross-browser | High system usage, overkill for static sites |