

NHẬP MÔN LẬP TRÌNH (Introduction to Programming)

Chapter 7 – Algorithm with Python (Lesson 1 – Thinking in Algorithm ...)

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Programming

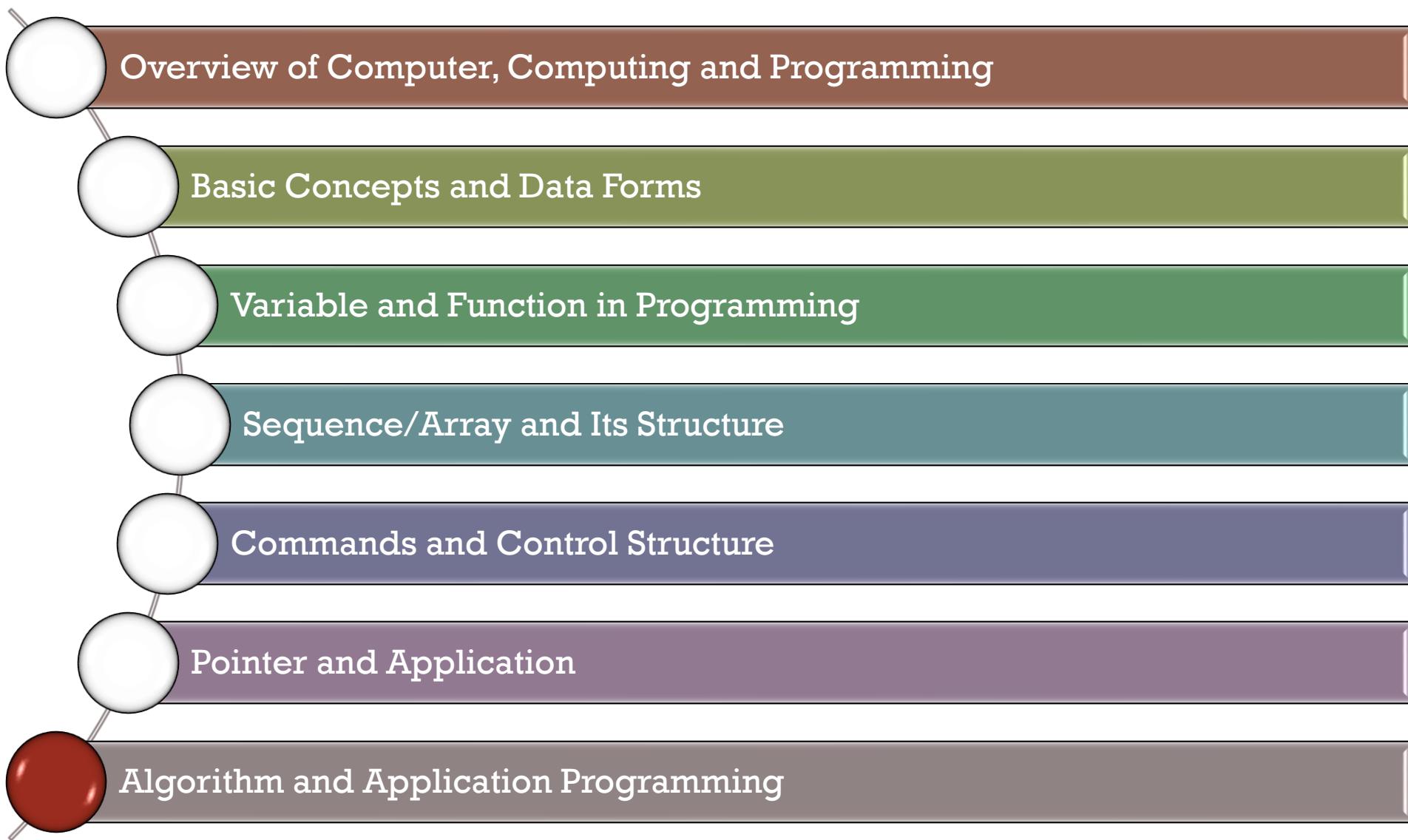
Hamilton was a self-taught programmer, working in the US in the 1960's. Owing to the success of her previous work, Hamilton was the first programmer to be hired for the Apollo project. She became the Director of Software Engineering at the MIT Instrumentation lab. Her lab developed the on-board flight software for NASA's Apollo space project, which took humankind to the moon.

The achievement was a monumental task at a time when computer technology was in its infancy: The astronauts had access to only 72 kilobytes of computer memory (a 256-gigabyte cell phone today carries almost a million times more storage space). Programmers had to use paper punch cards to feed information into room-sized computers with no screen interface.

Margaret Hamilton, NASA's lead software engineer for the Apollo, stands next to the code she wrote by hand that took humanity to the moon in 1969.



Outline



References

Main:

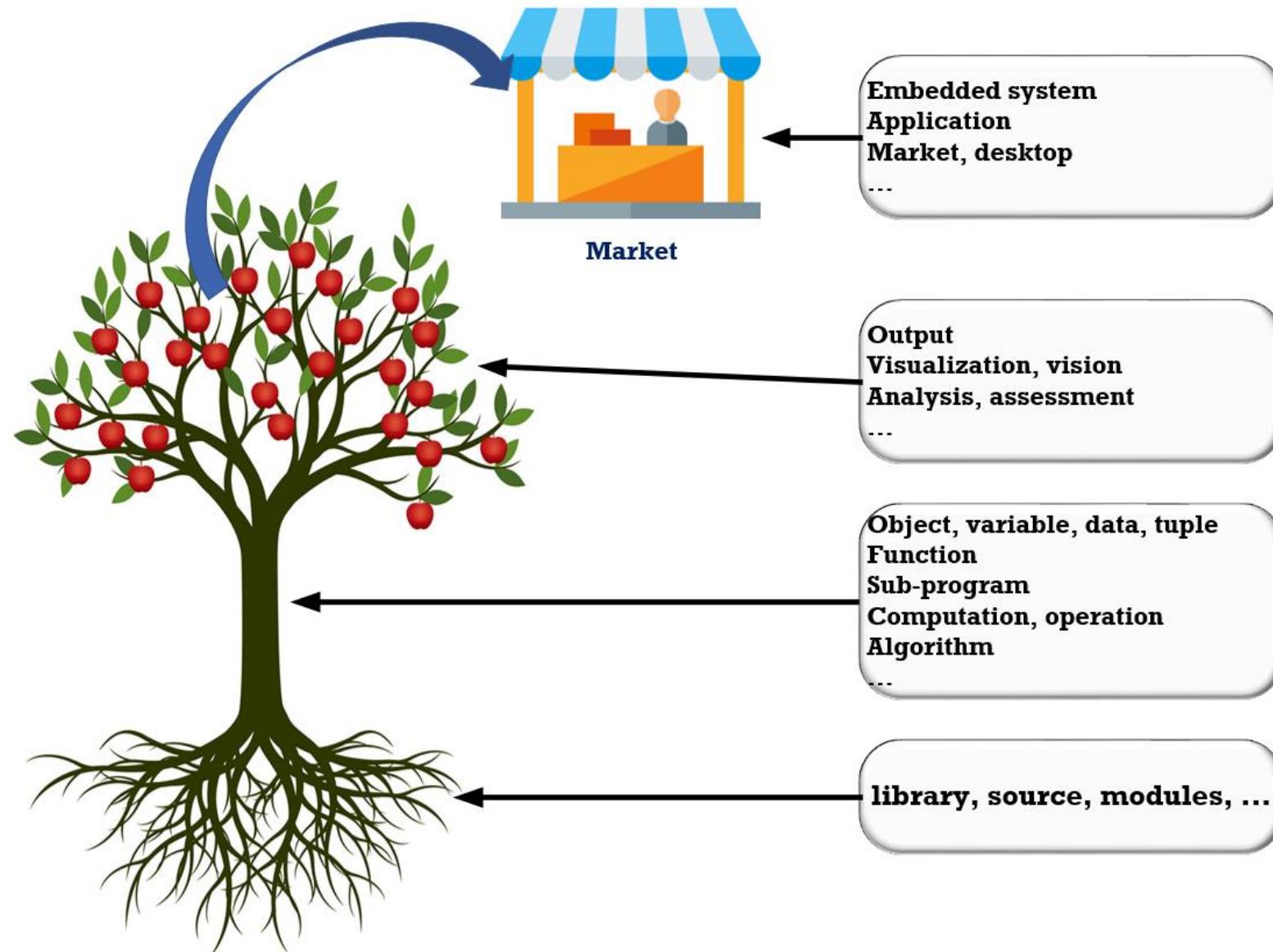
- Maurizio Gabbrielli and Simone Martini, 2010. *Programming Languages: Principles and Paradigms*, Springer.
- Cao Hoàng Trụ, 2004. *Ngôn ngữ lập trình- Các nguyên lý và mô hình*, Nhà xuất bản Đại học Quốc gia Tp. Hồ Chí Minh

More:

- Wes McKinney, 2013. *Python for Data Analysis*, O'Reilly Media.
- Guido van Rossum, Fred L. Drake, Jr.,, 2012. *The Python Library Reference*, Release 3.2.3.
- Slides here are collected and modified from several sources in Universities and Internet.

Computer programs

□ General structure:



Content of Chapter 7

1. What is algorithm? Thinking in algorithms
2. Data structure and Algorithms
3. Applications

Structure of Computer programs

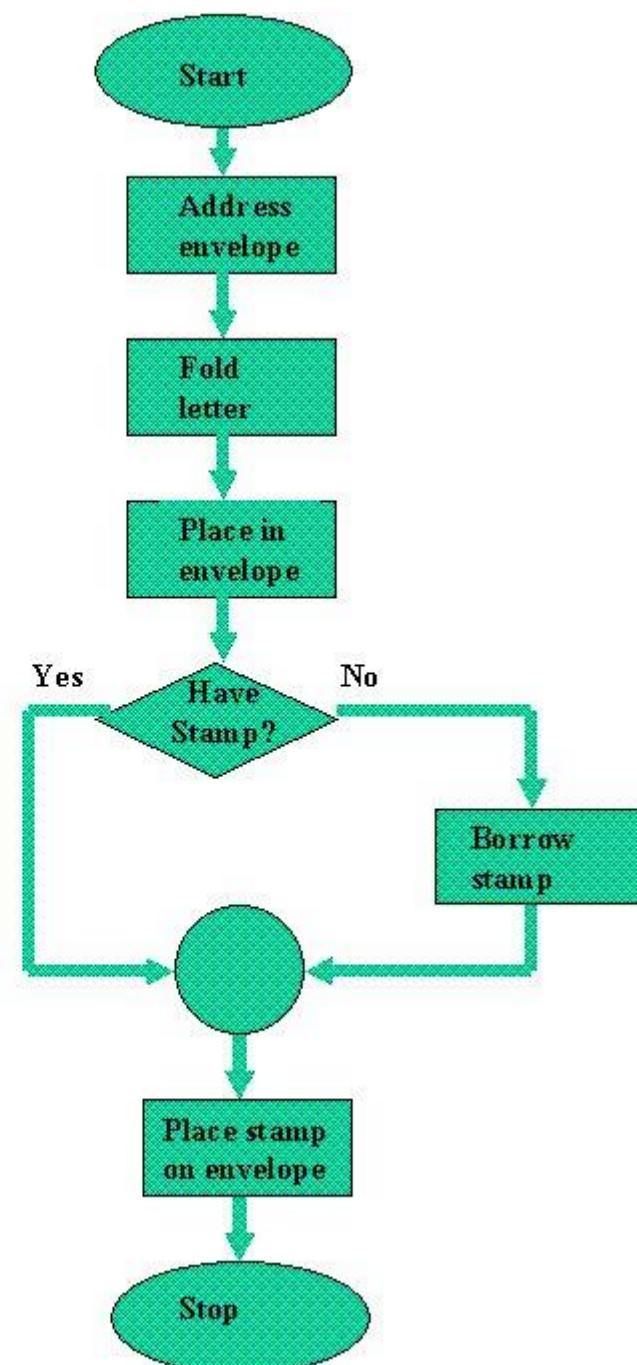
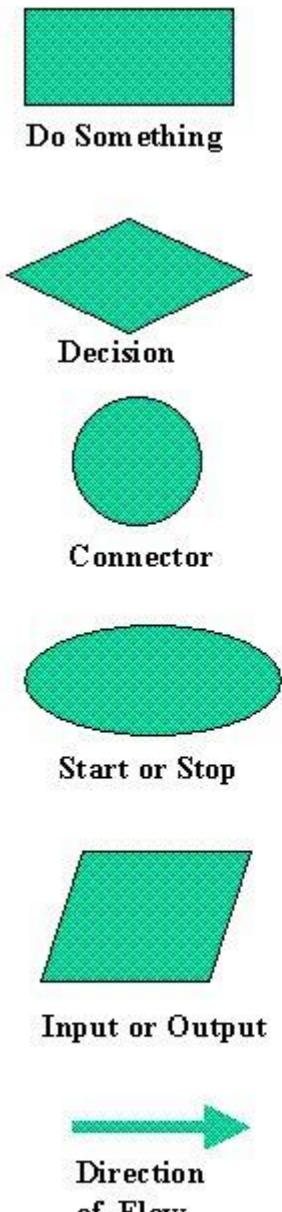
□ Python Programming Analysis:

- Objects
- Types: boolean, integer, float, string, complex
- Variables: global variables, local variables
- Methods, Calculation, Computations
- Classes, functions
- Sequences: list, tuples, set, dictionary
- Arrays: 1D array (vector), 2D array (matrix), n-D array ...

Structure of Computer programs

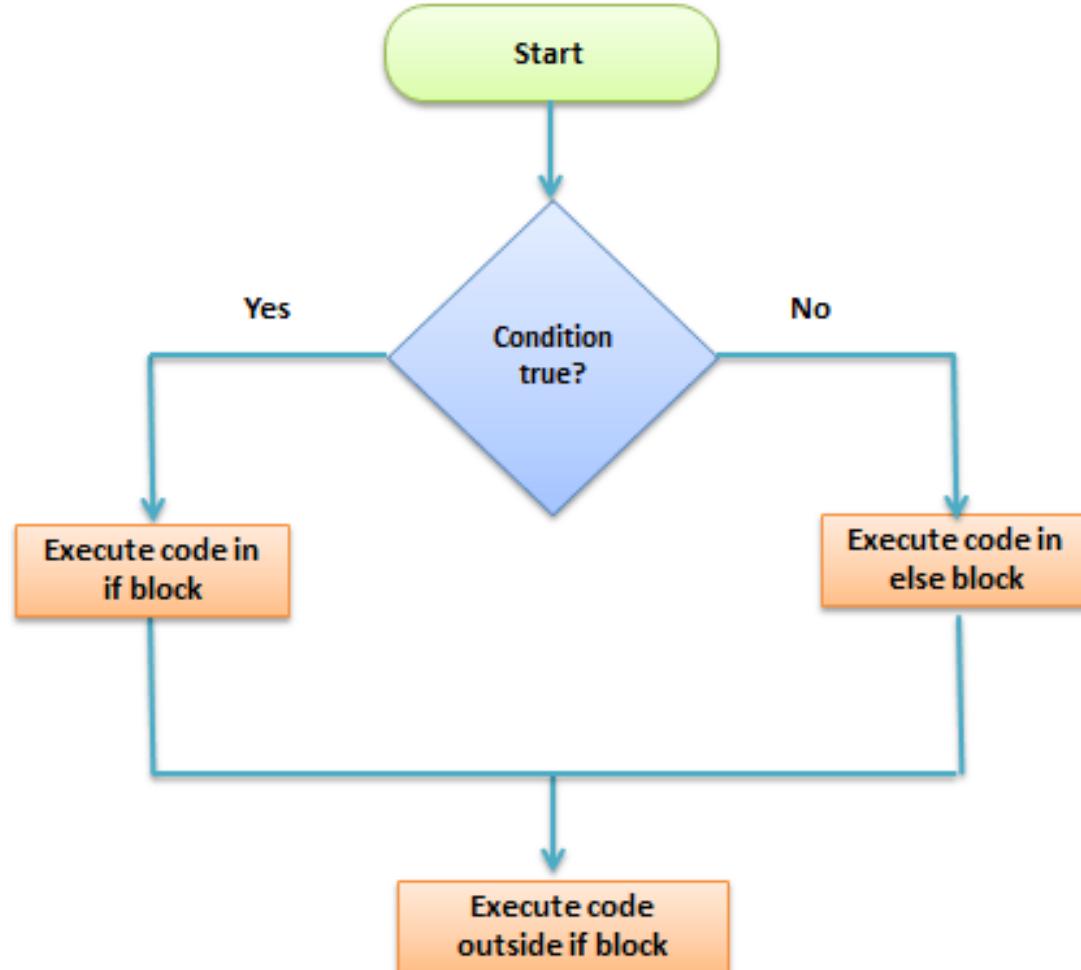
□ Computer programming:

- Modeling
- Data Reading-Writing-Updating-Deleting
- Flow charts, diagram, graph/figure ...

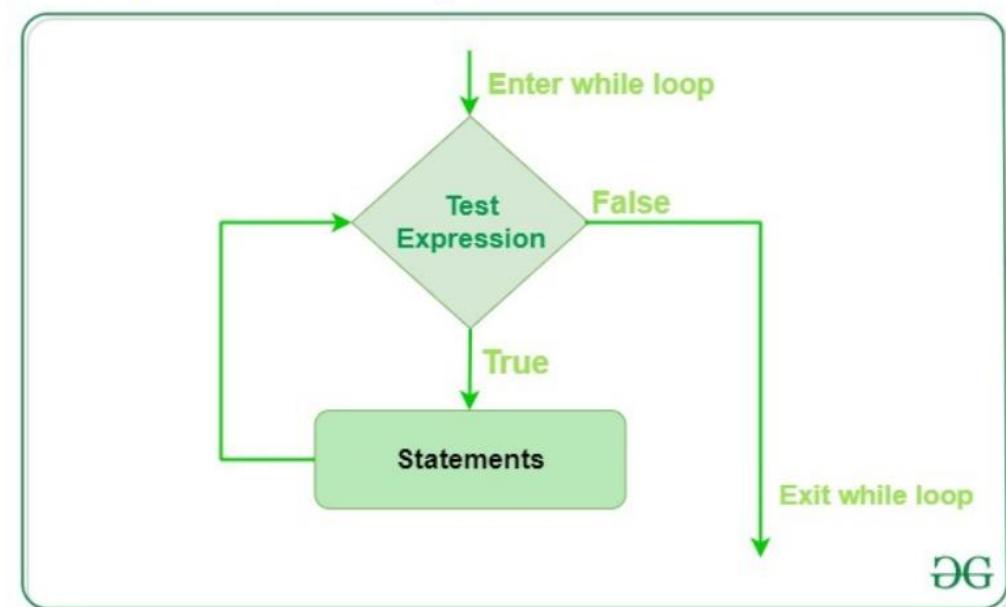


Python Command/Control/Statement

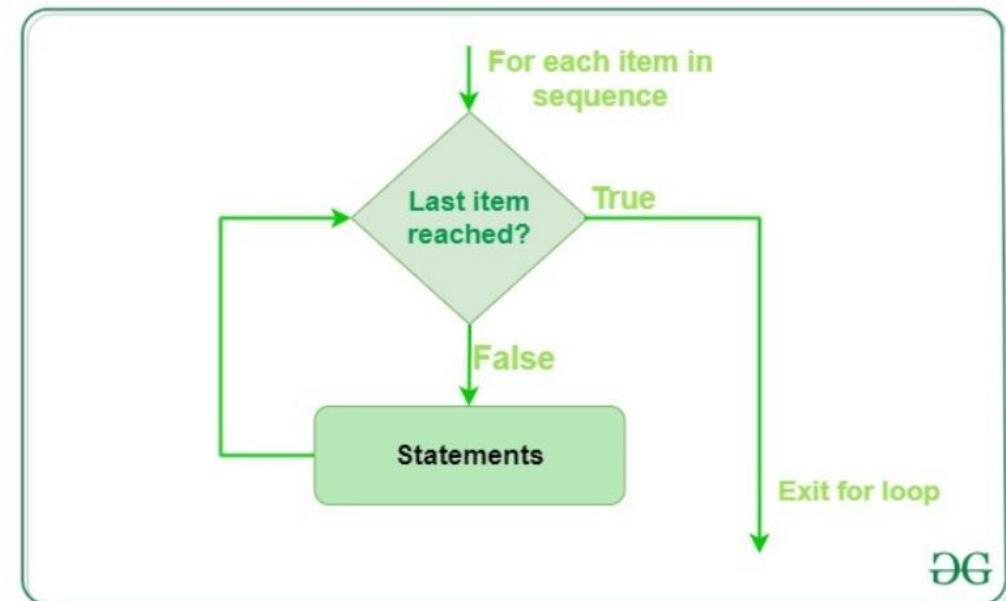
- For ... loop, While ... Loop, If/else ... statement



Flowchart of While Loop :

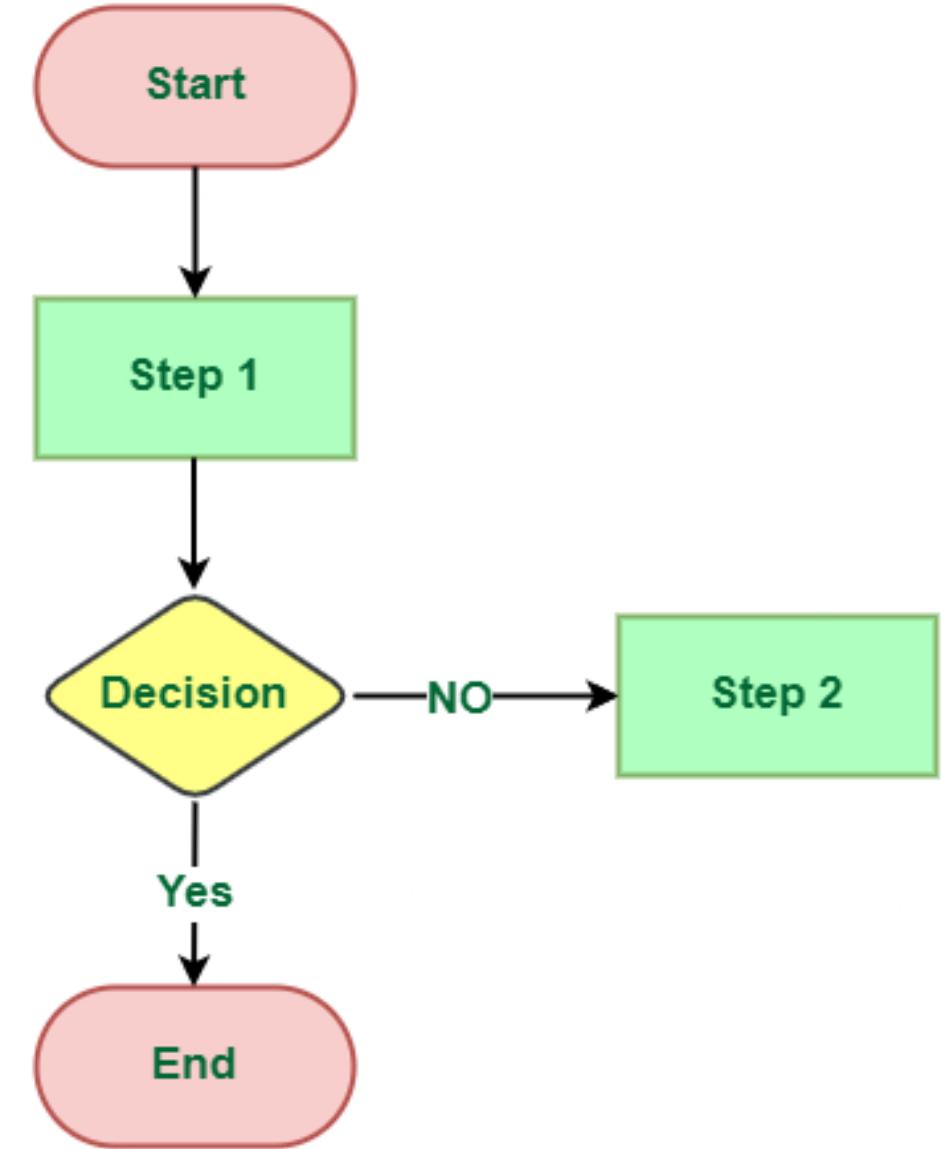


Flowchart of for loop



Python Programming

Algorithms



Python Algorithms

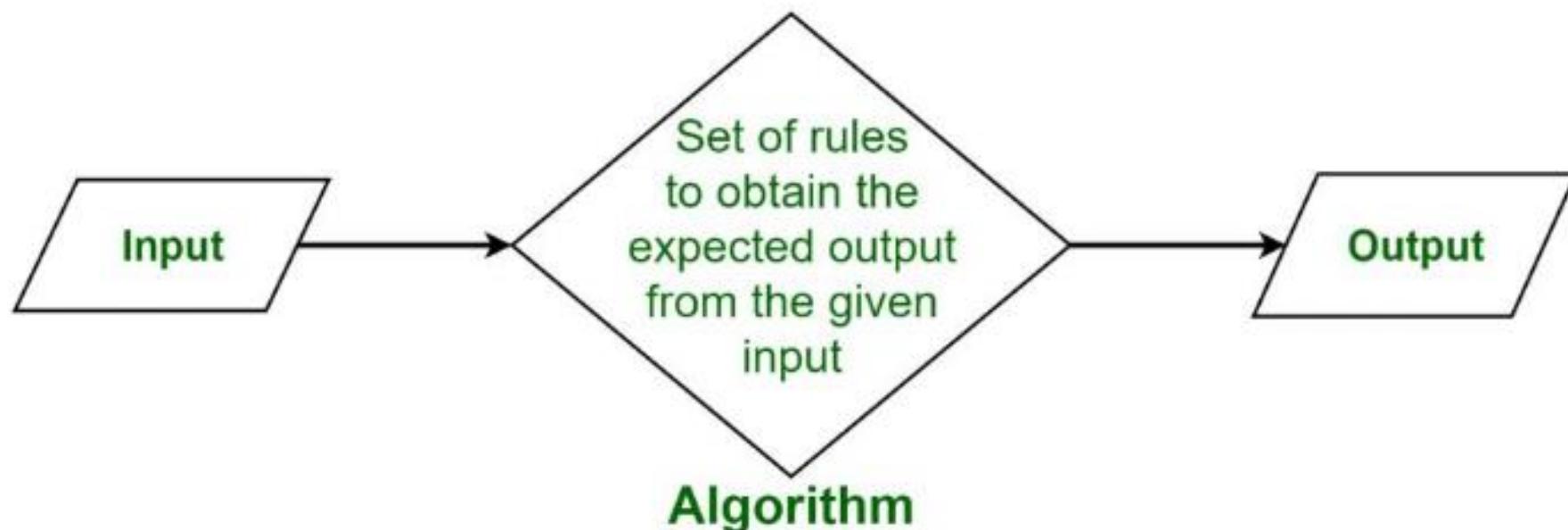
□ What is an algorithm?

- An algorithm is a procedure to accomplish a specific task. An algorithm is the idea behind any reasonable computer program.
- "A set of finite rules or instructions to be followed in calculations or other problem-solving operations ". "A procedure for solving a mathematical problem in a finite number of steps that frequently involves recursive operations".

Problem: Sorting

Input: A sequence of n keys a_1, \dots, a_n .

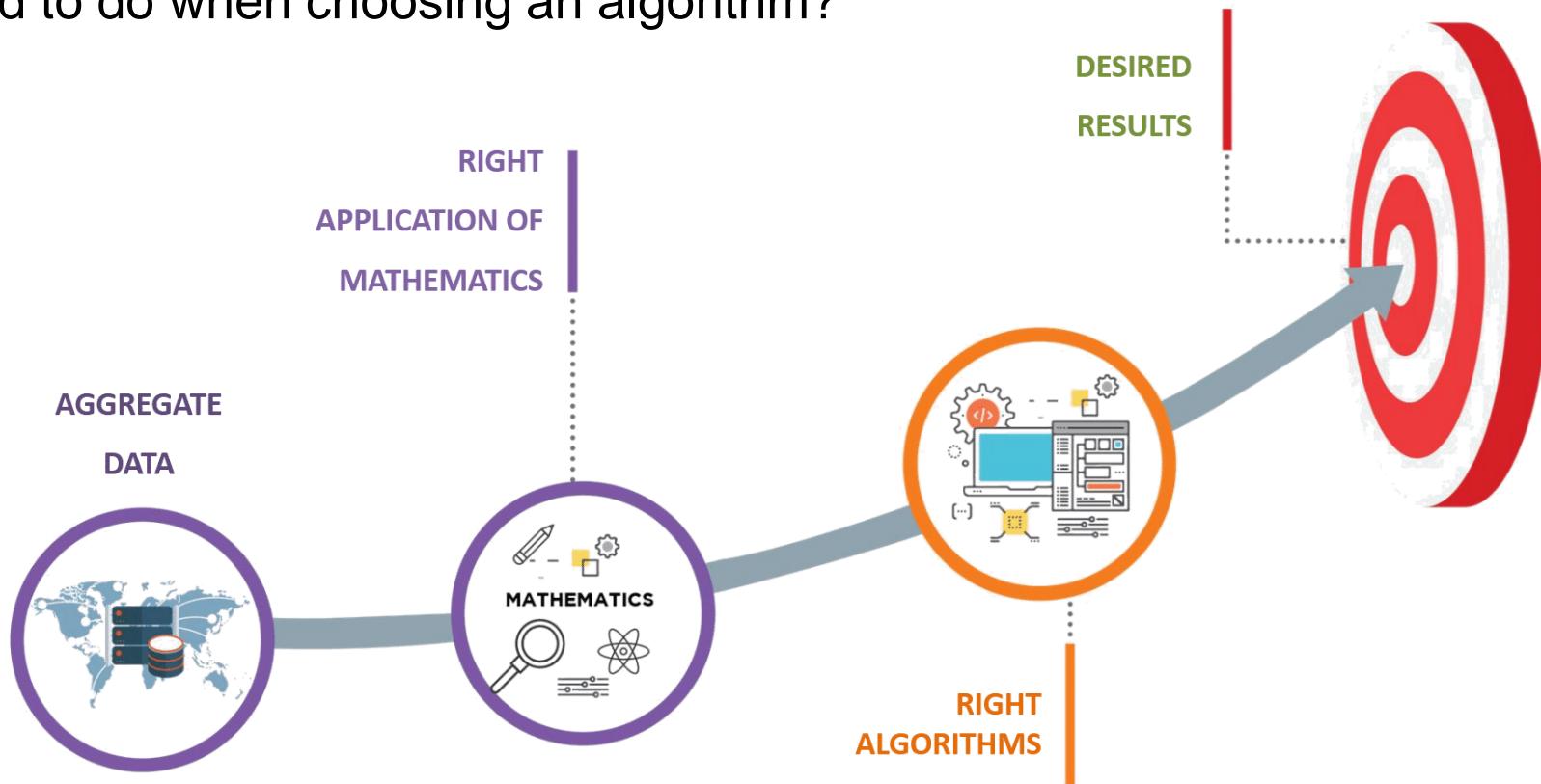
Output: The permutation (reordering) of the input sequence such that $a'_1 \leq a'_2 \leq \dots \leq a'_{n-1} \leq a'_n$.



Python Algorithms

❑ Thinking in Algorithms:

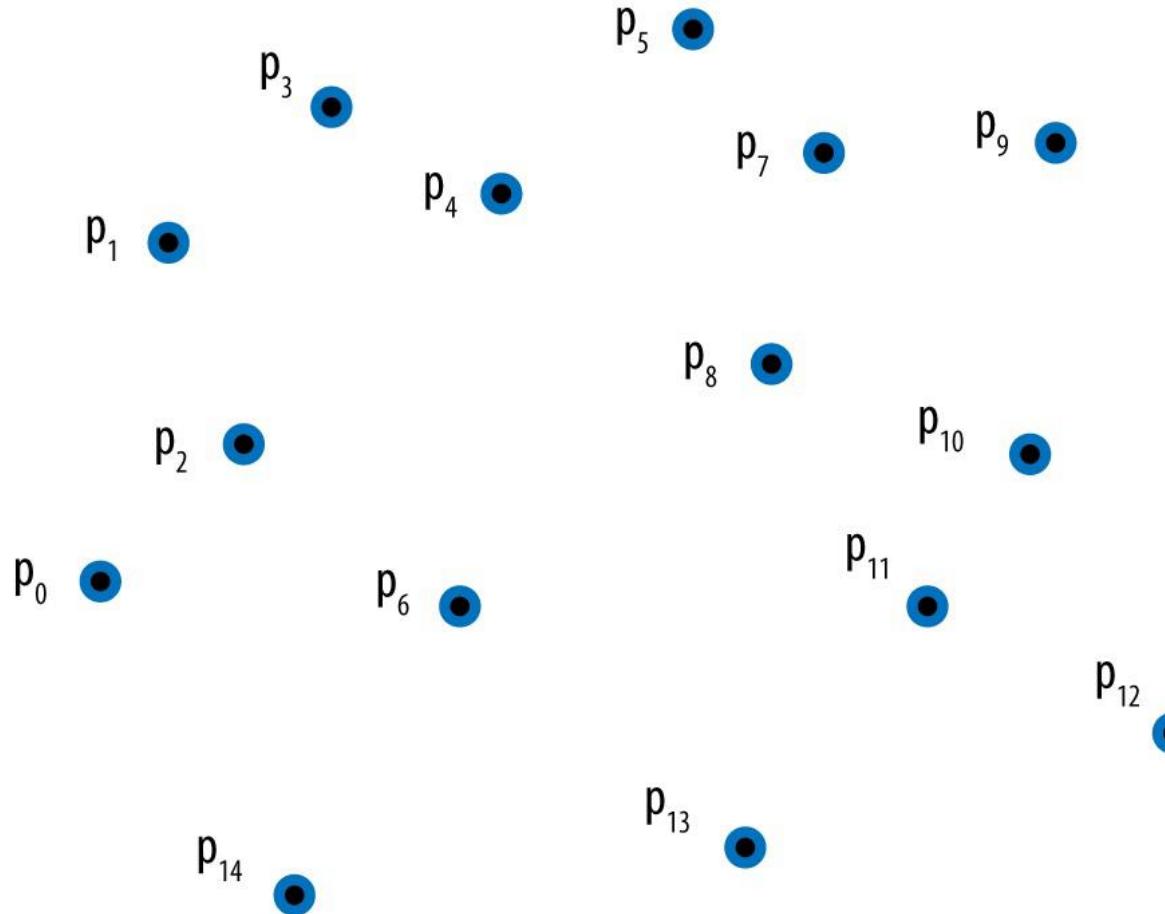
- Data structures have been tightly tied to algorithms since the dawn of computing.
- A number of general approaches used by algorithms to solve problems.
- What do you need to do when choosing an algorithm?



Python Algorithms

□ Thinking in Algorithms:

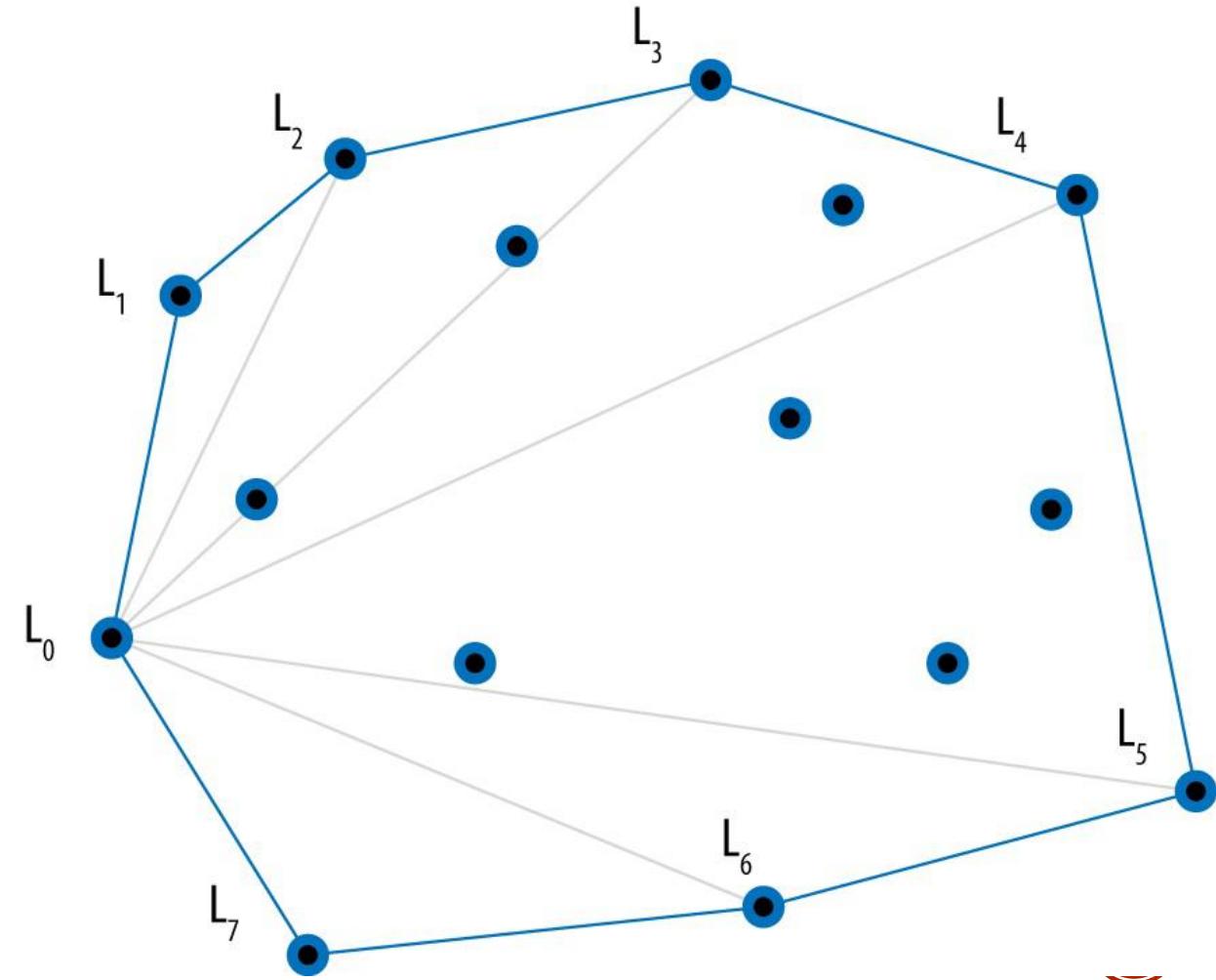
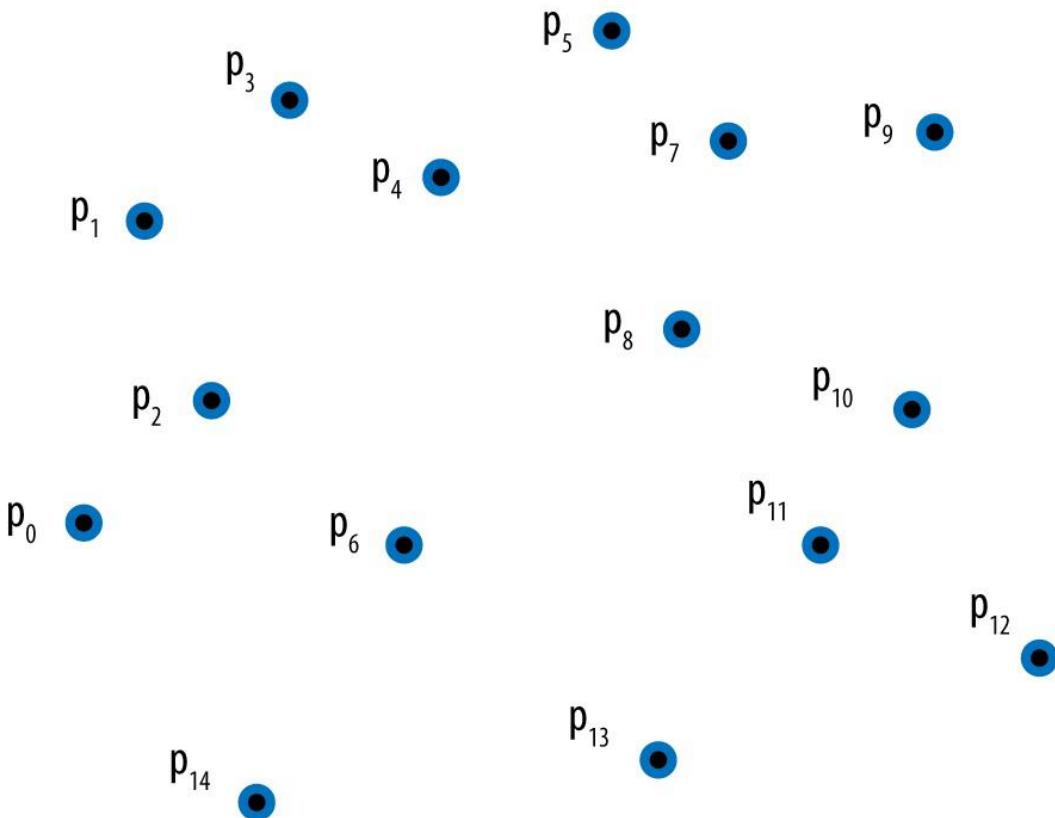
- The first step in designing an algorithm is to understand the problem you want to solve.
- Let's start with a sample problem from the field of computational geometry.



Python Algorithms

□ Thinking in Algorithms:

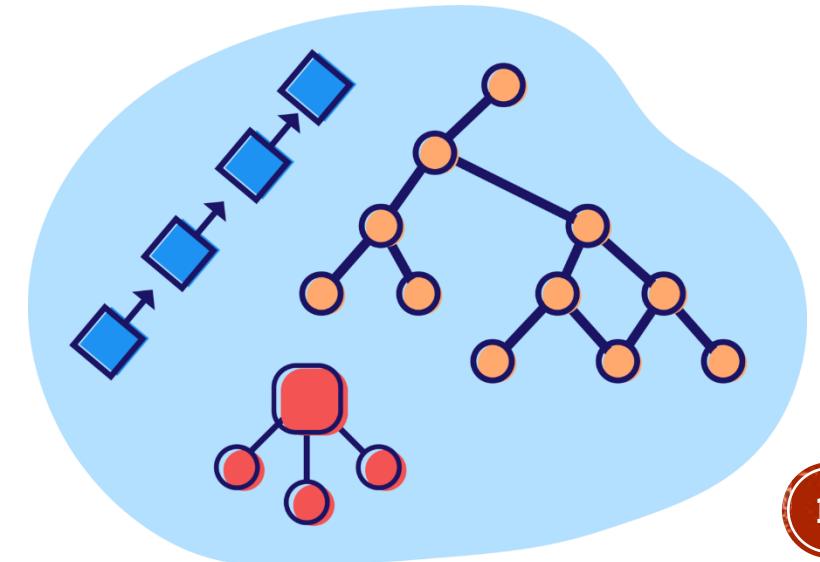
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Python Algorithms

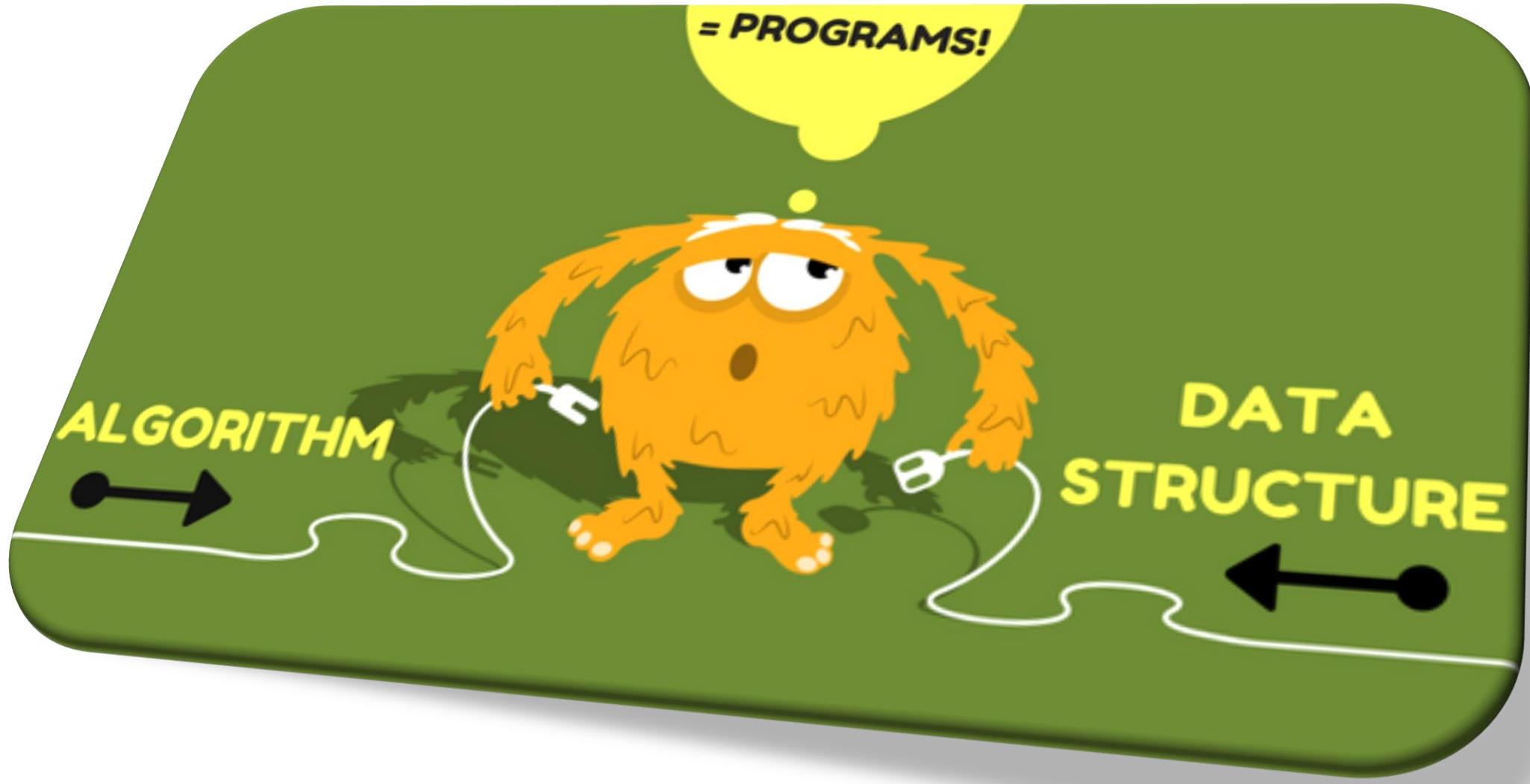
❑ Why Data Structures and Algorithms?

- This is for those who have just started learning algorithms and wondered how impactful it will be to boost their career/programming skills. It is also for those who wonder why big companies like Google, Facebook, and Amazon hire programmers who are exceptionally good at optimizing Algorithms.
 - **Programming is all about data structures and algorithms.** Data structures are used to hold data while algorithms are used to solve the problem using that data.
 - **Data structures and algorithms** (DSA) goes through solutions to standard problems in detail and gives you an insight into how efficient it is to use each one of them. It also teaches you the science of evaluating the efficiency of an algorithm. This enables you to choose the best of various choices.



Python Algorithms

□ Why Data Structures and Algorithms?



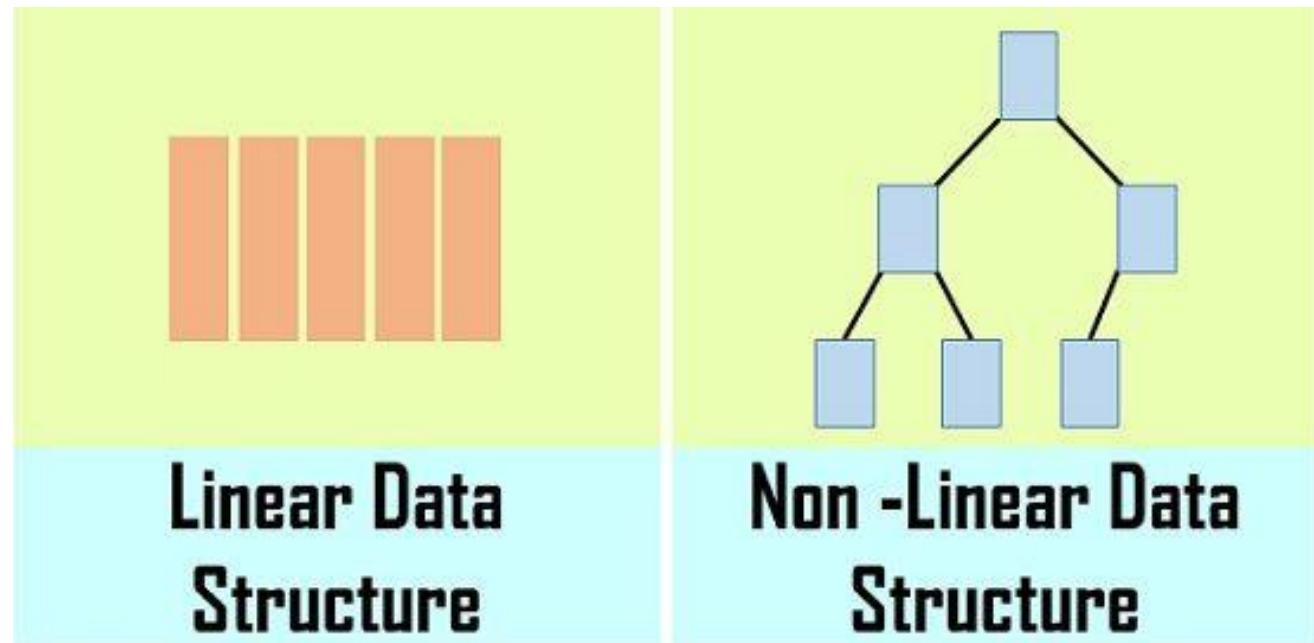
Python Algorithms

□ Data Structure and Types:

- Data structure is a storage that is used to store and organize data. It is a way of arranging data on a computer so that it can be accessed and updated efficiently.

Types of Data Structure. Basically, data structures are divided into two categories:

- Linear data structure
- Non-linear data structure



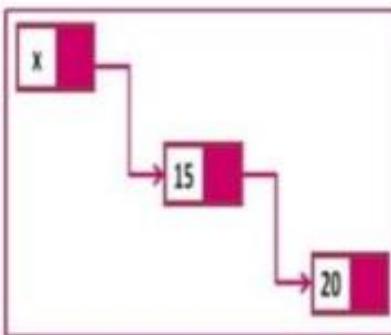
Python Algorithms

□ Data Structure and Types:

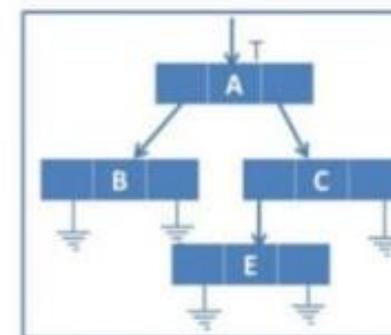
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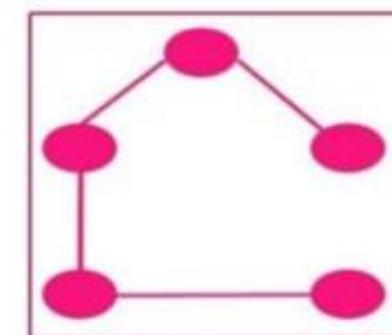
Sorting



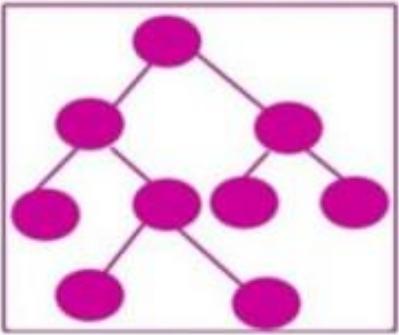
Link list



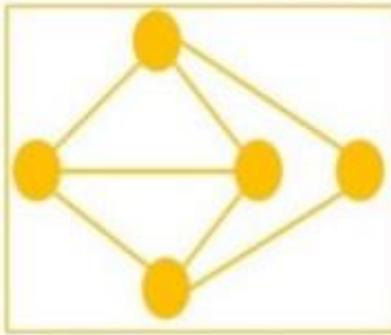
list



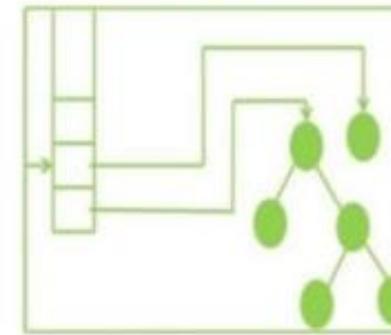
spanning tree



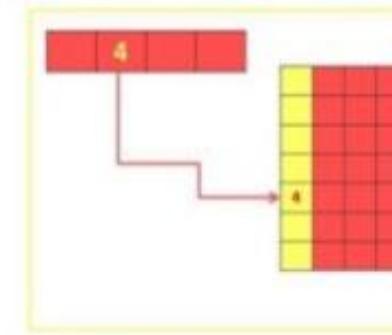
Tree



Graph



Stack

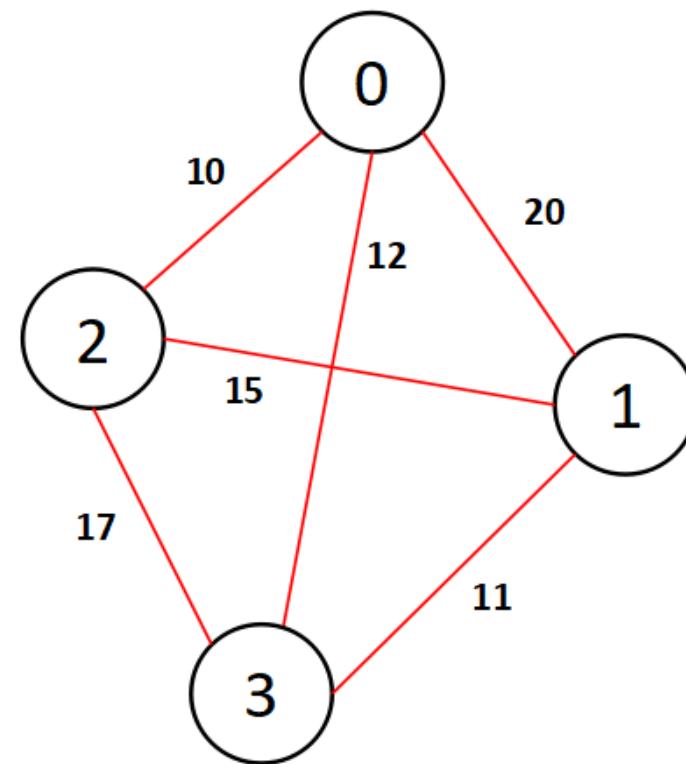
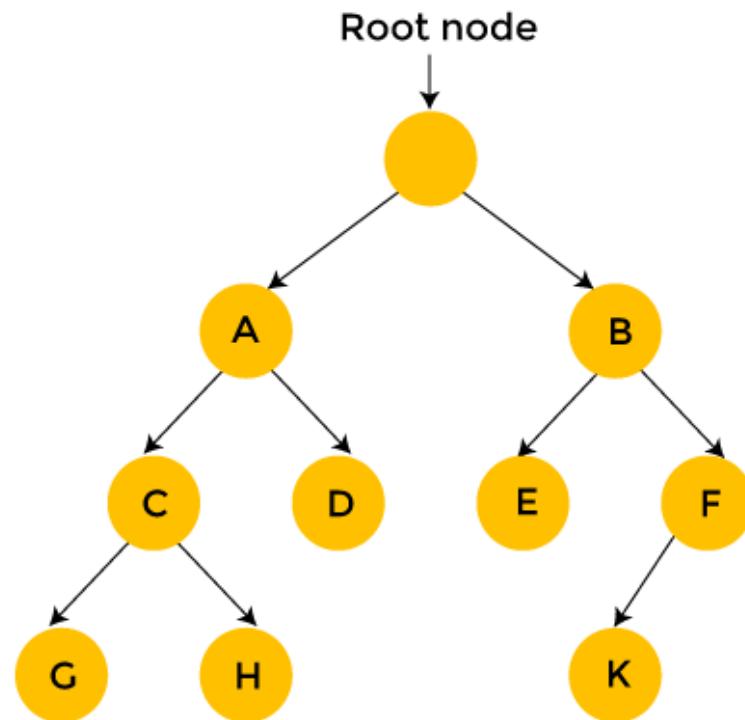


Hashing

Python Algorithms

□ Types of Algorithms:

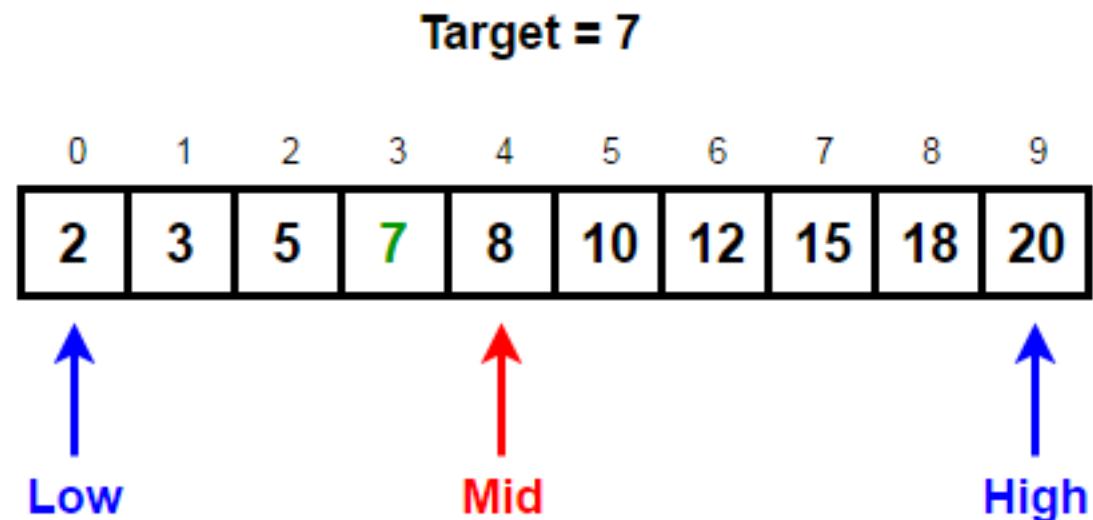
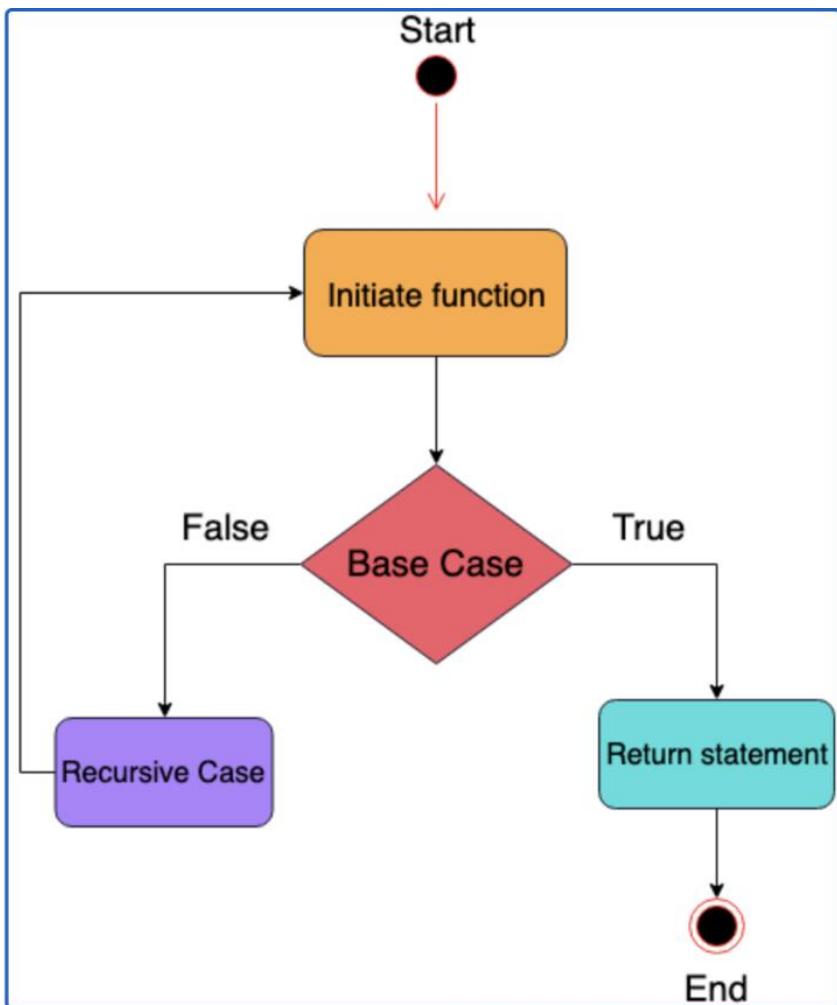
- **Brute Force Algorithm:** It is the simplest approach for a problem. A brute force algorithm is the first approach that comes to finding when we see a problem.



Python Algorithms

□ Types of Algorithms:

- **Recursive Algorithm:** A recursive algorithm is based on recursion. In this case, a problem is broken into several sub-parts and called the same function again and again.



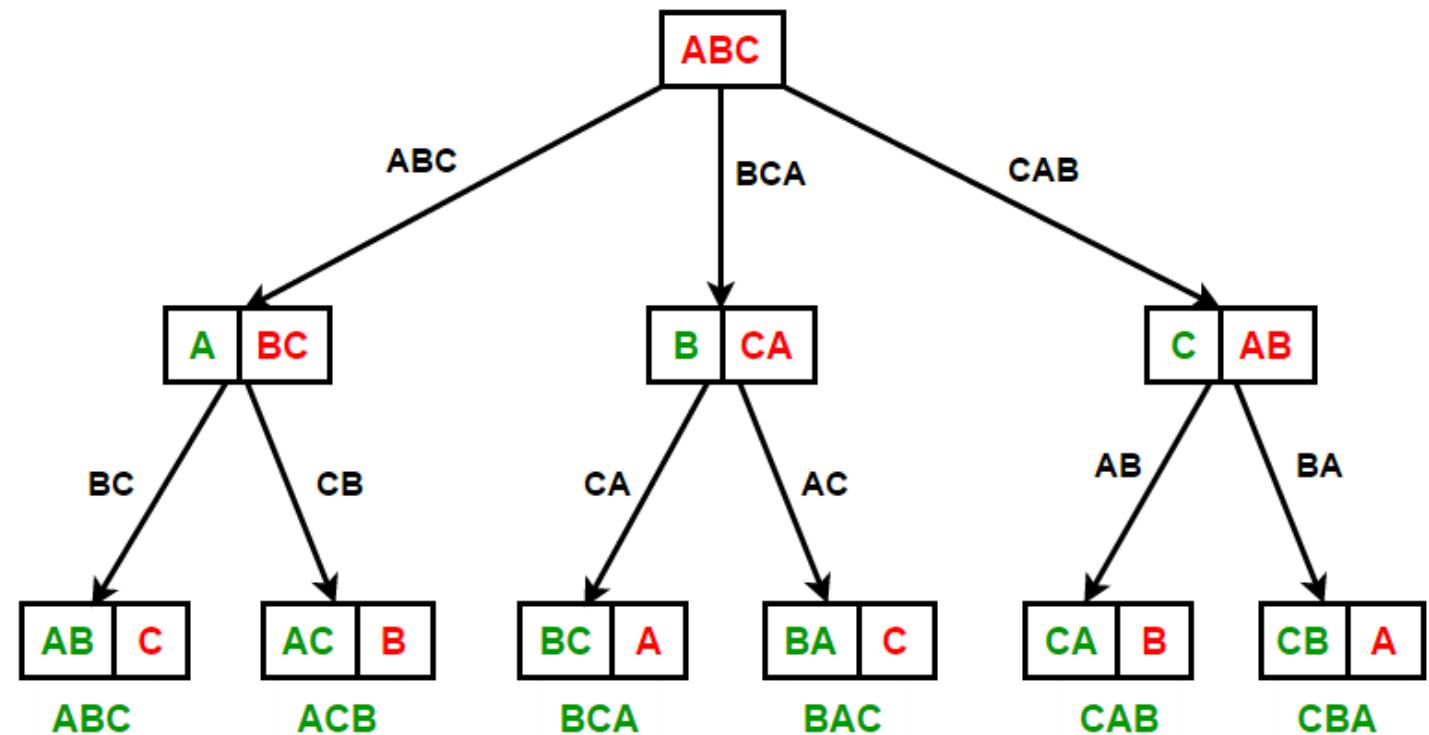
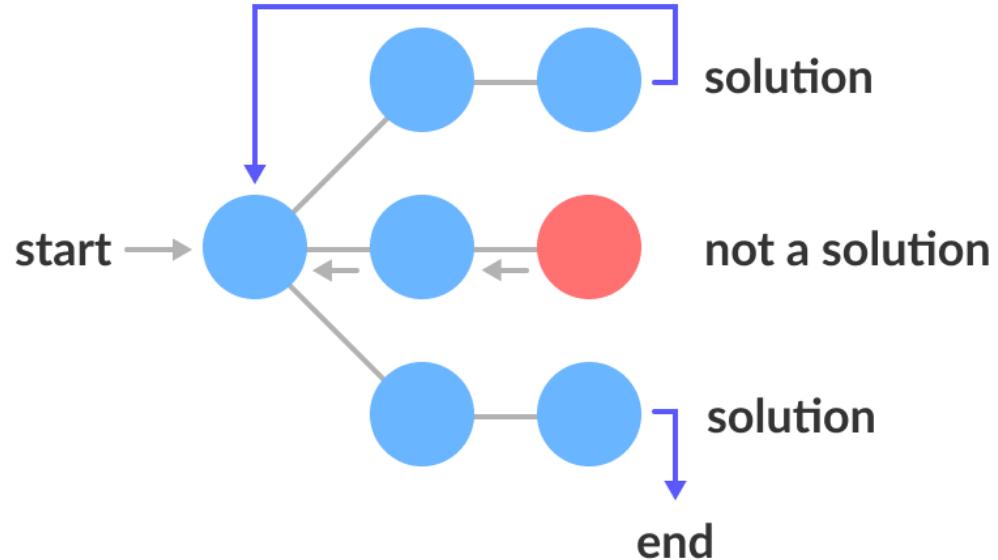
Since 8 (Mid) > 7 (target),
we discard the right half and go LEFT

New High = Mid - 1

Python Algorithms

□ Types of Algorithms:

- **Backtracking Algorithm:** The backtracking algorithm basically builds the solution by searching among all possible solutions. Using this algorithm, we keep on building the solution following criteria. Whenever a solution fails we trace back to the failure point and build on the next solution and continue this process till we find the solution or all possible solutions are looked after.



Recursion Tree for string "ABC"



Python Algorithms

□ Types of Algorithms:

- **Searching Algorithm:** Searching algorithms are the ones that are used for searching elements or groups of elements from a particular data structure. They can be of different types based on their approach or the data structure in which the element should be found.

5	4	3	2	1
---	---	---	---	---

searching for 3

5	4	3	2	1
---	---	---	---	---

5 === 3? No, next!

5	4	3	2	1
---	---	---	---	---

4 == 3? No, next!

5	4	3	2	1
---	---	---	---	---

3 == 3? Yes, found it!

EXAMPLE

A

Array of 10 Digits
[2,4,6,8,10,12,14,16,18,20]

Find: 18

First Iteration

Right = n

0	1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18	20

Array[mid] = (l+r) / 2

MID

Guru99.com

Second Iteration

C

5	6	7	8	9
12	14	16	18	20

The Lower Half of the array
is dropped because 18 is
greater than 10

1

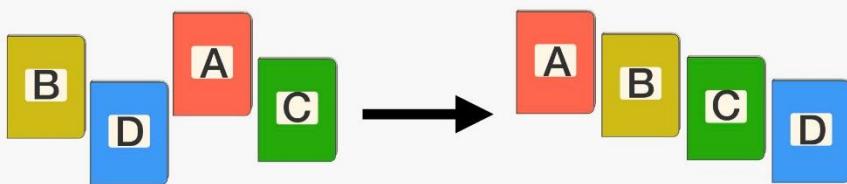
The iterations continue and data keeps on decreasing in same manner until **18** is found

Python Algorithms

□ Types of Algorithms:

- **Sorting Algorithm:** Sorting is arranging a group of data in a particular manner according to the requirement. The algorithms which help in performing this function are called sorting algorithms. Generally sorting algorithms are used to sort groups of data in an increasing or decreasing manner.

Sorting Algorithms



Unsorted Array

8	1	3	2	7	4
---	---	---	---	---	---

Sorted Array

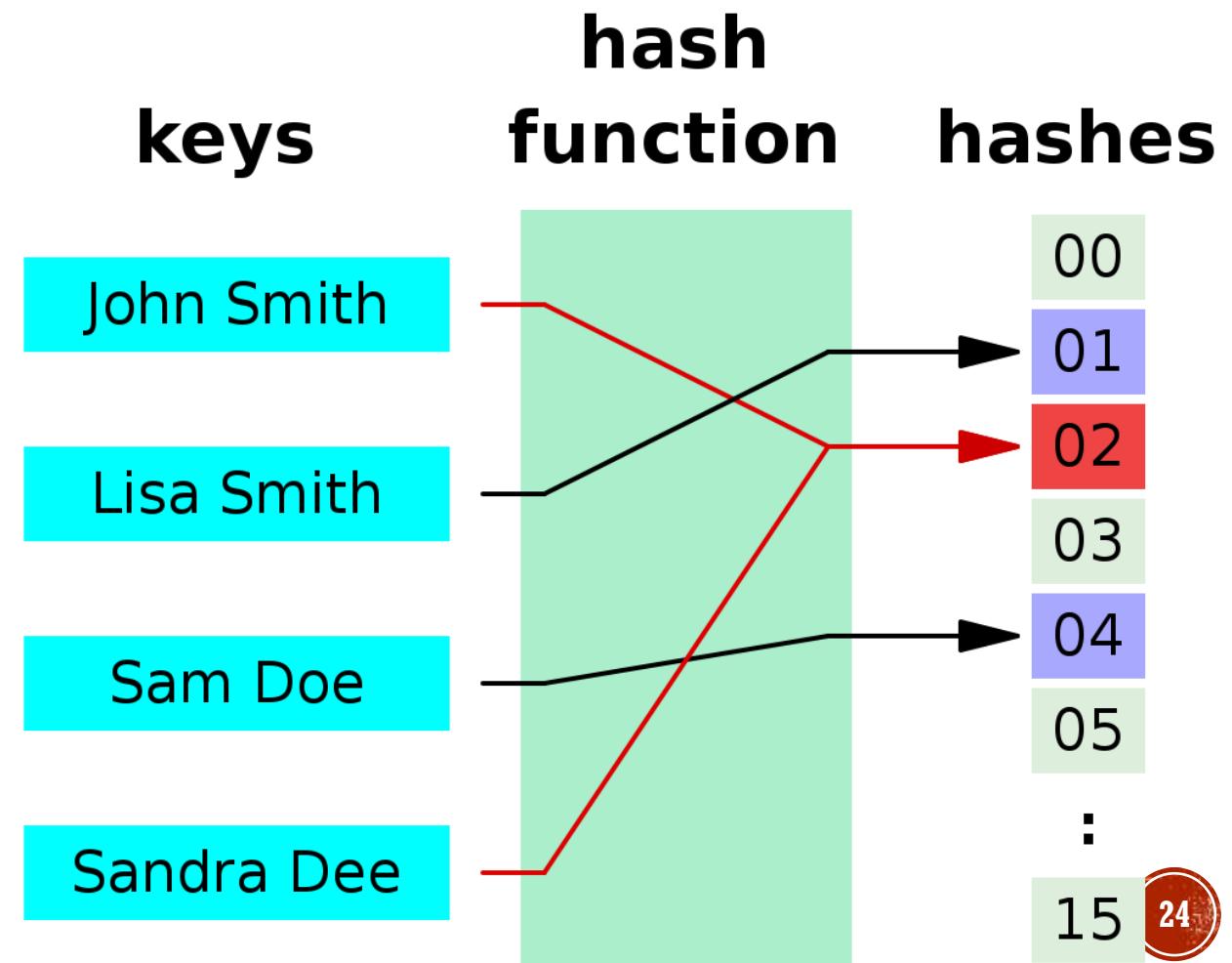
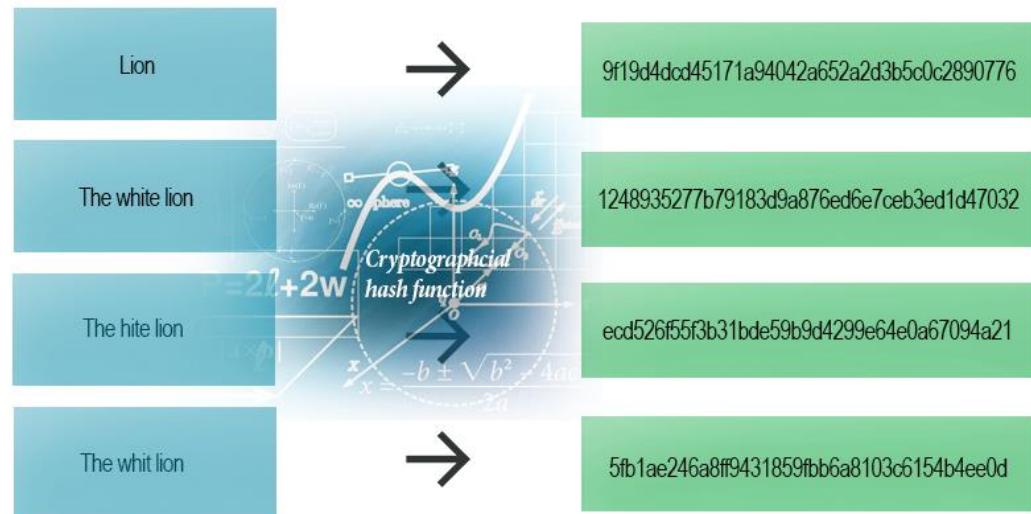
1	2	3	4	7	8
---	---	---	---	---	---



Python Algorithms

❑ Types of Algorithms:

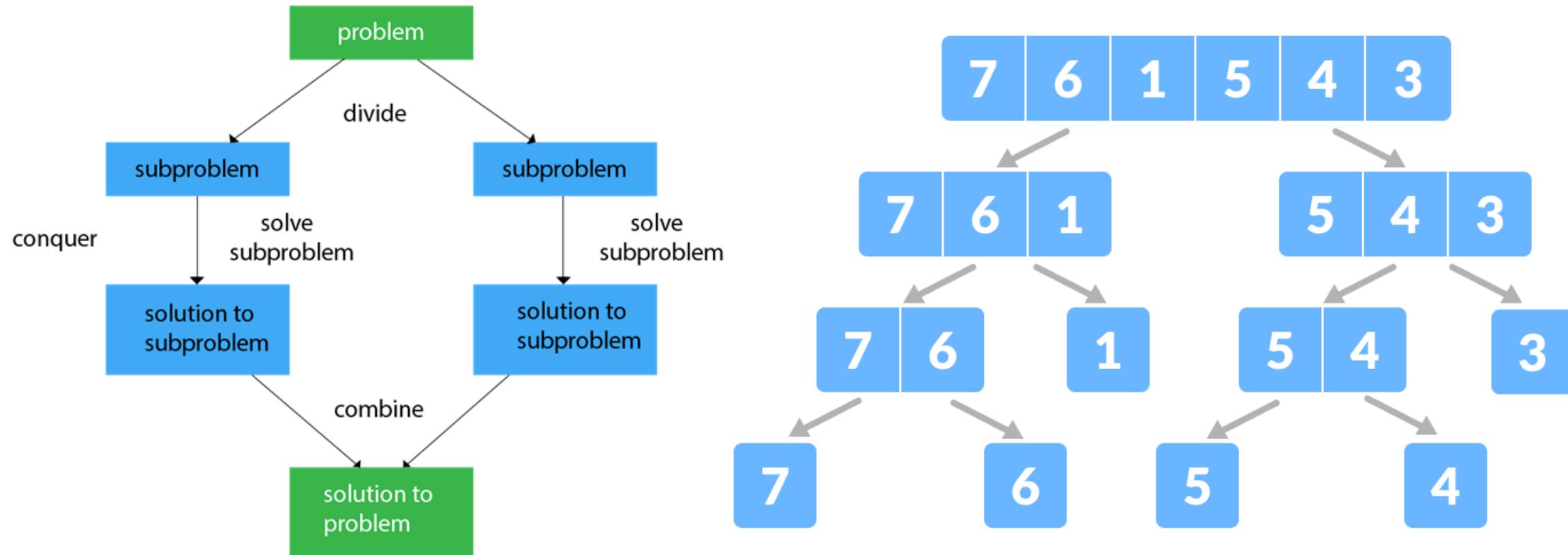
- **Hashing Algorithm:** Hashing algorithms work similarly to the searching algorithm. But they contain an index with a key ID. In hashing, a key is assigned to specific data.



Python Algorithms

❑ Types of Algorithms:

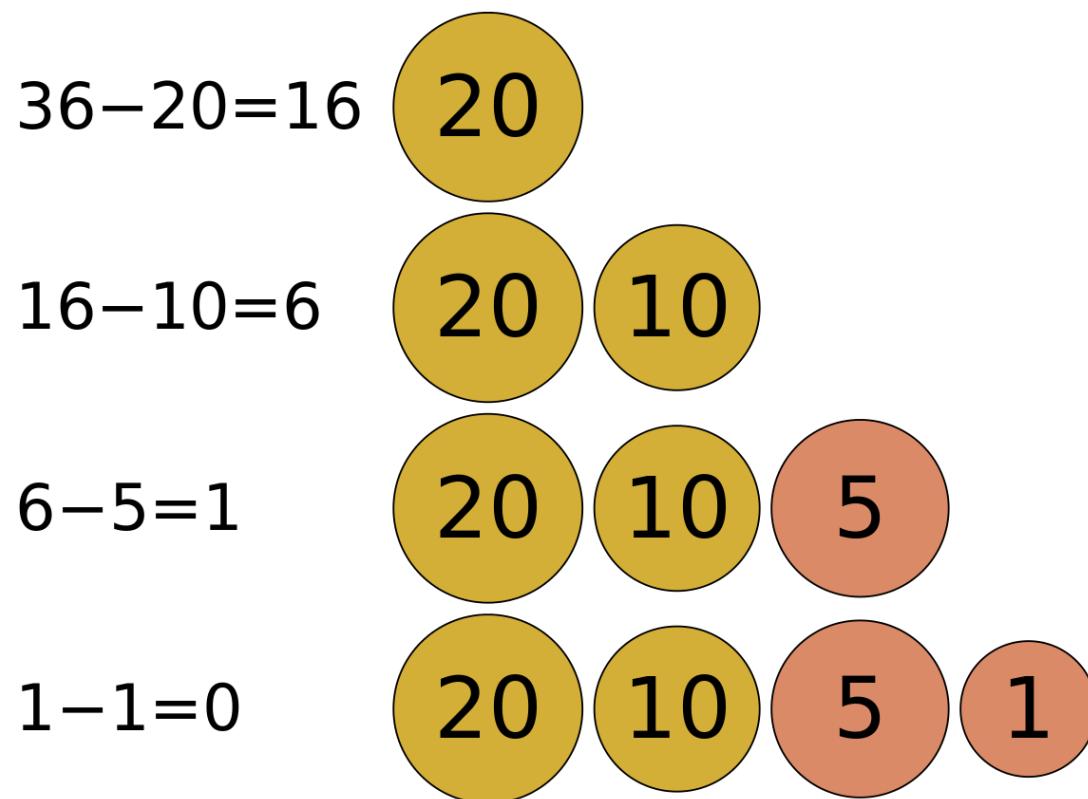
- **Divide and Conquer Algorithm:** This algorithm breaks a problem into sub-problems, solves a single sub-problem and merges the solutions together to get the final solution. It consists of the following three steps: Divide – Solve - Combine



Python Algorithms

❑ Types of Algorithms:

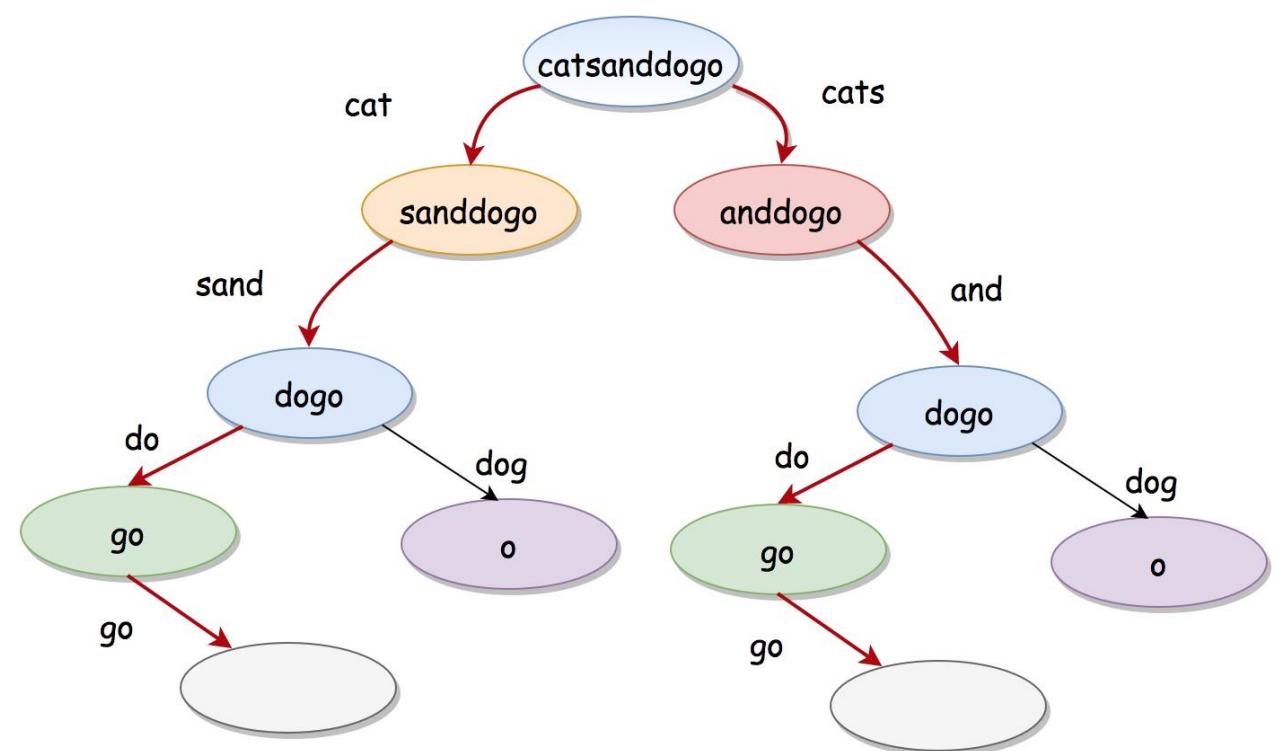
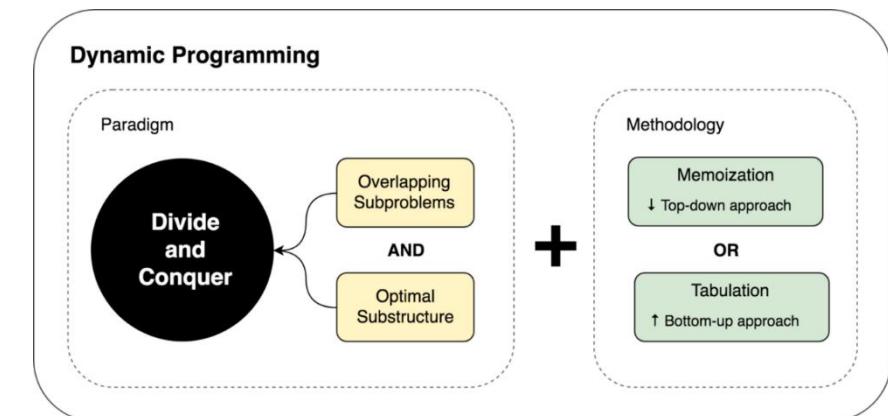
- **Greedy Algorithm:** In this type of algorithm the solution is built part by part. The solution of the next part is built based on the immediate benefit of the next part. The one solution giving the most benefit will be chosen as the solution for the next part.



Python Algorithms

❑ Types of Algorithms:

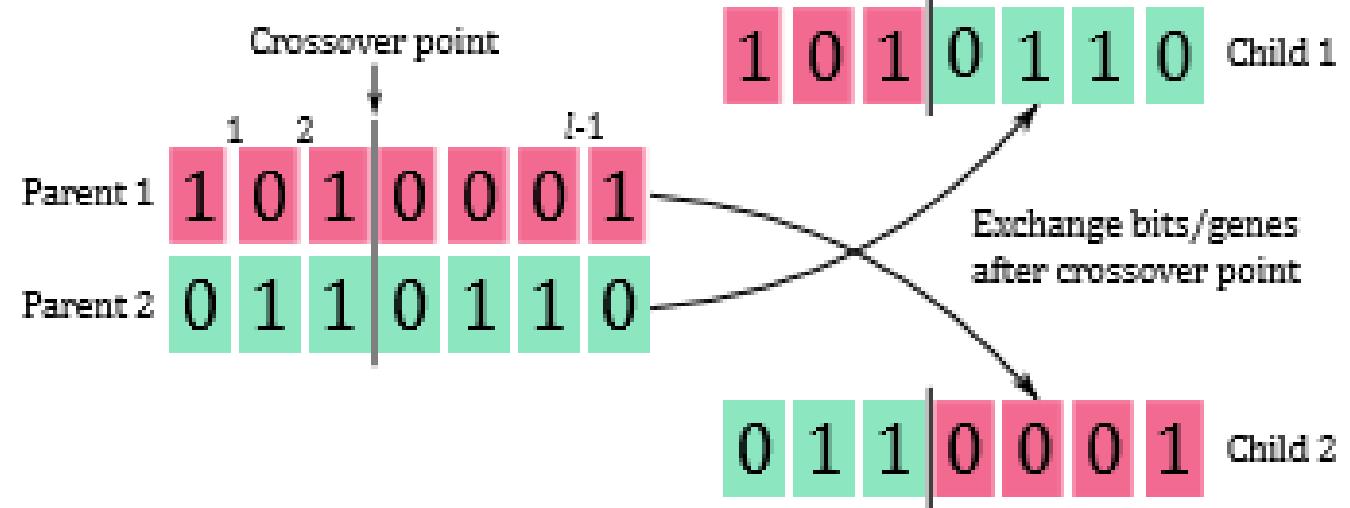
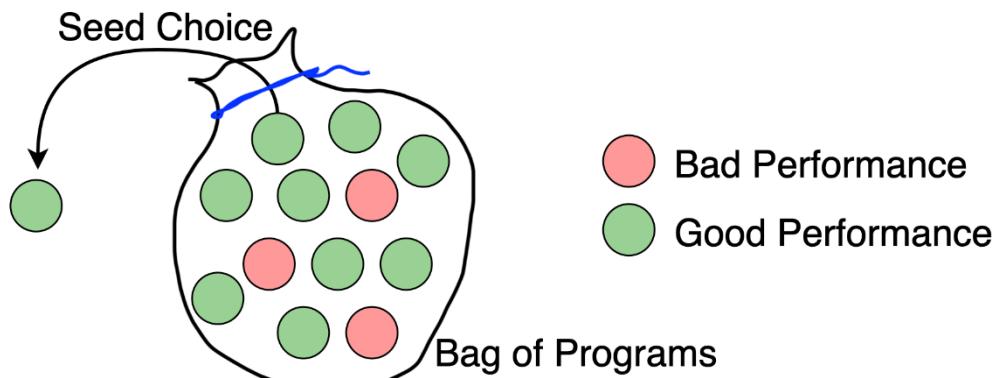
- **Dynamic Programming Algorithm:** This algorithm uses the concept of using the already found solution to avoid repetitive calculation of the same part of the problem. It divides the problem into smaller overlapping subproblems and solves them.



Python Algorithms

❑ Types of Algorithms:

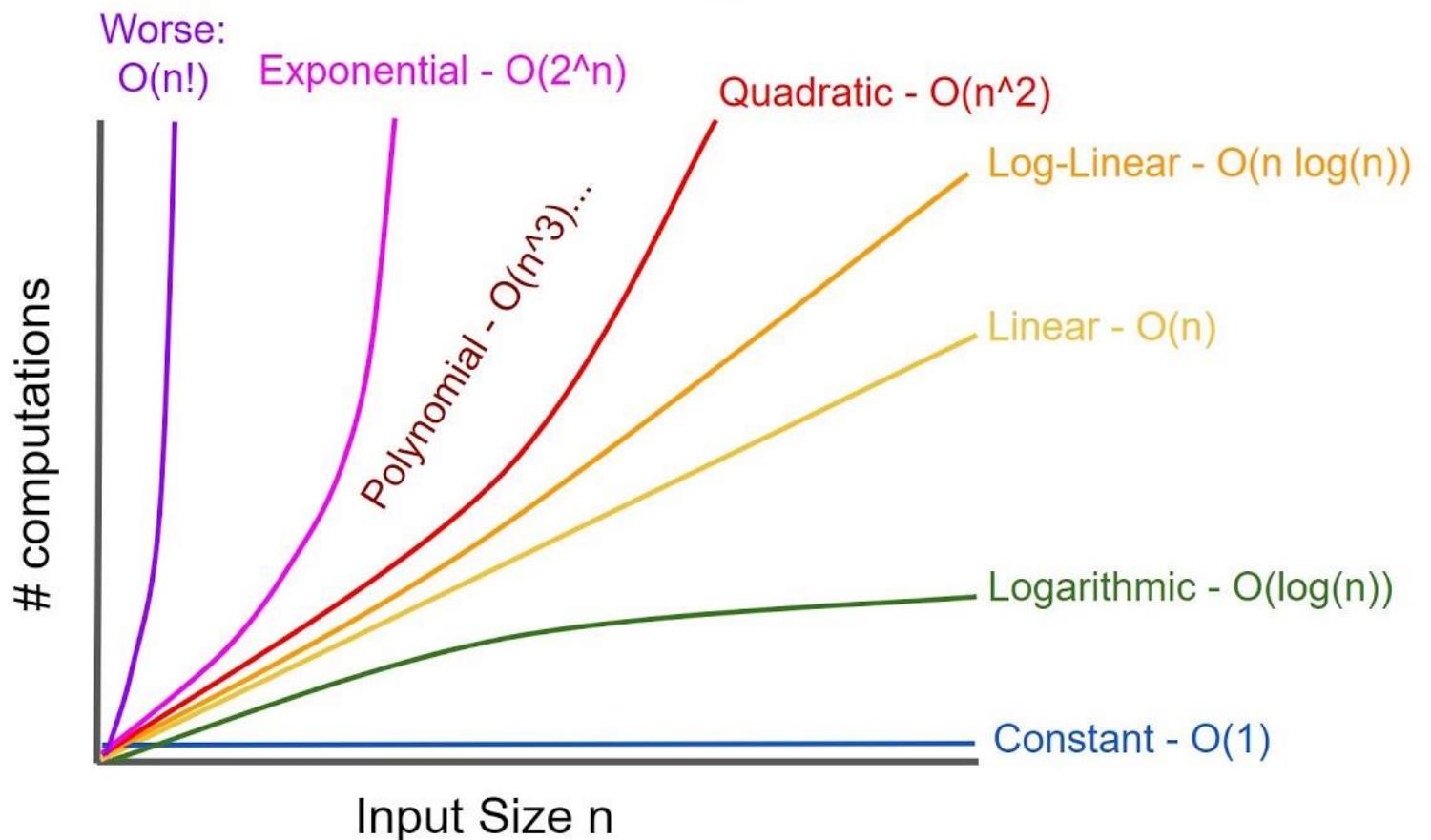
- **Randomized Algorithm:** In the randomized algorithm we use a random number so it gives immediate benefit. The random number helps in deciding the expected outcome.



Python Algorithms

❑ Performance:

- Constant: $O(1)$
- Logarithmic: $O(\log n)$
- Sublinear: $O(n^d)$ for $d < 1$
- Linear: $O(n)$
- Linearithmic: $O(n \log n)$
- Quadratic: $O(n^2)$
- Exponential: $O(2^n)$



Logistic

???



A story of ...

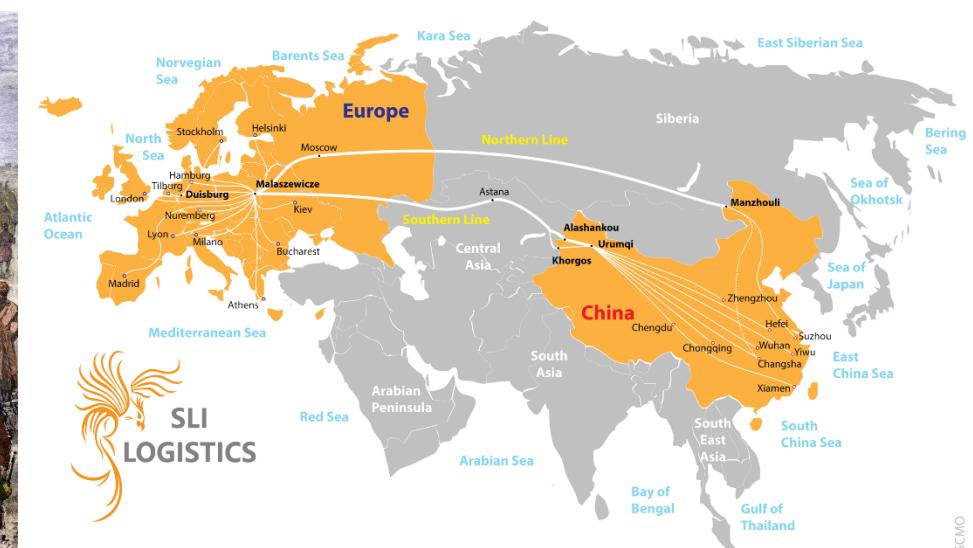
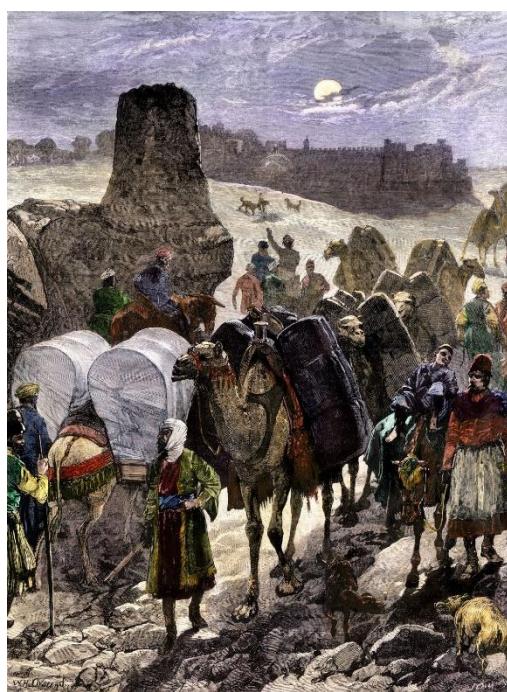
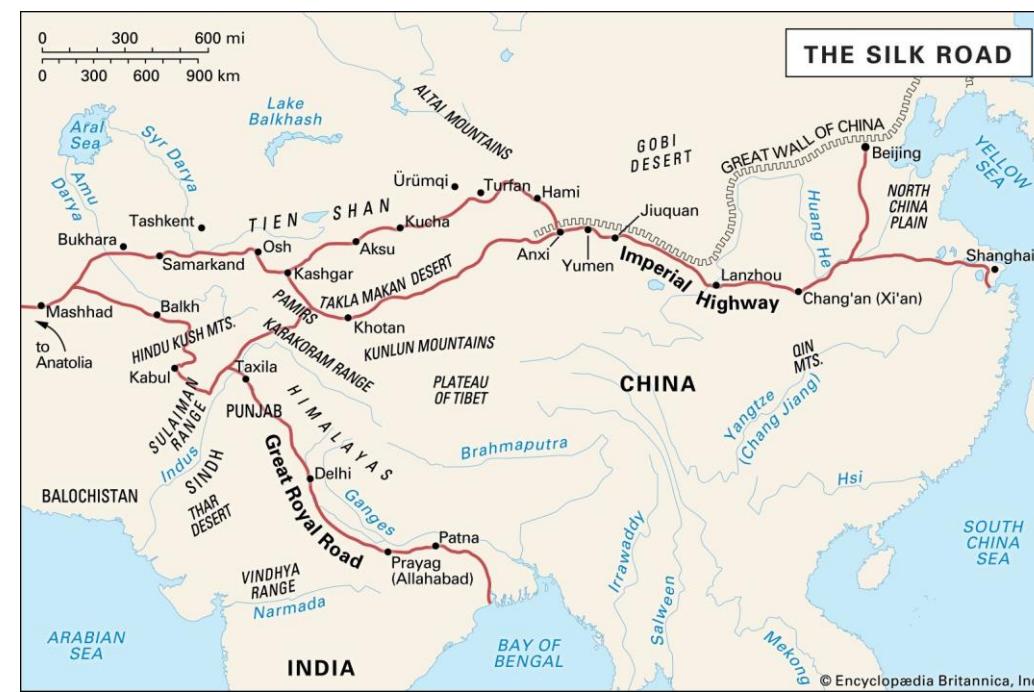
Silk road ... to ... Modern Logistic

Silk road

Time period: Around 114 BCE – 1450s CE

The Silk Road was an ancient trade route that linked the Western world with the Middle East and Asia. It was a major conduit for trade between the Roman Empire and China and later between medieval European kingdoms and China.

Con đường tơ lụa là một tuyến đường thương mại cổ xưa nối liền thế giới phương Tây với Trung Đông và châu Á. Đó là một đường dẫn chính cho thương mại giữa Đế chế La Mã và Trung Quốc và sau đó là giữa các vương quốc châu Âu thời trung cổ và Trung Quốc.



Silk road

Tơ lụa đi về phía Tây, vải len, vàng và bạc đi về phía Đông. Trung Quốc cũng tiếp nhận Cơ đốc giáo Nestorian và Phật giáo (từ Ấn Độ) thông qua Con đường tơ lụa.

Bắt nguồn từ Tây An (Sian), con đường dài 4.000 dặm (6.400 km), là một con đường dành cho các đoàn lữ hành, men theo Vạn Lý Trường Thành của Trung Quốc về phía tây bắc, băng qua sa mạc Takla Makan, leo lên Pamirs (núi), băng qua Afghanistan , và tiếp tục đến Levant; từ đó hàng hóa được vận chuyển qua Địa Trung Hải.

Thương mại Con đường tơ lụa đóng một vai trò quan trọng trong việc mở ra các mối quan hệ chính trị và kinh tế giữa Trung Quốc, Hàn Quốc, Nhật Bản, Ấn Độ, Iran, Châu Âu, Sừng châu Phi và Ả Rập. Ngoài hàng hóa, mạng lưới đã tạo điều kiện thuận lợi cho việc trao đổi ý tưởng, tôn giáo (đặc biệt là Phật giáo), triết học và khám phá khoa học chưa từng có, nhiều trong số đó đã được đồng bộ hóa hoặc định hình lại bởi các xã hội tiếp xúc với chúng.

Các phần của Con đường tơ lụa tồn tại dưới dạng đường cao tốc trải nhựa nối Pakistan và Khu tự trị Duy Ngô Nhĩ Tân Cương ở Trung Quốc. Trong thế kỷ 21, Liên Hợp Quốc đã lên kế hoạch tài trợ cho một đường cao tốc và đường sắt xuyên châu Á. Con đường tơ lụa cũng truyền cảm hứng cho Sáng kiến Vành đai và Con đường của Trung Quốc, một chiến lược phát triển cơ sở hạ tầng toàn cầu do Chủ tịch kiêm Tổng Bí thư Tập Cận Bình đề xướng.



Silk road

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From West to East these goods include:

- Horses
- Saddles and Riding Tack
- The grapevine and grapes
- Dogs and other animals both exotic and domestic
- Animal furs and skins
- Honey
- Fruits
- Glassware
- Woolen blankets, rugs, carpets
- Textiles (such as curtains)
- Gold and Silver
- Camels
- Slaves
- Weapons and armor



From East to West the goods include:

- Silk
- Tea
- Dyes
- Precious Stones
- China (plates, bowls, cups, vases)
- Porcelain
- Spices (such as cinnamon and ginger)
- Bronze and gold artifacts
- Medicine
- Perfumes
- Ivory
- Rice
- Paper
- Gunpowder



Modern Logistics

The global logistic market was valued at **\$7,641** billion USD



Ocean Freight

Over 95% of the world's trade travels via ocean freight – moving across seas and between ports. With our ocean freight services, our team will get your cargo on the vessel that best suits your needs. We handle your logistics, so you can focus on what you do best.



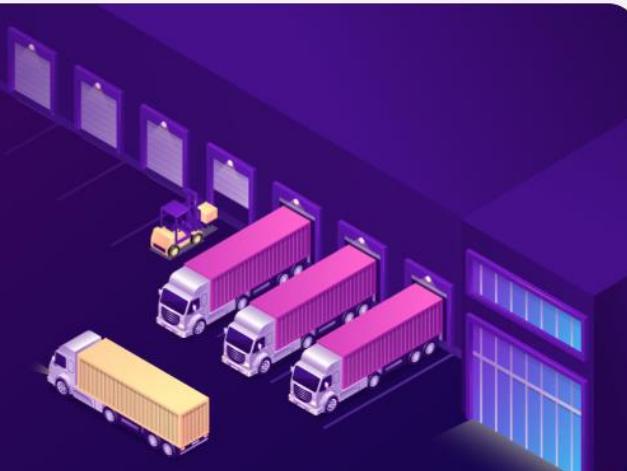
Air Freight

Silk Road Logistic provides international air freight services. We offer custom-tailored air freight logistics solutions for a wide variety of cargo. With a large network across the globe, we assure you that your shipments are handled with optimal care.



Road Freight

Among the advantages of road transport are its speed for short and medium distances, its flexibility and door-to-door service. At Silk Road Logistic we transport complete cargoes of any kind of freight, with savings in both time and costs. Thanks to our own truck fleet and a solid network of associates, we can offer you an efficient and streamlined road freight transport service.



Logistics

- The global logistic market was valued at \$7,641 billion USD in 2017, \$13,000 billion USD by 2027
- Logistics and supply chain can be a game changer in terms of creating new revenue for your company. If you break free of the silo thinking you may see ways to use logistics to make more money.
- Air cargo rates range from \$4.00-\$8.00 per kilogram.



Logistics

- The global logistic market will value at \$13,000 billion USD by 2027
- Air cargo rates range from \$4.00-\$8.00 per kilogram

how many airplane trips?



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Aircraft	Volume (m ³)	Payload
Airbus A330-200F	475	70,000 kg (154,000 lb)
Airbus A380	342	68,000 kg (150,000 lb)
Airbus Beluga	1210	47,000 kg (104,000 lb)
Airbus BelugaXL	2615	53,000 kg (117,000 lb)



Logistics

- The global logistic market will value at \$13,000 billion USD by 2027
- Air cargo rates range from \$4.00-\$8.00 per kilogram

how many containers?



40' OPEN-TOP

FreightRight
SIMPLE, RELIABLE LOGISTICS.

Internal length 12.03m / 39.5ft
Internal width 2.4m / 7.9ft
Internal height 2.34m / 7.8ft
Tare weight 3,980kg / 8,774 lbs
Payload capacity 26,500kg / 58,422 lbs
Cubic capacity 66.7 m ³ / 2,356 cu ft



Top 3 logistics companies in the world (2021)



Logistics

Top 3 logistics companies by revenue in the world 2021

□ UPS

- UPS is a parcel delivery service based in the United States, which has been operating for over a century. UPS operates in shipping, air freight, trucking, last-mile distribution, and drone delivery, among other areas. With \$100, the company began in 1907 as a small messenger service in Seattle.
- UPS also operates over 35 million square feet of distribution and warehousing facilities in over 1,000 locations across 120 countries, serving over 220 countries and territories.
- Revenue: \$74.969 billion
- Headquarters: Atlanta, Georgia, USA



Logistics

Top 3 logistics companies by revenue for you in the world 2021

DHL Group

- DHL is a German company that was founded in the United States. DHL Air Cargo began operations in 1969, and by the late 1970s, the business had grown to provide services all over the world. Deutsche Post began buying stock in the company in 1998 and completed the purchase of DHL in 2002, extending the DHL name to other services.
- After the privatization of Germany's national postal service in 1995, Deutsche Post was created. DHL currently operates 430 warehouses totaling 11 million square meter.
- Revenue: €63.3 billion
- Headquarters: Bonn, Germany



Logistics

Top 3 logistics companies by revenue for you in the world 2021

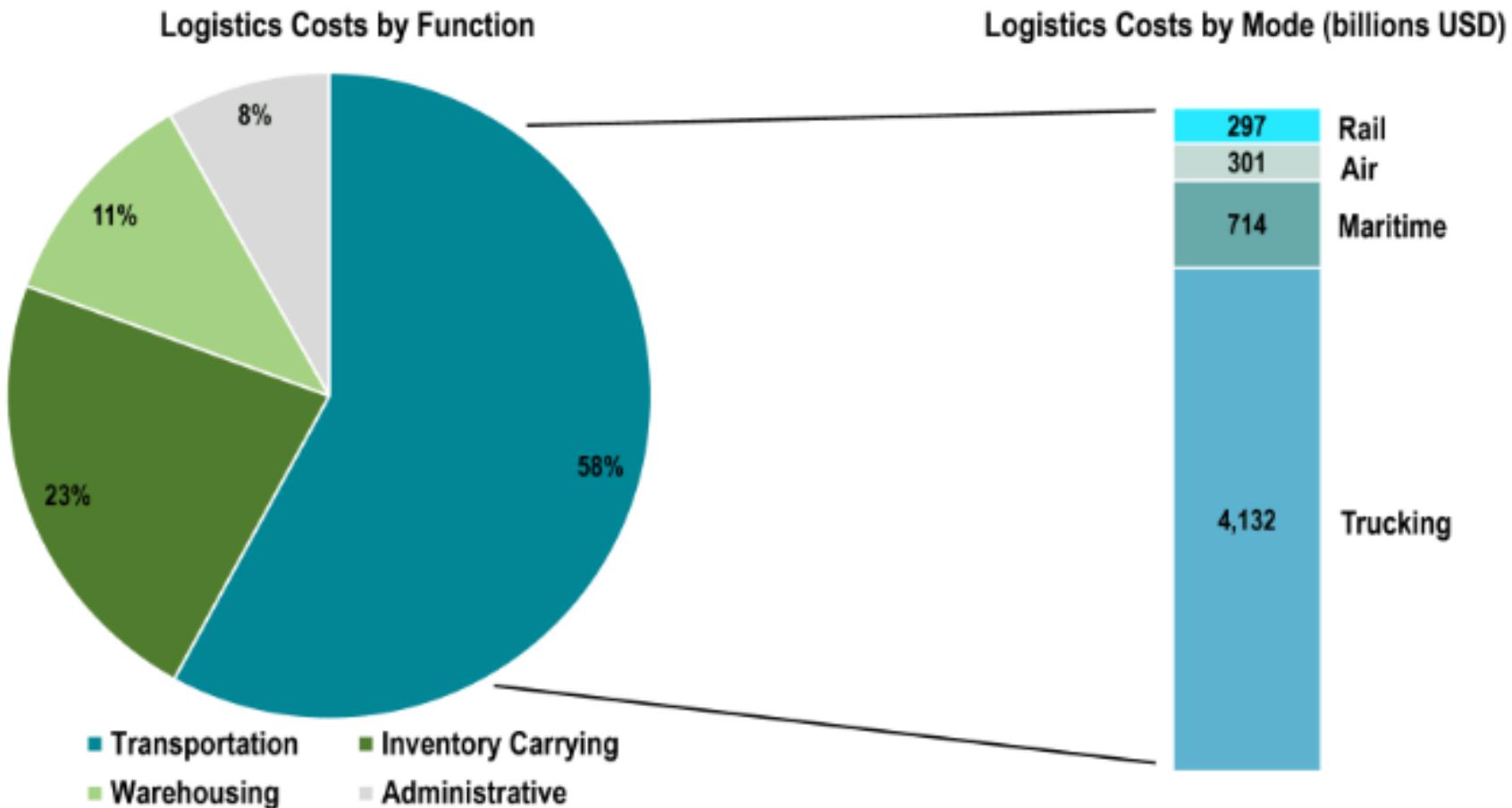
FedEx Corporation

- FedEx, formerly known as Federal Express, is a global freight company based in the United States that was established in 1971 as a system for expedited deliveries. FedEx is the world's largest cargo carrier in terms of scheduled freight tonne kilometers (FTK) and the fourth largest in terms of fleet size.
- FedEx set out to become a full-service freight provider and a major logistics competitor. FedEx is now a global leader, with operations in more than 220 countries and more than 3 thousand square meter of warehouse space under its control.
- Revenue: \$69.217 billion
- Headquarters: Memphis, Tennessee, USA



Practices (Logistic problems)

Global Logistics Costs by Function and Mode, 2018



Global Logistics Costs by Function and Mode, 2018



Practices (Logistic problems)

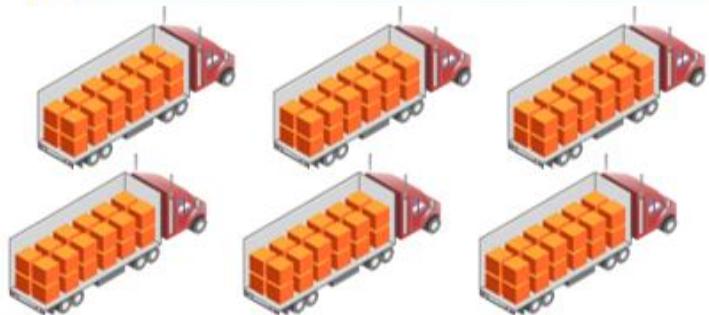


2000 containers
500 packages/container

30 mins/tour



1 hour/tour



Shipping truck: 100 packs/tour

2 hour/tour



Warehouse imports 2000 containers
1 container = 500 packages

? Cần bao nhiêu trucks để vận chuyển
hết hàng hóa trong vòng 1 tuần

Viết code Python lập trình giải pháp!



Practices (Logistic problems)

❑ Xem xét model:

Xây dựng mô hình toán mô tả và đề xuất giải pháp.

Vẽ flowchart lập trình chương trình cho Python.

Viết code python thực thi giải thuật/giải pháp đã đề xuất.

- ? Cần bao nhiêu trucks để vận chuyển hết hàng hóa trong thời gian yêu cầu
- ? Giả sử công ty có 100 trucks, thời gian tối thiểu để ship toàn bộ số hàng có trong kho
- ? Giả sử công ty có 100 trucks, chi phí tối thiểu để ship toàn bộ số hàng có trong kho
- ? Với 100 trucks, chi phí và thời gian tối thiểu để ship toàn bộ số hàng có trong kho



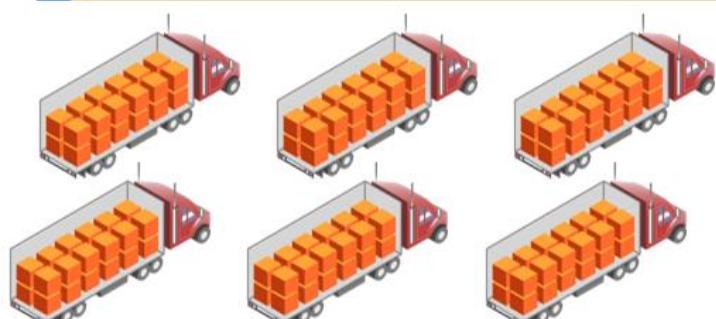
Practices (Logistic problems)



Warehouse imports N_c (containers)
1 container = N_p (packages)

N_c (containers)

N_p (packages/container)



Shipping truck: N_{pt} (packs/tour)

Build Python algorithms for ...

$A_{1,t}$ (mins/tour)

$C_{1,t}$ (\$/tour)

$A_{2,t}$ (hour/tour)

$C_{2,t}$ (\$/tour)

$A_{3,t}$ (hour/tour)

$C_{3,t}$ (\$/tour)



Area 1
 $N_{1,p}$ (packages)



Area 2
 $N_{2,p}$ (packages)



Area 3
 $N_{3,p}$ (packages)



Practices: Algorithms

Design of Algorithm in Python Programming

