What problem solving strategies do you know?

CONTENT

- Stepwise refinement
- Divide and conquer
- Working backwards
- Extreme cases
- Tables and charts
- Trial and error

Why is this Important?

01

**Good Decisions**

02

Make the Problem Solving Process Easier

Stepwise refinement

What is stepwise refinement ?

- Stepwise Refinement is the process of breaking down a programming problem into a series of steps.
- Programming approach beginning with a high-level view of the problem
- Problem is broken down into smaller, more manageable steps
- One by one, you build and enhance each step at each level
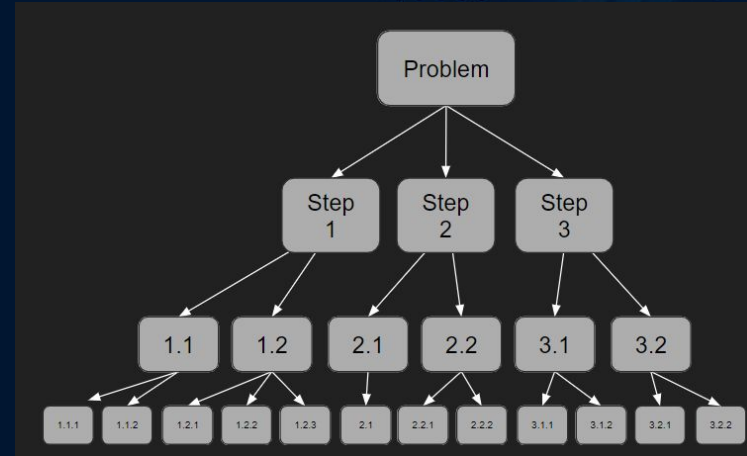
when to use stepwise refinement ?

- Used when there are extremely complex or difficult problems that are hard to solve just from thinking.
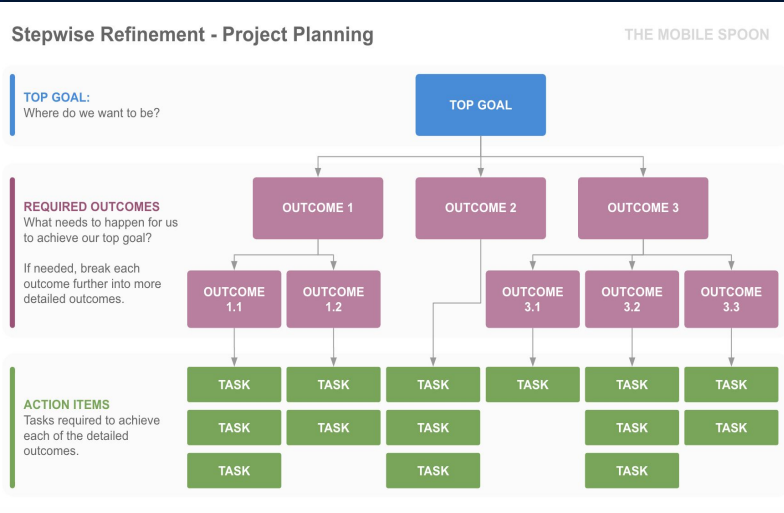
What is Stepwise Refinement?

Strategy on how to use stepwise refinement.

Stepwise Refinement - Project Planning — THE MOBILE SPOON

Stepwise refinement is mostly used in computer science as it is a computer science problem solving technique, you will notice that most of the problems that are solved using stepwise refinement are complex issues as it is easy to put into smaller subtopics.

How would I use stepwise refinement to solve a programing problem?

1. The problem
2. Put into the required subtopic
3. Break each subtopic into more refined subtopics.(Detailed)
4. You keep repeating step 3 until the one of the subtopics is easy to solve

What are the 4 steps of stepwise refinement

Example for stepwise refinement.

Problem : Convert Fahrenheit temperature to Celsius temperature.

★ Accept Fahrenheit temperature as input.
  ○ Prompt the user to enter a Fahrenheit temperature.
  ○ Accept the temperature value as input.
  ○ Store the temperature value in a variable.
★ Calculate Celsius temperature.
  ○ Functions for the celsius temperature
  ○ Functions for the fahrenheit temperature

★ Output results.
  ○ Console log the output temperature
- You can decompose the problem into 2-3 3 steps first
- program the line that prompts the user to enter the Fahrenheit temperature.
- Then you test it and look for errors.
- Write code to accept the input Fahrenheit temperature and store it in a variable.

```java
public class Temperature {
  public static void main(String[] args) {
    System.out.print("Enter a Fahrenheit temperature: ");
  }
}
```

```javascript
function cToF(celsius)
{
    var cTemp = celsius;
    var cToFahr = cTemp * 9 / 5 + 32;
    var message = cTemp+'\xB0C is ' + cToFahr + ' \xB0F.';
    console.log(message);
}

function fToC(fahrenheit)
{
    var fTemp = fahrenheit;
    var fToCel = (fTemp - 32) * 5 / 9;
    var message = fTemp+'\xB0F is ' + fToCel + '\xB0C.';
    console.log(message);
}
cToF(60);
fToC(45);
```

Divide and conquer

What is divide and conquer ?

Divide and Conquer is an algorithmic paradigm that uses the Divide, Conquer, and Combine technique to solve a problem.

- **Divide:** This involves dividing the problem into smaller sub-problems.

- **Conquer:** Solve sub-problems by calling recursively until solved.

- **Combine:** Combine the sub-problems to get the final solution of the whole problem.
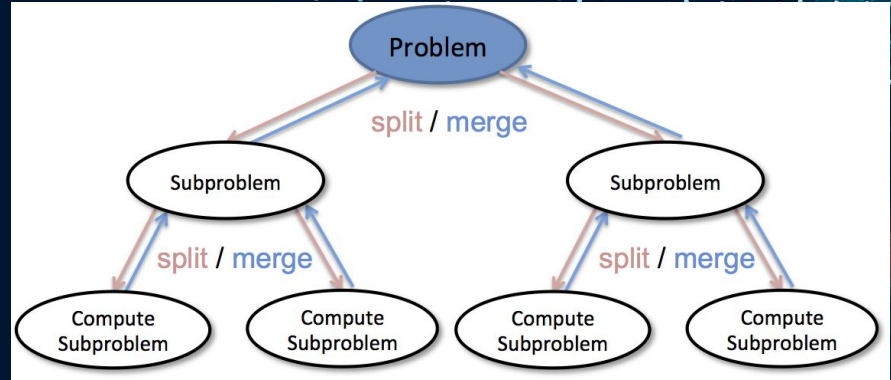
What is Divide and conquer
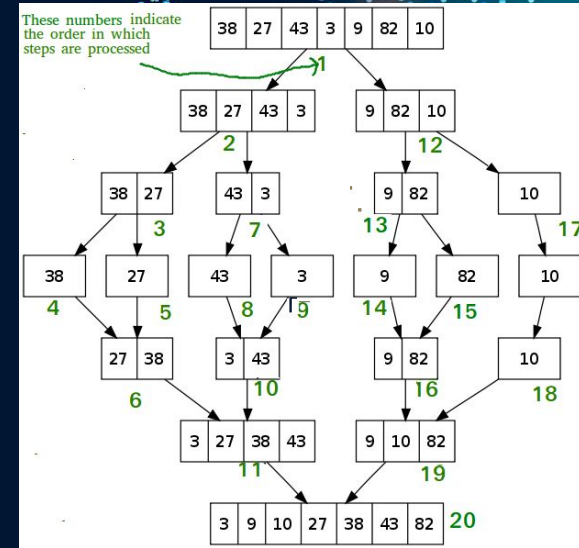
Divide and conquer in algorithms ?

The divide-and-conquer paradigm is frequently used to find the best solution to a problem.

Algorithm is a collection of instructions used to solve problems or complete tasks based on knowledge of available options.
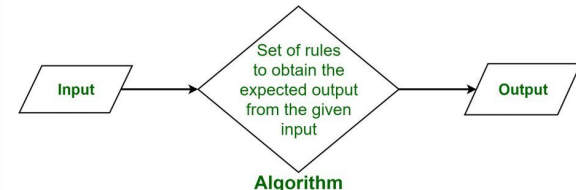
In computer science, an algorithm is a set of instructions that gives the computer the ability to do everything.

Some standard algorithms that follow divide and conquer.

- Quicksort
- Mergesort
- Closest pair of points
- Strassen's Algorithm
- Cooley–Tukey Fast Fourier Transform (FFT) algorithm
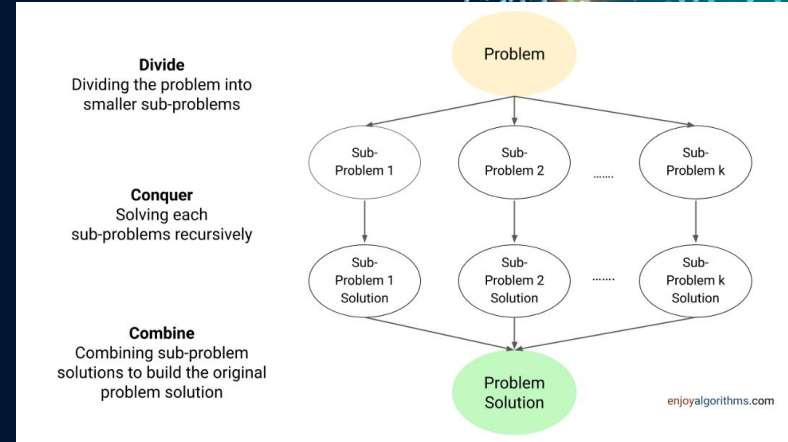- Karatsuba algorithm for fast multiplication

Strategy for divide and conquer.

Using divide and conquer to gain power as a politicians or using divide and conquer to solve algorithms these strategies will help you apply it to anything you do.

How to use divide and conquer :

- ❏ You break the problem into 2 smaller problems
- ❏ Which is more manageable
- ❏ Then understand the subtopics one by one
- ❏ Divide the subtopics into smaller topics until you are able to solve the problem.

Divide
Dividing the problem into smaller sub-problems

Conquer
Solving each sub-problems recursively

Combine
Combining sub-problem solutions to build the original problem solution

Problem

Sub-Problem 1   Sub-Problem 2   ......   Sub-Problem k

Sub-Problem 1 Solution   Sub-Problem 2 Solution   ......   Sub-Problem k Solution

Problem Solution

enjoyalgorithms.com

Is Divide and conquer a efficient problem solving method ?

Pros and Cons for stepwise refinement
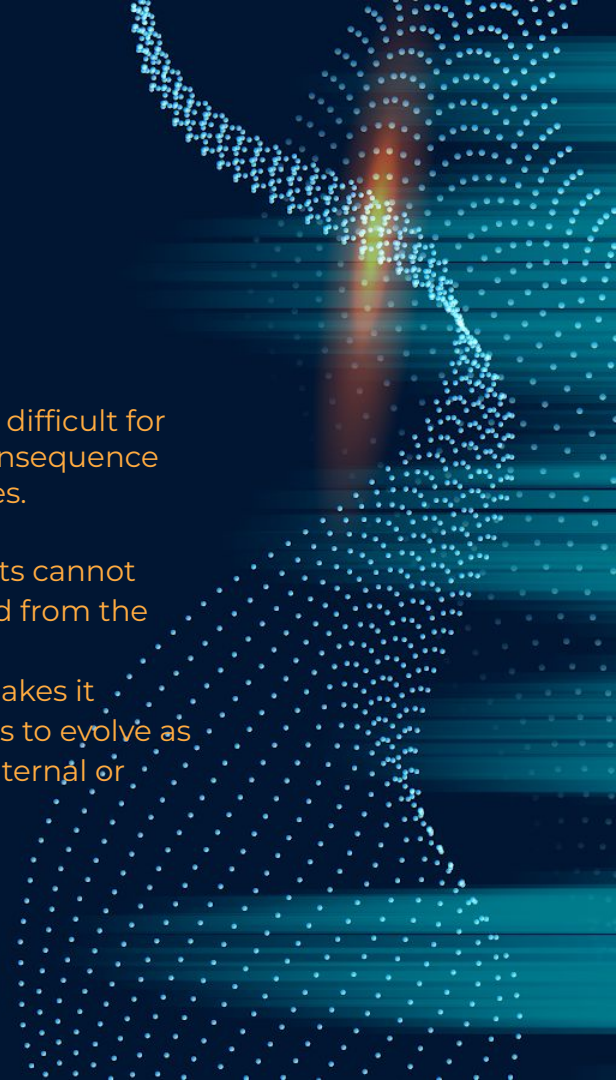
Pros

Pros of this technique are by breaking down the problem into smaller parts you are able to understand the concept better.

- Large projects can be broken down and certain components issued to different developers.
- The overview makes the project easy to manage.
- Is easy to solve complex problems as easy to execute, plan and monitor.

Cons

Stepwise refining makes it difficult for initiatives to evolve as a consequence of internal or external forces.

- Investigatory projects cannot always be developed from the top-design.
- Stepwise refining makes it difficult for initiatives to evolve as a consequence of internal or external forces.

Pros and Cons for Divide and conquer

Pros

Divide and conquer is easy to use with problems that are easy to divide into smaller subtopics. Parallelism is an advantage as it allows you to divide the problem into 2 or 3 subtopics.

- Solving difficult problems
- Parallelism

Cons

- Recursion
- Problem decomposition can be very complex, making divide and conquer ineffective.
- Stack size
- The implementation of logic determines efficiency.

Working Backwards

An individual or team starts at the desired goal, and works backwards, finding a path which can lead to the goal.

End ⟩ Beginning ⟩

For instance, in a maze...

Start

Exit

What is the Purpose?

Perspective

Changing the method you are solving your problems will give you a new view on the problem

Focused Plan

Plans will be focused on the goal

Time for Difficulties

Difficult questions and choices come at the end

Planning

Will you allow to see all the obstacles and plan for them

What is the Purpose of working backwards?

Working Backwards in Amazon

Amazon was creating lots of products, some which sold well, and some that didn't.

Eventually, they began losing money since the products were not as successful as they hoped for, so they developed a strategy.

Rather than building a product, then seeing if it is successful, they seek the customer's needs and produce products accordingly. This strategy is working backwards.
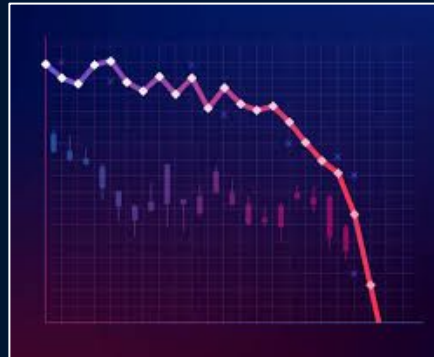
"The Working Backwards Process is not designed to be easy, it is designed to save a huge amount of work on the backend, and to make sure we are building the right thing", said Bezos.

Ian McAllister (Amazon employee) shared that the method seeks "to work backwards from the customer, rather than starting with an idea for a product and trying to bolt customers onto it."

Why did Amazon develop this Strategy? What was it for?

What Was The Strategy?

It is to work backwards by:

- Starting at the customer

- Focus on the needs and wants of the customer

- Plan what is needed to be done to achieve this product/service.

- Begin production of the product/service

Note: Amazon also uses a long term approach to ensure the success of the product/service
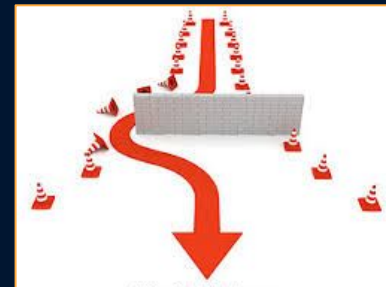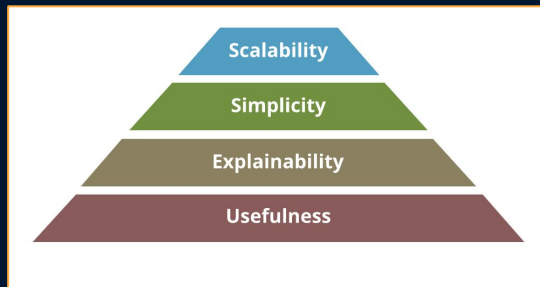
What Does This Achieve?

CLEAR TARGET

- Goal is clear, the path to the goal is clear

- The team has a understanding of the final product and how to achieve it

Easy Process

- The difficult choices and questions are out of the way early

Scalability

Simplicity

Explainability

Usefulness

What does this strategy achieve?

Extreme Cases

Extreme cases is the process in which you think of the worst case scenario in order to prepare for it.

What is the Purpose of Extreme Cases?

Thinking | Allows for deeper levels of thinking

Risk-Reward | Allows to see the possible risks and rewards before doing something

Preparation | Allow you to prepare for the worst, and the best.

Where can we use extreme cases?

Extreme Cases in an Online Store

- An online store gets around 40-50 purchases daily

- The servers of this store can only handle up to 60 purchases at a time

- Black friday is approaching, meaning the number of purchases is expected to increase by 10-15 times

- The servers should be configured into being able to handle up to 20 times the normal purchases at a time, otherwise, the online store will crash when the number of purchases exceeds 60 resulting in a loss of customers
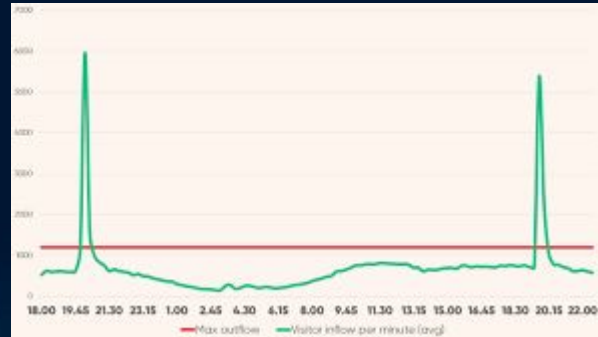
Well, that was more popular than we thought

We need a quick time out, but don't worry. We'll email you when things are back to normal.

What is an example of extreme cases that we have done IN CLASS?

Extreme Cases in OUR CLASS

Backup Files

- Backing up files is a form of solving problems with extreme cases

- When we organize our replit files in another program in case replit goes down, we are preparing for a worst case scenario

What does this achieve?

We have our code saved in case replit goes down so that we do not lose our code.

Tables & Charts

What are some ways we can use visual tools like tables or charts/graphs to problem solve?

How do Tables Help us Problem Solve?

This method of problem solving relies heavily on math, as the contents of the table will consist mainly of numbers.

While you might be good with math, many people find it easier to solve mathematical problems by visualizing numbers in a table or chart.
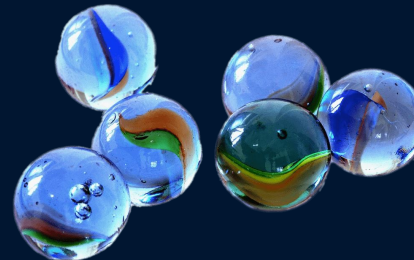
Examples of using tables to solve problems

A simple example of a problem that can be solved using a table is as follows:

Steve has a bag of marbles, for every 1 green marble she has, she has 2 red marbles as well.

How many total marbles does steve have based on a certain number on green marbles?

Green	1	2	3
Red	2	4	6
Total	3	6	9

+

How do Tables Help us Problem Solve?

What are some scenarios where you can use these problem solving strategies?