Algorithms & Data Structure

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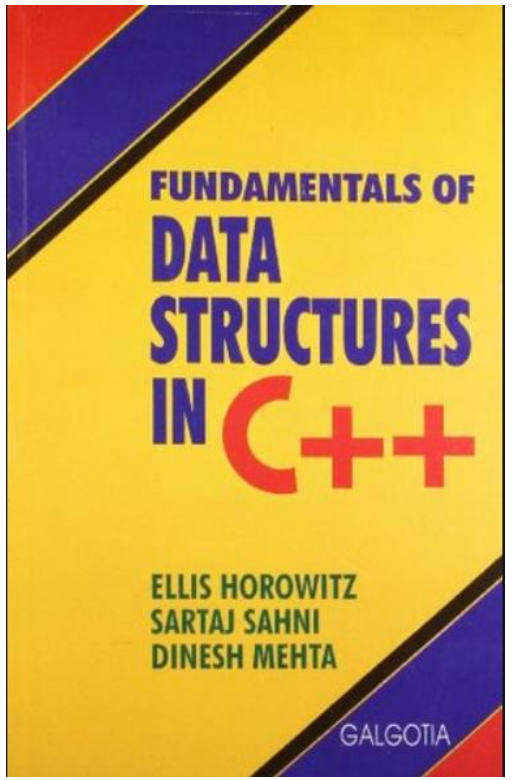
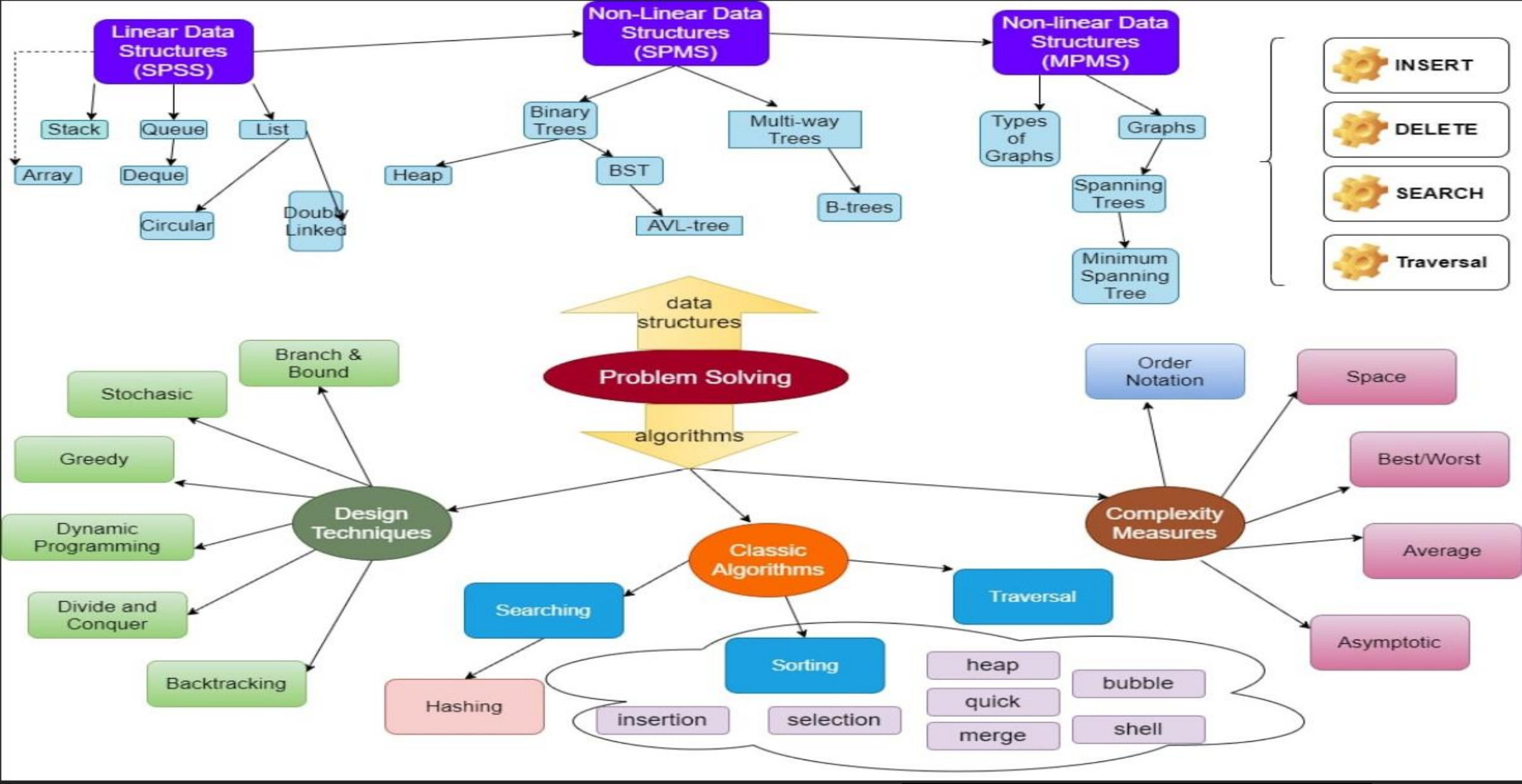
Module 2: Algorithms and Data Structures

- **Text Book:**
  - Fundamentals of Data Structures in C++ by Horowitz, Sahani & Mehta
- **Topics:**
  - 1.Problem Solving & Computational Thinking
  - 2.Introduction to Data Structures & Recursion
  - 3.Stacks
  - 4.Queues
  - 5.Linked List Data Structures
  - 6.Trees & Applications
  - 7.Introduction to Algorithms
  - 8.Searching and Sorting
  - 9.Hash Functions and Hash Tables
  - 10.Graph & Applications
  - 11.Algorithm Designs




Linear Data Structures (SPSS)
Non-Linear Data Structures (SPMS)
Non-linear Data Structures (MPMS)
Stack
Queue
List
Array
Deque
Circular
Doubly Linked
Binary Trees
Multi-way Trees
Heap
BST
AVL-tree
B-trees
Types of Graphs
Graphs
Spanning Trees
Minimum Spanning Tree
INSERT
DELETE
SEARCH
Traversal
data structures
Problem Solving
algorithms
Branch & Bound
Stochasic
Greedy
Dynamic Programming
Divide and Conquer
Backtracking
Design Techniques
Classic Algorithms
Searching
Hashing
Sorting
insertion
selection
heap
quick
merge
bubble
shell
Traversal
Order Notation
Space
Best/Worst
Average
Asymptotic
Complexity Measures

Agenda

- **Problem Solving & Computational Thinking**
- **Algorithm & Data Structure**
  - OODesign: ADTs
- **Recursion**
  - Base condition
  - Direct & indirect recursion
  - Memory allocation
  - Pros and Cons
  - Complexity analysis

Computational Thinking : Researcher

- Niklaus Wirth

Linus Torvalds

Martin Karplus, Michael Levitt, and Arieh Warshel

Why Study Algorithms and Data Structures?

- World domination

Modern World of Computing

- Age of Big Data, birth of Data Science
- Digitization, communication, sensing, imaging…
- Entertainment, science, maps, health, environmental, banking…

00101010010101010101001001001010100001001001010...

- Volume, variety, velocity, variability
- What all happens in 1 Internet minute?

What Happens in an **Internet Minute?**

639,800 GB of global IP data transferred

20
New victims of identity theft

204 million
Emails sent

47,000
App downloads

$83,000
In sales

61,141
Hours of music

20 million
Photo views

3,000
Photo uploads

320+
New Twitter accounts

100,000
New tweets

135
Botnet infections

6
New Wikipedia articles published

1,300
New mobile users

100+
New Linkedin accounts

277,000
Logins

6 million
Facebook views

2+ million
Search queries

30
Hours of video uploaded

1.3 million
Video views

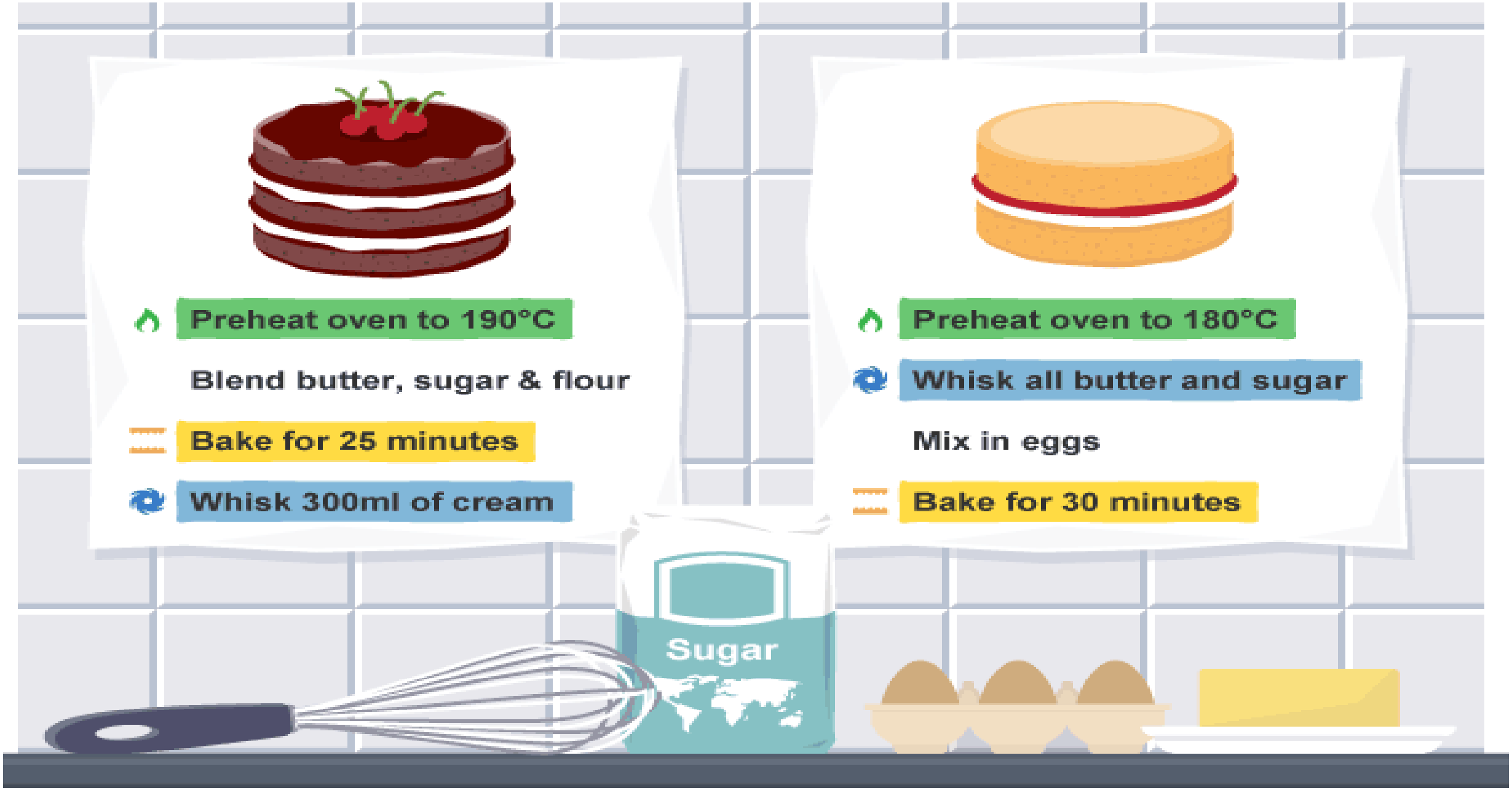
And **Future Growth** is **Staggering**

Today, the number of networked devices = the global population

By **2015**, the number of networked devices = 2x the global population

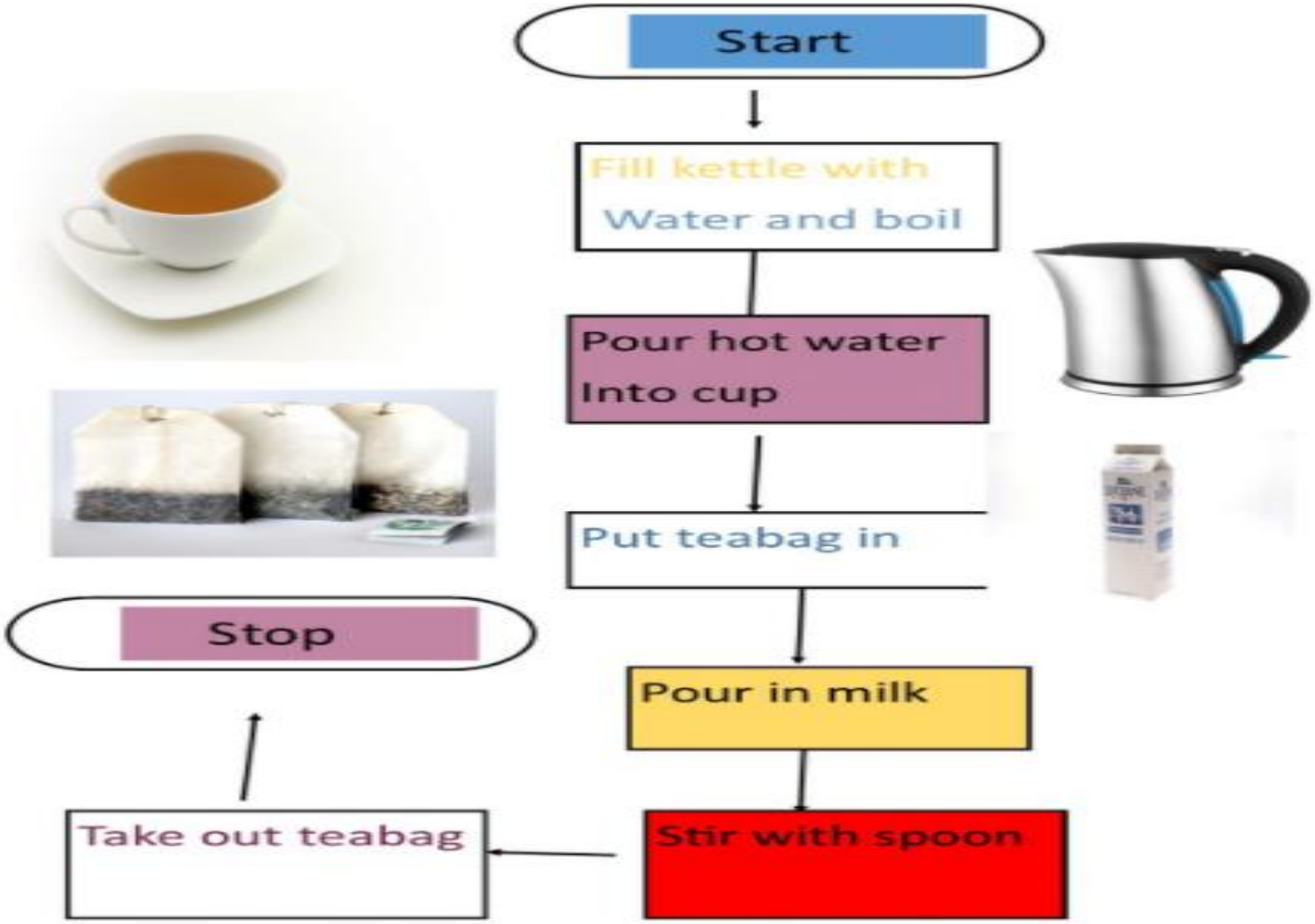
In **2015**, it would take you **5 years** to view all video crossing IP networks each **second**

Credit: Intel Corporation


Preheat oven to 190°C
Blend butter, sugar & flour
Bake for 25 minutes
Whisk 300ml of cream
Preheat oven to 180°C
Whisk all butter and sugar
Mix in eggs
Bake for 30 minutes
Sugar

Problem Solving Chart

Write Algorithm to prepare a Tea

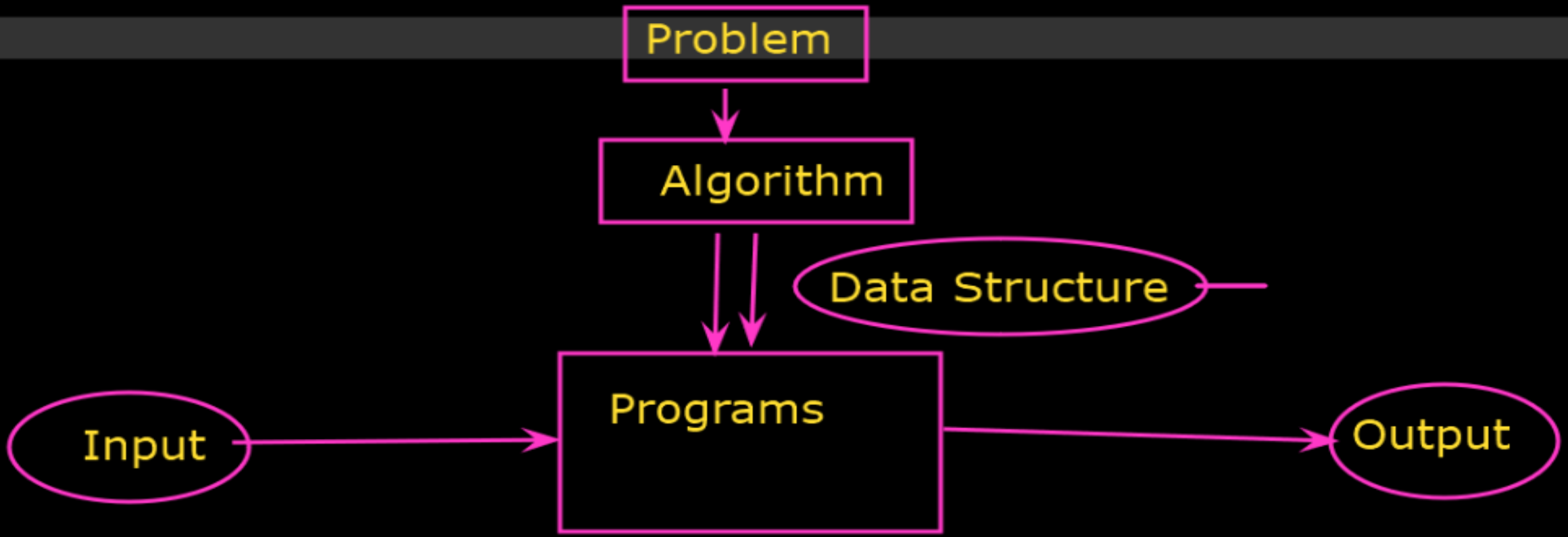


Definition

- **Data:**
  - Collection of Raw facts.
- **Algorithm:**
  - Outline, the essence of a computational procedure, step-by-step instructions.
- **Program:**
  - An implementation of an algorithm in some programming language
- **Data Structure:**
  - Organization of data needed to solve the problem.
  - The programmatic way of storing data so that data can be used efficiently

Program:step by step execution.
-Data + algorithms = Program

Data Structure:organization of data in efficient way.



Algorithm Design Strategies

- Brute force
- Divide and conquer
- Decrease and conquer
- Transform and conquer
- Greedy approach
- Dynamic programming
- Backtracking and branch and bound
- Space and time tradeoffs

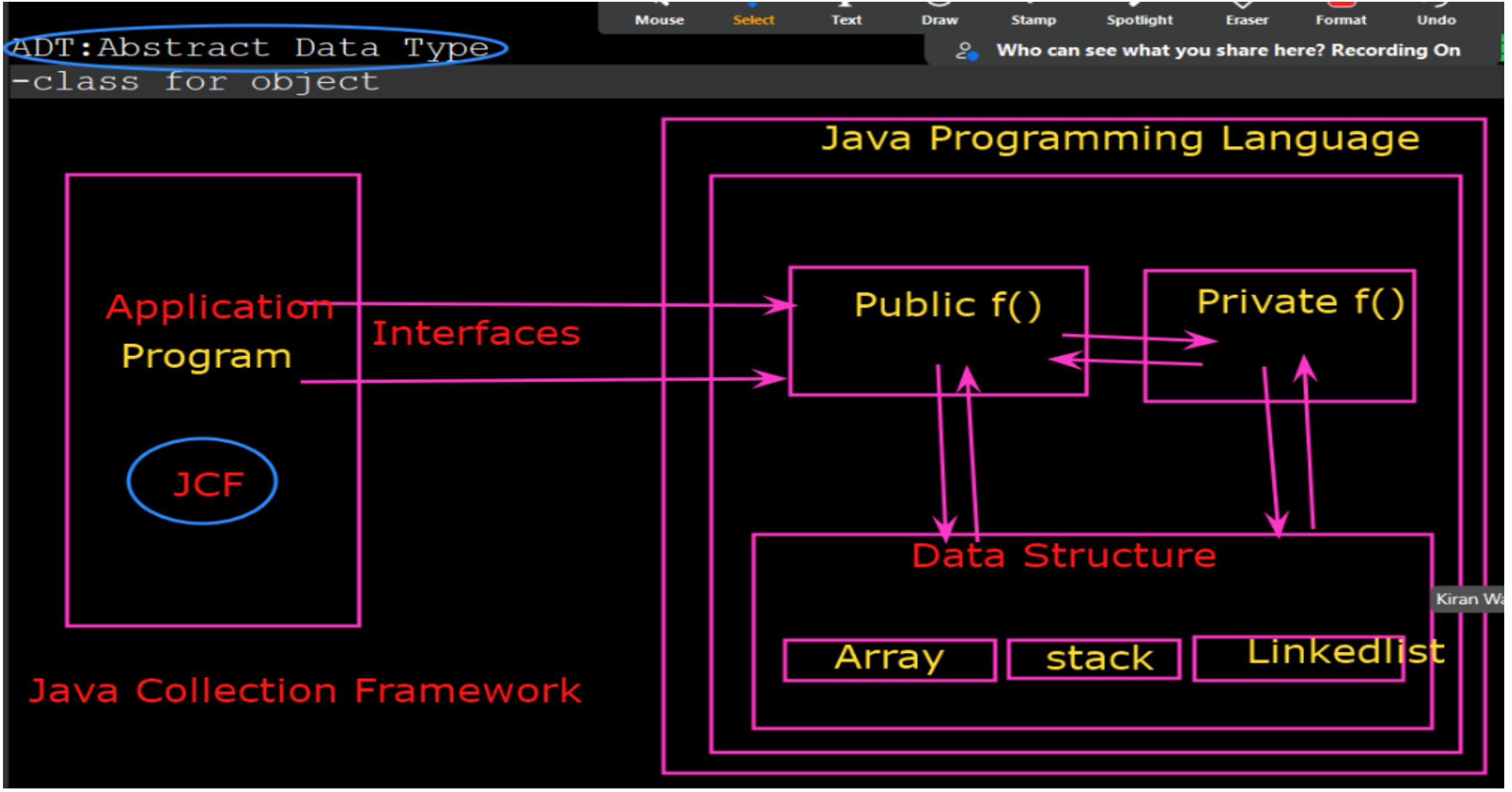
Invented or applied by many genius in CS

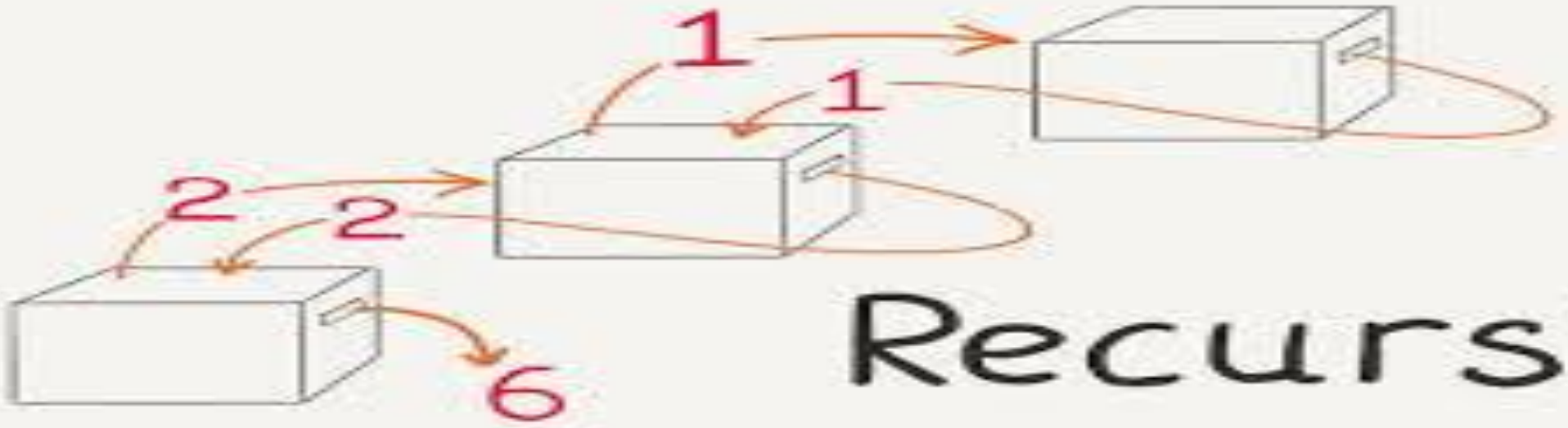
Mouse Select Text Draw Stamp Spotlight Eraser Format Undo

Who can see what you share here? Recording On

ADT:Abstract Data Type

-class for object

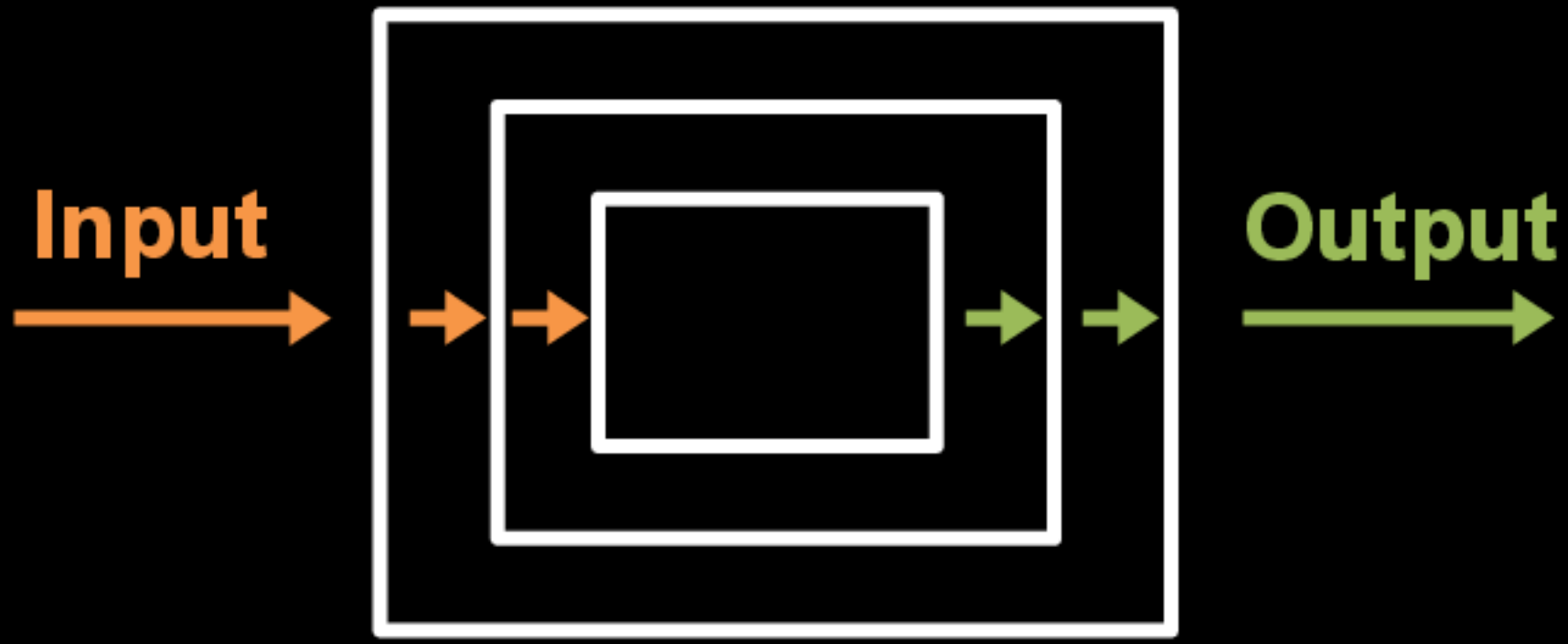




Topics

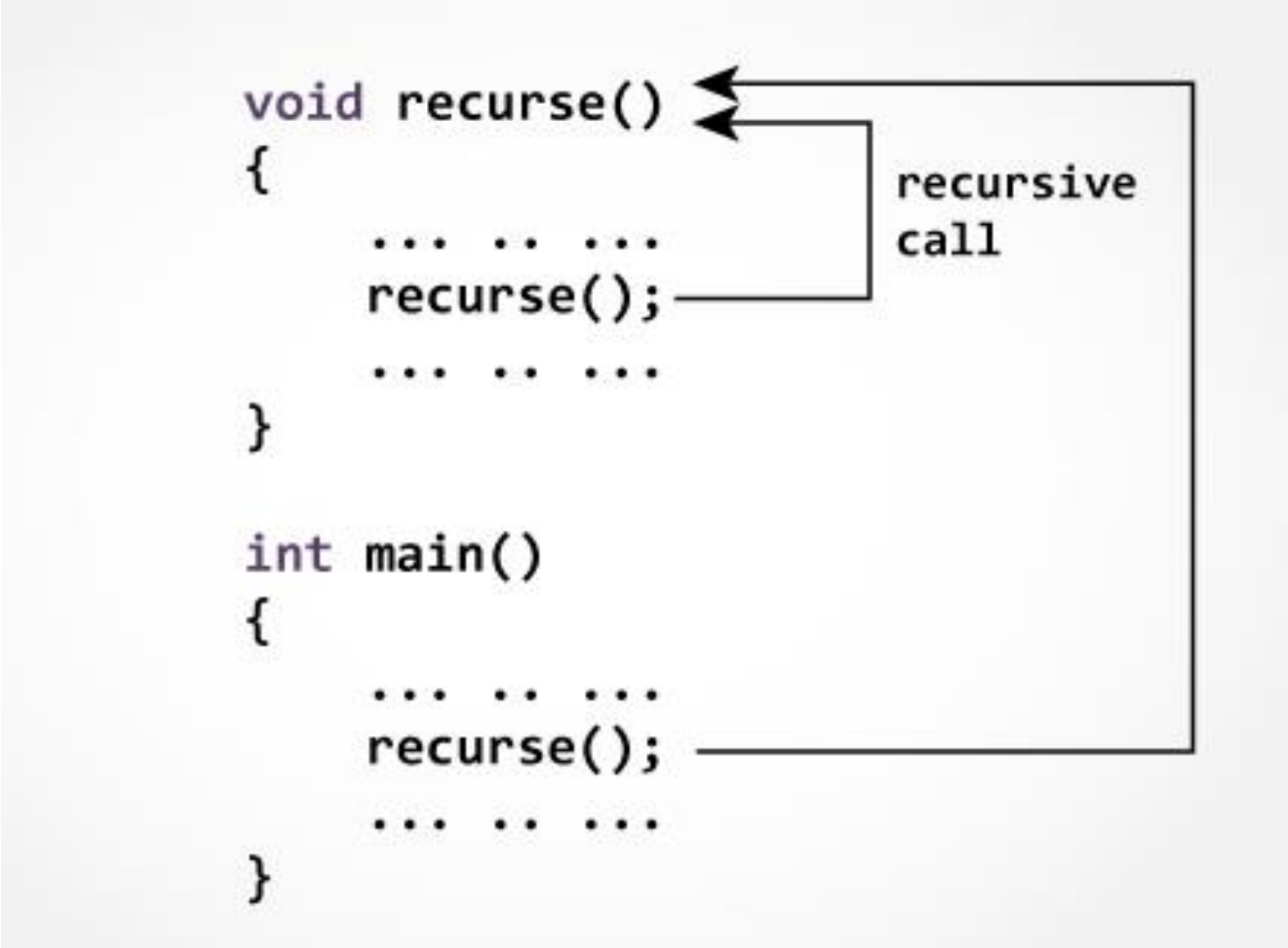
1. Recursive definitions and Processes
2. Writing Recursive Programs
3. Efficiency in Recursion
4. Towers of Hanoi problem.

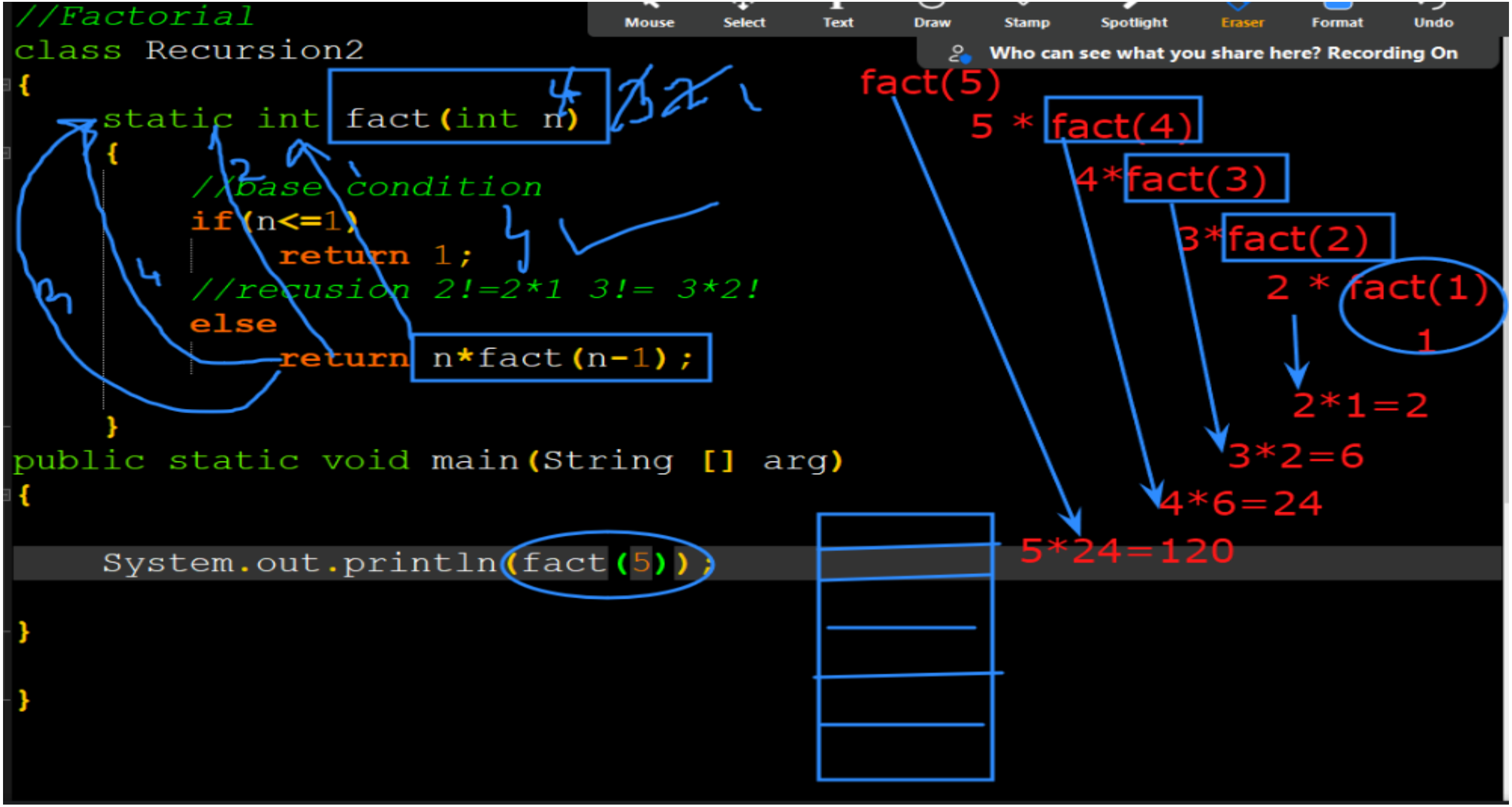
Recursion



- **What is Recursion?**
  The process in which a function calls itself directly or indirectly is called **recursion** and the corresponding function is called as **recursive function**.
- Using recursive algorithm, certain problems can be solved quite easily.
- Examples of such problems are
- Towers of Hanoi (TOH),
- Inorder/Preorder/Postorder Tree Traversals,
- DFS of Graph, etc.

How does Recursion works?




//Factorial
class Recursion2
{
static int fact(int n)
{
//base condition
if(n<=1)
return 1;
//recusion 2!=2*1 3!= 3*2!
else
return n*fact(n-1);
}
public static void main(String [] arg)
{
System.out.println(fact(5));
}
}
Mouse
Select
Text
Draw
Stamp
Spotlight
Eraser
Format
Undo
Who can see what you share here? Recording On
fact(5)
5 * fact(4)
4*fact(3)
3*fact(2)
2 * fact(1)
1
2*1=2
3*2=6
4*6=24
5*24=120