

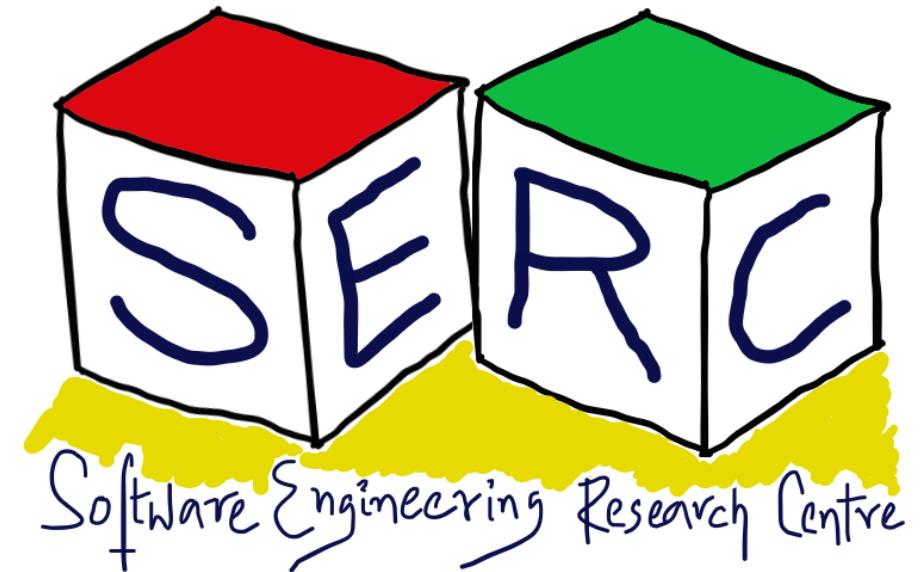
Introduction and Course Overview

CS6.401 Software Engineering

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Software-driven World

Software Driven World



Everything is increasingly powered by Software!



Smart bottles, watches



AI/GenAI platforms



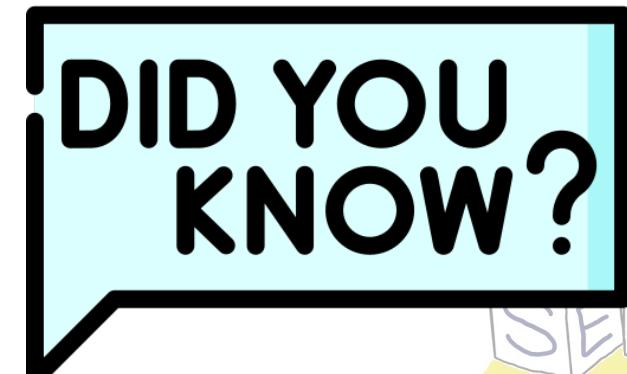
Boston Dynamics



Tesla Car in Autopilot mode

Some Interesting yet Serious Facts

1. About **70%** of the cost goes for software maintenance
2. Modern car runs **100 million** lines of code - Only going to increase!
3. Single autonomous car can generate up to **4000GB of data** per day!
4. By 2025, we will have **27 billion** connected IoT devices
5. > **50%** of the ML systems considered failures in production
6. Software emissions are equivalent to air, rail and shipping combined!!
7.





What is the big deal?

Let's draw some parallels

When do you say something is well engineered?

Functionality + Performance, Scale, Maintainability,.....

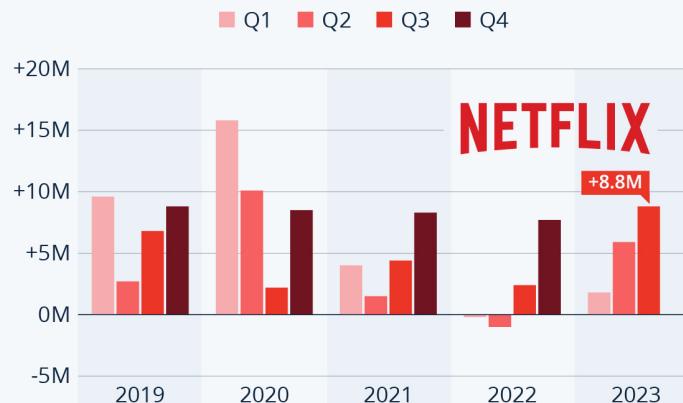
How Disney+ Hotstar managed its historic 5.9 crore concurrent viewership during WC finals

Mukund Acharya, Head of Technology, Disney+Hotstar, in an exclusive interview, revealed the tech behind Disney+ Hotstar's benchmark achievement during the ICC World Cup 2023.



Netflix Creates New Customers in Password-Sharing Crackdown

Net change in number of Netflix subscription, per quarter

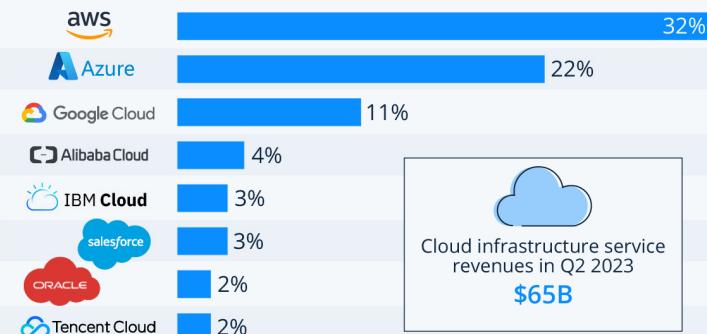


Source: Netflix



Amazon Maintains Lead in the Cloud Market

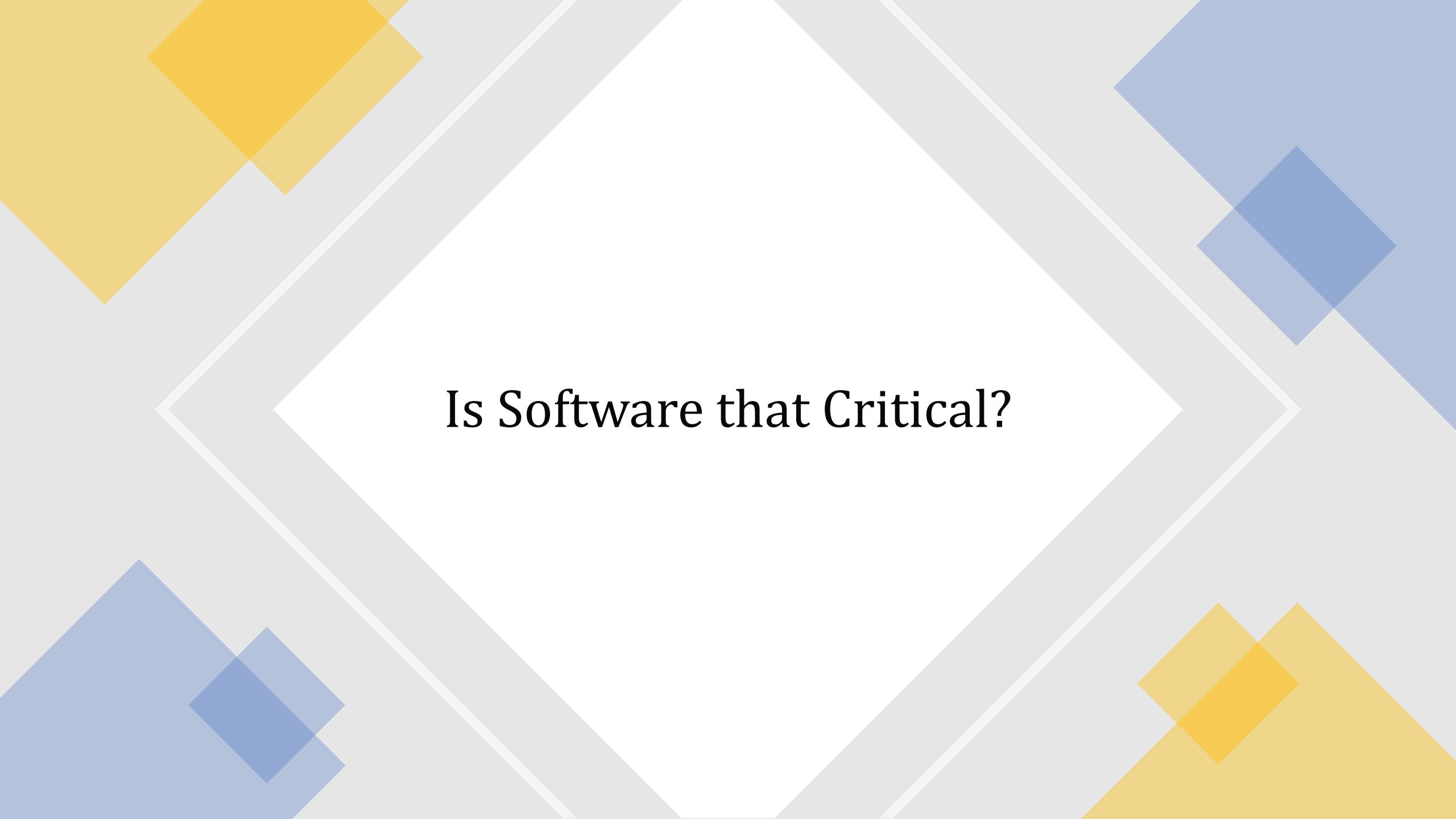
Worldwide market share of leading cloud infrastructure service providers in Q2 2023*



* Includes platform as a service (PaaS) and infrastructure as a service (IaaS) as well as hosted private cloud services

Source: Synergy Research Group





Is Software that Critical?

Few of the many software issues

TECH \ AMALUN \

Amazon Web Services says overwhelmed network devices triggered outage 7

Amazon says it plans to improve its response to outages

By Emma Roth | Dec 11, 2021, 3:34pm EST

Meta services are back ONLINE! Facebook, Instagram and WhatsApp were down for more than one hour worldwide that impacted thousands of users

- Facebook, Instagram and WhatsApp crashed around 11:30am ET on Friday
- The outage hit users worldwide who cited issues with websites and apps
- However, users also said they are unable to post on Facebook and Instagram

By STACY LIBERATORE FOR DAILYMAIL.COM

PUBLISHED: 17:34 GMT, 19 November 2021 | UPDATED: 18:28 GMT, 19 November 2021

Huge economical impact!!

Source: dailymail, google news

Few of the many software issues

Vox

r3c0de

Tesla needs to fix its deadly Autopilot problem

Tesla is facing heat from federal officials following an investigation into a fatal crash involving its Autopilot.

By [Rebecca Heilweil](#) | Feb 26, 2020, 1:50pm EST

Catastrophic software errors doomed Boeing's airplanes and nearly destroyed its NASA spaceship. Experts blame the leadership's 'lack of engineering culture.'

MORGAN MCFALL-JOHNSON

| FEB 29, 2020, 18:41 IST



Can be fatal!!

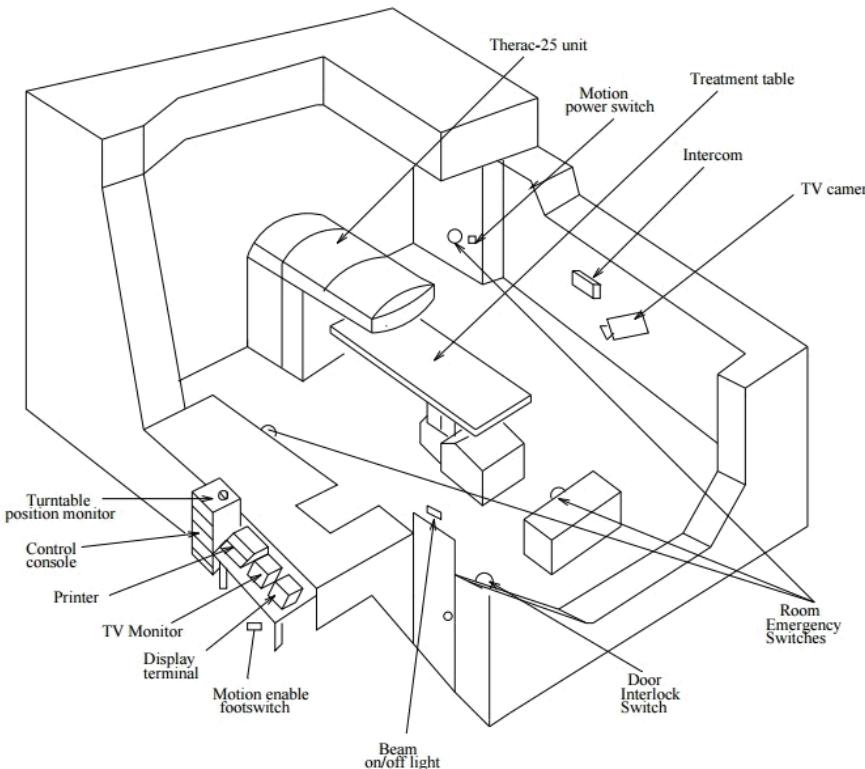


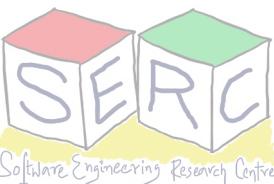
Figure 5: A typical Therac-25 facility after the final CAP.

Why Software Engineering?

Why Study Software Engineering?

- Acquire skills to understand and build high quality software systems
 - Systems could be large and complex - millions of lines of code
 - How to comprehend an existing system?
 - How to break a program into smaller and manageable parts?
 - Development of large and complex software requires teamwork
 - Achieve sufficient quality (eg: maintainability, performance, reliability etc.)
- Learn techniques: specification, designing, development, testing, project management, etc.

It's still a young discipline – The term “software engineering” was just coined in 1968



Software Engineer is not just another title

- Software engineer is considered as just another role sometimes
- Many countries require software engineers to go through a certification or licensing process
- Going forward software engineers will be dealing with more and more critical systems

Licensing is already in place in some countries for some specific SE roles!!

Licensing Professional Software Engineers: Seize the Opportunity

By Phillip A. Laplante

Communications of the ACM, July 2014, Vol. 57 No. 7, Pages 38-40

10.1145/2618111

[Comments \(1\)](#)

VIEW AS:



SHARE:



In his July 2013 *Communications* column, ACM President Vint Cerf revisited the controversy of licensing professional software engineers in the U.S. This issue has been one that divides the profession since reasonable cases can be made both pro and con. Officially, ACM has opposed and IEEE has supported such licensure. Even within both organizations, though, there is substantial support and opposition.^{1,2,3,5} I think President Cerf was right in suggesting that, because of the dramatic growth in interacting software in both devices and in applications that significantly impact peoples' lives, and more importantly, because licensing is happening, we have reached a tipping point.

[SIGN IN for Full Access](#)

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MORE NEWS & OPINIONS

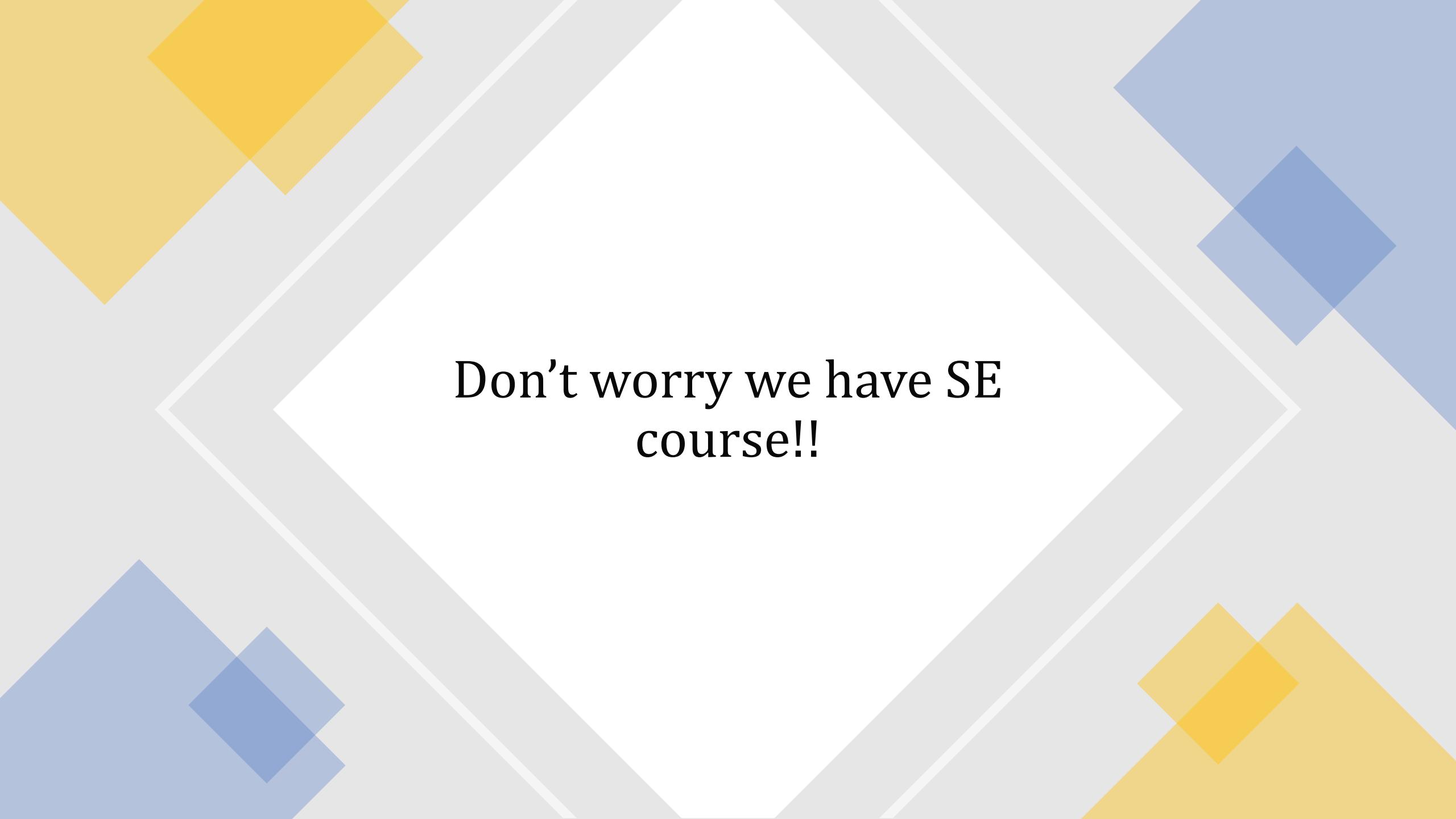
[Hundreds of Windows Networks](#)

[Infected with Raspberry Robin Worm](#)

PC Magazine

[Mobile-App Privacy Nutrition](#)

[Labels Missing Key Ingredients](#)



Don't worry we have SE
course!!

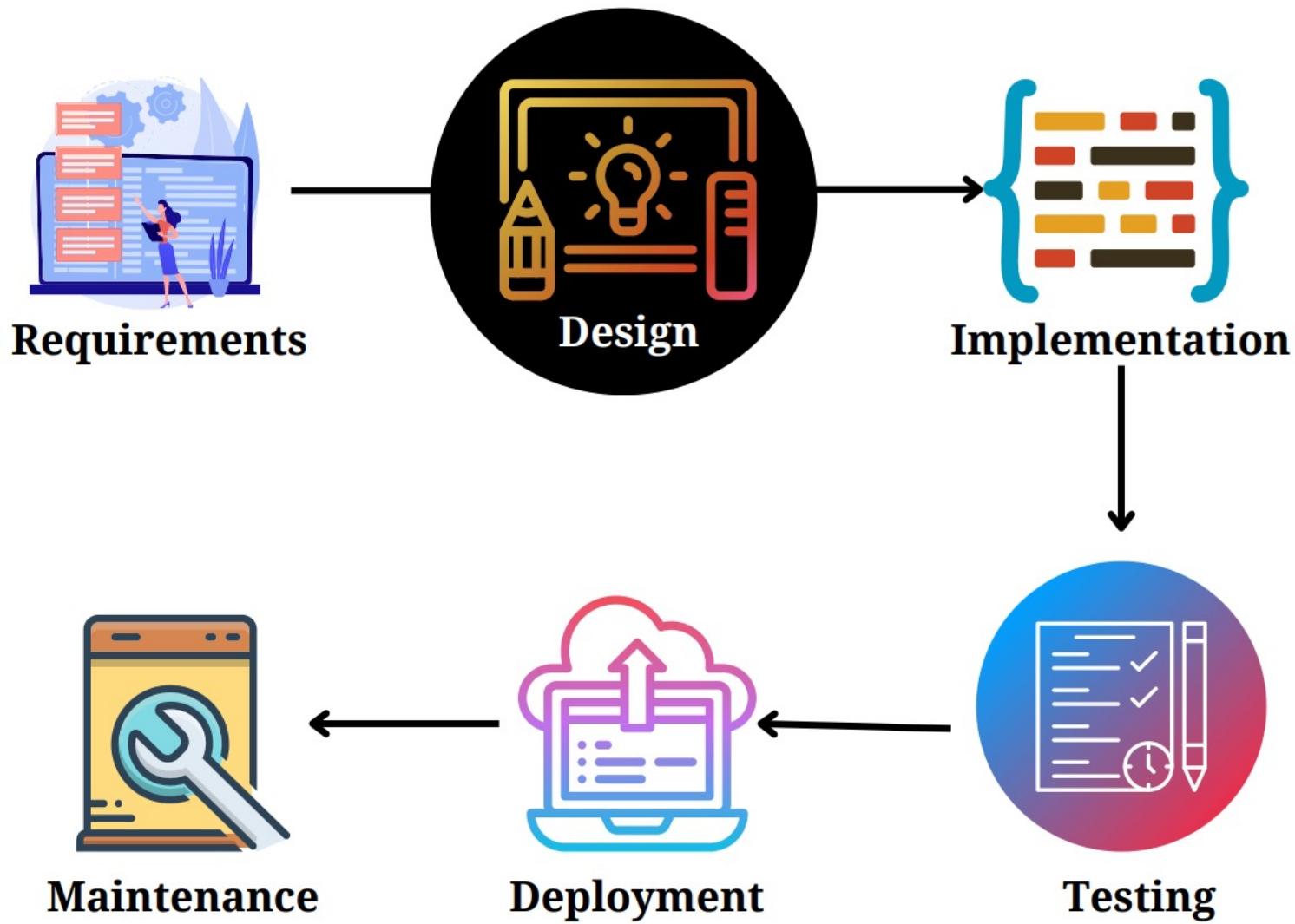
What probably you have done so far?

- IIIT Undergrad: Introduction to software systems (ISS), low level OO principles and some high-level design in Design and Analysis of Software Systems (DASS)
- Grads at IIIT: Problem solving course and Software Systems Development
- Others: Some software development experience or an undergrad course in software/systems engineering or similar courses

Minimum Prerequisites

1. Basic idea on: Abstraction, Modularization/Decomposition, Coupling, Cohesion, etc.
2. Some programming language(s) (eg:, python, JS etc.)
3. Basic OO principles and implementations: Encapsulation, inheritance, Polymorphism
4. At least 1 OOP language, & 1 RDBMS.
5. Idea about various phases in SDLC
6. Minimal knowledge of practices: Version control, bug tracking, task management, etc.

Software Development Lifecycle





This course is about
Software Design!

What kind of design? - Lets' take an Example

Assume that there are two strings, string1 = “user” and string2 = “password”. Write a simple program that takes two strings, inputString1 and inputString2 as inputs and compares them with string1 and string 2 respectively. If the strings match, then output should be true, else False

Sample input

user password

This is a simple string match program!!!

Sample Output

True

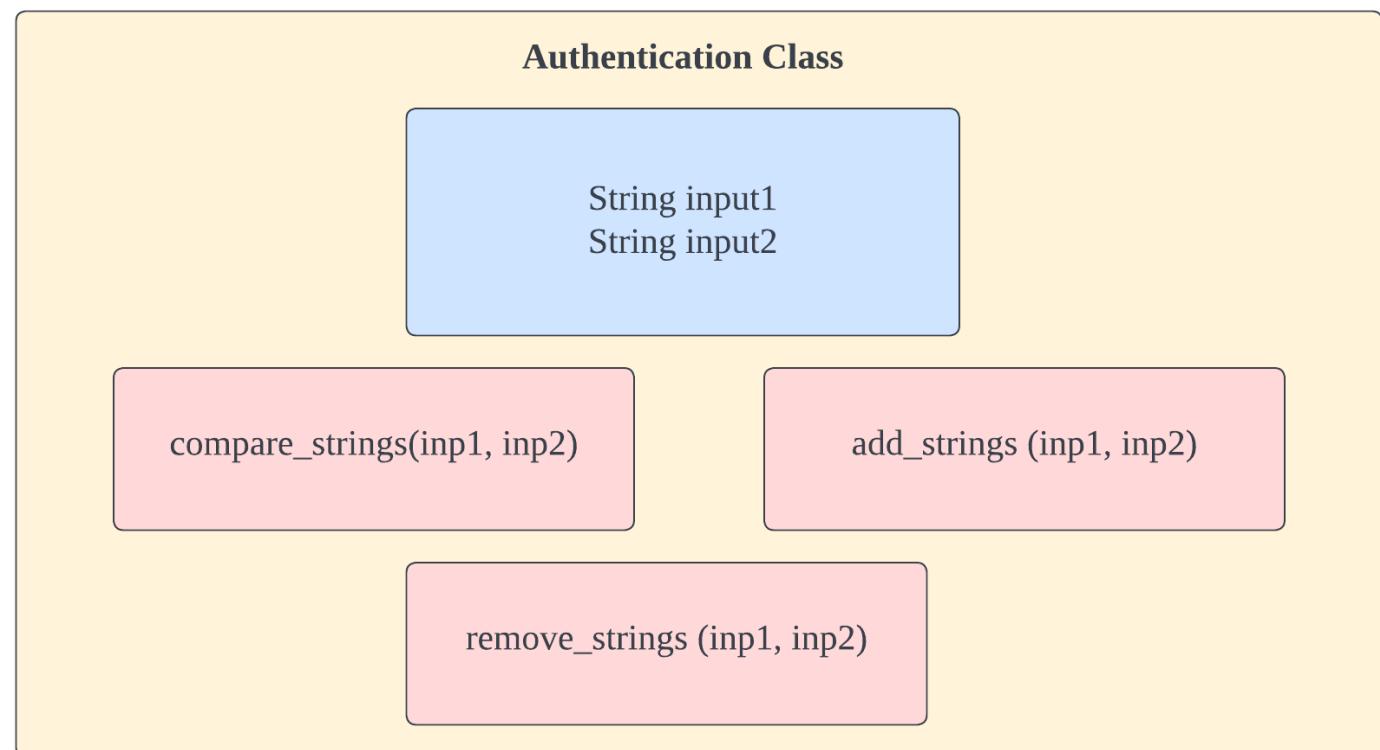
compare_strings(inp1, inp2)

Not at this level!!

What kind of design? - Lets' go little more higher

Modify the above into an authentication module. You should be able to add two new strings (username, password) and the program should be able to find a match given two strings.

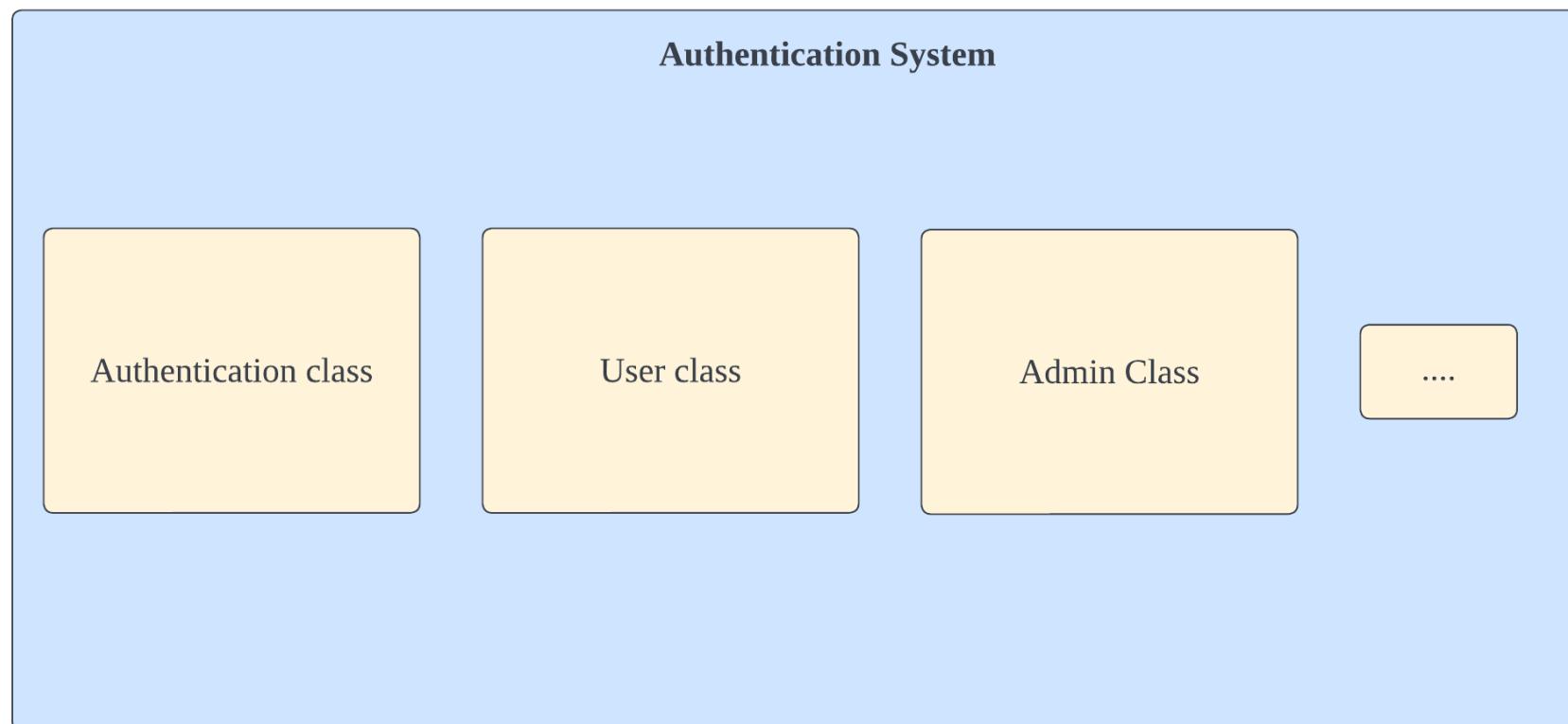
Little at this level!!



What kind of design? - Lets' go little more higher

Modify the above into an authentication system. Any user should be able to register and login. The system should support multiple types of user

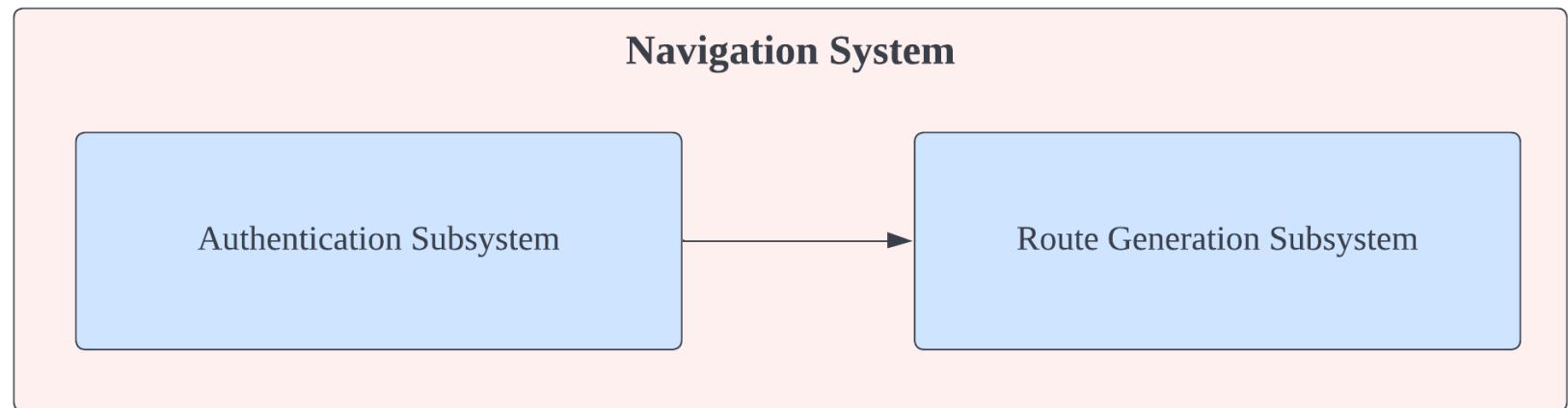
Yes, this level!!



What kind of design? - Lets' go even further higher

Assume that there is another sub system that allows users to find the shortest path between two given cities. Now, integrate this with the authentication system.

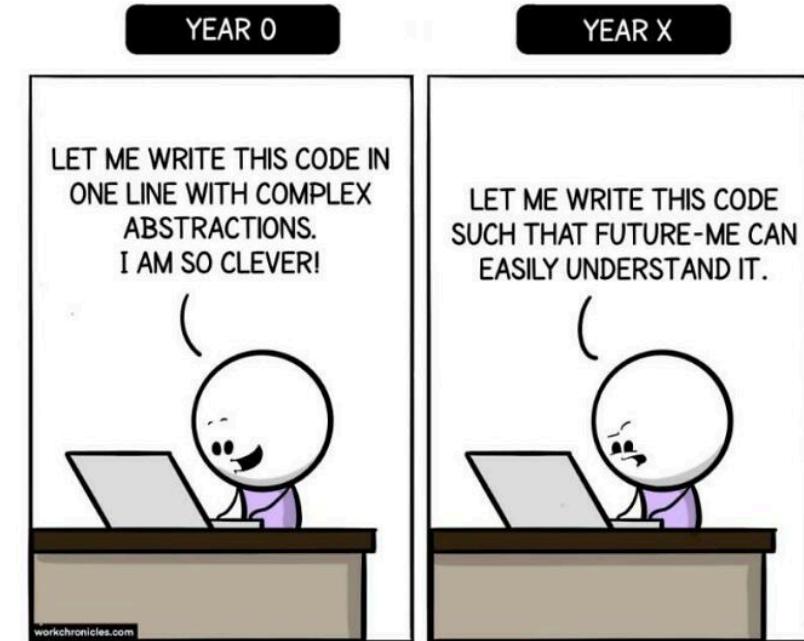
Yes, this level!!



What all needs to be considered? – scalability, performance, reliability,....

Why Design is important?

- It is like technical kernel of Software engineering
- Ensures traceability between requirements and final product
- Allows to have a complete picture of the software before construction
- Allows to discuss, confirm, reason and perform different analysis even before development - **why?**



*“Software is **not limited by physics**, like buildings are. It is **limited by imagination, by design**, by organization. In short, it is limited by properties of people, not by properties of the world. We have **met the enemy, and he is us**”*



Ralph Jhonson

Martin Fowler, *Who needs an Architect?* IEEE Software, 2003

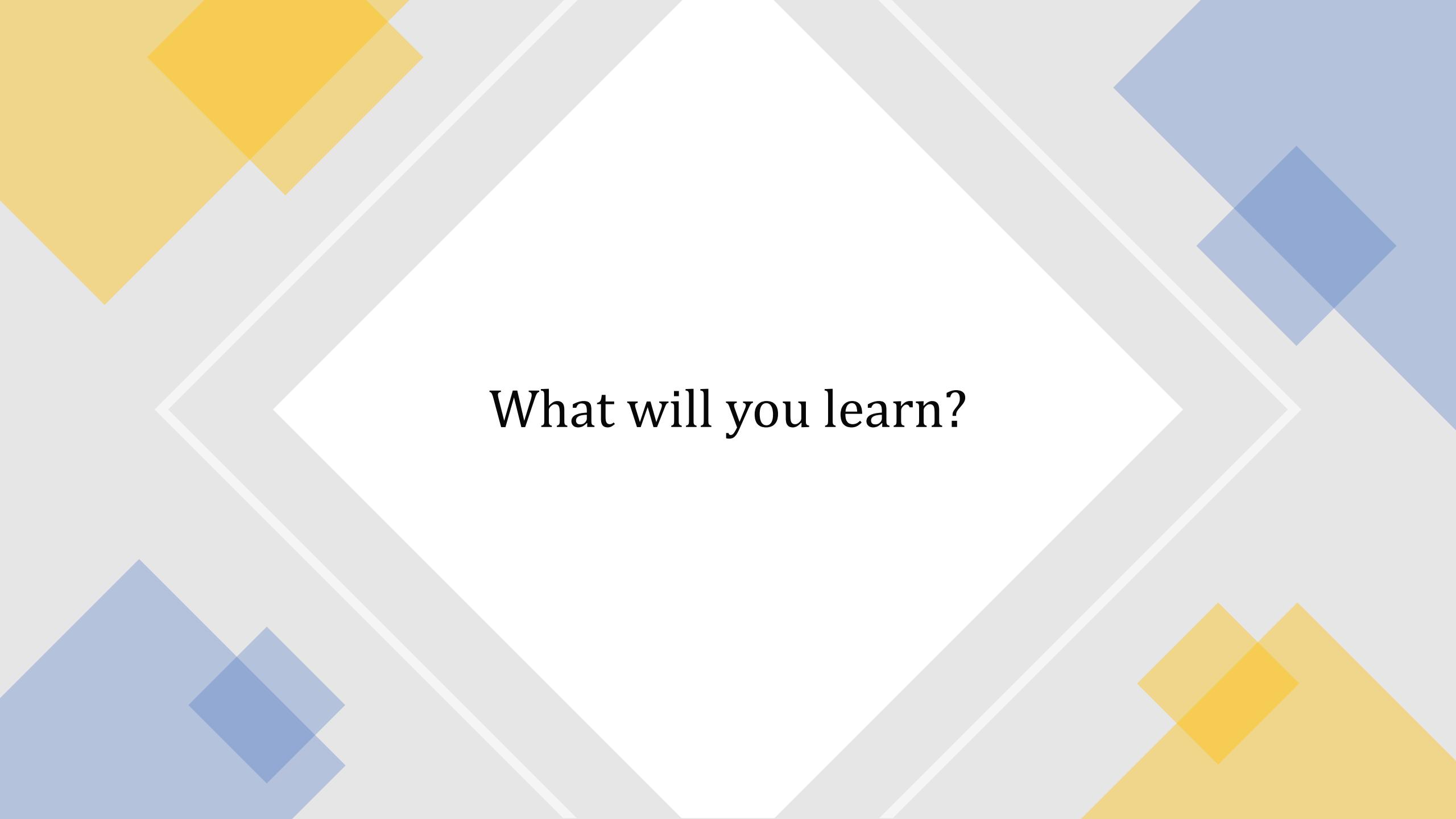
SE - Major Principles

Abstraction

1. Focus on the relevant parts of the problem
2. Helps simplifying the problem and look at a larger picture

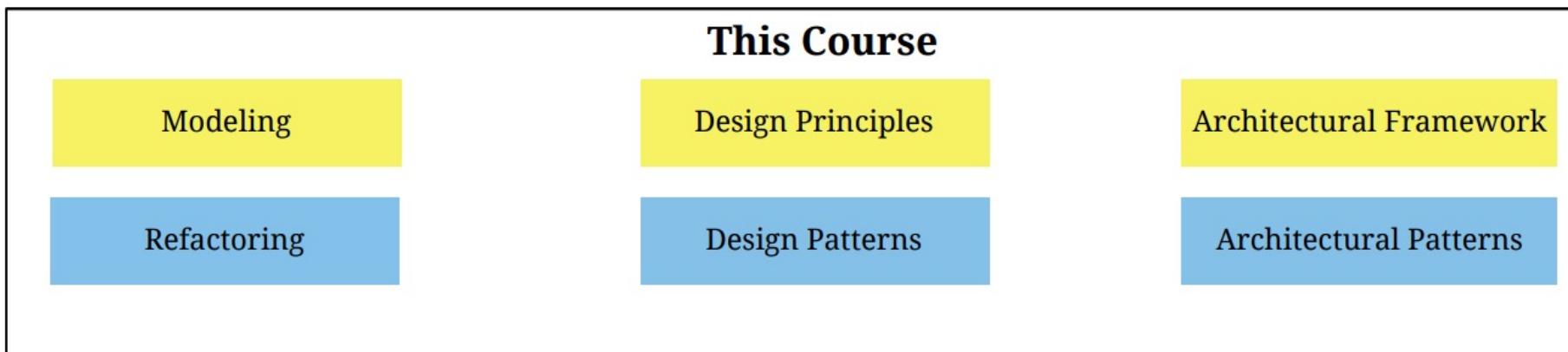
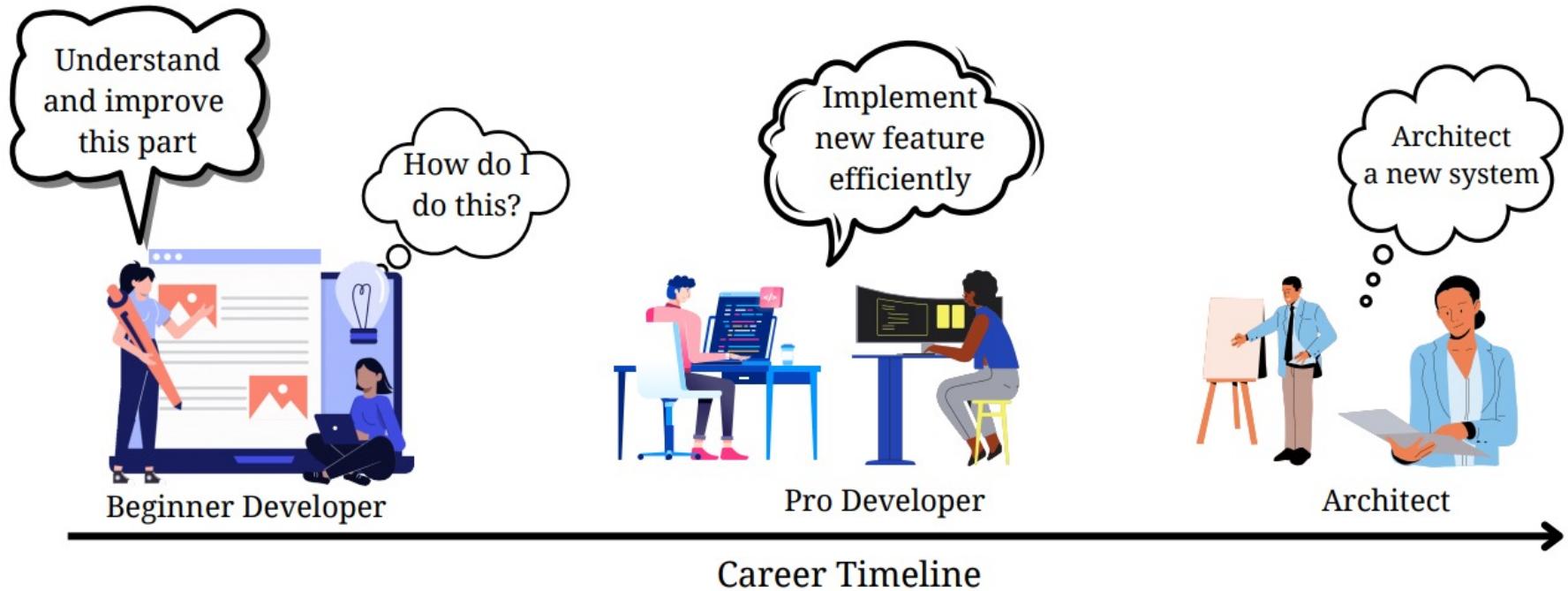
Decomposition

1. Decompose problem into small and independent pieces
2. Each pieces can be solved separately
3. The overall solution can be attained by solving smaller pieces and putting them together



What will you learn?

Course Outline



Course Outline

How to comprehend existing software subsystems?

- Applying principles of refactoring

How to design software systems through abstractions and decompositions?

- Design Patterns and Architectural Patterns

How to apply them to your application?

- Deal with subsystems at higher level of abstraction provided by patterns

What if there is no exact match for a given problem?

- Evaluate alternatives and analyze trade-offs

How to capture and document the design decisions?

- Both at low level and high level

Teaching and Learning Methodology

- Problem based learning methodology
- A blend of conceptual lectures with group/individual activities
- This has been a working formula
 - Learners engage in the materials
 - Hands on activities enables deeper understanding
 - Resembles the true career situation

Start forming the teams!!

Meet the Team



Karthik



Ayush



Mayush



Sai Venu



Seshadri



Shubham



Siddharth

Distribution of Grades

Component	Weightage
Final Exam	20%
Mid-term Quiz	10%
Assignments	15%
3 Unit Projects (3*15)	45%
Other In-class activities	10%

Note: The instructor reserve the right to make minor changes
No extension requests please - **Extra days and soft deadlines!!**

Course Logistics

- Course announcements, management - 
- All resources, information and materials - 
https://karthikv1392.github.io/cs6401_se/
- At any point, feel free to contact either the instructor or TA
- Instructor office hours (Thursday 11:00 AM to 12:00 PM)
- Feedbacks are always welcome!!

Thank You



Course website: karthikv1392.github.io/cs6401_se

Email: karthik.vaidhyanathan@iiit.ac.in

Web: <https://karthikvaidhyanathan.com>