CS3213 Project – Week 3

Requirement Modeling | 26-01-2022

- ❑ Discussion Requirement Elicitation
- ❑ Discussion Requirement Models
- ❑ Comments to Software Architecture
- ❑ Assignment 3
- ❑ Assignment 4

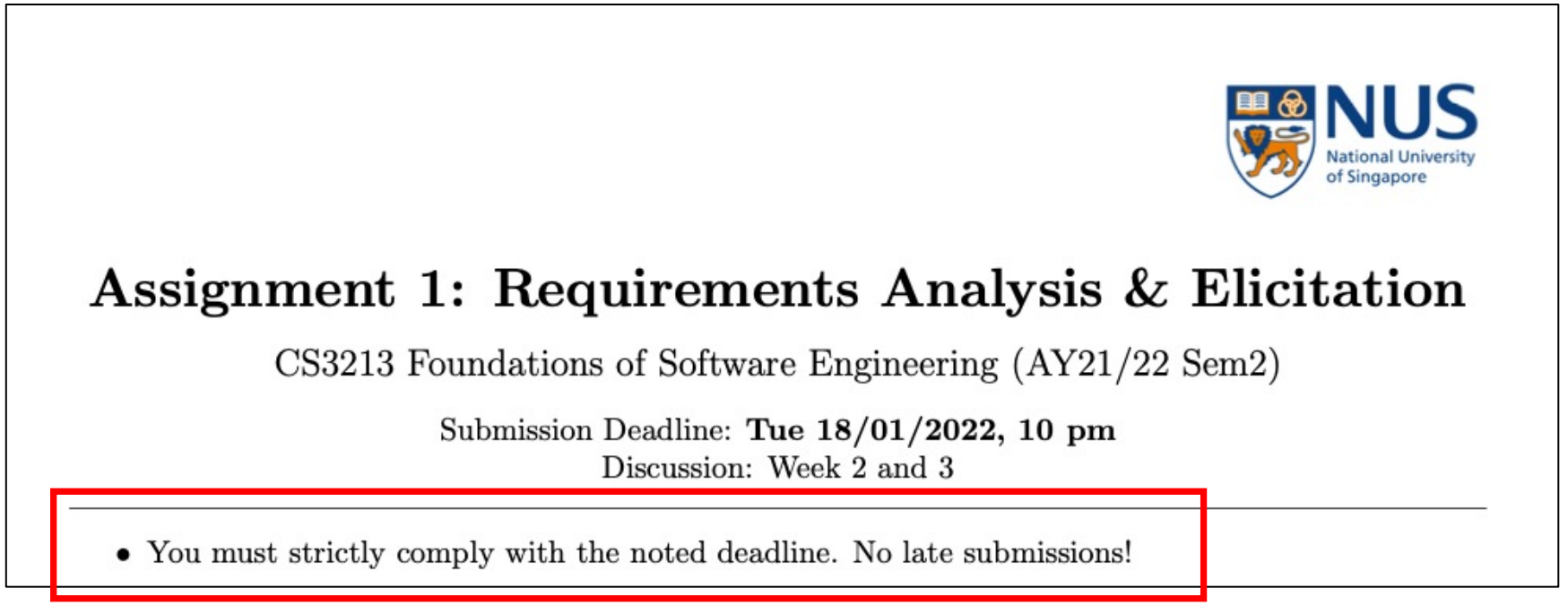
Group & Project Selection Deadlines

~~**Deadline** for group registration[1]:~~
~~**Friday, Jan 21, 10 am**~~

Deadline for project selection[1]:
Friday, Jan 28, 10 am

[1] https://docs.google.com/spreadsheets/d/15sk6WnvQHTjClhMi_TUuyDkylow6lOmMHVhD5n3Qu-I/edit?usp=sharing

Comment for „late“ submissions



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Assignment 1: Requirements Analysis & Elicitation

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Tue 18/01/2022, 10 pm**
Discussion: Week 2 and 3

- You must strictly comply with the noted deadline. No late submissions!

→ See CS3213 assignments as a project and manage your deadlines accordingly.

Sidenote: also check the naming scheme!

Last two weeks

- ❏ A1: Requirements Analysis & Elicitation
- ❏ Requirements Elicitation with Stakeholders
- ❏ A2: Requirements Modeling

Requirements Analysis & Elicitation

will be discussed in the lab sessions

some remarks today

Requirement Elicitation – Closing Remarks

- ❏ begin **gentle** and proceed with **caution**
- ❏ prepare your **catalogue of questions** and ask **systematically**
- ❏ reveal **contradictions**
- ❏ **special cases** usually require more effort as the default case – you need to explore **all eventualities** in the system **with** the customer
- ❏ do not forget the **„as-is“ state**
- ❏ Jewish motherhood (example of the *door access system*)

Discussion: Requirement Models

- *submitted models will be discussed in the lab sessions*
- different models have different **purposes**
  - Goal Model: Stakeholders become more aware of potential alternatives for meeting their goals, and are therefore less likely to over-specify by prematurely committing to certain technological solutions.
  - Use Case Model: overview functional features of system, easy understandale description of scenarios and special cases
  - Activity Diagram: process flows and their actions/activities
  - Sequence Diagram: interaction between objects
  - State Transition Chart: object states and their transitions
  - …

Common Modeling Purposes

- clarifying requirements
  - modeling techniques need to support "why" and "how else" types of reasoning analysis
  - incremental process
- provide traceability of rationales
- management of change
- verification of achievement of requirements
- support of reuse

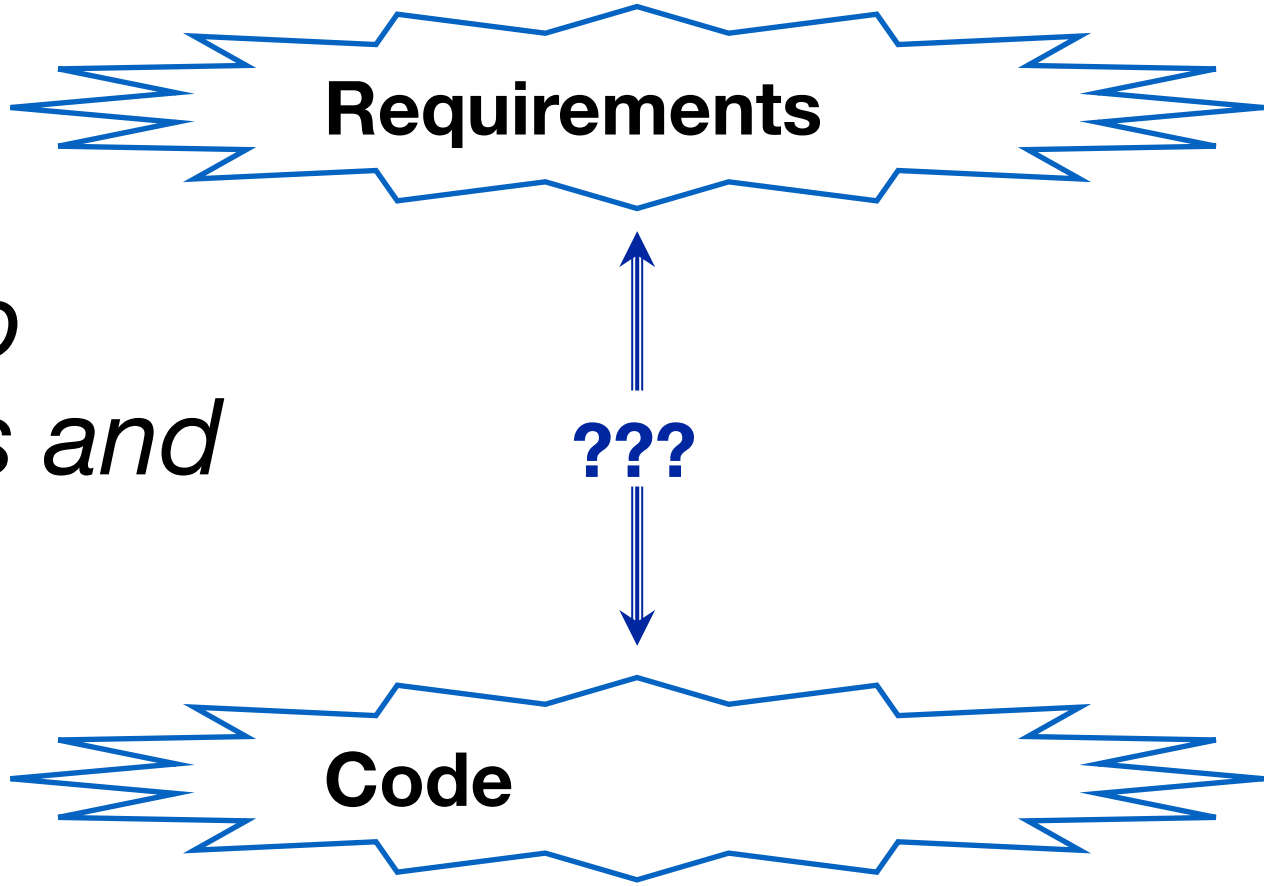
Requirement Engineering – Common Challenges

- ❏ Limited access to project stakeholders
- ❏ Project stakeholders do not know what they want
- ❏ Project stakeholders change their minds
- ❏ Conflicting priorities
- ❏ Developers don’t understand the problem domain
- ❏ Developers don't understand the requirements

Any remaining question about requirements engineering?

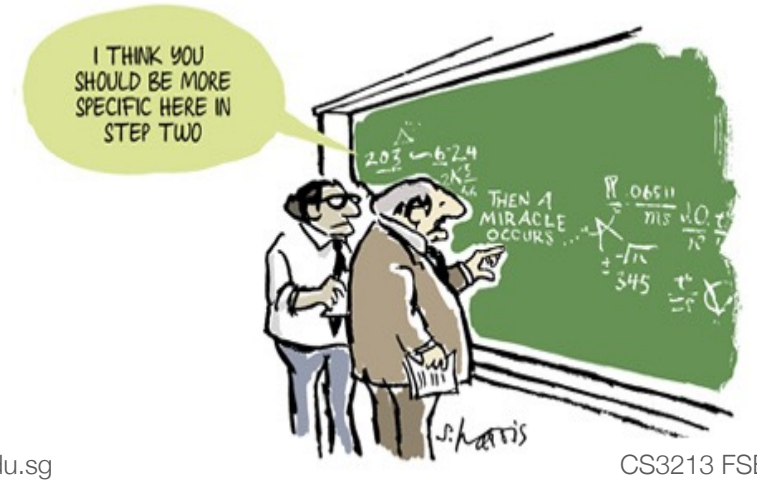
Comments to Software Architecture

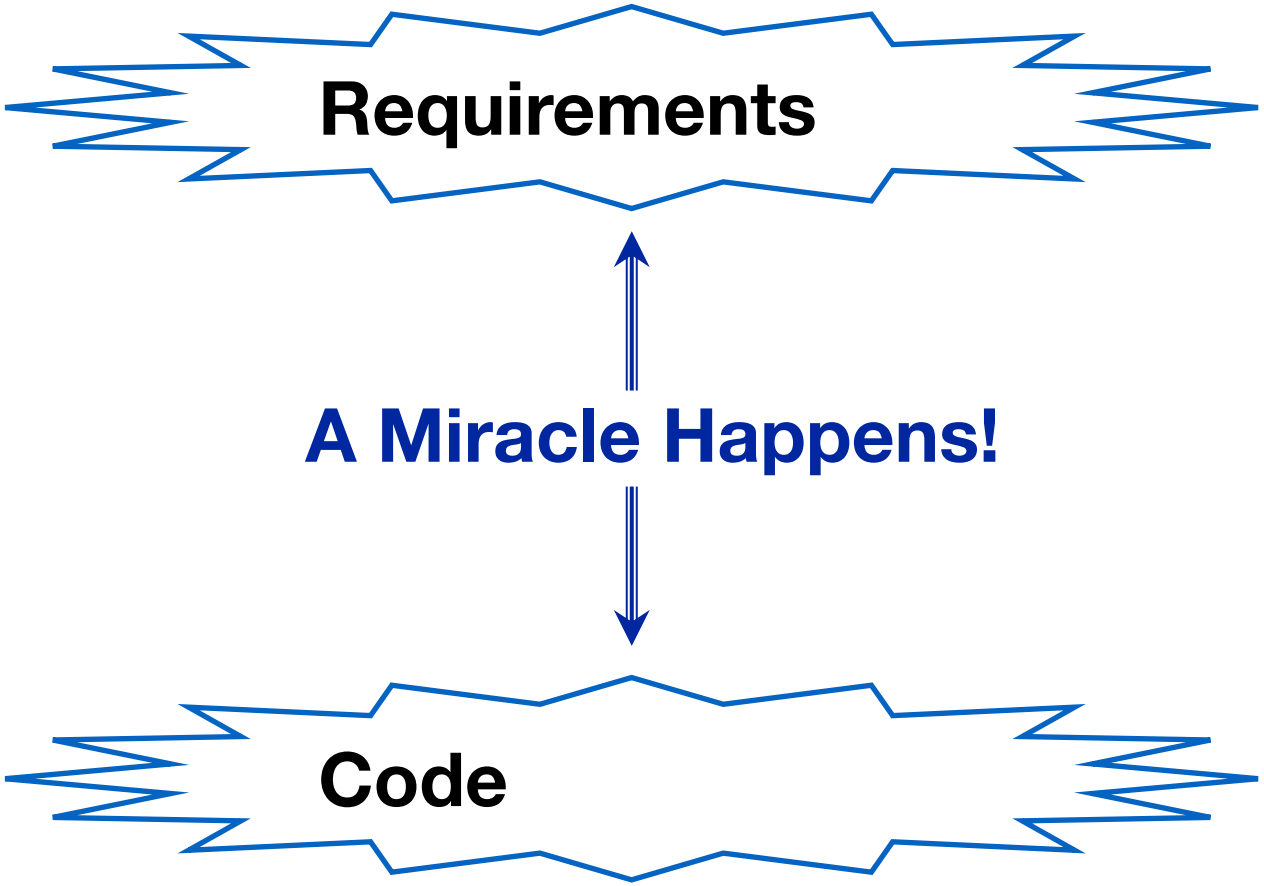
How to bridge the gap between requirements and code?



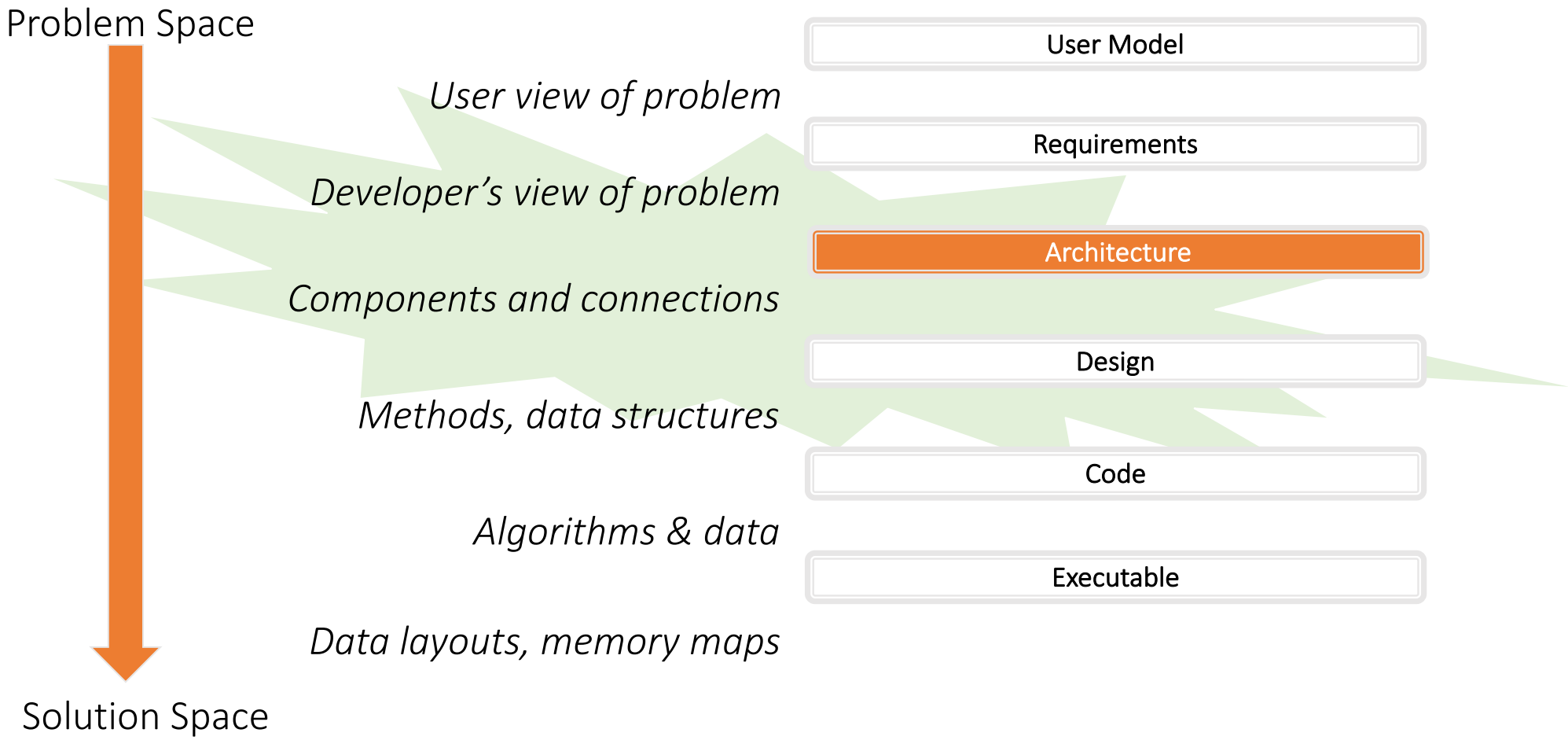
The Traditional Answer

- ❑ Ad hoc
- ❑ Requires gurus
- ❑ Unpredictable
- ❑ Costly

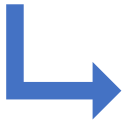




Role of Software Architecture: Bridging the Gap



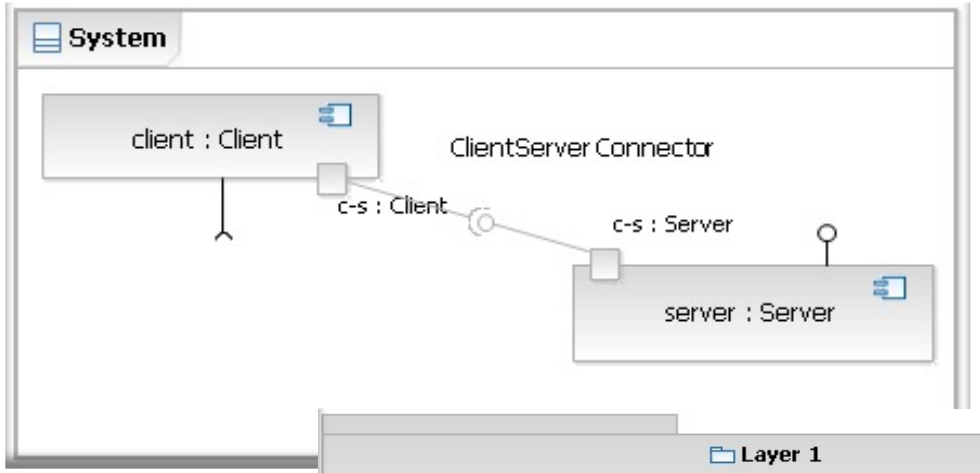
Architecture as Tool for Managing Complexity

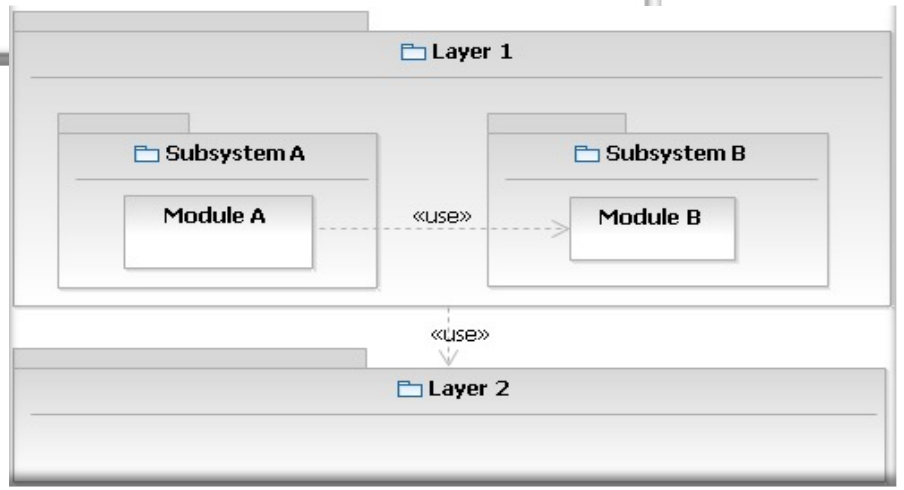


is a result of software engineering challenges and software's nature (overlay of all challenges, imprecise specifications, …)

Let's view *Software Architecture* as *conceptual tool* for dealing with the **complexity**. That is, architecture is a set of concepts which impose **order on complexity**.

Stuctures!





- ❑ What elements are there?
- ❑ How are they interconnected?
- ❑ What does the connection mean?

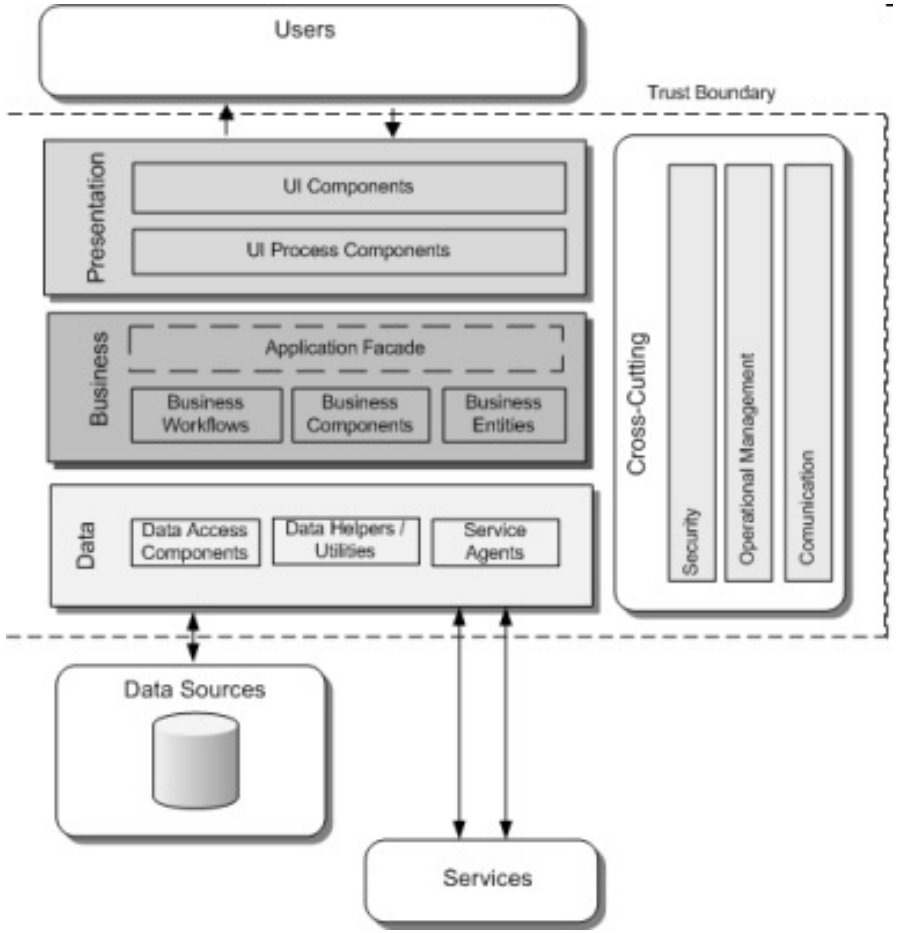
Overall conceptual idea:

→ Each part can be built fairly independently of the other parts

→ However, these parts must be put together to solve the larger problem in the end

Static Structures: Focus on Components

- E.g. layered architecture
- Typical example often found in practice
- Meaning of boxes and lines is not defined
- Incomplete representation of relationships existing in the presented structure



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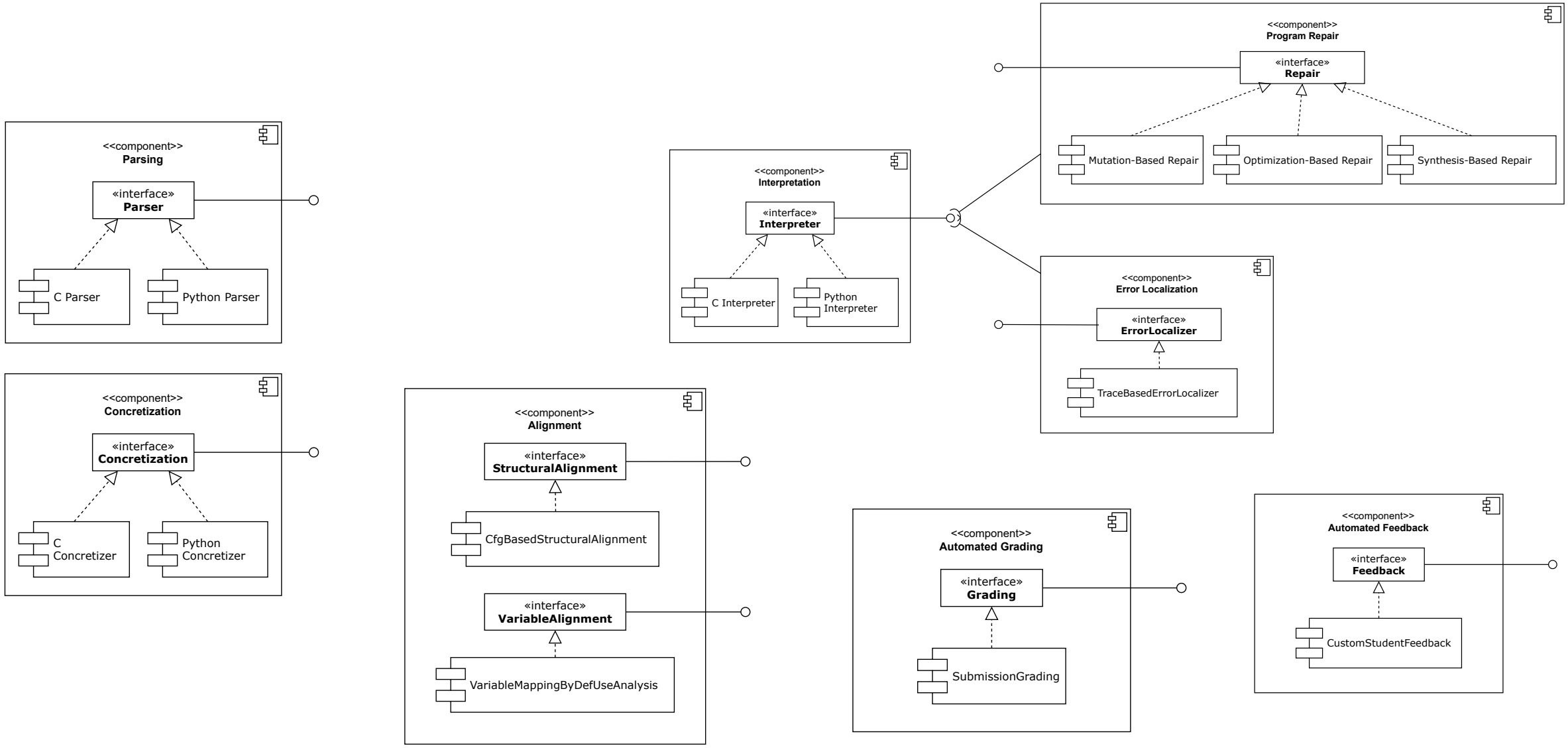
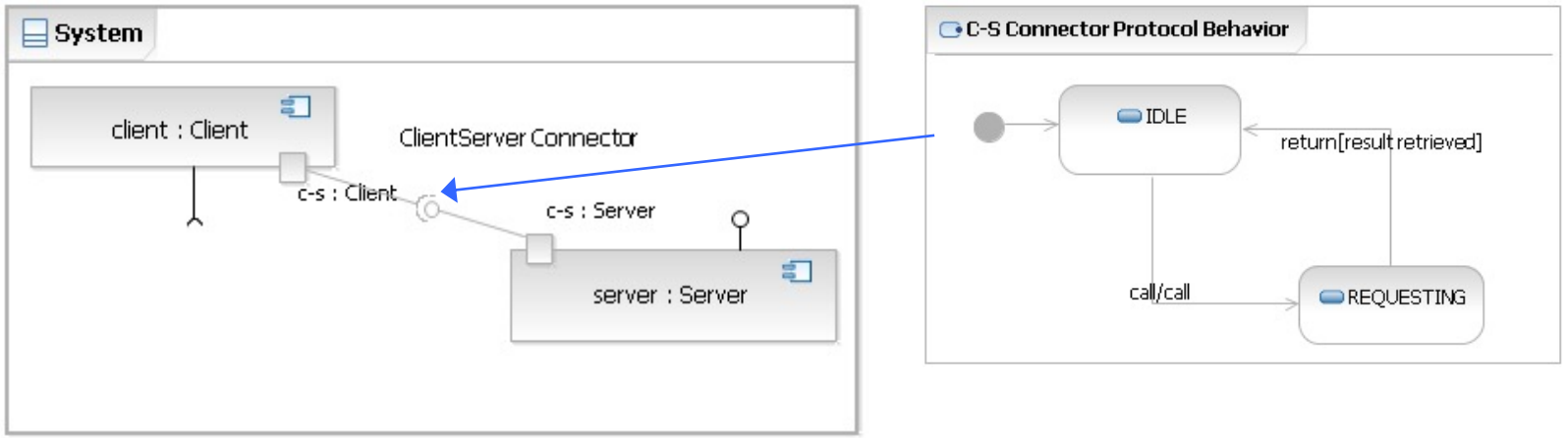
Static Structures

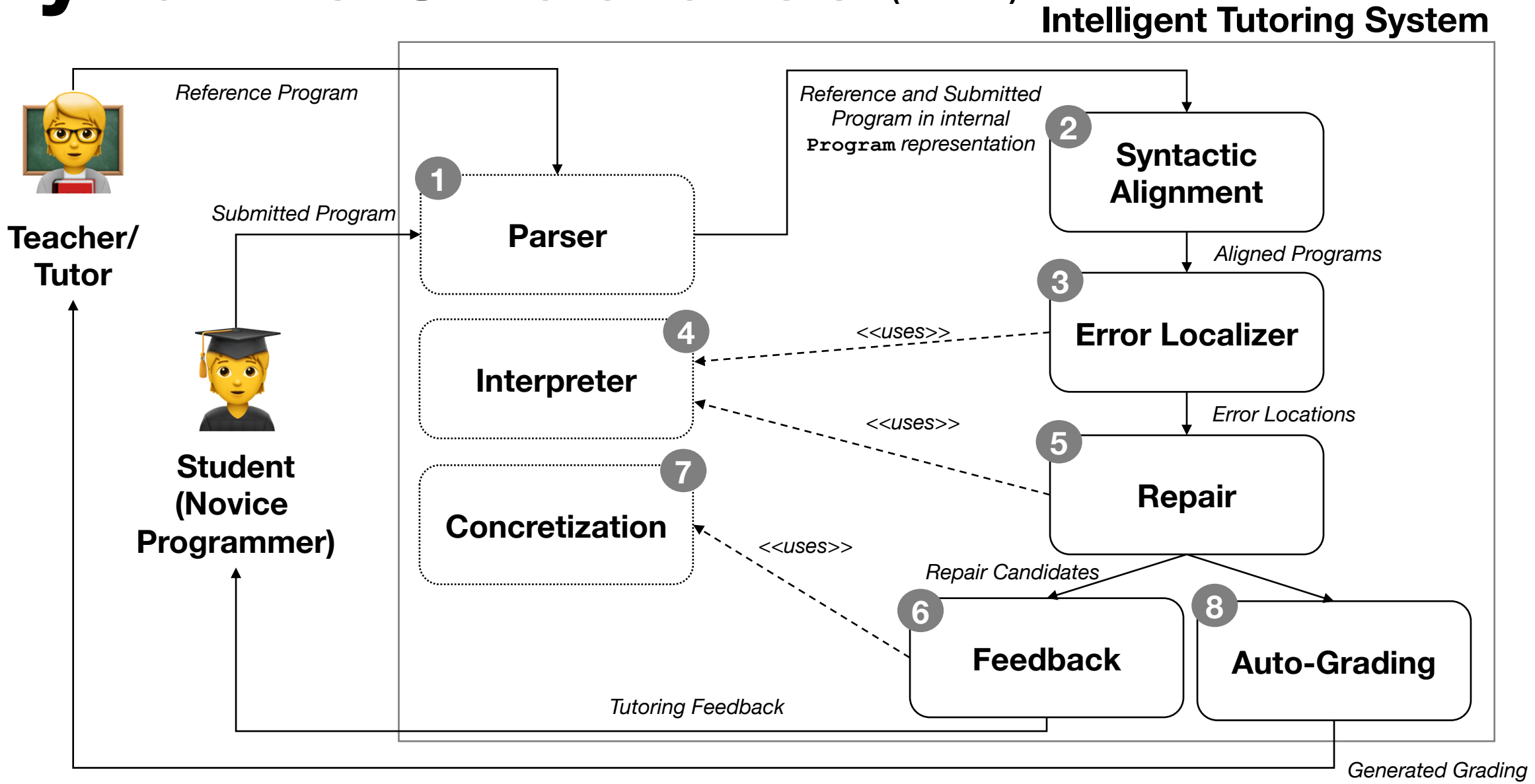


Dynamic Structures: Focus is On Connectors

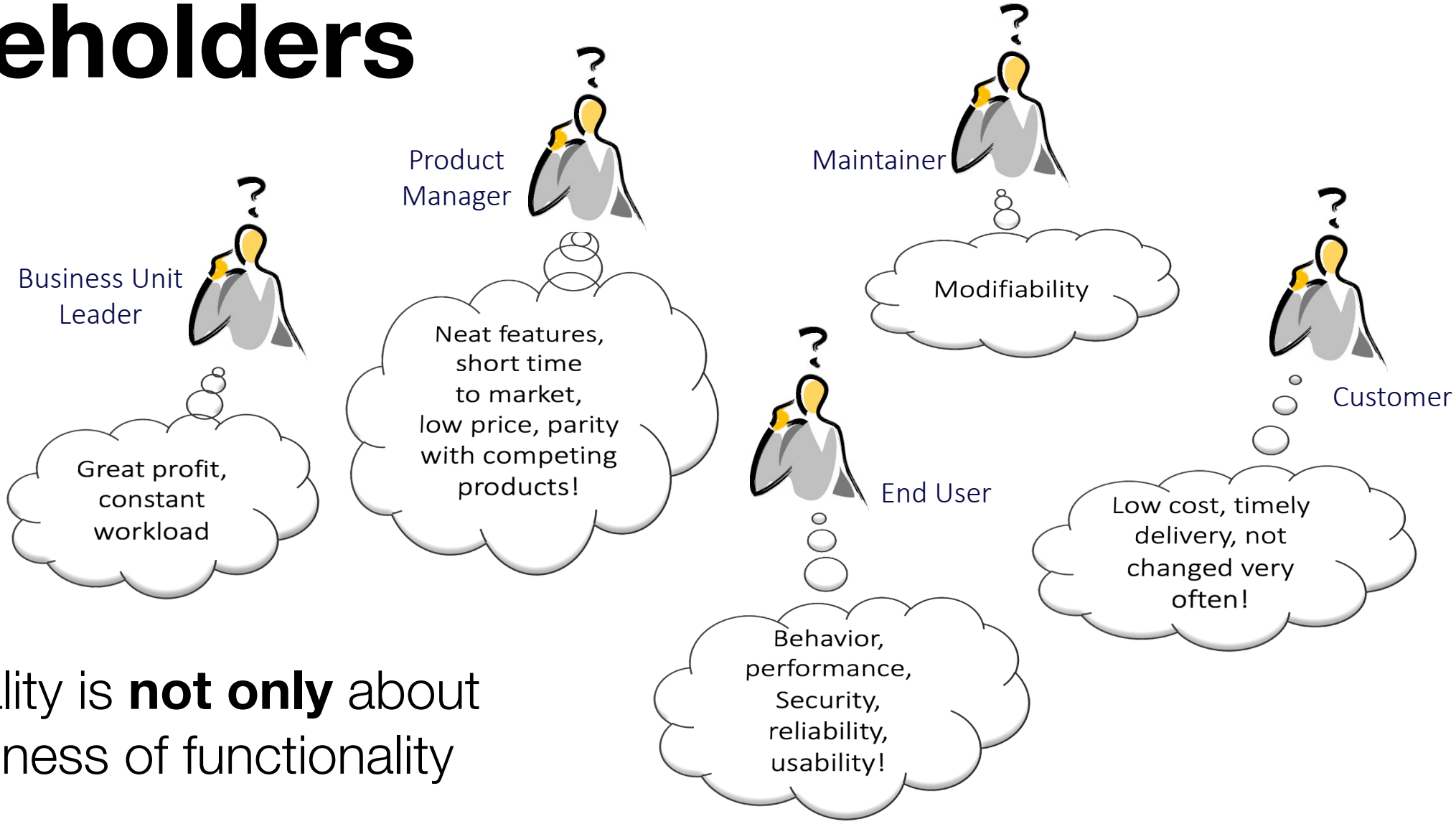
- What is behind relationships?
- How do elements communicate?
- What assumptions do elements make?



Dynamic Structures (informal)



Potential Concerns of Some Stakeholders

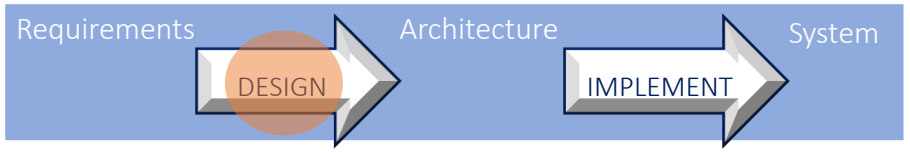


→ Quality is **not only** about correctness of functionality

Architecture Essentials – Design Principles

- ❏ Abstraction
- ❏ Separation of Concerns
- ❏ Decomposition: divide & conquer
- ❏ Modularization: coupling & cohesion
- ❏ Encapsulation: information hiding
- ❏ Well-Defined Interfaces
- ❏ Architectural Styles
  - Pipe-and-Filter
  - Shared-Data
  - Publish-Subscribe
  - Client Server Style
  - Peer-to-Peer Style
  - Communicating-Processes Style

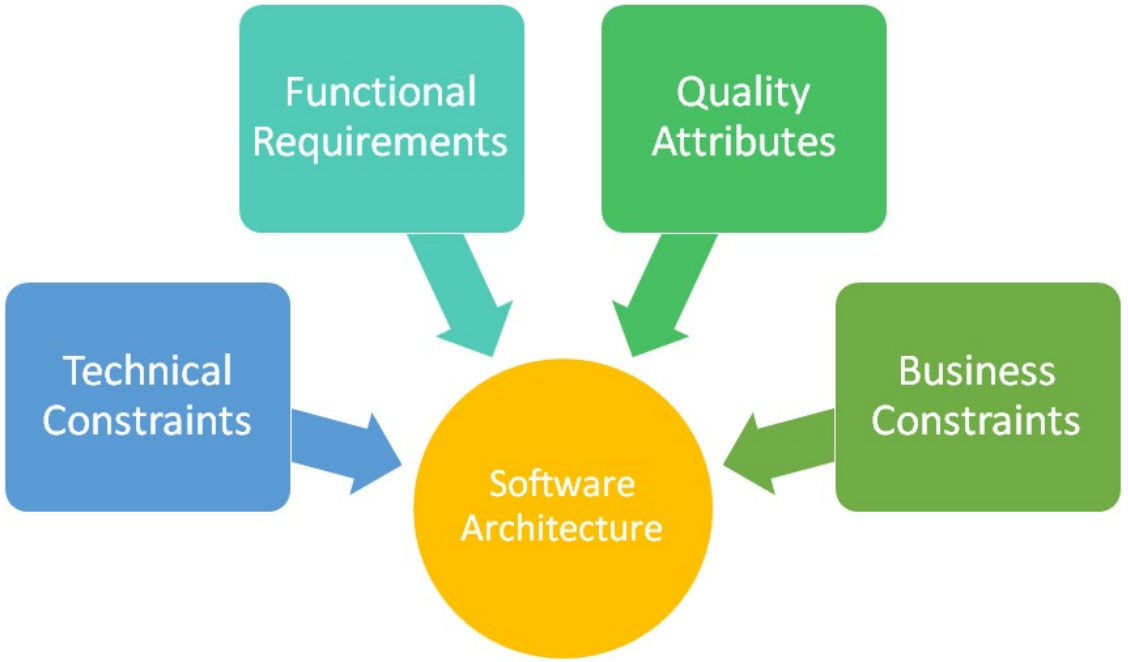
Define Architecture: Design and Communication



- Design is driven by a single architect (or a small group of architects with an identified leader)
- Basic architectural design process
  - Choose the **architectural drivers**
  - Drivers are derived from requirements most highly ranked
  - Drivers thus combine specific set of functional and quality requirements that will dominantly 'shape' the architecture
- Choose an architectural style
- Instantiate module types and allocate functionality

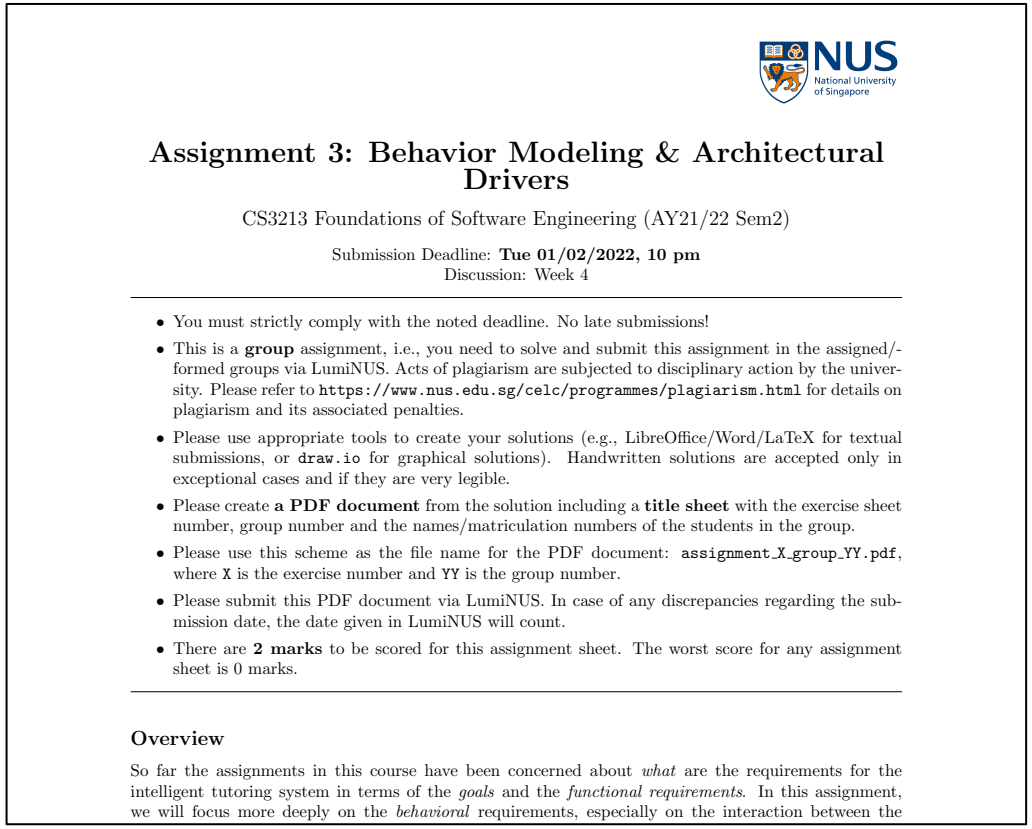
Architectural Drivers

- **Business goals**
  - Customer organization
  - Developing organization
- **Quality attributes**
- **Key functional requirements**
  - Unique properties
  - Make system viable
- **Constraints**
  - Organizational and technical
  - Cost and time



https://medium.com/@janerikfra/architectural-drivers-in-modern-software-architecture-cb7a42527bf2

Assignment 3: Behavioral Modeling & Architectural Drivers



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Assignment 3: Behavior Modeling & Architectural Drivers

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Tue 01/02/2022, 10 pm**
Discussion: Week 4

- You must strictly comply with the noted deadline. No late submissions!
- This is a **group** assignment, i.e., you need to solve and submit this assignment in the assigned/-formed groups via LumiNUS. Acts of plagiarism are subjected to disciplinary action by the university. Please refer to `https://www.nus.edu.sg/celc/programmes/plagiarism.html` for details on plagiarism and its associated penalties.
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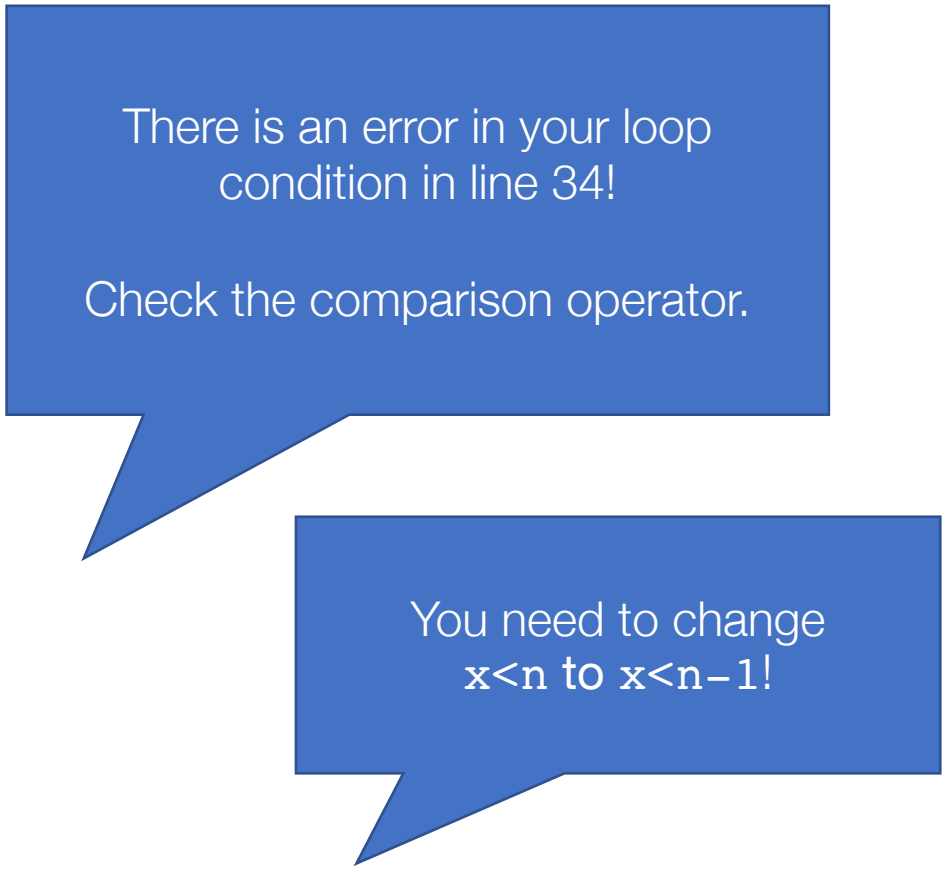
- There are **2 marks** to be scored for this assignment sheet. The worst score for any assignment sheet is 0 marks.

Overview

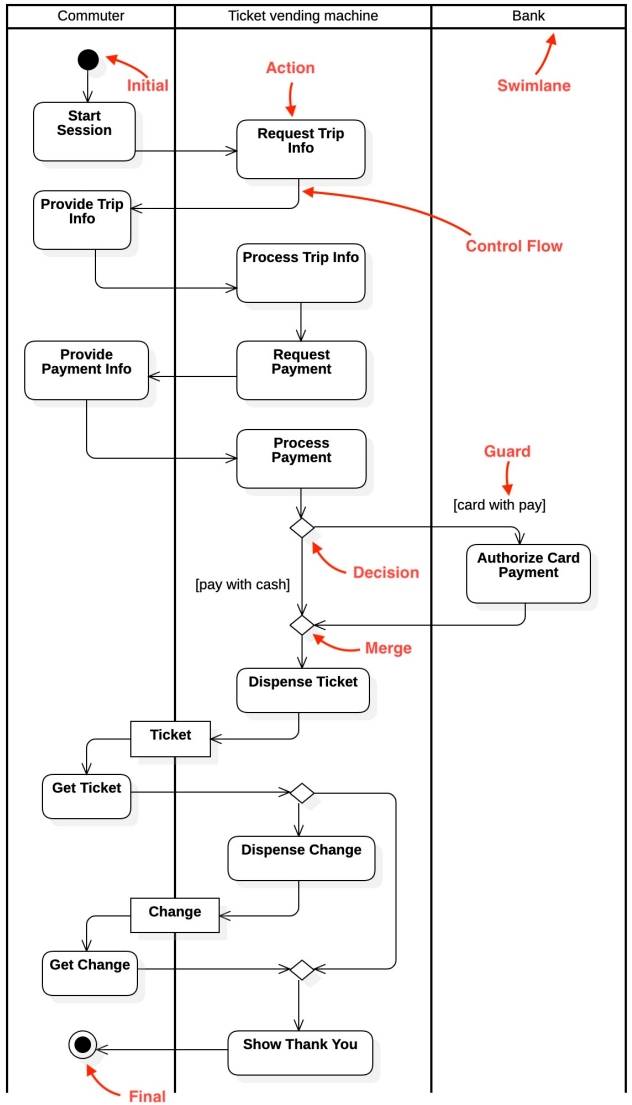
So far the assignments in this course have been concerned about *what* are the requirements for the intelligent tutoring system in terms of the *goals* and the *functional requirements*. In this assignment, we will focus more deeply on the *behavioral* requirements, especially on the interaction between the

Task 1: Student Feedback



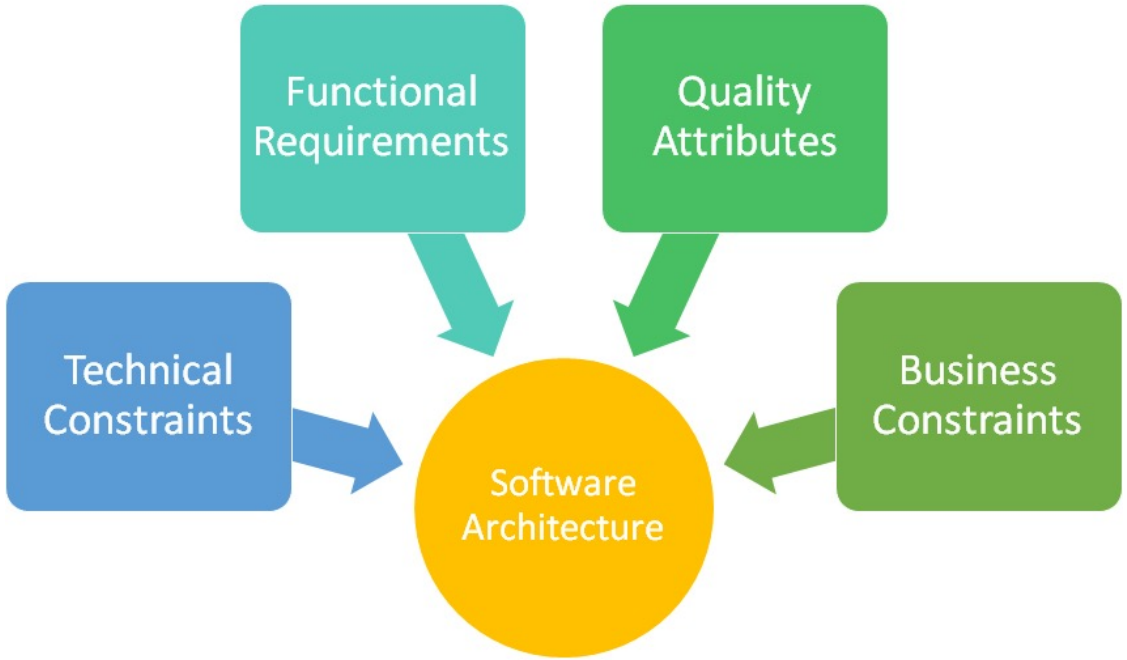
- ❑ identify **three core aspects** that are relevant for student feedback
- ❑ create an **UML Sequence Diagram** to model your envisioned feedback interaction
- ❑ use your own experience as student to improve the interaction model → can go beyond the requirement elicitation session

Task 2: Behavioral Modeling



- pick **one** additional **complex scenarios** and provide a **behavior model**
- choose your **own** model type (e.g., state charts, finite state machines, sequence diagrams, etc.)
- but you need to **justify** your choice

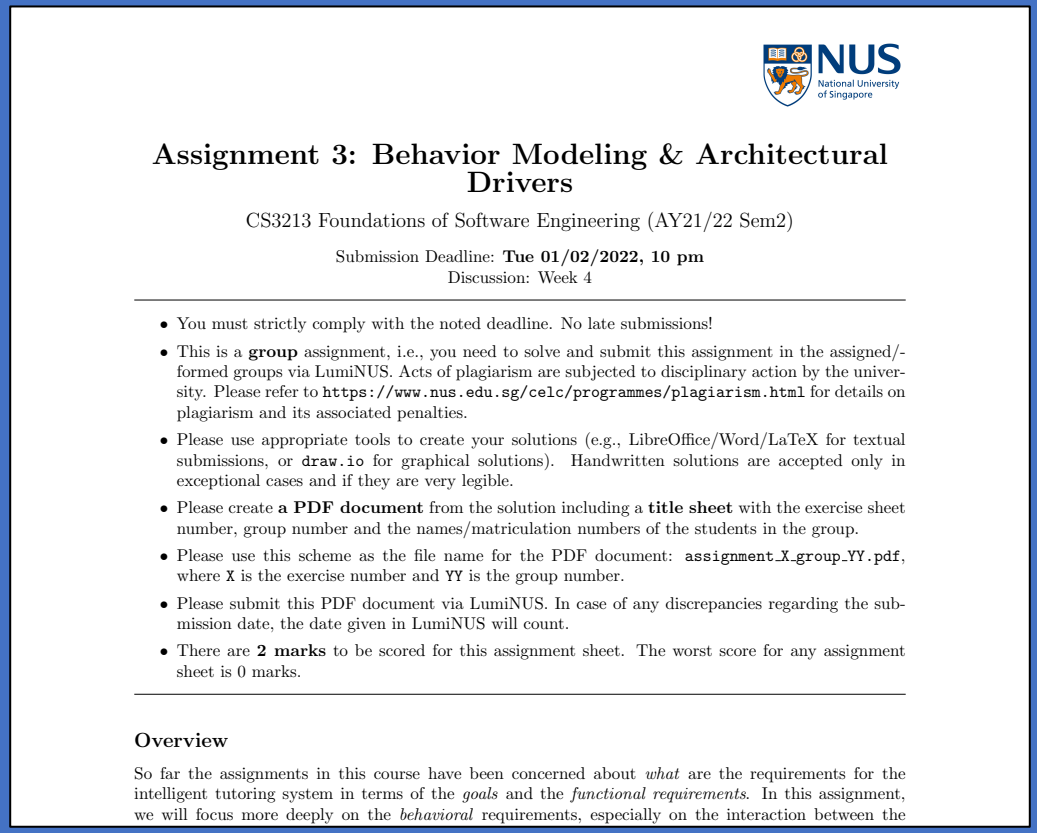
Task 3: Architectural Drivers



https://medium.com/@janerikfra/architectural-drivers-in-modern-software-architecture-cb7a42527bf2

- ❑ identify two **main architectural drivers**
- ❑ provide an **explanation** and **justification** for your choices

Any remaining question for Assignment 3?



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Assignment 4: Module Design & Solution Strategy

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Assignment 4a: Module Design

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Tue 08/02/2022, 10 pm**
Discussion: Week 5

- This Assignment **4a** is meant for groups who have picked a project with id ∈ {1.1, 1.2, 2.1, 3.1, 3.2, 4.1, 4.2}. Other groups need to work on Assignment **4b** instead.
- You must strictly comply with the noted deadline. No late submissions!
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We already provided a collection of *projects*, from which you already have selected one with your

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Assignment 4b: Solution Strategy

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Tue 08/02/2022, 10 pm**
Discussion: Week 5

- This Assignment **4b** is meant for groups who have picked a project with id ∈ {3.3, 4.3, 5.1, 5.2}. Other groups need to work on Assignment **4a** instead. The Assignment 4b is meant for projects, which include a fair amount of research without a very concrete implementation task. This makes it necessary to first document the decided strategy, e.g., which approaches/algorithms to implement or which solution ideas are followed, before any module design can be established.
- You must strictly comply with the noted deadline. No late submissions!
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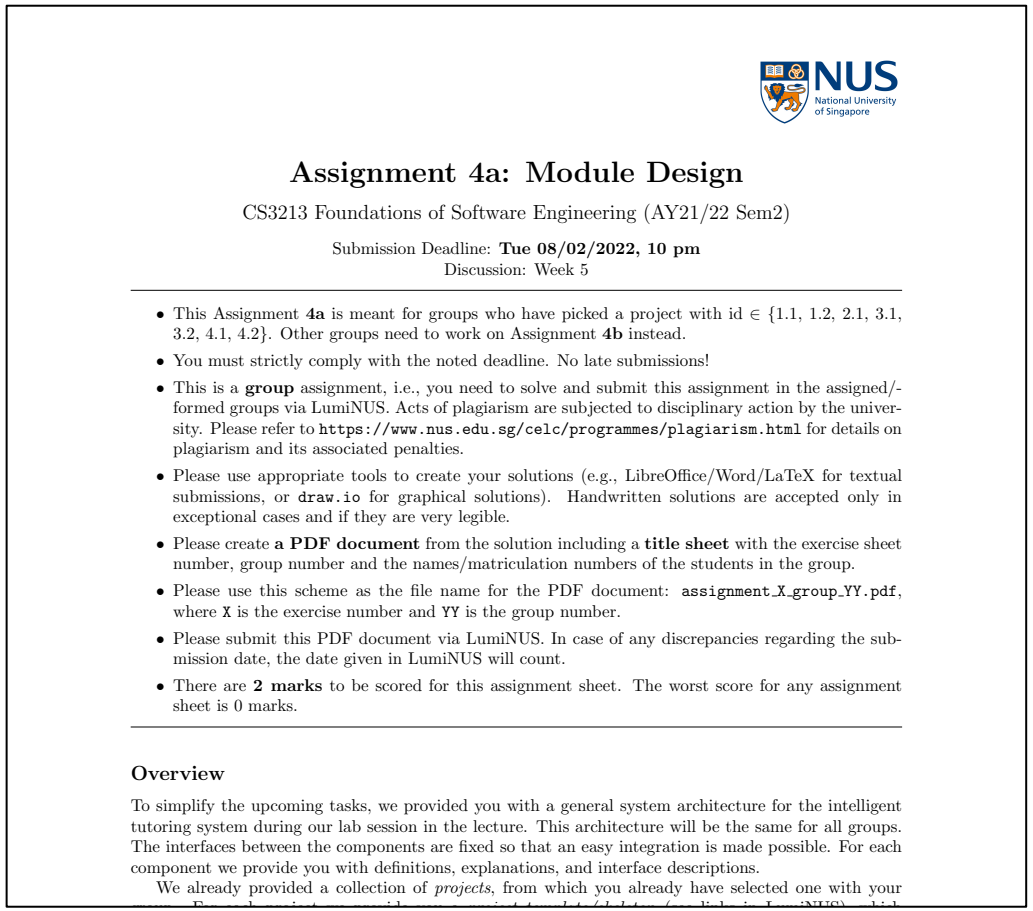
Assignment 4a: Module Design



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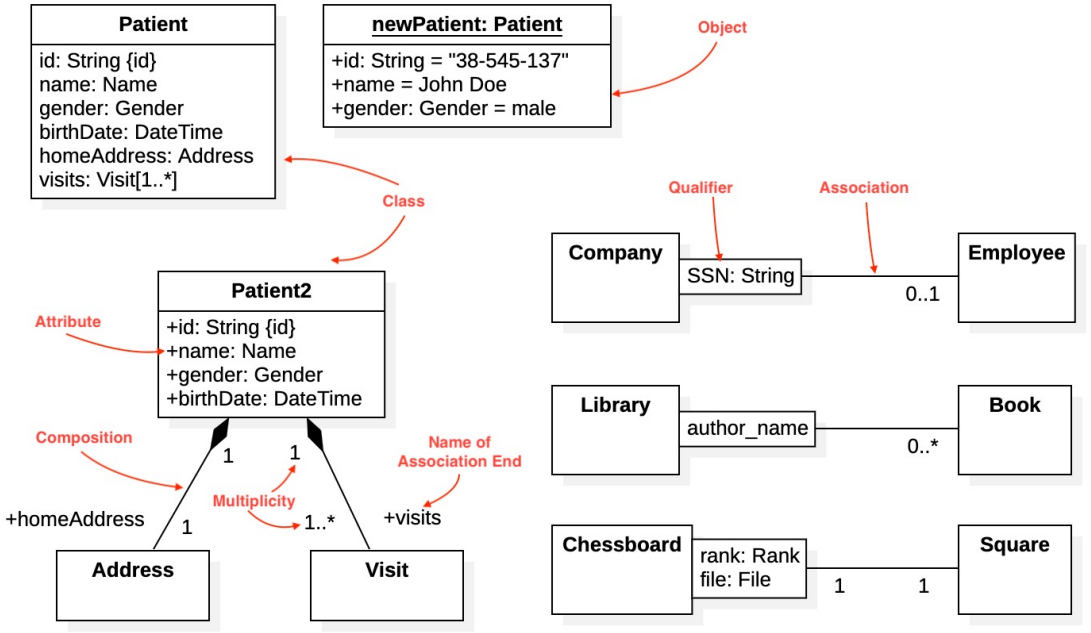
1.1 C Parser
1.2 Python Parser

2.1 CFG-Based Alignment

3.1 C Interpreter
3.2 Python Interpreter

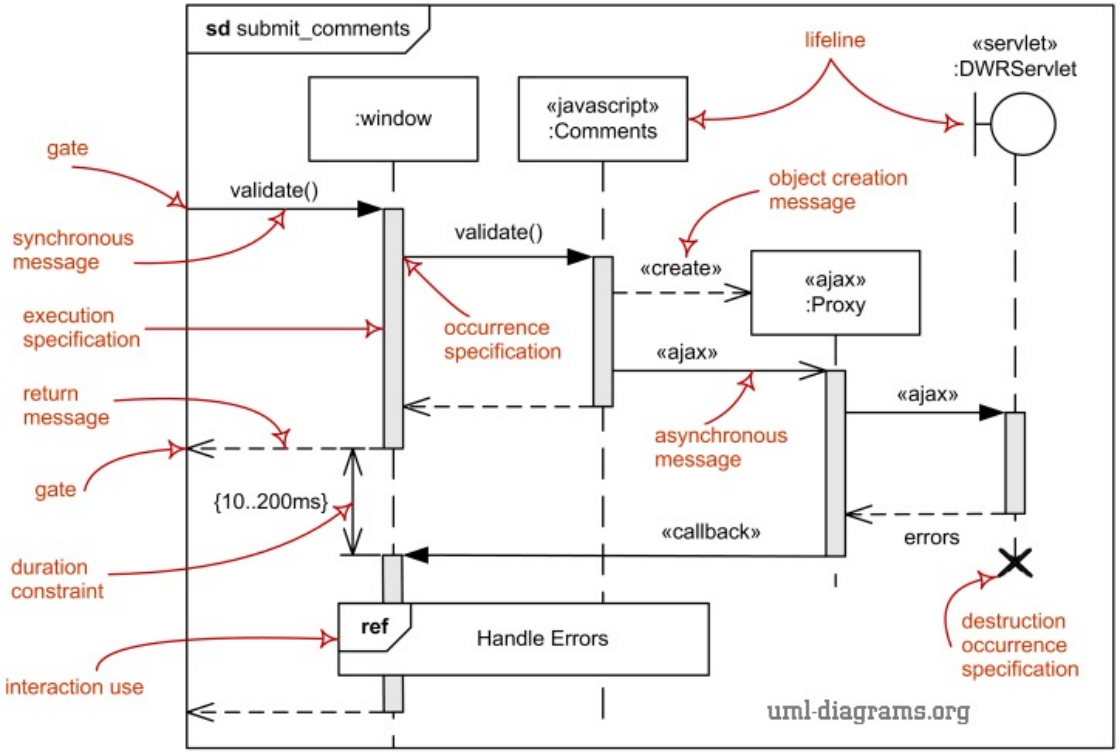
4.1 Refactoring-based Repair
4.2 Optimization-based Repair

Assignment 4a - Task 1: Structural Design



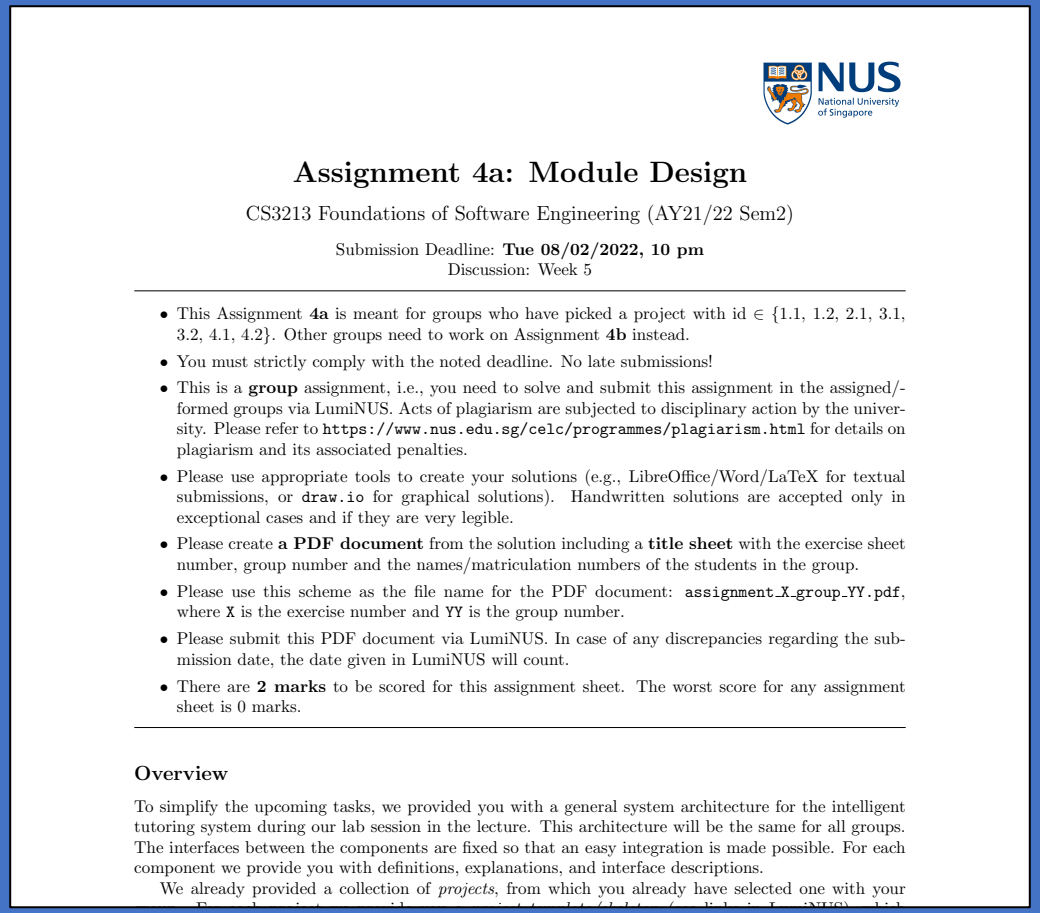
- create a **UML Class Diagram** including all relevant classes, methods, fields, dependencies and relationships
- your structural design should enable you to implement the project requirements and to divide the workload in your team
- Note: your design will evolve but the initial design needs to be thorough

Assignment 4a - Task 2: Behavioral Design



- use a **UML Sequence Diagram** to model the main flow of your project by showing the interaction between the relevant objects
- needs to include the relevant provided objects and the concepts from your structural design (see Task 1)

Any remaining question for Assignment 4a?



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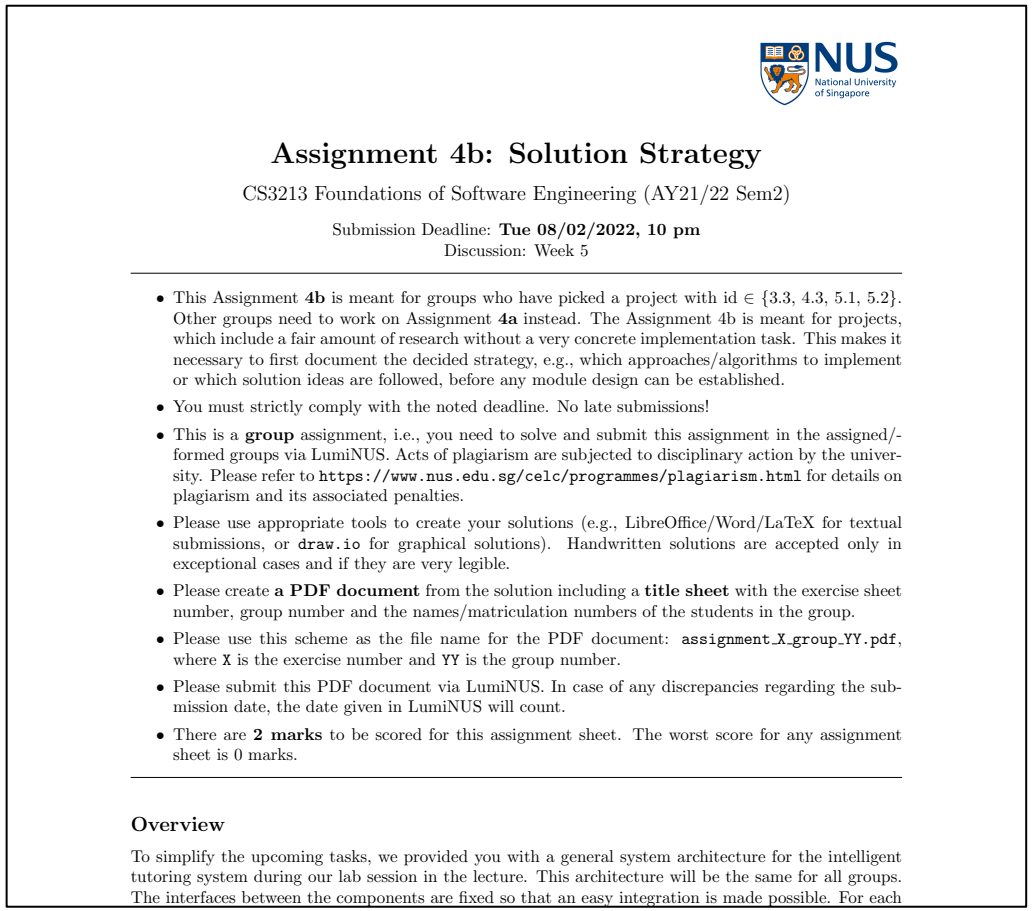
Assignment 4b: Solution Strategy



NUS National University of Singapore

Assignment 4b: Solution Strategy

CS3213 Foundations of Software Engineering (AY21/22 Sem2)

Submission Deadline: **Tue 08/02/2022, 10 pm**
Discussion: Week 5

- This Assignment **4b** is meant for groups who have picked a project with id $\in \{3.3, 4.3, 5.1, 5.2\}$. Other groups need to work on Assignment **4a** instead. The Assignment 4b is meant for projects, which include a fair amount of research without a very concrete implementation task. This makes it necessary to first document the decided strategy, e.g., which approaches/algorithms to implement or which solution ideas are followed, before any module design can be established.
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Overview

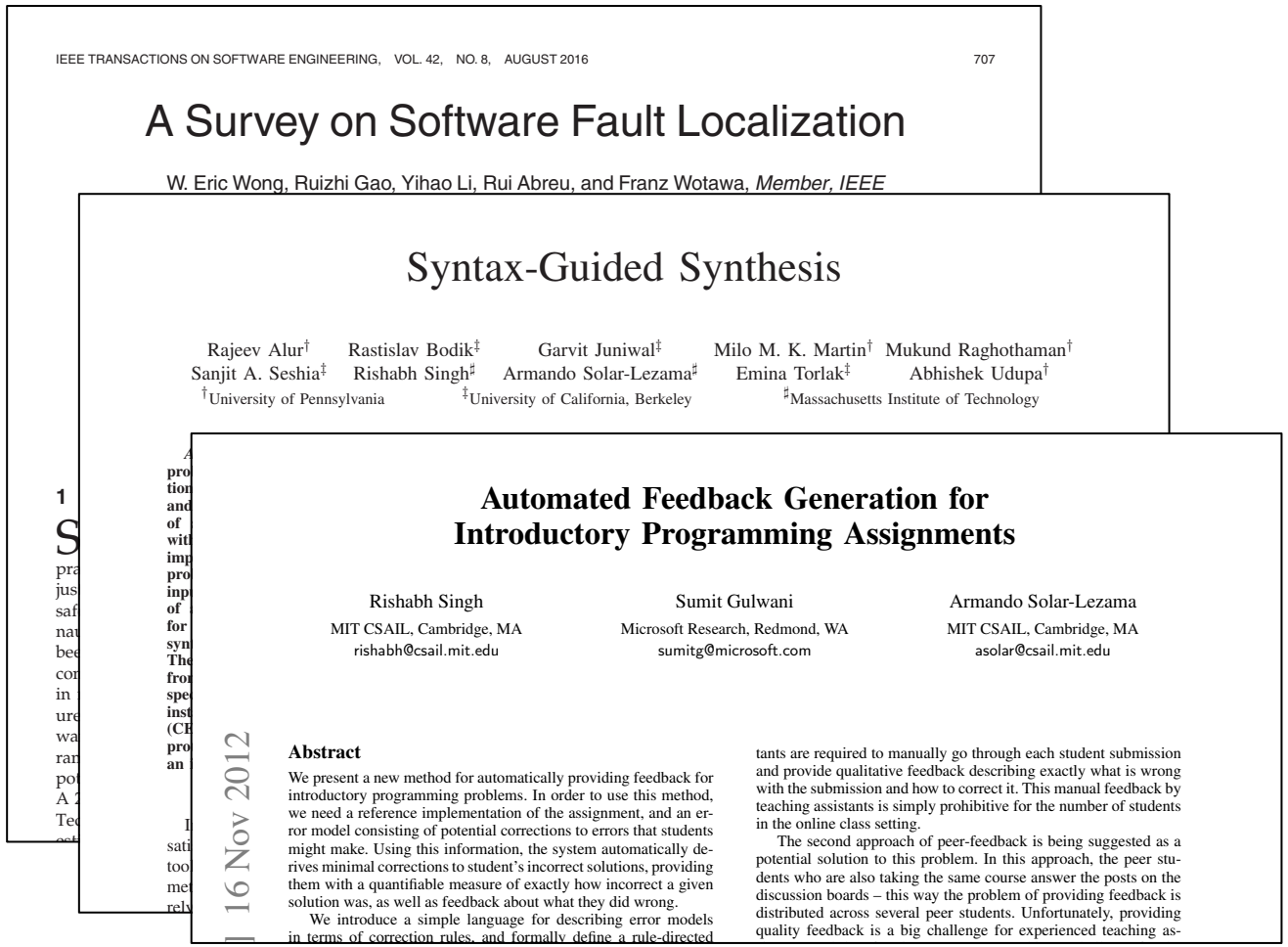
To simplify the upcoming tasks, we provided you with a general system architecture for the intelligent tutoring system during our lab session in the lecture. This architecture will be the same for all groups. The interfaces between the components are fixed so that an easy integration is made possible. For each

3.3 Error Localizer

4.3 Synthesis-based Repair

5.1 Automated Feedback
5.2 Automated Grading

Assignment 4b - Task 1: Background



IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, VOL. 42, NO. 8, AUGUST 2016 707

A Survey on Software Fault Localization

W. Eric Wong, Ruizhi Gao, Yihao Li, Rui Abreu, and Franz Wotawa, *Member, IEEE*

Syntax-Guided Synthesis

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Sanjit A. Seshia[‡] Rishabh Singh[♯] Armando Solar-Lezama[♯] Emina Torlak[‡] Abhishek Udupa[†]
[†]University of Pennsylvania [‡]University of California, Berkeley [♯]Massachusetts Institute of Technology

Automated Feedback Generation for Introductory Programming Assignments

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Abstract

We present a new method for automatically providing feedback for introductory programming problems. In order to use this method, we need a reference implementation of the assignment, and an error model consisting of potential corrections to errors that students might make. Using this information, the system automatically derives minimal corrections to student's incorrect solutions, providing them with a quantifiable measure of exactly how incorrect a given solution was, as well as feedback about what they did wrong.

We introduce a simple language for describing error models in terms of correction rules, and formally define a rule-directed

tants are required to manually go through each student submission and provide qualitative feedback describing exactly what is wrong with the submission and how to correct it. This manual feedback by teaching assistants is simply prohibitive for the number of students in the online class setting.

The second approach of peer-feedback is being suggested as a potential solution to this problem. In this approach, the peer students who are also taking the same course answer the posts on the discussion boards – this way the problem of providing feedback is distributed across several peer students. Unfortunately, providing quality feedback is a big challenge for experienced teaching as-

16 Nov 2012

- define the problem you are going to solve and discuss the necessary background for your solution ideas
- describe the related/existing work that is relevant for your project

Assignment 4b - Task 2: Solution

Describe your **solution ideas** and state any **dependencies** that you may require. Explain the relevant algorithms and discuss potential challenges.

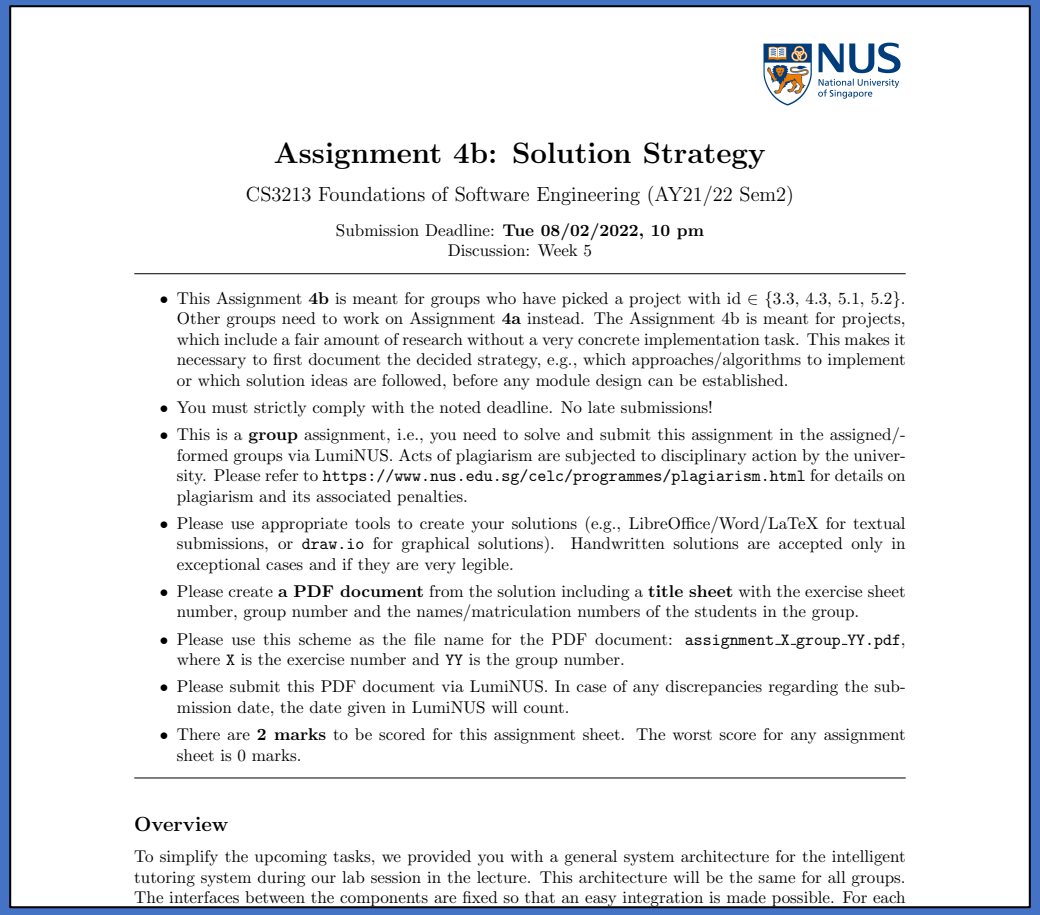
- ❑ *3.3 Error Localizer:* State **which error localization algorithms** you want to implement for your project, and **why** they are interesting to explore.
- ❑ *4.3 Synthesis-Based Repair:* Explain your selected strategy for **specification inference** and **program synthesis**.
- ❑ *5.1 Automated Feedback:* Describe your selected **feedback mechanism**. In particular, describe **which information** you will need from the system, e.g., any side-products like error locations.
- ❑ *5.2 Automated Grading:* Describe your selected **grading mechanism**. In particular, describe **which information** you will need from the system, e.g., any side-products like error locations.

Assignment 4b - Task 3: Evaluation

Describe your **evaluation plan**, including which **test data** you will require and how you plan to retrieve them.

- *3.3 Error Localizer:* In your case it is meant to produce a **comparison** between these (at least two) **different** algorithms, hence, your evaluation should be designed to **show these differences**.
- *4.3 Synthesis-Based Repair:* **Each step** in the synthesis-based repair workflow needs to be evaluated, e.g., repair constraint generation and program/expression synthesis. Present your plan on how to generate/create corresponding test data.
- *5.1+5.2 Automated Feedback/Grading:* Due to the involved **user interaction**, your project is specifically difficult to test/evaluate. Feedback and Grading is (at least to some extent) subjective, so the expected outcome is not clearly defined. Describe your plans on **how to solve this challenge** and discuss any problems.

Any remaining question for Assignment 4b?



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Conclusion

- ❏ Requirement Analysis, Elicitation, and Modeling **needs training**
- ❏ Next step: entering the **solution space**

Next Week:
Chinese New Year

- ➢ ITS Architecture is already shared
- ➢ Assignment 4:
  (a) Module Design
  (b) Strategy Planning

In two weeks:
Module Design & Project Planning