INTRODUCTION TO COMPUTER SCIENCE

BCS1110

Dr. Ashish Sai

🗓️ Week 1 - Lecture 1

💻 bcs1110.ashish.nl

📍EPD150 MSM Conference Hall

Welcome to BCS1110!

Plan for today

- About us
- What is Computer Science?
- The beauty and potential of Computer Science
- Computational Thinking
- Course Logistics

About us

(Humans of BCS1110)

Part 1/5

Dr. Ashish Sai

Lecturer

Department of Advanced Computing Sciences

📍PHS1 C4.005

📧ashish.sai@maastrichtuniversity.nl

💻ashish.nl

Current affiliation

Assistant Professor - **Open Universiteit**

Past employment

- Expert Group Member - Crypto Sustainability, **World Economic Forum**
- Research Scholar - **University of California, Berkeley**
- Lecturer - **University of Amsterdam**
- Teaching Fellow - **Trinity College Dublin**

WORLD ECONOMIC FORUM

Berkeley UNIVERSITY OF CALIFORNIA

UNIVERSITY OF AMSTERDAM

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Dr. Tom Bitterman

Senior Lecturer

Department of Advanced Computing Sciences

📍PHS1 C4.005

📧tom.bitterman@maastrichtuniversity.nl

Tom has been coding network applications since before there was a Web. He has extensive experience in infrastructure development and mentoring. He is interested in creating leading-edge technology.

Teaching Assistants

Giorgos Vainterlis
Christos Koromilas
Tiago Ferreira
Nikola Prianikov
Jounaid Beaufils
Sam Goldie
Alexandra Zamfir
José Manuel Ros
Tauseef Ahmed
Dumitru versebeniuc
Abhimanyu Anand
Alexander Padula
Thomas Vroom
Derrick Timmermans
Fivos Tzavellos

What is Computer Science?

Part 2/5

Computer Science: An Evolving Discipline 🖥️

> What is Computer Science?

- Difficult to define:
  - Evolving nature of the field
  - Broad scope covering diverse disciplines (e.g., mathematics, engineering, linguistics)
  - Deep interweaving of theory and applications 🔗

Computer Science: A Science Viewpoint 🔬

- **Definition:** Study of algorithms, computation, and information processing 🧮
- **Emphasis:** *Understanding theoretical foundations and problem-solving* 💡
- **Scope:** Investigates algorithmic complexity, computability, and mathematical nature of computing systems

Computer Science: An Engineering Viewpoint 🛠️

- **Definition:** Focus on designing and developing computer systems and applications
- **Emphasis:** *Practical implementation, optimization, and building technologies* 🔧
- **Scope:** Includes hardware design, software development, networking, and user interface design 🌐

The Holistic View of Computer Science 🌐

- Embraces diverse methodologies from multiple disciplines
- Combines **mathematical rigor**, **scientific inquiry**, and **engineering methodologies** to innovate
- As computer scientists, understanding this interplay empowers us to create cutting-edge technologies with real-world impact 💡

Computer Science is *Not Only* Programming

- Programming is an essential part, but computer science opens doors to a wide array of exciting fields and opportunities

Themes in Computer Science 📝

Broadly speaking, there are three disciplines in CS[1]:

1. **Hardware:** Focus on physical computer components and systems
2. **Software:** Diverse applications, systems, and development tools
3. **Theory:** Study of algorithms, computability, and cryptography

[1] Please note that this list is not exhaustive

Computer Systems: Hardware 🔧

- **Hardware:** Physical components of a computer and its supporting devices
- Subfields: Computer Architecture, Circuit Design
- Career Opportunities: Hardware Engineer, Computer Architect
- ASML (Circuit Design, Semiconductor Manufacturing)

ASML

PHILIPS

Software: Applications, Systems, and Development 💻📊🛠️

Applications Software

- Programs that perform various tasks for users
- Subfields: Web Development, Mobile App Development
- Career Opportunities: Web Developer, Mobile App Developer

Systems Software

- Programs that directly control computer hardware
- Subfields: Operating Systems, Device Drivers
- Career Opportunities: Systems Administrator, Device Driver Developer

Development Software

- Programs used to create other software applications
- Subfields: Integrated Development Environments (IDEs), Version Control
- Career Opportunities: Software Engineer, IDE Developer

tomtom

Booking

Theory: Algorithms, Computability, and Cryptography 🔬🔐🔍

Algorithms

- Study of step-by-step procedures for problem-solving
- Subfields: Algorithm Analysis, Data Structures
- Career Opportunities: Algorithm Developer, Data Scientist

Computability

- Investigates the power and limitations of computation
- Subfields: Computational Complexity Theory, Formal Languages
- Career Opportunities: Theoretical Computer Scientist, Researcher

Cryptography

- Ensures secure communication and data protection
- Subfields: Encryption, Cryptanalysis
- Career Opportunities: Cryptographer, Security Analyst

TNO innovation for life

iDEAL

Applications of CS 📱

Computer Vision

Natural language Processing

Virtual Reality

Robotics

Social Aspects of Computer Science 🌐🤝

- Addressing the societal impact of automation, privacy, and ethical considerations
- Ensuring technology benefits society while avoiding harmful effects

> **Required reading**: 80 Million Tiny Images dataset by MIT (on Canvas)

The beauty and potential of Computer Science

Part 3/5

I think CS is an *extraordinary* field:

- Combines logic and creativity, structure and chaos, standardisation and non-standardisation
- Builds something from nothing and solves previously unsolved problems
- The potential of Computer Science seems limitless, constrained only by our own creativity

Intersection of Logic and Creativity

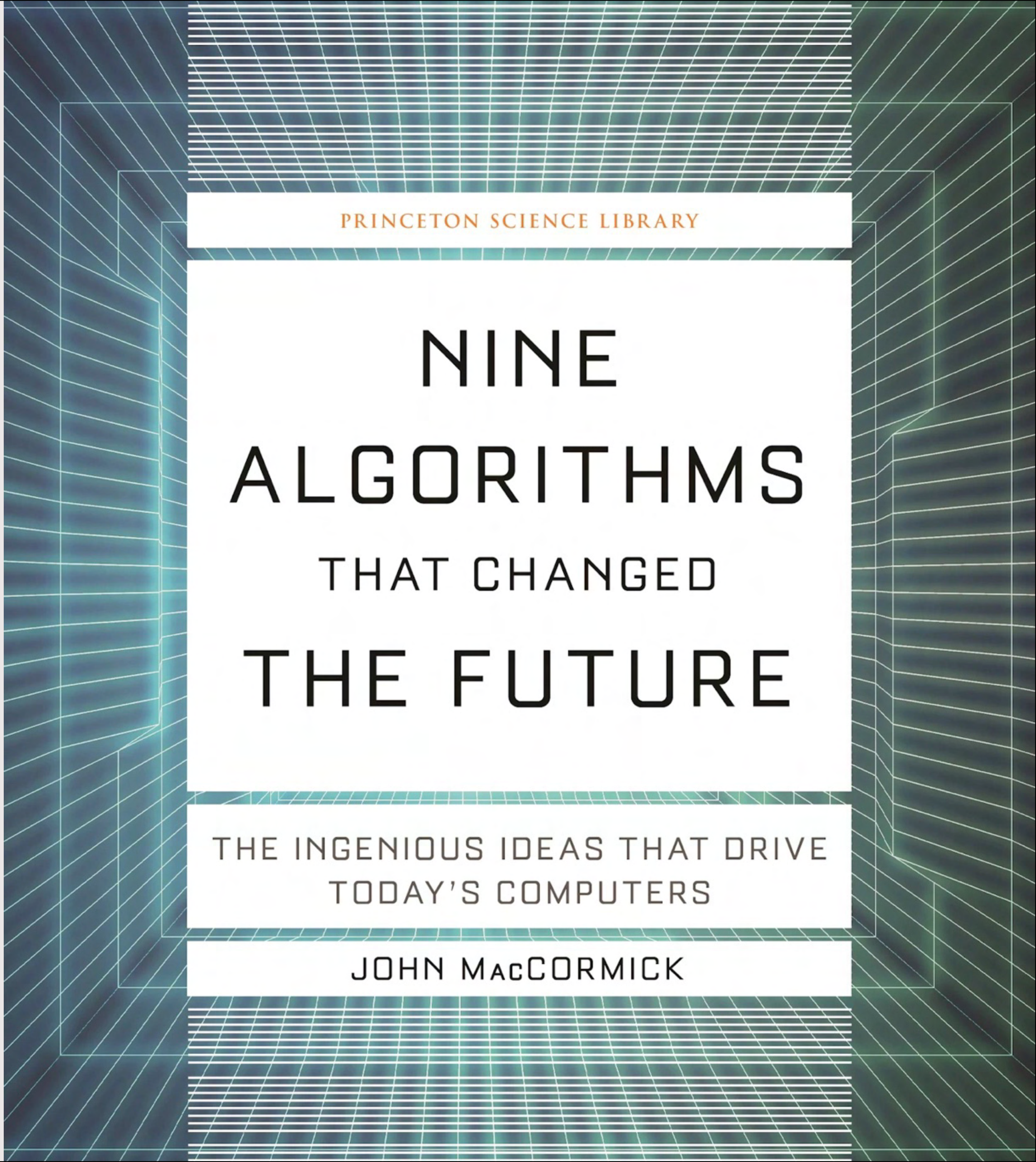
Part 3.1

Applying Logical Thinking to Create Innovative and Creative Solutions

- Finding logical patterns and principles to drive innovation
- Utilizing principled engineering techniques to design efficient and effective solutions

Example

- Search engine indexing
- PageRank
- Public-key cryptography
- Forward error correction
- Pattern recognition
- Data compression
- Database
- Digital signature
- Computability



PRINCETON SCIENCE LIBRARY

NINE ALGORITHMS THAT CHANGED THE FUTURE

THE INGENIOUS IDEAS THAT DRIVE TODAY'S COMPUTERS

JOHN MacCORMICK

Structure and Chaos

Part 3.2

CS requires organizing complex systems and ~~data structures~~ while handling unpredictable events and edge cases

How a communications failure crippled the Dutch rail network[1]

[1] Report by The RailTech.com, Published on 02-06-2021 at 10:15: Link

Standardisation and Non-Standardisation

Part 3.3

Standardised and Non-Standardised Concepts 🖥️🔍

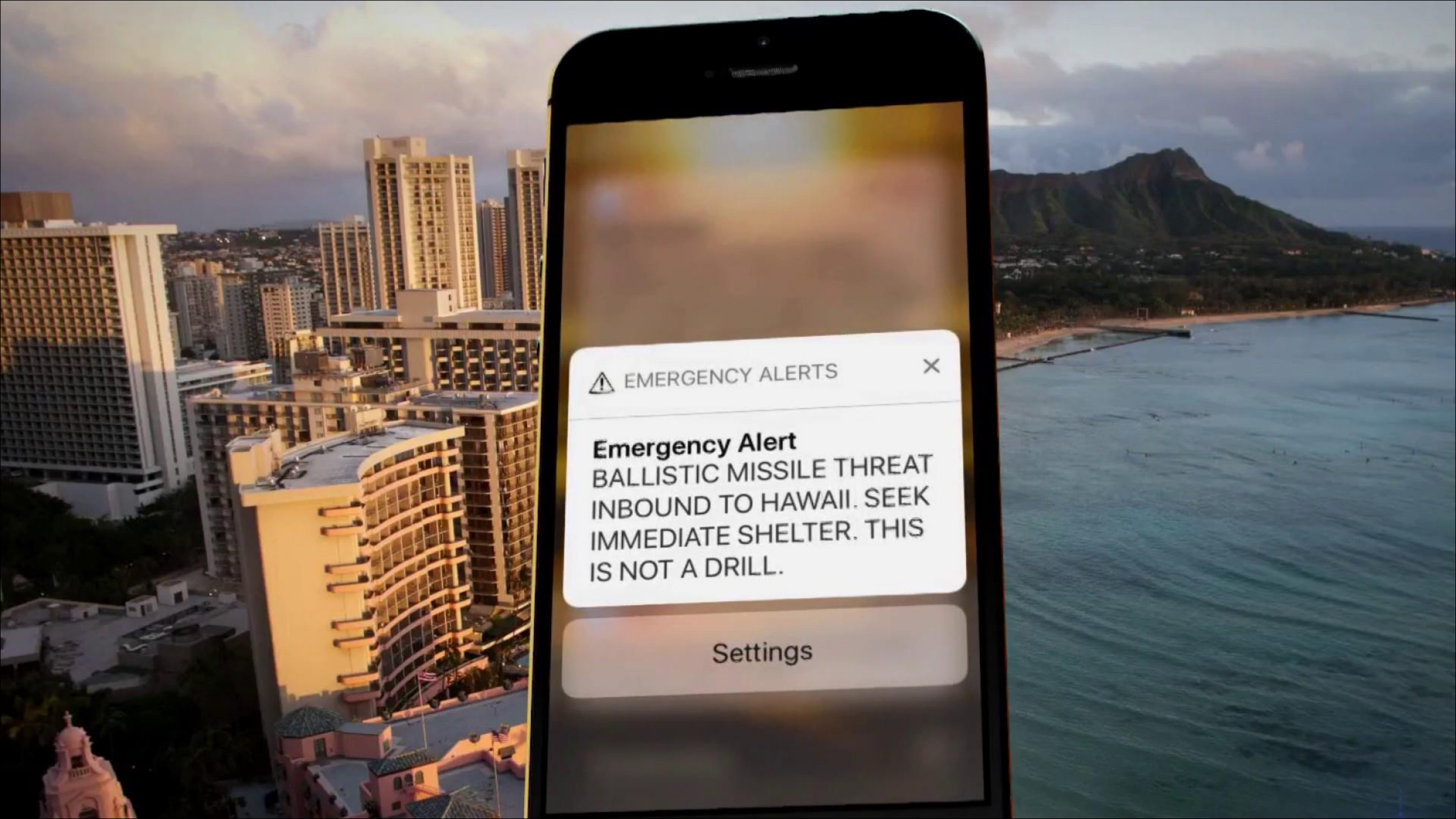
- Computer Science involves **standardised** (concrete) and **non-standardised** (abstract) concepts

Standardised Concepts:

- Specific, well-defined elements
- Precise and consistent, enabling interoperability

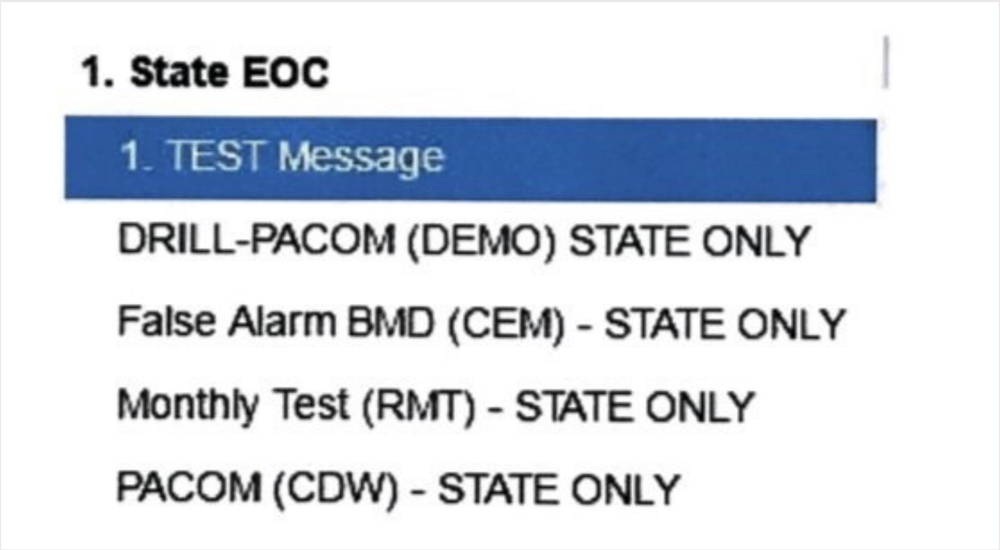
Non-Standardised Concepts:

- Generalized ideas and theoretical principles
- Allow flexibility and innovation



Emergency Alert
BALLISTIC MISSILE THREAT INBOUND TO HAWAII. SEEK IMMEDIATE SHELTER. THIS IS NOT A DRILL.

> The human was supposed to have clicked DRILL - PACOM (CDW) - STATE ONLY that morning but accidentally clicked PACOM (CDW) - STATE ONLY instead, thereby sending an actual alert



1. State EOC

1. TEST Message

DRILL-PACOM (DEMO) STATE ONLY

False Alarm BMD (CEM) - STATE ONLY

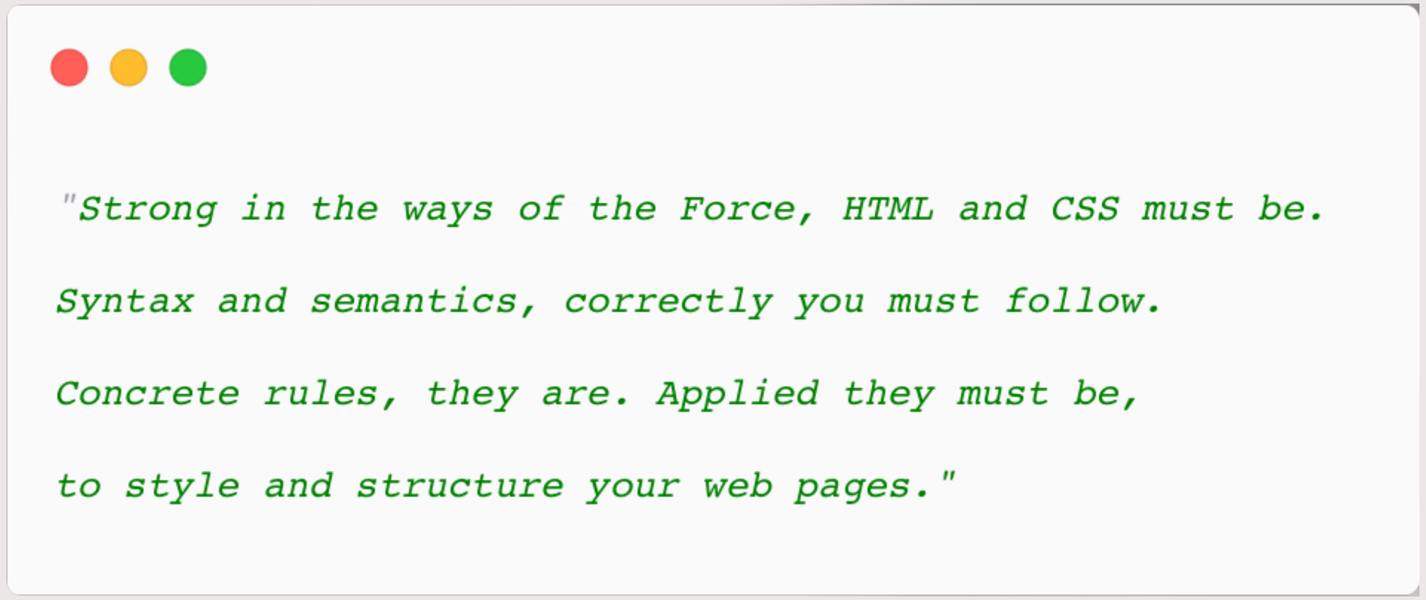
Monthly Test (RMT) - STATE ONLY

PACOM (CDW) - STATE ONLY

Input:

```
<!DOCTYPE html>
<html>
<head>
  <title>Yoda Concreteness Example</title>
  <style>
    .my-yoda {
      color: green;
      font-size: 24px;
    }
  </style>
</head>
<body>
  <h1 class="my-yoda">
    "Strong in the ways of the Force, HTML
and CSS must be. <br>
    Syntax and semantics, correctly you
must follow. <br>
    Concrete rules, they are. Applied they
must be, <br>
    to style and structure your web pages."
  </h1>
</body>
</html>
```

Output



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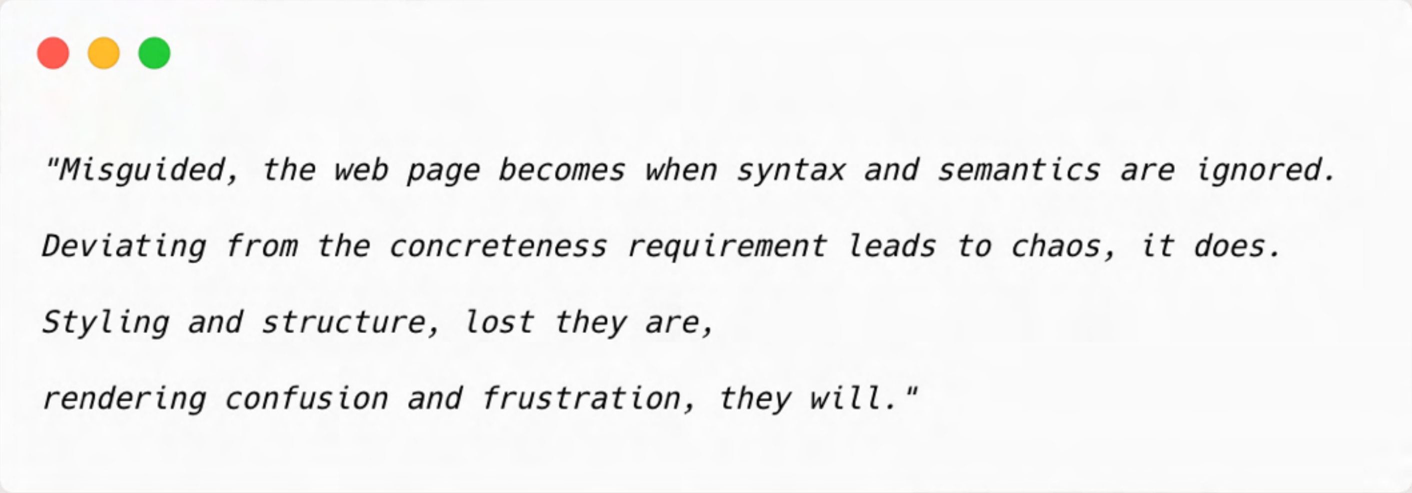
<body>
  <h1 class="my-yoda">
    "Misguided, the web page becomes when
syntax and semantics are ignored. <br>
    Deviating from the concreteness
requirement leads to chaos, it does. <br>
    Styling and structure, lost they are,
rendering confusion and frustration, they
will."
  </h1>
</body>
</html>
```

Output



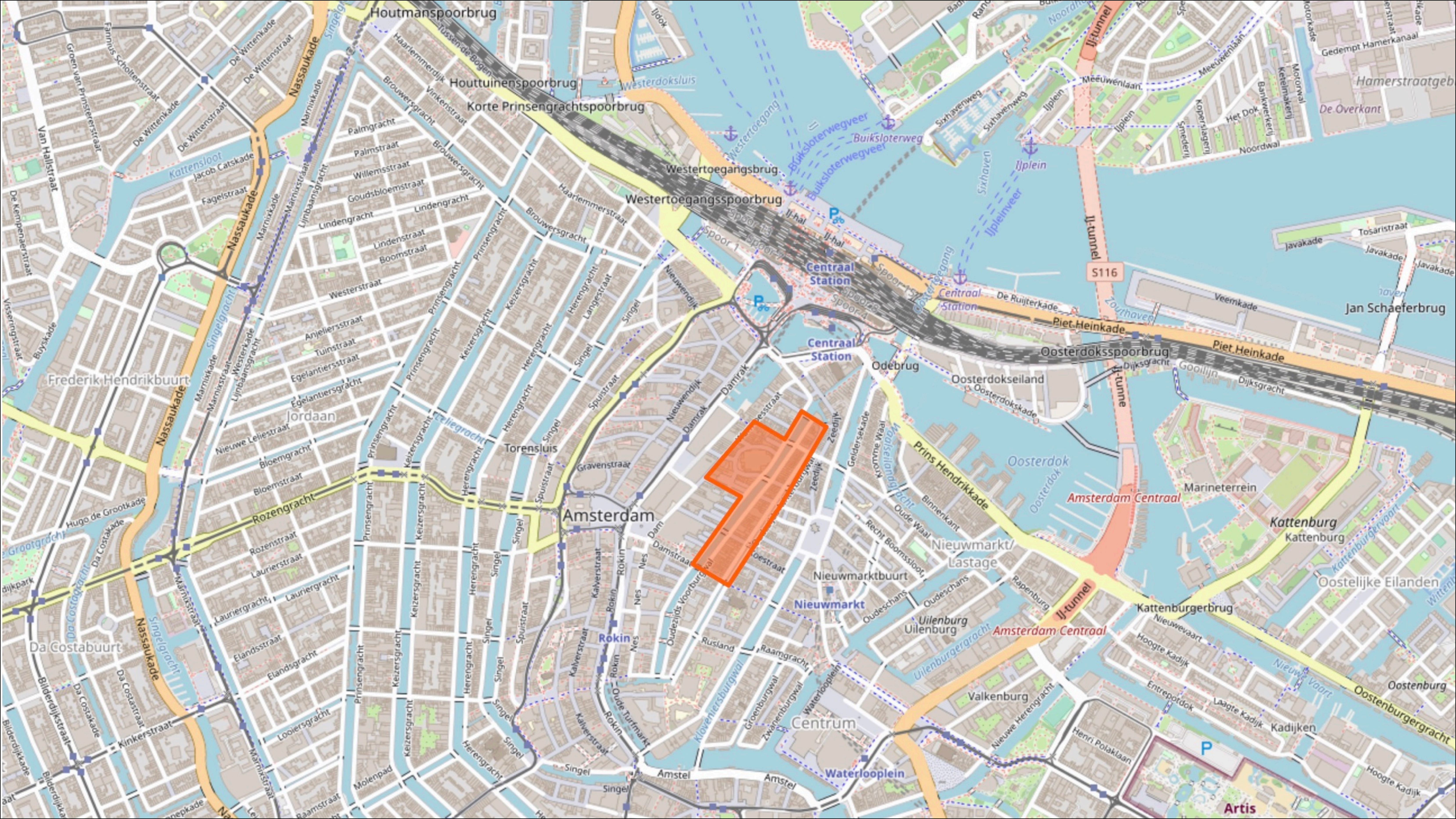
```
"Misguided, the web page becomes when syntax and semantics are ignored.
Deviating from the concreteness requirement leads to chaos, it does.
Styling and structure, lost they are,
rendering confusion and frustration, they will."
```

Building Something New

Part 3.4

Creating Something New in CS 🌟

- Even when utilizing existing knowledge and resources, computer scientists are constantly creating something new
- They learn and explore new concepts, techniques, and technologies to build innovative solutions



Houtmanspoorbrug
Houttuinenspoorbrug
Korte Prinsengrachtspoorbrug
Westertoegangsbrug
Westertoegangsspoorbrug
Westerdoksluis
Westertoegang
Buiksloterwegveer
Buiksloterweg
IJpleinveer
IJplein
Sixhaven
Sixhavenweg
Meeuwenlaan
Noordwal
Hamerstraatgebied
De Overkant
Gedempt Hamerkanaal
IJ-tunnel
S116
Centraal Station
Spoor 1
Spoor 4
IJ-hal
De Ruijterkade
Piet Heinkade
Oosterdoksspoorbrug
Oosterdokseiland
Oosterdokskade
Oosterdok
Odebrug
Dijksgracht
Gooilijn
Veemkade
Javakade
Tosaristraat
Jan Schaeferbrug
Prins Hendrikkade
Marineterrein
Kattenburg
Kattenburgerbrug
Amsterdam Centraal
Oostelijke Eilanden
Oostenburg
Oostenburgergracht
Nieuwe Vaart
Kadijken
Hoogte Kadijk
Laagte Kadijk
Entrepotdok
Artis
P
Nieuwmarkt/Lastage
Nieuwmarktbuurt
Nieuwmarkt
Uilenburg
Uilenburgergracht
Valkenburg
Nieuwe Herengracht
Henri Polaklaan
Waterlooplein
Centrum
Zeedijk
Geldersekade
Kromme Waal
Waalseilandsgracht
Binnenkant
Oude Waal
Recht Boomssloot
Oudeschans
Rapenburg
Damrak
Dam
Damstraat
Oudezijds Voorburgwal
Warmoesstraat
Nes
Rokin
Kalverstraat
Oude Turfmarkt
Kloveniersburgwal
Groenburgwal
Zwanenburgwal
Raamgracht
Rusland
Amstel
Singel
Amsterdam
Nieuwendijk
Gravenstraat
Torensluis
Spuistraat
Herengracht
Keizersgracht
Prinsengracht
Leliegracht
Jordaan
Frederik Hendrikbuurt
Nassaukade
Singelgracht
Marnixstraat
Rozengracht
Westerstraat
Egelantiersgracht
Egelantiersstraat
Tuinstraat
Anjeliersstraat
Bloemgracht
Bloemstraat
Nieuwe Leliestraat
Lindengracht
Lindenstraat
Boomstraat
Goudsbloemstraat
Willemsstraat
Palmstraat
Palmgracht
Brouwersgracht
Haarlemmerdijk
Haarlemmerstraat
Vinkenstraat
Fagelstraat
Jacob Catskade
Kattensloot
De Wittenkade
De Wittenstraat
Van Hallstraat
Buyskade
Da Costakade
Da Costagracht
Da Costabuurt
Da Costastraat
Hugo de Grootkade
Kinkerstraat
Bilderdijkstraat
Bilderdijkkade
Elandsgracht
Elandsstraat
Lauriergracht
Laurierstraat
Rozenstraat
Looiersgracht
Molenpad

PREDICTIVE POLICING - DATA SCIENCE IN POLITIEWERK

https://kombijde.politie.nl/vakgebieden/ict/predictiv

Software is Magic✨

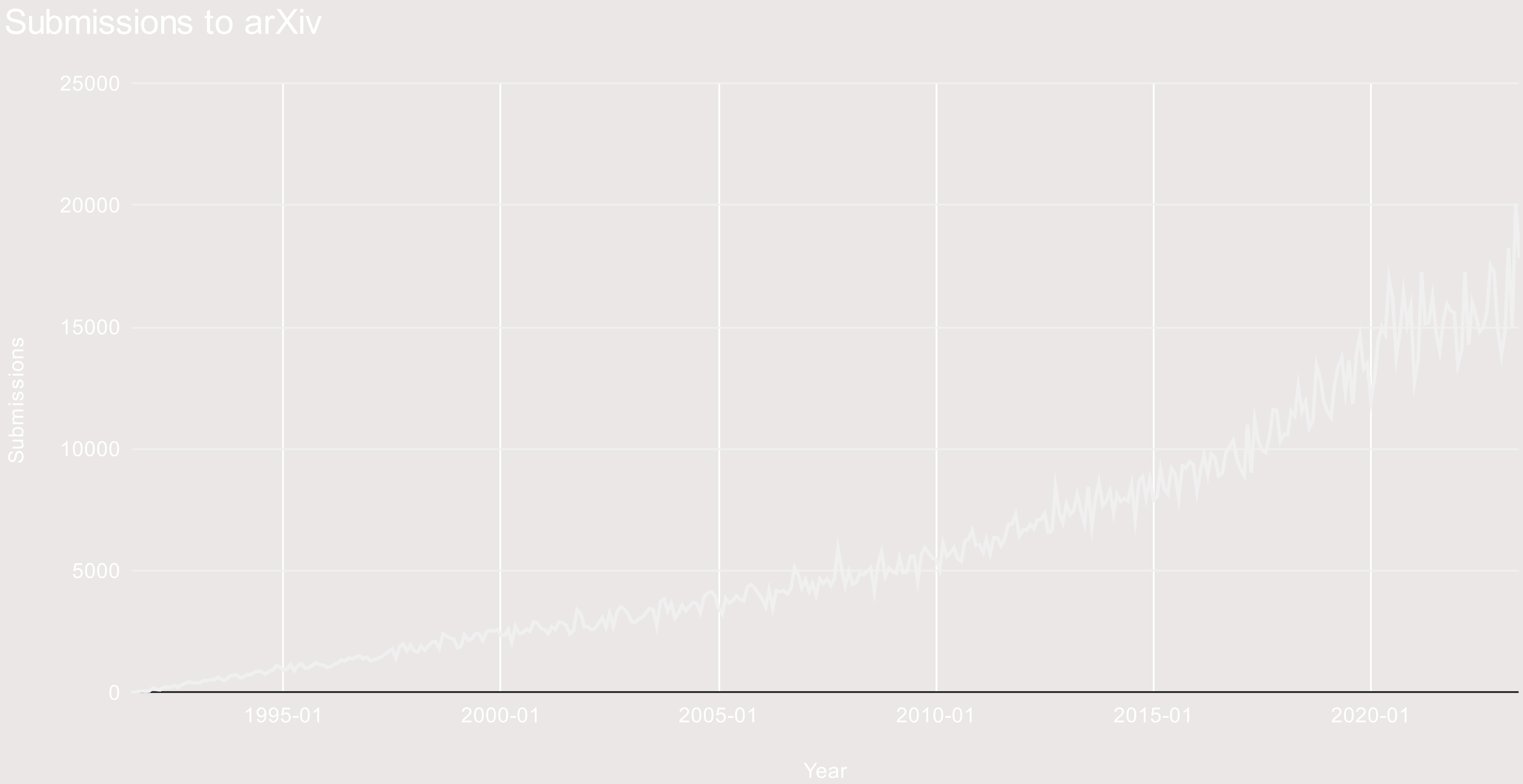
- Software is often regarded as the closest thing to actual magic
- Software transforms simple instructions into limitless possibilities and enables machines to perform complex tasks at an unprecedented scale

ICD

"An implantable device that monitors and treats life-threatening heart rhythm abnormalities through electrical shock therapy"

The Early Stages

Part 3.5



We are continuously exploring and learning, like banging sticks together, not yet composing symphonies

Boundless Potential

SHORT BREAK

Do not leave your seat (5 min)

What will you lean from BCS1110?

The process of *recognising* aspects of computation in the world that surrounds us, and applying *tools* and *techniques* from Computer Science to understand and reason about both *natural* and *artificial* *systems* and processes

Computational Thinking

Part 4/5

Problem Solving

Introduction to Problem-Solving 🧩

- Problem-solving involves transforming an undesirable state (problem) into a desirable one (solution)
- Real-world problems are complex and require a systematic approach
- Following a guide or process can help in tackling complex tasks effectively

Pólya's Systematic Approach 📝

- George Pólya's problem-solving approach:
- (Don't give up)
    1. Understand the problem
    2. Devise a plan
    3. Execute the plan
    4. Review and extend the solution
- Pólya's method is inspired by the traditions of mathematical and natural sciences

Computational Thinking

Part 4/5

Decomposition and Abstraction

Introduction to Decomposition and Heuristics 🔍🏛️

- Decomposition: Breaking down complex problems into simpler parts
- Very important in computer science for managing complexity
- Heuristics: Problem-solving techniques yielding good enough answers

Decomposition and Divide-and-Conquer Strategy 🪓🛡️

- Decomposition: Breaking a complex problem into simpler parts
- Divide-and-Conquer: Used in various domains (e.g., military, politics)

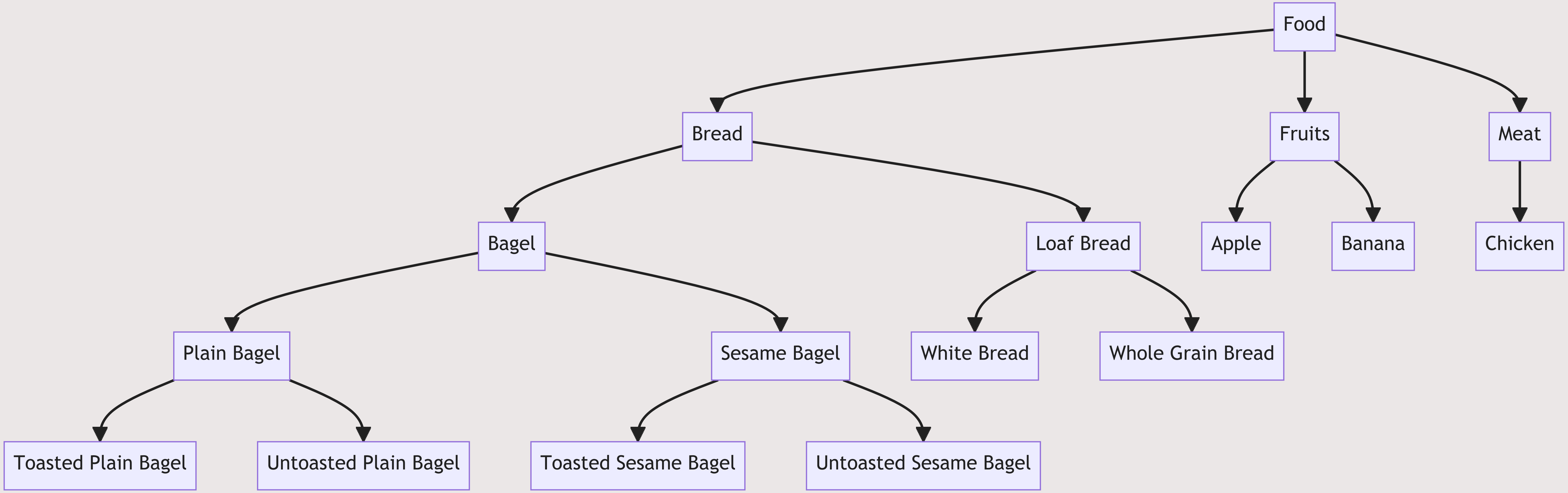
Other Effective Problem-Solving Strategies 🧠💡

- Critical thinking: Questioning ideas and justifying decisions
- Solving a concrete instance: Simplifying problems with specific examples
- Finding related problems: Examining solutions to analogous problems
- Working backward: Starting from the goal and deducing steps backward

Abstraction

- Abstraction is a way to simplify complex systems by focusing on the high-level overview rather than the nitty-gritty details. It allows us to understand and solve problems more efficiently by removing unnecessary information

Abstraction



Course Overview

Part 5/5

Course Philosophy

- Most introductory courses focus on programming proficiency but often overlook computational thinking
- We start with a *complete program* and explore various aspects of **computer science**. So less focus on programming and more focus on computational thinking

Essential Concepts

- Algorithms
- Computing hardware
- Models of computation
- Computer networks
- Cyber Security

Topic	Lectures	Lab
Week 1: Introduction	2 Lectures	1 Lab
Week 2: Algorithm and Git	2 Lectures	1 Lab
Week 3: Theory of Computation	2 Lectures	1 Lab
Week 4: Computer Networks	2 Lectures	1 Lab
Week 5: Cyber Security	2 Lectures	1 Lab
Week 6: Project Week	No Lectures	No Lab
Week 7: Exam Prep	2 Q&A Sessions	No Lab

Grading

Assignment	Points	Percent
JavaCraft Project	25	25%
Final Exam	75	75%
Total	100	—

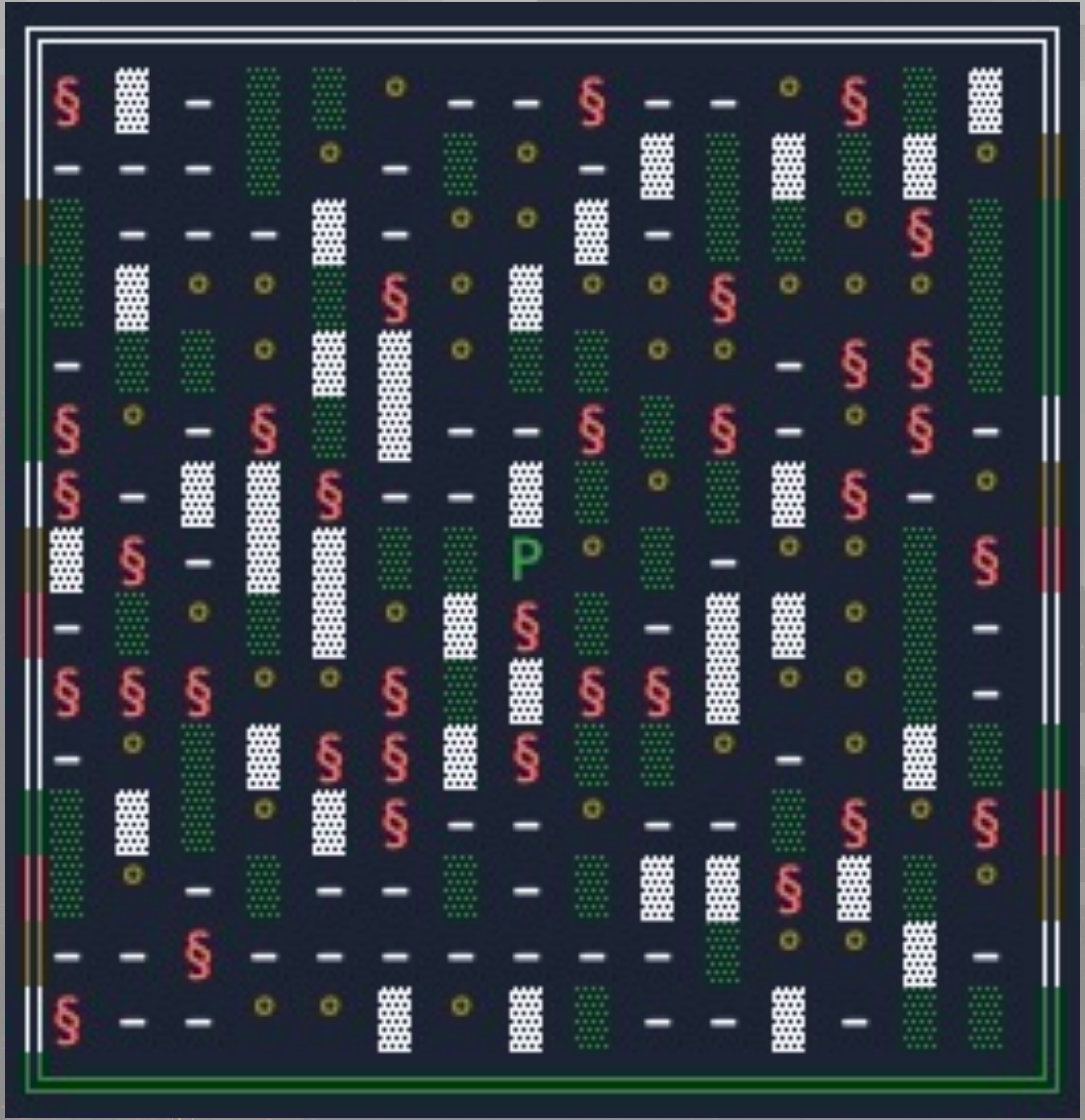
> To pass the course, you need to get more than 60% in total

Grade	Range
10	96–100%
9	90–95%
8	80–89%
7	70–79%
6	60–69%
F	<60

JAVA CRAFT

BCS1110

Not at all inspired by minecraft



What do we expect from you?

Section 5.1

Programming Expectations 👨‍💻

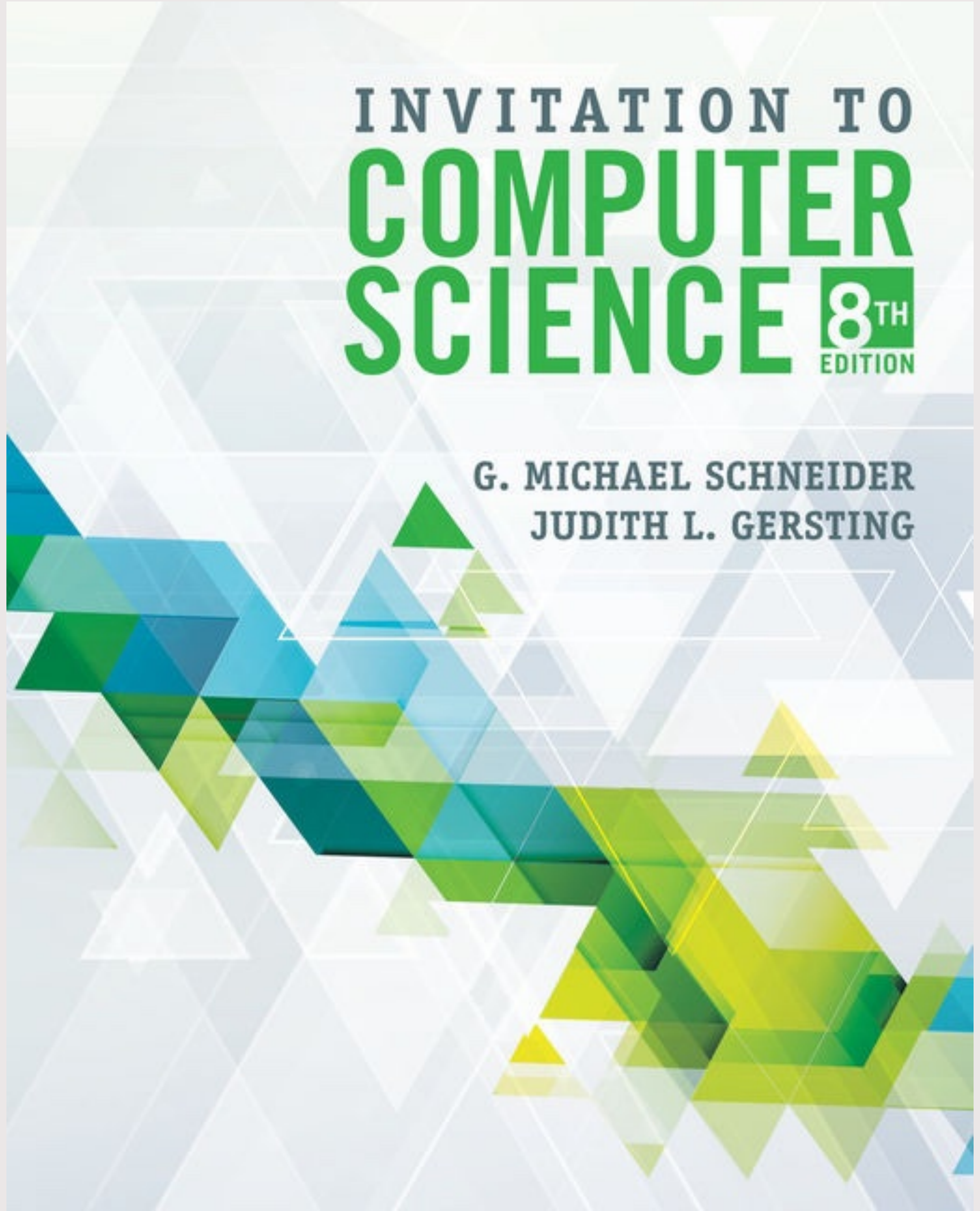
- You follow **BCS1120** and learn **Java** ☕ (or you already know how to work with Java)
- You will need to write some code but most importantly you need to **understand** and **modify** existing code in Java

Attendance and participation

- You are *expected* to come to the lectures each Monday and Tuesday🏫[1]
- You also have to attend your 🥼 labs on Thursday

[1] I **strongly** recommend that you attend all the lectures and labs

Course Material[1]



Other materials

- I will occasionally also use two other text (see course page) (No need to buy these either)

Java and VSCode

- We piggybank on BCS1120’s setup
- Use VSCode for the project

[1] You do not need to buy the book, I will provide you all the information you need within the lecture notes

Important pep talk!

- I promise you **can** (and *will*) succeed in this class
- I'm fully committed to making sure that you learn everything you were hoping to learn from this class!

Support

Section 5.2

Support from me

- I will make whatever accommodations I can to help you learn and understand the class material and finish project
- If you tell me you're having trouble, I will not judge you or think less of you. I hope you'll extend me the same grace
- You are always welcome to talk to me about things that you're going through, though. If I can't help you, I usually know somebody who can

If you need **extra help**, or if you need more time with something, or if you feel like you’re behind or not understanding everything, **do not suffer in silence! Talk to me!** I will work with you. **I promise**

Student hours ⏳

- Student hours are set times dedicated to all of you (most professors call these “office hours”; I don’t)
- This means that I will be in my office (🏫**PHS1 C4.005**, *Thursday before from 10 to 11*) waiting for you to come by talk to me with whatever questions you have

Course Policies

Section 5.3

SIMPLE: BE KIND, BE NICE AND BE CONSIDERATE

Class Policies

- We do not tolerate discrimination and/or violence of any sort
  - We live in a world with a long history of racism and need to actively combat that in both our actions and language, so please be mindful

Academic Honesty

- Violation of UM's Policy on Academic Honesty will result in an Fail in the course and possible disciplinary action[1]

Special Needs

- Please talk to me this week

[1] So seriously, just don't cheat or plagiarize!

Course Communication

- Course Website: 🖥️ bcs1110.ashish.nl & UM Canvas
- Discord Sever
- Email[1]

[1] E-mail and Discord are the best ways to get in contact with me. I will try to respond to all course-related e-mails and Discord messages within 24 hours (really), but also remember that life can be busy and chaotic for everyone (including me!), so if I don’t respond right away, don’t worry!

REMEMBER: I AM HERE TO SUPPORT YOU IF YOU NEED IT.

👋 LET’S HAVE A GREAT SEMESTER!