SIT105 –Thinking Technology and Design

Class 01

Part 1 – About this unit

Part 2 – Problem solving

A/Prof. Xiao Liu

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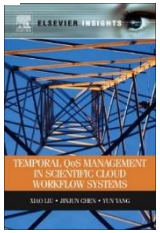
About Me

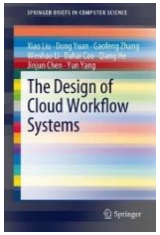
- Visit https://sites.google.com/site/drxiaoliu/
- Education
  - 2000-2007, Bachelor and Master in Information Technology, School of Management, Hefei University of Technology, China
  - 2007-2011, PhD in Computer Science and Software Engineering, Swinburne University of Technology, Australia
- Employment
  - 2011-2012, Postdoc Research Fellow and Sessional Lecturer, Swinburne University of Technology, Australia
  - 2012-2015, Associate Professor, Software Engineering Institute, East China Normal University, China
  - 2015-2020, Senior Lecturer, School of IT, Deakin University, Australia
  - 2018-, Associate Head of School (International)
  - 2021-, Associate Professor, School of IT, Deakin University, Australia

About Me

- Teaching
  - SIT102 Introduction to Programming
  - SIT172 Programming for Engineers
  - SIT221 Data Structures and Algorithms
  - SIT222 Operating System Concepts
  - SIT321 Software Engineering
  - SIT323 Cloud Applications and Development
  - SIT105 Thinking Technology and Design
  - Introduction to Cloud Computing and Big Data
  - Distributed Computing: Cloud Computing with Window Azure Platform
  - Web Programming
  - Software Engineering Project
- Research
  - Software Engineering: Software Process, Requirements Engineering, Human Factors
  - Distributed Computing: Workflow Systems, Cloud Computing, Mobile Computing, Edge/Fog Computing
  - AI and Machine Learning: Natural Language Processing, Federated Learning, Multimodal Learning, Large Language Models

About Me





- Research Publications
  - Over 200 publications
    - Over 60 journal articles (CORE A*/A, Q1)
    - Over 50 conference papers (CORE A*/A)
    - H-index: 35 (according to Google Scholar), citations>5200
- HDR Student Supervision
  - Honours Students
    - Completed 5 at Deakin (4 have progressed to PhD, all with scholarships)
  - Master by Research Students
    - Completed 6 at East China Normal University, 2 won National Scholarship for postgraduate students, MOE China (5 out of 200 in the school)
    - Employed by eBay Research, Baidu, SAP
  - PhD Students
    - Successful supervision to completion of 3 PhD students
    - Currently supervising 7 PhD student as Principal/Executive Supervisor and 4 PhD students (as Co-/Associate Supervisor)

Scholarships available, open for Honours and PhD students!
Please contact me if you are interested to apply.

How About YOU

- What's your name?
- What's your course/major?
- Why do you choose this unit?
- What do you want to get from this unit?
- What do you think critical thinking is?
- Do you think critical thinking is an important skill for your study and future career?

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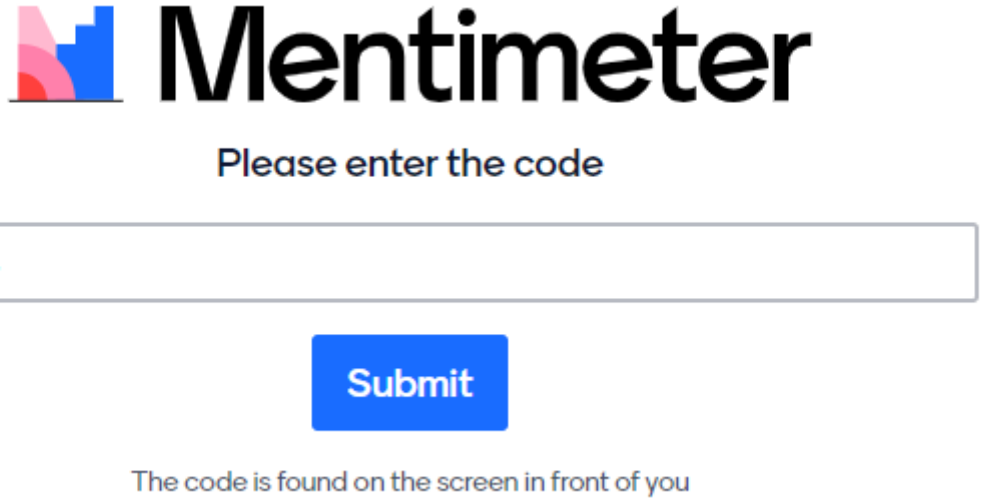
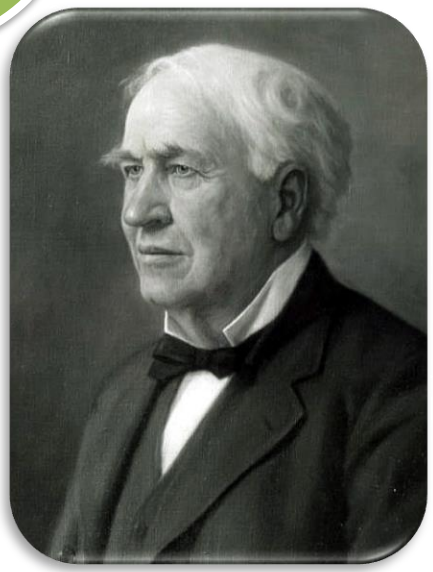


A quote to remember on your first week!

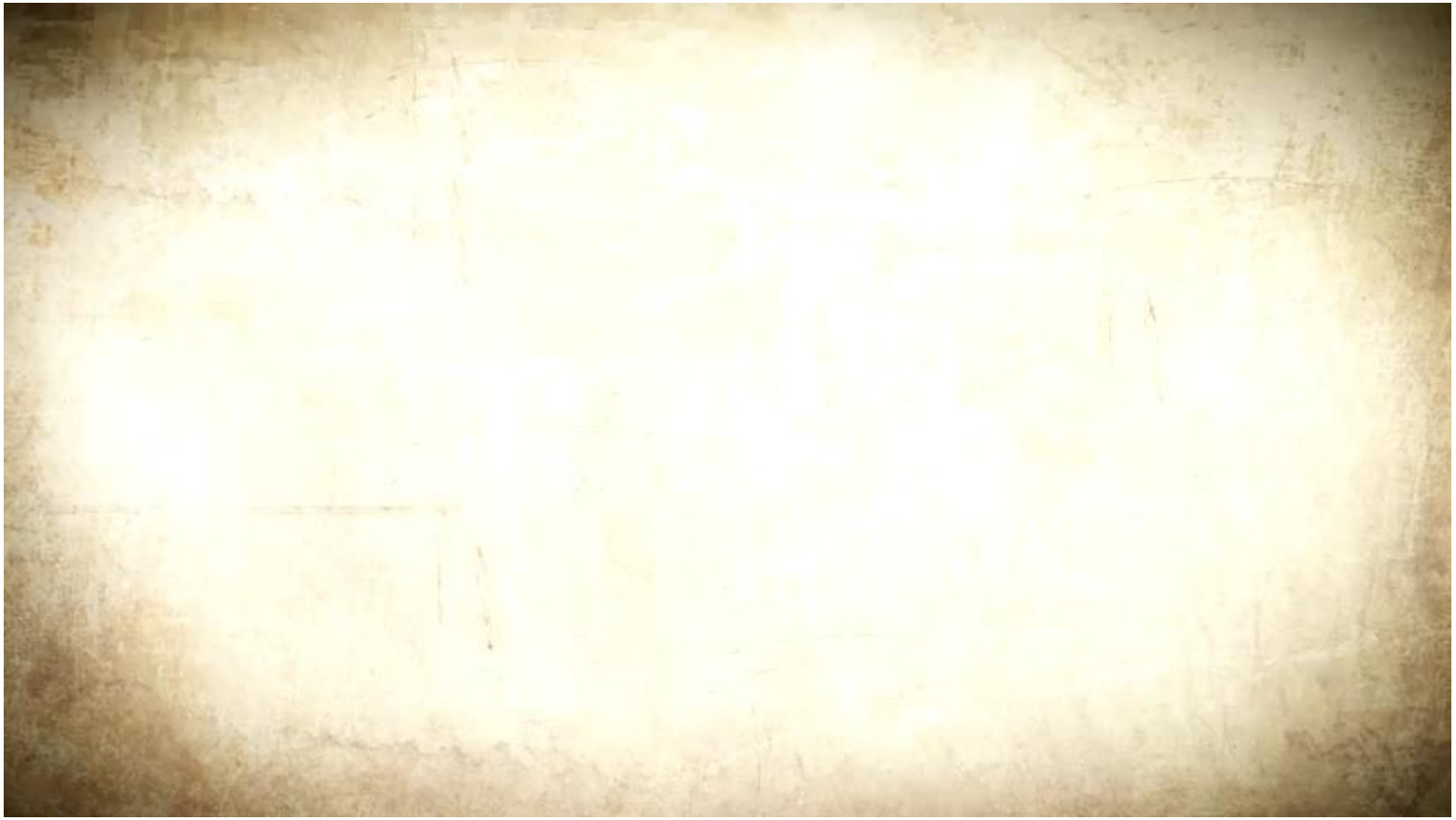
"Our greatest weakness lies in giving up. The most certain way to succeed is always to try just one more time."

–Thomas A. Edison

One of the first and greatest critical thinkers!



[Video]
History of Thomas Edison



Today's Outline

First Half

- What is this unit about?
- What are the learning outcomes for SIT105 ?
- Assessments
- Text book?

Second Half

- Introducing problem solving
- Analyzing and problem solving real-world issues


First Half!

Critical Thinking?

- If you google “critical thinking Deakin university”, you will find
  - SIT105-Thinking Technology and Design (Core Unit for all IT courses, School of IT)
  - ASP108 - Critical Thinking (Core Unit in Bachelor of Arts, Philosophy, School of Arts and Education)
  - EAD112 - Critical Thinking and Problem Solving: Using Analysis to Develop Solutions (Associate Degree of Education)
  - MPM732 - Critical Thinking for Managers (Master of Business Administration, Master of Engineering (Professional), Master of Commerce)
  - And more…

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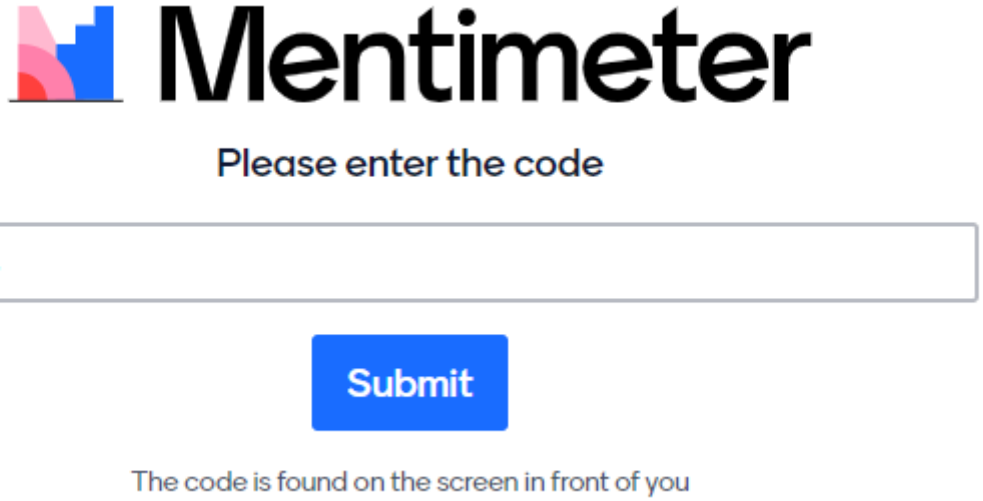


What is SIT105 about ?

The goal of this unit is to:

- Applying critical thinking and problem solving skills.
  - From technical and non-technical perspectives.
- Assist you in having a deeper understanding of problems revolving around technology.
- Cultivate your reflective thinking – What? Why? When?
  - Reflective thinking is critical for success in situations which are unpredictable or complex when you are working with customers or clients.
  - Reflective thinking helps you to:
    - Develop an attitude where you ask questions
    - Identify areas for improvement
    - Be able to respond to new challenges
    - Applying what you have learned from one situation to other situations
- Begin your journey of designing and developing technology.
  - How? By starting with designing algorithms.

SIT105 History

- Old Name: Critical Thinking and Problem Solving for IT

- New Name: Thinking Technology and Design

Learning and Assessment – ULO's

Your assessments are linked to your unit learning outcomes.

- The unit learning outcomes = the specifics of what you are learning.
- All unit learning outcomes are assessed.
- Learning outcomes are observable, measurable, achievable and important!

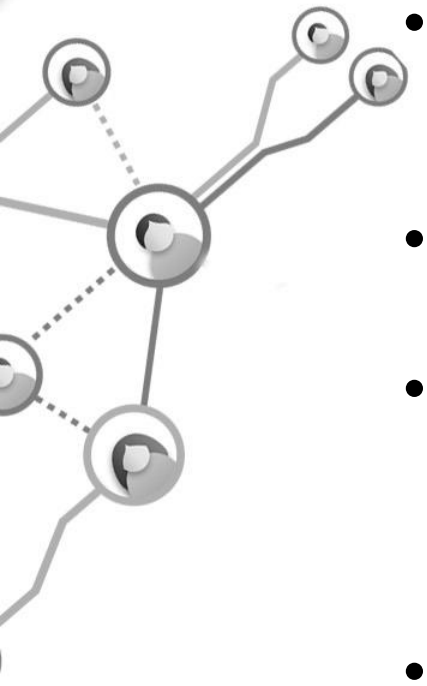
Unit and course learning outcomes are professional accreditation requirements and standards, and relevant Australian Qualification Framework specifications.

Each course here at Deakin has clear pathways of outcome and accomplishment, with developmental support.
Unit learning outcomes are aligned with learning outcomes for your **course** and aligned with **Deakin's Graduate Learning Outcomes**.

Unit Learning Outcomes

At the successful completion of this unit students can:

- **ULO1** Apply critical thinking techniques and IT discourse to identify and analyse problems from technical and non-technical perspectives.
- **ULO2** Develop strategies using generic and IT specific techniques to explore algorithms.
- **ULO3** Create algorithms using the input-processing-output model, defining diagrams and pseudo-code to demonstrate simple program design.
- **ULO4** Develop tests using assertions to evaluate and ensure correctness of algorithms



A new theme since 2023

- Online misinformation management
  - https://veski.counterinfodemic.org/

A new focused theme for 2024

Climate Misinformation

What is climate misinformation

How can we debunk climate misinformation

How can we help to fight climate misinformation

Large Language Models (LLMs)

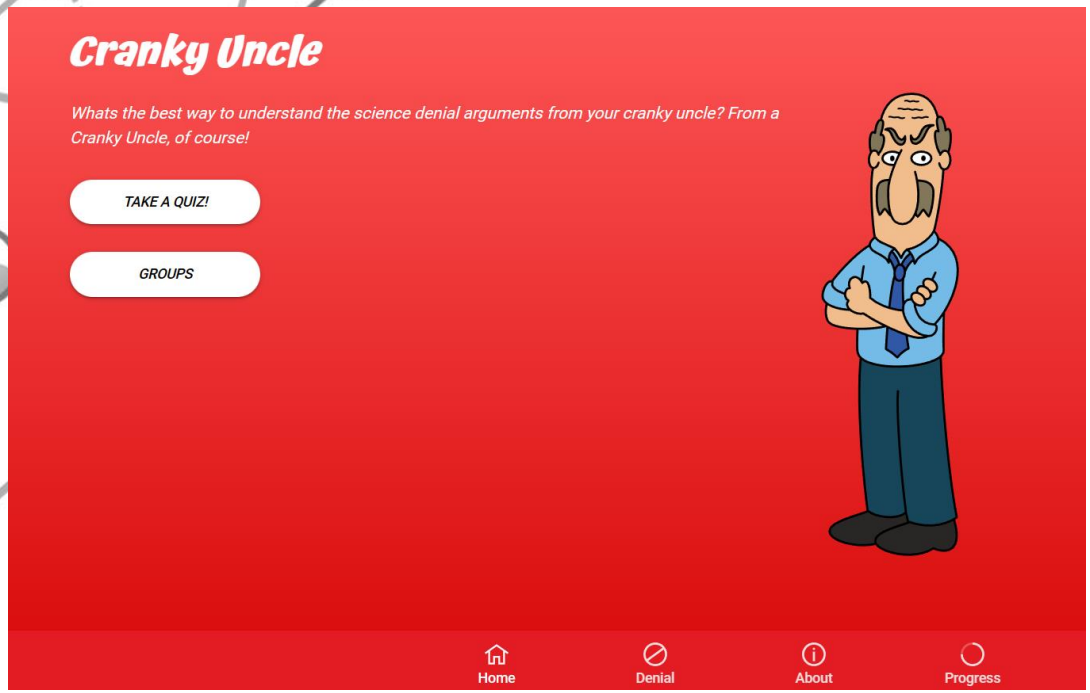
What are LLMs

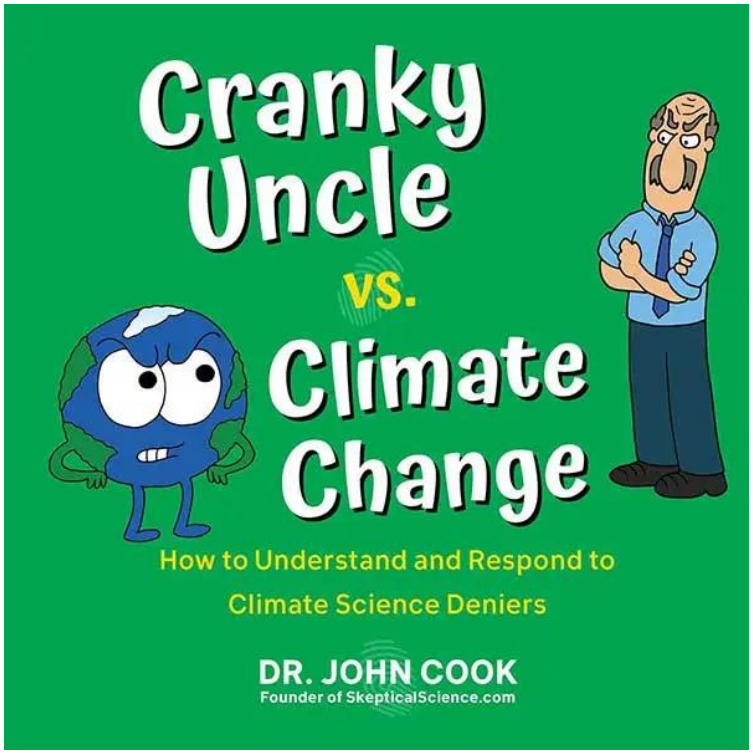
How can we use LLMs

How can we use LLMs to fight climate misinformation

A New Game since 2023

- Cranky Uncle
  - https://app.crankyuncle.info





Text Books

- **There is no prescribed textbook for this unit.**
- Recommended learning resources
- Recommended text:
  - l Critical Thinking and Problem Solving for IT, Custom Publication, Jackson et al, 1st edition
- Other recommended reference books include:
  - Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills / Kallet, Michael. (2014).
  - Mastering the requirements process: getting requirements right / Suzanne Robertson, James Robertson. (2016).
  - Critical Thinking Skills: Effective Analysis, Argument and Reflection, 3rd edition, 2017. Palgrave Study Skills. Stella Cottrell
  - Critical Thinking: A User's Manual, 2nd Edition, 2016. Debra Jackson and Paul Newberry. Cengage Learning.
  - Simple Program Design: a step-by-step approach, 5th Edition, 2007. Lesley Anne Robertson. Thomson.
  - Critical Thinking, 10th Edition. Brooke Noel Moore and Richard Parker. McGraw-Hill Higher Education.
  - Smart Thinking, 2016. Palgrave Study Skills Bryan Greetham.

Classes and Practical's @ Deakin

So we will have two different kinds of interaction here in this unit.

- **Classes (entire student group)**
  - For the first 5 classes we will think about critical thinking and problem solving revolving around different technology themes. We will have multimedia, activities and group discussions on these topics, linking in the theory.
  - The following 5 classes, we will pursue your learning of constructing algorithms (your first step into more hands on technology). This will be a combination of me teaching theory and some discussion points.
  - Finishing with a final week of exam revision.
- **Workshops (divided into smaller groups)**
  - First class will be an introductory session to ease into things.
  - First, we will use these sessions to continue our learning on the class topics, focusing on group work activities, discussion questions and problem solving.
  - The next 6 classes, we will focus on writing algorithms, starting off very easy and finishing with more advanced.

SIT105@SWU-Intensive Teaching

- 3 weeks durations with 3-4 sessions each week
  - Monday: Classes
  - Tuesday: Classes
  - Wednesday: Classes, Workshops/Games
  - Thursday: Webinars, Games and “ASK ME ANYTHING”

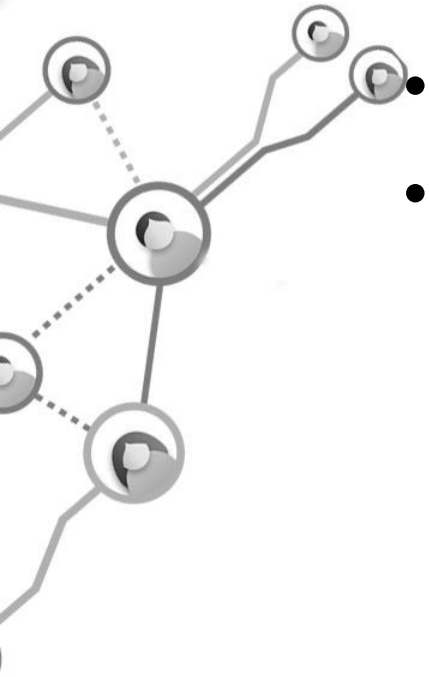
Teaching Schedule SIT105@SWU

学期周	周一	周二	周三	周四
11	6/05 (Class) 下午7-9节	7/05 (Class) 上午1-3节	8/05 (Class, Workshop) 上午1-3节	9/05 (Workshop, Game, ASK) 下午9-11节
12	13/05(Class) 下午7-9节	14/05 (Class) 上午1-3节	15/05 (Class, Workshop) 上午1-3节	16/05 (Webinar, Game, ASK) 下午9-11节
13	20 (Class) 下午7-9节	21 (Class) 上午1-3节	22 (Unit Review, ASK) – Last Class 上午1-2节	

- Workshop activities (tentative)
  - 8/05, recorded Guest Lecture by John Cook
  - 9/05, Game and “ASK ME ANYTHING”
  - 15/05, recorded Guest Lecture by John Cook
  - 16/05, live Guest Lecture by Oscar Wu on fact-checking using Large Language Models, Game and “ASK ME ANYTHING”
  - 22/05, Unit Review, exam tips and “ASK ME ANYTHING”

Assessment

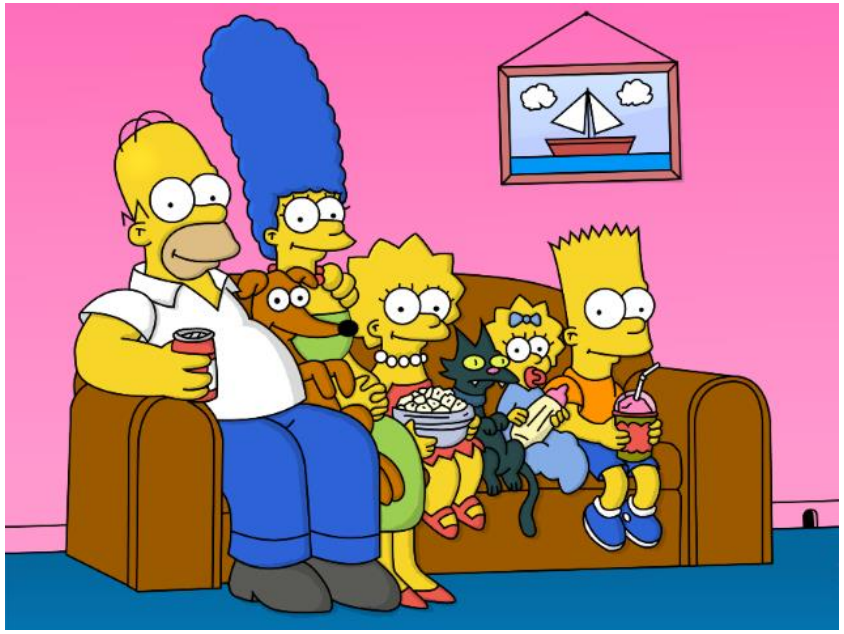
- Play Cranky Uncle Game and earn at least 600 points (You can start from today)
- Mid-term Quiz
- Final exam



Questions?

Good Luck !

Enjoy Your Study of SIT105

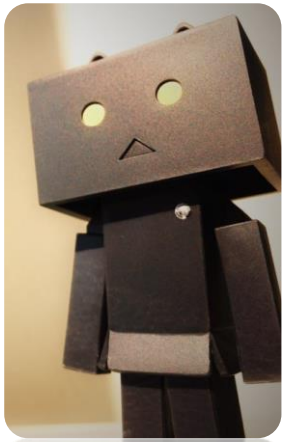


Second Half!

Problem Solving &
Future Medical
Technologies

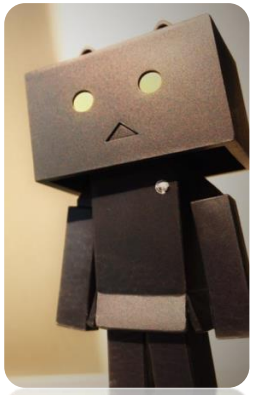
Today's Outline
Medicine and Technology

- Problem solving introduction
- Research: Problem solving techniques
- Problem 1: 5 future medical technologies
- Activity: Define problem solving techniques!
- Problem 2: Technology failure
- Problem 3: Hacking
- Readings



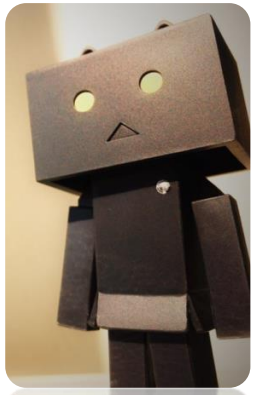
Problem Solving Intro

- The world of Information Technology is full of **problems, and decisions**, but many people do not have the appropriate skills to manage them.
- As problem solvers we try to improve the actual state of an IT project by finding an answer or a solution to a problem.
- One way which can really boost our problem solving skills is when we work in a team to solve problems.
  - This can often be more beneficial than individual.



Problem Solving… get specific!

- When we think of problems in broad terms, it makes them much harder to solve!
  - My internet download speed sucks!
  - Everything on my phone is not working!
- What you want to do is try to hone in and obtain **key facts**.
  - This can help you to get to the key issues and find out what you need to solve exactly.



Frame your Design Challenge

from IDEO
Field Guide to
Human Centered Design

Frame Your Design Challenge

What is the problem you're trying to solve?

Improving the lives of children.

1) **Take a stab at framing it as a design question.**

How might we improve the lives of children?

2) **Now, state the ultimate impact you're trying to have.**

We want very young children in low-income communities to thrive.

3) **What are some possible solutions to your problem?**

Think broadly. It's fine to start a project with a hunch or two, but make sure you allow for surprising outcomes.

Better nutrition, parents engaging with young kids to spur brain development, better education around parenting, early childhood education centers, better access to neonatal care and vaccines.

4) **Finally, write down some of the context and constraints that you're facing.**

They could be geographic, technological, time-based, or have to do with the population you're trying to reach.

Because children aren't in control of their circumstances, we wanted to address our solution to their parents.

We want a solution that could work across different regions.

5) **Does your original question need a tweak? Try it again.**

How might parents in low-income communities ensure children thrive in their first five years.

How Might We …

Check the quality of your Design Question

From The Field Guide to Human-Centered Design - IDEO

How Might We …

Check the quality of your Design Question

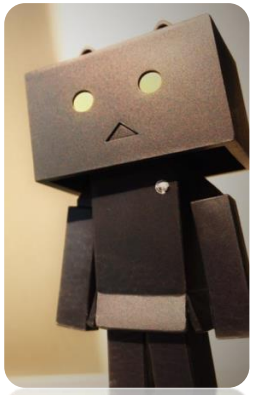
- A properly framed *How Might We* doesn't suggest a particular solution, but gives you the perfect frame for innovative thinking
- Now take a look at your *How Might We* question and ask yourself if it allows for a variety of solutions. If it doesn't, broaden it.
- Your *How Might We* should generate a number of possible answers and will become a launchpad for your Brainstorms
- Make sure that your *How Might We's* aren't too broad. It's a tricky process but a good How Might We should give you both a narrow enough frame to let you know where to start your Brainstorm, but also enough breadth to give you room to explore wild ideas.

From The Field Guide to Human-Centered Design - IDEO

Problem Solving… get specific!

- You want to **define your problem** and its severity as precisely as possible!
- By doing this, you will be:
  - Assessing the **current** (actual) state of affairs
  - Specifying the **desired** (ideal) state of affairs (goals)

- By doing this, it can help to set your technological problem on the pathway to being solved!



Problem Solving Process

…..An example from the U.S Air Force

- Let's check out the process that the military uses to solve problems!
- https://www.airuniversity.af.edu/Portals/10/eSchool/documents/Support%20Center%20Material/A3_Problem_Solving_Brochure.pdf

	USAF Problem-Solving Process **OODA – Observe, Orient, Decide, & Act** 8-Step Problem Solving Process	Approval Information/Signatures
O O D A	4. Determine Root Cause O O D A	6. See Countermeasures Through

Problem Solving Process

.....An example from the U.S Air Force

AIR FORCE EIGHT-STEP PROBLEM-SOLVING MODEL

1. Clarify & Validate the Problem — (O) O D A

a. Does this problem, when solved, help meet needs identified by the organization?
   - Is it linked to the SA&D of organization?
   - Does it help satisfy customer needs (VOC)?

b. Does this problem, when solved, address key issues identified during SWOT analysis?

c. Has this problem been identified and directed by a Value Stream Map at the appropriate level?
   - What does the "Future State" need?
   - What resources have been identified to address this issue?

d. What opportunities were identified or observed by the process or problem area "walk"?
   - Will addressing or improving these issues deliver results that relate to #a or #b?
   - Will addressing or improving this problem deliver the desired future state from #c?

TOOLS: SA&D, Voice of Customer, VSM, Go & See

2. Break Down the Problem/Identify Performance Gaps — (O) O D A

a. Does the problem require more analysis or does leadership have enough information to execute a solution?
   - Is this simply a leadership directive?

b. If more data is needed, how do we measure performance now?
   - What are the KPIs? What is the performance gap?

c. Does other "non-existent" data need to be gathered?

d. What does the data indicate are the potential root causes?

e. Does the data review indicate a bottleneck or constraint?

TOOLS: KPI/Metrics, Performance Gap Analysis, Bottleneck Analysis

3. Set Improvement Target — O (O) D A

a. Is the improvement target measurable? Is it concrete? Is it challenging?

b. Is the target "Output Oriented"?
   - What is the desired output?
   - Should be "things to achieve"; should avoid "things to do"
     -- Will be addressed by Action Plans (Step 5)

c. The desired target should:
   - Do what? By how much? By when?

d. If it is a Process Problem, what is the future state?
   - How will it be realized?

TOOLS: Ideal State, Future State Mapping, B-SMART

4. Determine Root Cause — O (O) D A

a. What root cause analysis tools are necessary?
   - Why are these tools necessary?
   - What benefit will be gained by using them?
   - Who will need to be involved in the root cause analysis?
     -- 10 heads are better than one
     -- Remember "cultural" issues related to problem

b. What is (are) the root cause(s) according to the tools?

c. How will the root cause be addressed?

d. Will addressing these address the performance gap?

e. Can the problem be turned on or off by addressing the root cause?

f. Does the root cause make sense if the 5 Whys are worked in reverse?
   - Working in reverse, say "therefore" between each of the "whys"

TOOLS: 5 Whys, Brainstorming, Pareto, Affinity, Fishbone, Control Charts

5. Develop Countermeasures — O O (D) A

a. Develop potential countermeasures
   - Tools and philosophies from Lean, TOC, 6 Sigma and BPR as appropriate

b. Select the most practical and effective countermeasures

c. Build consensus with others by involving all stakeholders appropriately
   - Communicate, communicate, communicate

d. Create clear and detailed action plan
   - B-SMART actions
   - Reference Facilitation Techniques as appropriate

TOOLS: A3, Action Plans, Timelines, Financial Reporting Template

6. See Countermeasures Through — O O D (A)

a. Which philosophy best prescribes tools that address root cause(s)?

b. Which tools best address root cause(s)?

c. Which method for implementation fits the tool and improvement need?
   - Rapid Improvement Event?
   - Improvement Project?
   - Point Improvement or "Just Do It"?

d. If RIE or Project, create "Charter" and communicate

e. What training or education is needed? By Whom?

TOOLS: 6S & Visual Mgt, Standard Work, Cell Design, Variation Reduction, Error Proofing, Quick Changeover, TPM, RIE

7. Confirm Results & Process — O O D (A)

a. How are we performing relative to the Observe phase (Steps 1 & 2)?

b. How are we performing relative to Step 3?

c. How are we performing relative to Financial Reporting Template projections?

d. If we are not meeting targets, do we need to return to Step 4?
   - Most problem solving "breakdowns" occur relative to improper root cause identification

TOOLS: KPIs/Metrics, Performance Mgt, SA&D, Standard Work, Audit

8. Standardize Successful Processes — O O D (A)

a. What is needed to Standardize Improvements?
   - Tech Order changes?
   - Air Force Instruction changes?
   - Official Instruction changes?

b. How should improvements and lessons learned be communicated?
   - Continuous Process Improvement-Mgt Tool (PowerSteering)
   - Key meetings?

c. Were other opportunities or problems identified by the Problem Solving Process?
   - Restart OODA Loop

TOOLS: Checkpoints/Standardization Table, Report Out Theme Story, Broad Implementation, CPI Mgt Tool

http://afso21.af.mil

Problem Solving Methods?

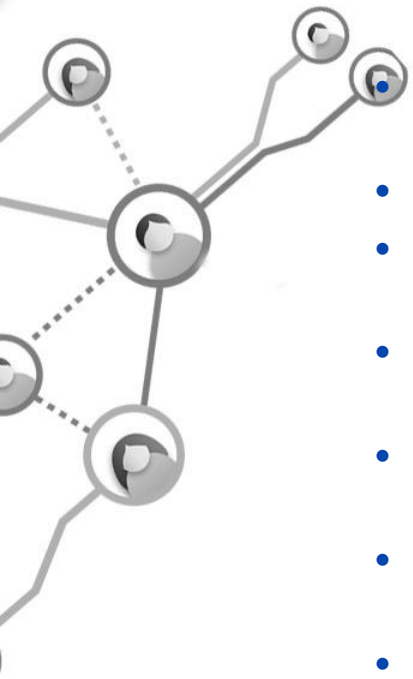
- **So, why do we need them?**
  - To help us figure out solutions to problems in the most effective and efficient way.
    - As there is not always 1 way to solve a problem.
  - Often work in IT revolves around solving problems to come up with a solution for a client.
  - We have a number of techniques at our disposal to do this.

Full List of Techniques

Problem Solving Techniques
What is the list?

1. Abstraction
2. Analogy
3. Brainstorming
4. Divide and Conquer
5. Hypothesis Testing
6. Lateral Thinking
7. Means-Ends Analysis
8. Method of Focal Objects
9. Morphological Analysis
10. Reduction
11. Research
12. Root Cause Analysis
13. Trial-and-Error

https://en.wikipedia.org/wiki/Problem_solving



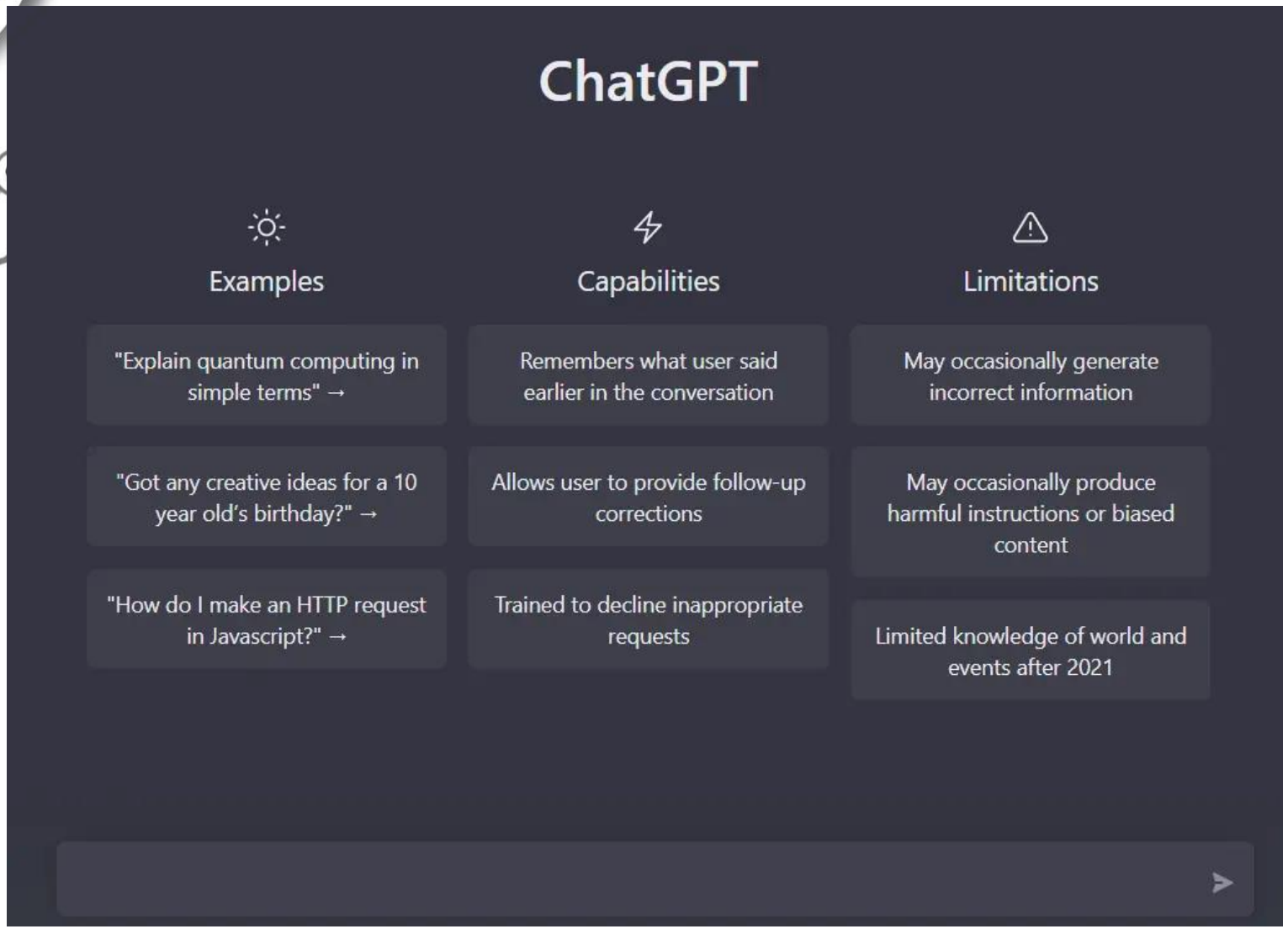
- Abstraction: solving the problem in a model of the system before applying it to the real system
- Analogy: using a solution that solves an analogous problem
- Brainstorming: (especially among groups of people) suggesting a large number of solutions or ideas and combining and developing them until an optimum solution is found
- Divide and conquer: breaking down a large, complex problem into smaller, solvable problems
- Hypothesis testing: assuming a possible explanation to the problem and trying to prove (or, in some contexts, disprove) the assumption
- Lateral thinking: approaching solutions indirectly and creatively
- Means-ends analysis: choosing an action at each step to move closer to the goal
- Method of focal objects: synthesizing seemingly non-matching characteristics of different objects into something new
- Morphological analysis: assessing the output and interactions of an entire system
- Proof: try to prove that the problem cannot be solved. The point where the proof fails will be the starting point for solving it
- Reduction: transforming the problem into another problem for which solutions exist
- Research: employing existing ideas or adapting existing solutions to similar problems
- Root cause analysis: identifying the cause of a problem
- Trial-and-error: testing possible solutions until the right one is found

Brainstorming, Done Right!

Class Activity- Define the Problem Solving Techniques

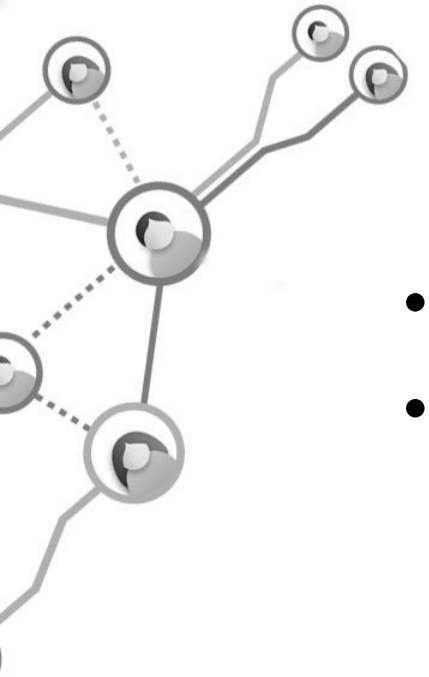
1. Forming a group of 5 students:
    1. You will discuss the questions as a group
    2. Only one student needs to go to menti.com and type in the answers
    3. Each student in each group need to come up with at least one answer
    4. We will check them together at the end

ChatGPT


ChatGPT
Examples
"Explain quantum computing in simple terms" →
"Got any creative ideas for a 10 year old's birthday?" →
"How do I make an HTTP request in Javascript?" →
Capabilities
Remembers what user said earlier in the conversation
Allows user to provide follow-up corrections
Trained to decline inappropriate requests
Limitations
May occasionally generate incorrect information
May occasionally produce harmful instructions or biased content
Limited knowledge of world and events after 2021

ChatGPT

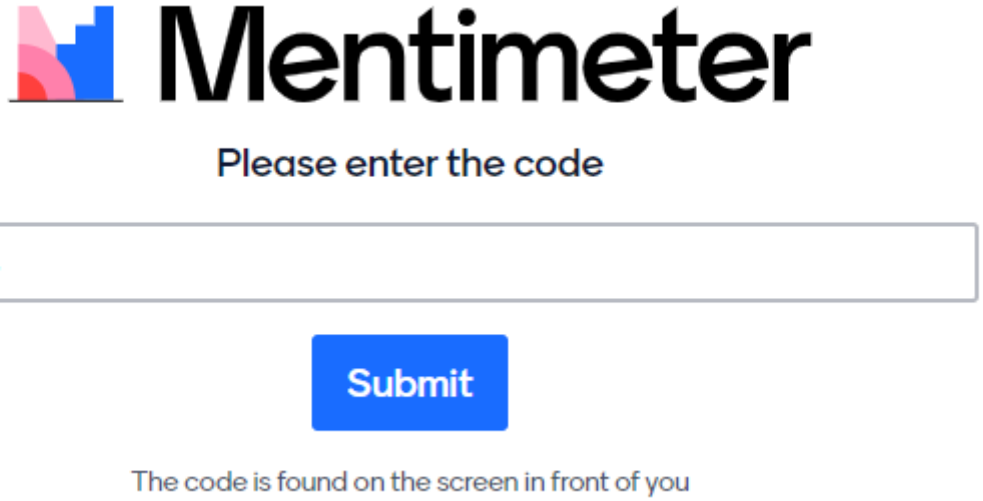
- Discuss within your group about what could be the opportunities and threats?



- SparkDesk – 科大讯飞星火大模型
- https://xinghuo.xfyun.cn/desk

Let’s go to www.menti.com

- Type in the code 3767904



A SWOT Analysis of ChatGPT

- SWOT: strengths, weaknesses, opportunities, and threats
  - https://avidopenaccess.org/resource/a-swot-analysis-of-chatgpt/

What you think the 5 most popular future medical technologies might be!

Problem 1

Use one or more of the problem solving techniques you discovered, and come up with a list. Let's give it a go!

<u>What are the 5 in your list</u>, <u>and what problem solving technique</u> did you use to figure them out?

Problem 1 Solution

Solution: So what are five popular new medical technologies?

There is many new medical technologies coming out but here are five popular ones:

1. **Robots** –The surgeon sits at a computer station and directs the movements of a robot.
2. **Exoskeleton suits** – to allow partially-paralyzed individuals to walk again.
3. **Body sensors** - to monitor everything from sleep apnea to blood pressure.
4. **3D Printers** – to manufacture medical equipment, prostheses, or even drugs.
5. **CloudHealth** - Online access to patient personal health information.

Possible Approach: Brainstorming with Research?

1. **Brainstorming**: You collaborated in a group to come up with ideas.
2. You may have used **Research** to discover possible answers (e.g. googling or baidu).

Problem 1 Approach

Problem 2

In the news!

Robotic surgery linked to 144 deaths in the US

A study into the safety of surgical robots has linked the machines' use to at least 144 deaths and more than 1,000 injuries over a 14-year period in the US.

- They list 1,166 cases of broken/burned parts falling into patients' bodies, which contributed to 119 injuries and one death.
- Uncontrolled movements and spontaneous powering on/off of the machines are said to have caused 52 injuries and two deaths.
- Electrical sparks, unintended charring and damaged accessory covers are linked to 193 injuries, including the burning of body tissues.
- And the loss of quality video feeds and/or reports of system error codes are said to have contributed to a further 41 injuries and one death.

Source: http://www.bbc.com/news/technology-33609495

Problem 2

Robotic surgery linked to 144 deaths in the US. How can this be avoided in the future?

- In your existing groups come up with responses for the following:
  1. What is the fundamental problem?
  2. Determine the best problem solving approach to go with to help avoid this!
     - Why did your group choose this?

Problem 2
Approach

Robotic surgery linked to 144 deaths in the US

- With this problem, an approach we could potentially use to solve this would be…

Abstraction!

- Solving the problem in a model of the system before applying it to the real system.
- Work out all the bugs in a model extensively before using it in real scenario's

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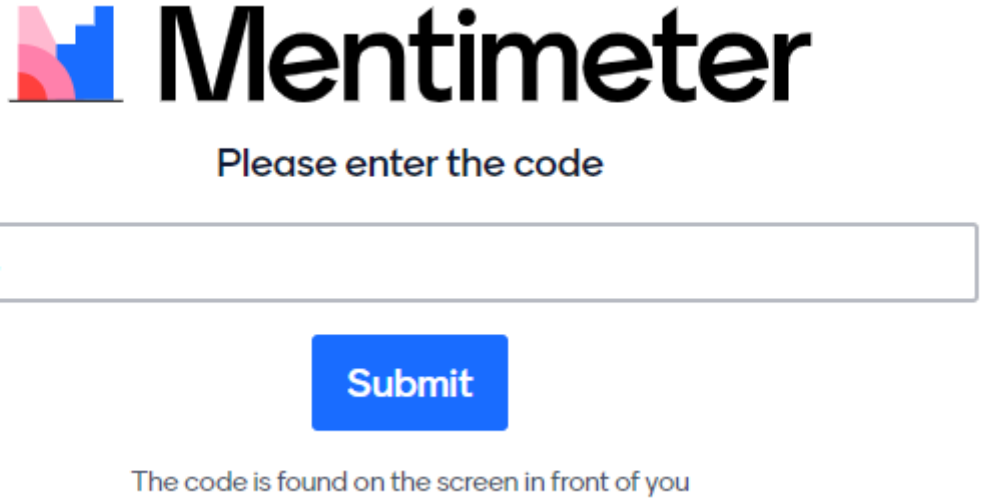
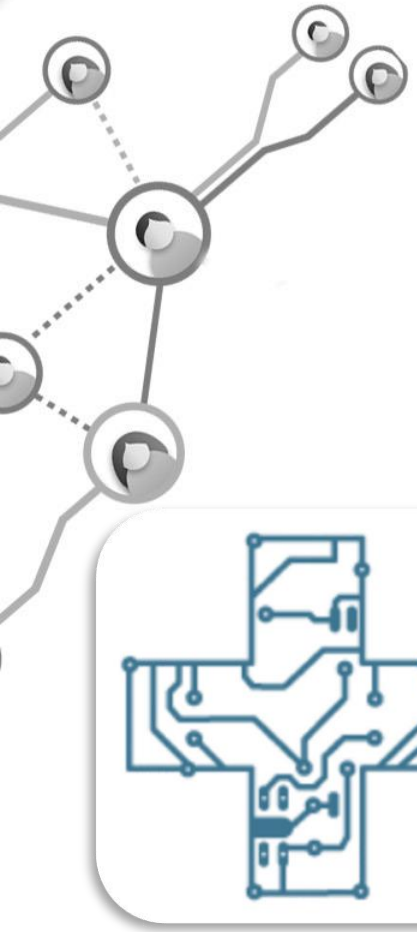


Problem 3

Future Medical: Hacking

- Many medical systems, such as heart monitoring systems use embedded systems (smaller versions of popular computer operating systems).
- We all know software (operating systems) can have errors, bugs or be hacked.
- Imagine a hacker purposely hacking one of these devices and causing it to go haywire or ignore certain conditions. In order to put a patient in danger.



How can this problem be solved?

1. Discuss the problem with your groups.
2. Determine the best problem solving approach to go with!
3. Why did your group choose this?

Problem 3 Approach

Future Medical: Hacking

- With this problem we could potentially use?

- **Morphological Analysis**!
- We could use this approach for the surgical robots, testing them before they are used in surgery's.
  - Analyse outputs and interactions.
  - Work backwards from outputs towards the system internals.
- Popular when you know very little about a system but you know the outputs/inputs!
  - We can figure out if the outputs are correct based upon the inputs.

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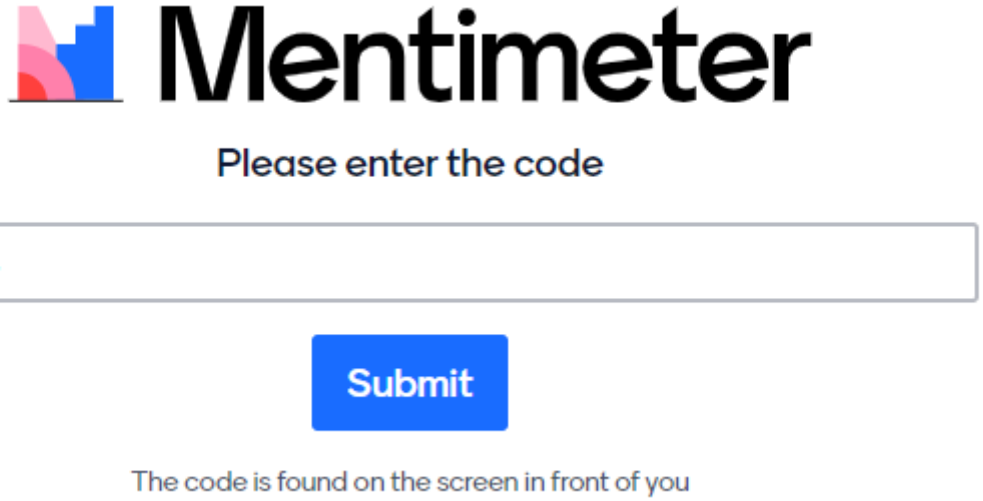
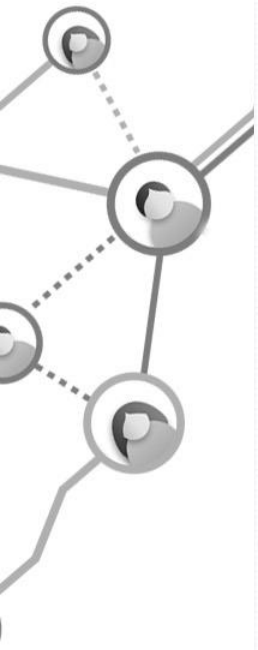
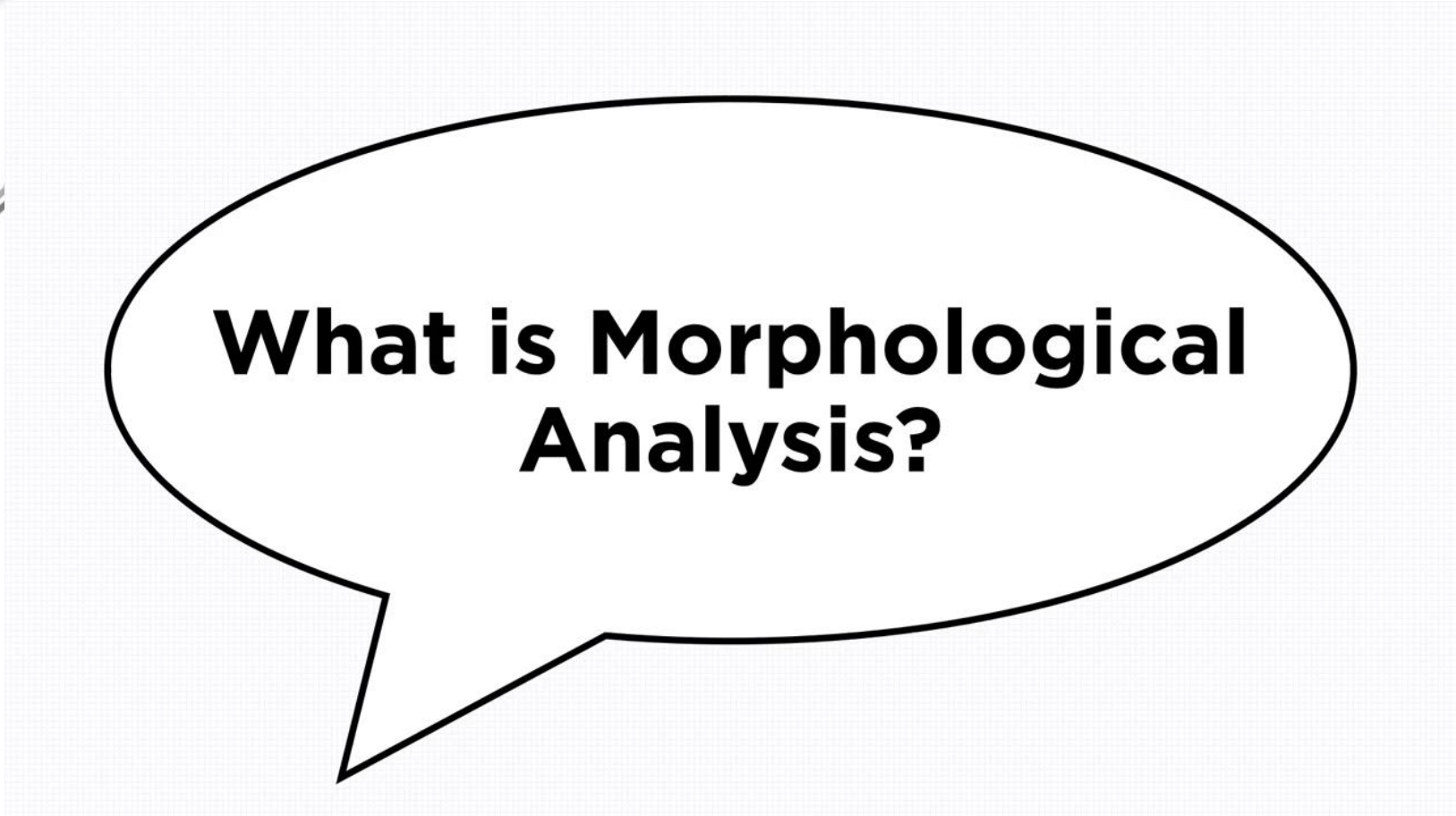


Morphological Analysis Explained





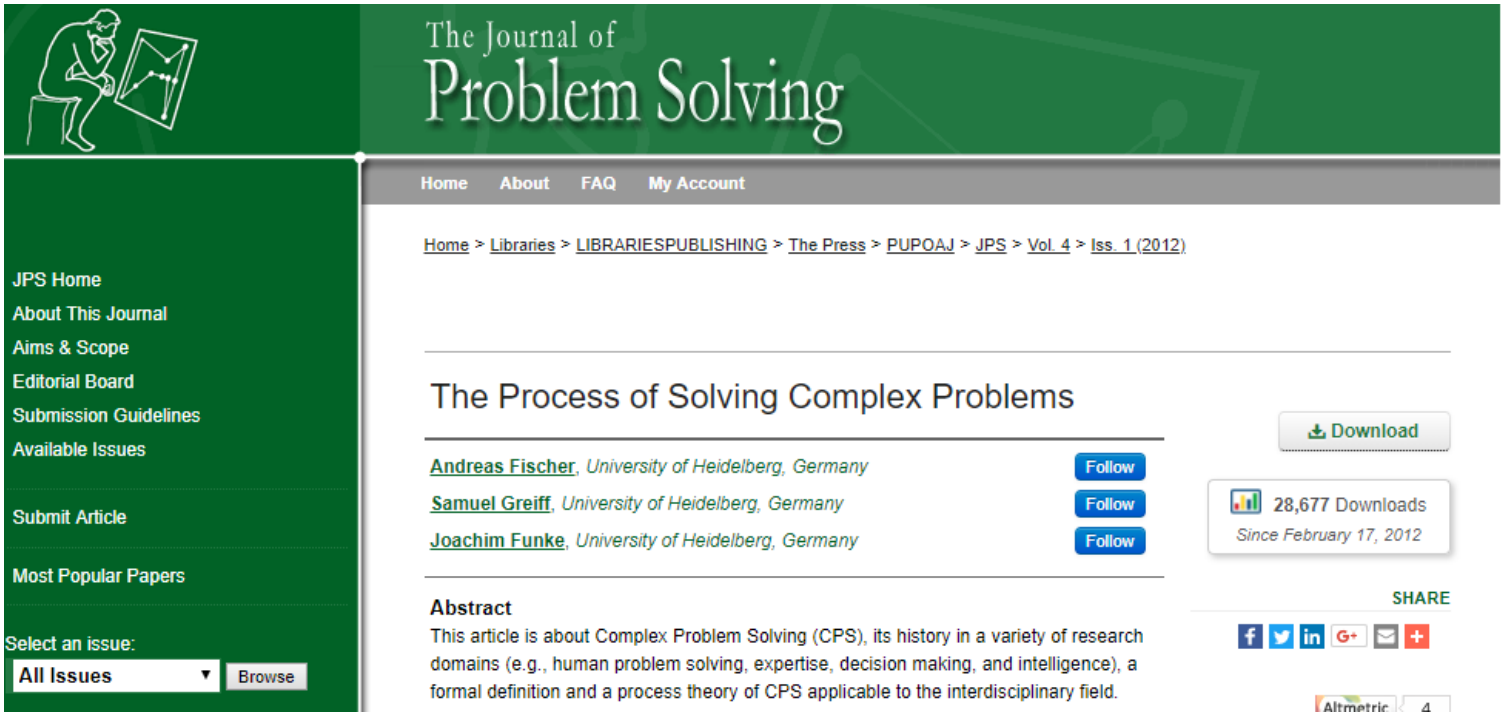
Conclusion

- In our theme this week, we looked at the future medical technology, its problems and its impact on society.
- We looked at various problem solving techniques and applied them to various scenario's.
  - Artificial Intelligence and hacking.
- Assisted you in having a deeper understanding of problems revolving around future medical technology, as well as how to potentially work towards solving them.
- Looked at what our ULO's are for this unit.

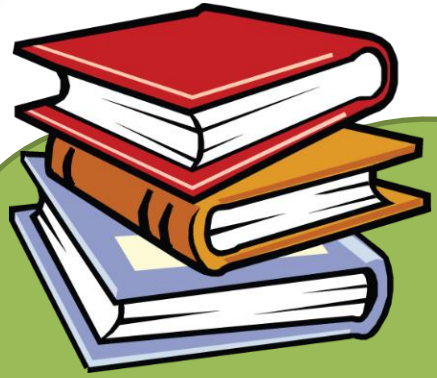
Problem Solving Post-Class Reading!

As part of this weeks after class reading I have provided an article from the Journal of Problem Solving.

The process of Solving Complex Problems!



Any Questions?



End of Class!

Read ‘The Process of Solving Complex Problems’ paper from the Journal of Problem Solving