

Computational Thinking Problem Solving Techniques

What is Computational Thinking?

- Computational thinking allows us to take a complex problem, understand what the problem is and develop possible solutions

Computational: Involving the calculation of answers, amounts and results (e.g. calculation and order)

Thinking: The activity of using your mind to consider something (e.g. reasoning and questioning)

Has 4 steps

1. **Decomposition** – breaking down a complex problem or system into smaller, more manageable parts
2. **Pattern recognition** – looking for similarities among and within problems
3. **Abstraction** – focusing on the important information only, ignoring irrelevant detail
4. **Algorithms** – developing a step-by-step solution to the problem, or the rules to follow to solve the problem

Abstraction: Biology

- Identifying and utilizing the structure of concepts/main ideas
- Simplifies things
 - Identifies what is important without worrying too much about the detail
- Allows us to manage the complexity of the context or content

1. * What is abstraction in computational thinking concept? Check all that apply.

Choose at least one answer.

- Simplifying the complexity
- Filtering out irrelevant detail
- Pointing out necessary information

All the options are descriptions of what abstraction is as a computational thinking competency.

Algorithms: Biology

- Following, identifying, using, and creating an ordered set of instructions
- Ordering things
- Ascending order
(e.g from 1 to 5, or from A B C to X Y Z)
- Descending order
(e.g from 5 to 1, or from Z Y X to C B A)
- Allows us to order the complexity of the context or content

Decomposition: Biology

- Breaking down data, processes or problems into smaller and more manageable components to solve a problem
- Each subproblem can then be examined or solved individually, as they are simpler to work with
- Natural way to solve problems
- Also known as to Divide and Conquer

Decomposition: Biology

- Solve complex problems
- If a complex problem is not decomposed, it is much harder to solve at once. Subproblems are usually easy to tackle
- Each subproblem can be solved by different parties of analysis
- Decomposition forces you to analyze your problem from different aspects

1. * Which of the computational thinking competency allows you to break down a complex phenomenon into smaller chunks to solve a problem?

Choose one of the following answers.

- Abstraction
- Algorithms
- Decomposition
- Pattern Recognition
- None of the above

Decomposition helps us to break down a problem into smaller chunks so that we can divide and conquer complexity.

Pattern Recognition: Biology

- Is observing patterns, trends and regularities in data (Google)
- A pattern is a discernible regularity
 - The elements of a pattern repeat in a predictable manner
- In computational thinking, a pattern is the spotted similarities and common differences between problems
- It involves finding the similarities or patterns among small, decomposed problems, which can help us solve complex problems more efficiently

Pattern Recognition

- Patterns make problems simpler and easy to solve
- Problems are easier to solve when they share patterns, we can use the same problem-solving solution wherever the pattern exists
- The more patterns we can find, the easier and quicker our problem solving will be

1. * Which of the following example(s) illustrates pattern recognition? Check all that apply.

Choose at least one answer.

- Having students to learn colors and shapes by clustering them
- Ascending the numbers
- Asking students to evaluate the locations of volcanoes and earthquakes across the globe
- Grouping students randomly

Ascending the numbers is about algorithms and not pattern recognition.

Grouping students randomly does not have a clear set of grouping and thus has no pattern.

1. * How does computational thinking benefit us the most?

Choose one of the following answers.

- To learn computer programing
- To think like a machine or computer
- To solve complex problems by using specific techniques
- None of the above

While computational thinking may support us in learning computer programing or to think like a machine or computer, it is most helpful in providing us with specific techniques to solve complex problems found in various aspects of our lives.

By breaking down a problem:

Look for similarities

Identify relevant information and opportunities

Create a plan for solution

1. * A MRT map is a good example of...

Choose one of the following answers.

- Algorithms
- Decomposition
- Abstraction
- Pattern recognition

Abstraction allows us to simplify the complexity and bring up relevant necessary information.

2. * Breaking down choreographic forms of dance into smaller acts (e.g., narrative, canon, retrograde) is an example of...

Choose one of the following answers.

- Abstraction
- Algorithms
- Pattern recognition
- Decomposition

Decomposition is a breaking down process while solving a problem.

3. * Baking a cake by following its step-by-step instructions is a good example of...

Choose one of the following answers.

- Algorithms

4. * Pairing up your socks back together is an example of...

Choose one of the following answers.

- Algorithms
- Pattern recognition
- Decomposition
- Abstraction

Pattern recognition helps us to match up the right sock pairs.

1. * Grouping given items according to their colors and shapes is a good example of...

Choose one of the following answers.

- Abstraction
- Algorithms
- Decomposition
- Pattern recognition

Pattern recognition helps us to group items in the same category.

2. * Evaluating the locations of volcanoes and earthquakes across the globe to find out similarities is a good example of...

Choose one of the following answers.

- Pattern recognition
- Decomposition
- Algorithms
- Abstraction

Pattern recognition helps us to find the similarities across locations.

1. * Computational thinking applications are more applicable in the computer science field.

Answer:

- True
- False

Computational thinking applications are applicable in any discipline.

2. * Computational thinking requires knowing technical skills.

Answer:

- True
- False

You do not have to have any technical skills to understand computational thinking.

1. * Computational thinking competencies allow us to....
(Check all that apply)

Choose at least one answer.

- Identify a complex problem
- Analyze what the problem is
- Construct possible solutions

Computational thinking competencies allow us to identify complex problems, detect the type of problem, and develop potential solutions to solve the problem.

2. * What are the benefits of computational thinking competencies?

Choose one of the following answers.

- It enables us to know how to use the computer.
- It enables us to understand how to solve complex problems.
- It enables us to know how computer parts work.
- It enables us to understand how programming works.

Computational thinking competencies allow us to solve complex real-world issues.

3. * Computational thinking application can facilitate improving our...
(Check all that apply)

Choose at least one answer.

- Problem-based learning skills
- Interdisciplinary connections
- Thinking skills

Computational thinking competencies allow us to improve not only our interdisciplinary connections, but also our problem-based learning and thinking skills.

Quantitative Reasoning Techniques

1. Framing concrete numerical questions
 2. Identifying tools and data for analysis
 3. Building models to analyze data
 4. Analyzing the results you obtained
- How to **frame** concrete numerical questions?
 - How to **identify** tools and data for analysis?
 - How to **build** models to analyse the data?
 - How to **analyse** the results you obtain?

Things to take note:

- Average is “on average”, We can not say more than this
- Deviation is how big is the ‘deviation’ or ‘how spread’ is your data from the mean
- High correlation means better prediction power for linear model

1. * Which of the following real-life questions can be considered as quantitative reasoning problems?

Choose at least one answer.

- When should I start from home to reach school on time?
- Should I buy health insurance at my current age, or wait?
- Which canteen stall to queue up for lunch if I am in a hurry?

Every problem mentioned in the question requires you to think quantitatively. In case of health insurance, you need to estimate the risk and gain based on probabilities. In case of time estimates, you need to know about routes and traffic flows. In case of canteen queues, you need to know about the processing time for the food as well as service time depending on the rush and manpower.

Identify your data:

What type of data is relevant?

- Binary: Did your headache subside?
- Continuous: How long did it take to subside?

How much data do you need?

- Is it sufficient to have a single data point?
- Is it required to have a million data points?

Do you want a comparison?

- Which base case would you compare with?
- Is it possible to get data for both the cases?

Formulate your Qn:

Which case seems to be better?

- Will better in **any one** of the trials suffice?
- Does it have to be better in **all the trials**?
- Is it fine if one is better **on average**?

Is average behaviour sufficient?

- What if the drug seems better on average?
- Do you know if the drug will **always** be better?
- How about being better **most of the time**?

1. * What does Standard Deviation of a distribution signify?

Choose one of the following answers.

- The “deviation” of data points from the average.
 The behaviour of each individual data point.
 The behaviour of data points “on an average”.
 The extreme behaviour of the data points.

Standard Deviation is the average deviation of a data point from the Mean of the distribution, computed as follows.
 $SD = \text{square-root}(\sum (\text{square}(data\ point - mean)))$

2. * What does Mean of a distribution signify?

Choose one of the following answers.

- The behaviour of data points “on an average”.
 The “deviation” of data points from the average.
 The behaviour of each individual data point.
 The extreme behaviour of the data points.

Mean is quite literally the “average” behavior of the data points, and is computed as “average” as well.

1. * What do you think is the probability (chance) of a data point being 7 Standard Deviations away from the Mean? Take a guess or search online for a technically correct estimate.

Choose one of the following answers.

- Probability 1/10, that is, chance of 1 in 10.
 Probability 1/100, that is, chance of 1 in 100.
 Probability 1/1000000, that is, 1 in a Million.
 Probability 1/1000000000, that is, 1 in a Billion.

Shocked? It is actually even less! Go through the remaining portion of the lesson to see how we use this.

1. * We found that the drug is not identical to the placebo in case of our headache trials. This means the drug actually works in case of headaches better (faster) than placebo. Will you now take the drug for headache?

Choose at least one answer.

- Not sure yet. The drug reduces the time only by 4 minutes on an average.
 Not sure yet. The drug works better in general, but will it work for me?
 Not sure yet. Need to perform a cost-benefit analysis if I know the price.
 Yes, of course. The drug will surely work for me in case of headaches.

The trials and statistics only provides you with numeric analysis of the problem. But decision making is a bigger challenge, and often your individual preference.

1. * Suppose you find that the mean marks obtained by students in your class is 75, while the standard deviation is 5. If there are 500 students in your class, then roughly how many of them scored between 70 to 80, if you assume a bell curve?

Choose one of the following answers.

- My guess will be about half of the class, that is, 250.
- No one scored within that range, as it is too narrow.
- Maximum students score within that range, so 450.
- Must be close to 68% for Mean +/- SD, that is, 340.

If you assume a distribution is like a bell-curve, that is, if you have a Normal/Gaussian distribution, then the number of data points within the band of Mean – SD to Mean + SD is expected to be 68% of the total data points. This is a property of Normal/Gaussian distributions.

1. * Area has a correlation of 0.76 with Price, while Quality has a correlation of 0.81 with Price. Area has a prediction error (standard error) of 51503 for Price. What do you think will be the error in case of predicting Price using Quality?

Choose one of the following answers.

- Must be less than 51503, but not sure how much.
- Error can be same as the standard error for Area.
- Errors are not at all related to the correlations.
- Error should be about half, that is, around 25000.

Correlation does matter in case of standard error for prediction, and the higher the correlation, the lower the standard error. So, it will surely be lower.

1. * Suppose you model you score for a course as follows.

$$\text{Score} = 5 \times \text{ClassTime}/\text{Week} + 3 \times \text{RevisionTime}/\text{Week} + 50$$

If the classes run for 3 hours a week, how much revision time would you need per week to score above 80?

Choose one of the following answers.

- The relationship is not provided in the given model.
- For Score > 80, we need RevisionTime/Week < 5 h.
- For Score > 80, we need RevisionTime/Week > 5 h.

The model gives you an estimate of score based on the features ClassTime and RevisionTime per week. Thus, we can calculate the features required to obtain a specific value (or range) of the response.

Managing Cybersecurity

Cyber security refers to the technologies, processes and practices that are put in place to protect data, devices, programs or networks from damage, malicious attack and unauthorised access

- 1. Beware of phishing (personal information, passwords, credit card details etc)**
 - a. Check who the sender is
 - b. Don't open or download new attachments
 - c. Look at the links
 - d. Beware of threatening language
 - e. Report and delete the email
 - f. Make sure its https (check URL)
 - g. Don't key in personal information to quickly
- 2. Be aware of common types of scams**
- 3. Maintain good habits in digital world**
 - a. Strong passwords
 - i. It is recommended to use passwords with unique combinations (letters, numbers, mixed case, special characters) that will enable your account to withstand relentless attacks by hackers
 - b. Don't re use same passwords
 - c. Careful with public wifi
 - d. Don't share your passwords
 - e. 2 factor authorisation
- 4. Update your softwares (especially anti-viruses)**

Data:

- Can be digital or physical
- 4 levels of security
 1. Open
 2. Restricted
 3. Confidential
 4. Classified

1. * Cyber security refers to _____ implemented by an organisation to protect its cyber assets from damage, malicious attack and unauthorised access. Select all that apply.

Choose at least one answer.

- practices
 technologies
 processes

Cyber security refers to the technologies, processes and practices that are put in place to protect data, devices, programs or networks from damage, malicious attack and unauthorised access.

1. * Please identify the strongest password combination from the following.

Choose one of the following answers.

- c3V@6t!G
- password
- P@ssw0rd
- S1ng@Pore

It is recommended to use passwords with unique combinations (letters, numbers, mixed case, special characters) that will enable your account to withstand relentless attacks by hackers.

1. * Data is only available in digital format.

Answer:

- True
- False

Data refers to information processed by a computer. Information can be in physical (e.g., text documents, images) or digital (e.g. audio clips, software programs) format.

2. * Data is classified into four levels of security. What are the four levels?

Choose one of the following answers.

- Open, Restricted, Confidential, Classified
- Public, Internal, Sensitive, Top Secret
- Open, Restricted, Confidential, Secret
- Open, Internal, In-confidence, Highly Confidential

For a recap of the four levels of data classification, please watch the video on Data Security again.

1. * What is the key purpose of Blind Carbon Copy (BCC)?

Choose one of the following answers.

- Meant for recipients who are required to take action in response to your email
- To keep someone in the loop even if a message does not directly concern them
- To keep the identities of the recipients confidential

The use of BCC can be applied when sending impersonal emails, such as announcements, to a large list of people who may not know one another. This is a polite gesture that respects the privacy of the receivers – protecting their identities while avoiding chain email communications that may be irrelevant to them.

2. * Which of the following statement best describes how we can reduce the risk of being hacked when connected to a public Wi-Fi network?

Choose one of the following answers.

- Always use trusted public Wi-Fi networks
- Avoid doing any sensitive transactions e.g. internet banking
- Ensure that your device has an up-to-date antivirus software
- All of the given options

For a recap of the best practices when connecting to a public Wi-Fi network, please watch the video on Acceptable IT Usage again.

3 main objectives taken by NTU

- Confidentiality
- Integrity
- Availability

The cyber security governance team is responsible for the

- Policies
- Standards
- Procedures

1. * What are the main objectives of the NTU Cybersecurity team? Select all that apply.

Choose at least one answer.

Integrity

Accountability

Availability

Confidentiality

The NTU Cybersecurity team aims to achieve:

1. Confidentiality - Ensure data or information cannot be read by unauthorized personnel.
2. Integrity - Data or information held by NTU remains accurate and unmodified by unauthorized personnel.
3. Availability - Data or service remains usable with sufficient capability to deliver our educational services.

These objectives are highly applicable across society and are the key considerations for many other organizations when managing cybersecurity.

Acceptable IT usage policy

Dos	Donts
Update password regularly	Don't share passwords
Keep password safe	Don't forward NTU documents to personal email
Use NTU email for official communications	Don't install non-licensed software
Use BCC for mass emails	Don't turn off antivirus or cancel software updates
Keep software updated	Don't overshare on social media

1. * Which of the following actions aligns with the Acceptable IT Usage Policy (AIUP)? Select all that apply.

Choose at least one answer.

- Do not forward any university document to your personal email address
- Share your passwords with close friends only
- Use Blind Carbon Copy (BCC) when sending mass emails

It is a violation to the AIUP to share your password with **anyone**.

Phishing:

Library Notice



NTU Library <NTU@ge.se>

13/10/2020 2:09am

Check the sender's
email address!

Dear Student,

Please be informed that your access to NTU Library System will expire soon. Your library enrollment "john1234" is set to expire on October 15, 2020 12:00, so this is a notification for you to renew now. To renew, simply click on the following link:

[University Library](https://tg.sv/yaawtg)

 https://tg.sv/yaawtg
Click or tap to follow link

Verify the legitimacy of the
link before clicking!

You will not be required to provide any identity information during this renewal process.

The above renewal link is only valid for a limited time. If you fail to renew your library enrollment before then, you will lose access to all library online services. For a list of the current library online services, please visit: **Urgent threatening language**

<https://www.ntu.edu.sg/library/Pages/default.aspx12>

If you have any questions concerning your status or access to the library online services, please contact the Library Help Desk as soon as possible.

Sincerely,

NTU Library,
50 Nanyang Ave, Singapore 639798
Email: libraries@ntu.edu.sg

The real email address is
library@ntu.edu.sg!

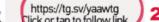
1. * What are the steps to check if we have received a phishing email such as the following? Match the steps labelled in the image with the correct description.

Library Notice

JY NTU Library <NTU@ge.se>  1
13/10/2020 2:09am

Dear Student,

Please be informed that your access to NTU Library System will expire soon. Your library enrollment "john1234" ~~is set~~ to expire on October 15, 2020 12:00, so this is a notification for you to renew now. To renew, simply click on the following link:

[University Library](https://tg.sv/yaawtg)  2
https://tg.sv/yaawtg

You will not be required to provide any identity information during this renewal process.

 3 The above renewal link is only valid for a limited time. If you fail to renew your library enrollment before then, you will lose access to all library online services. For a list of the current library online services, please visit:

<https://www.ntu.edu.sg/library/Pages/default.aspx12>

If you have any questions concerning your status or access to the library online services, please contact the Library Help Desk as soon as possible.

Sincerely,

NTU Library,
50 Nanyang Ave, Singapore 639798
Email: libraries@ntu.edu.sg

Pick up the corresponding answers

✓ Step 1

Check the sender's email address

✓ Step 2

Verify the legitimacy of the link before clicking

✓ Step 3

Look out for urgent threatening language



Good Cyber Hygiene habits

Passwords

- Strong passwords
- 2FA
- Long random passwords
- But easy to remember
- 12 characters, include upper & lower case, numbers, symbols
- Different accounts different passwords

Anti-virus

- Product device against malware

Spot signs of phishing

- Urgent or threatening language
- Request confidential information

- Promotes a reward
- Software application update

1. * From the previous video, we learn that the acronym PASS can help us to remember how we can practise good cyber hygiene. What does it stand for?

Choose one of the following answers.

- Protect devices, Auto sign-in, Synchronize data, Security
- Password, Auto sign-in, Spot signs of phishing, Security
- Protect devices, Antivirus, Synchronize data, Software application
- Password, Antivirus, Spot signs of phishing, Software application

PASS stands for Password, Antivirus, Spot signs of phishing, and Software application. This serves as a reminder and provides practical tips for us to stay cyber safe.