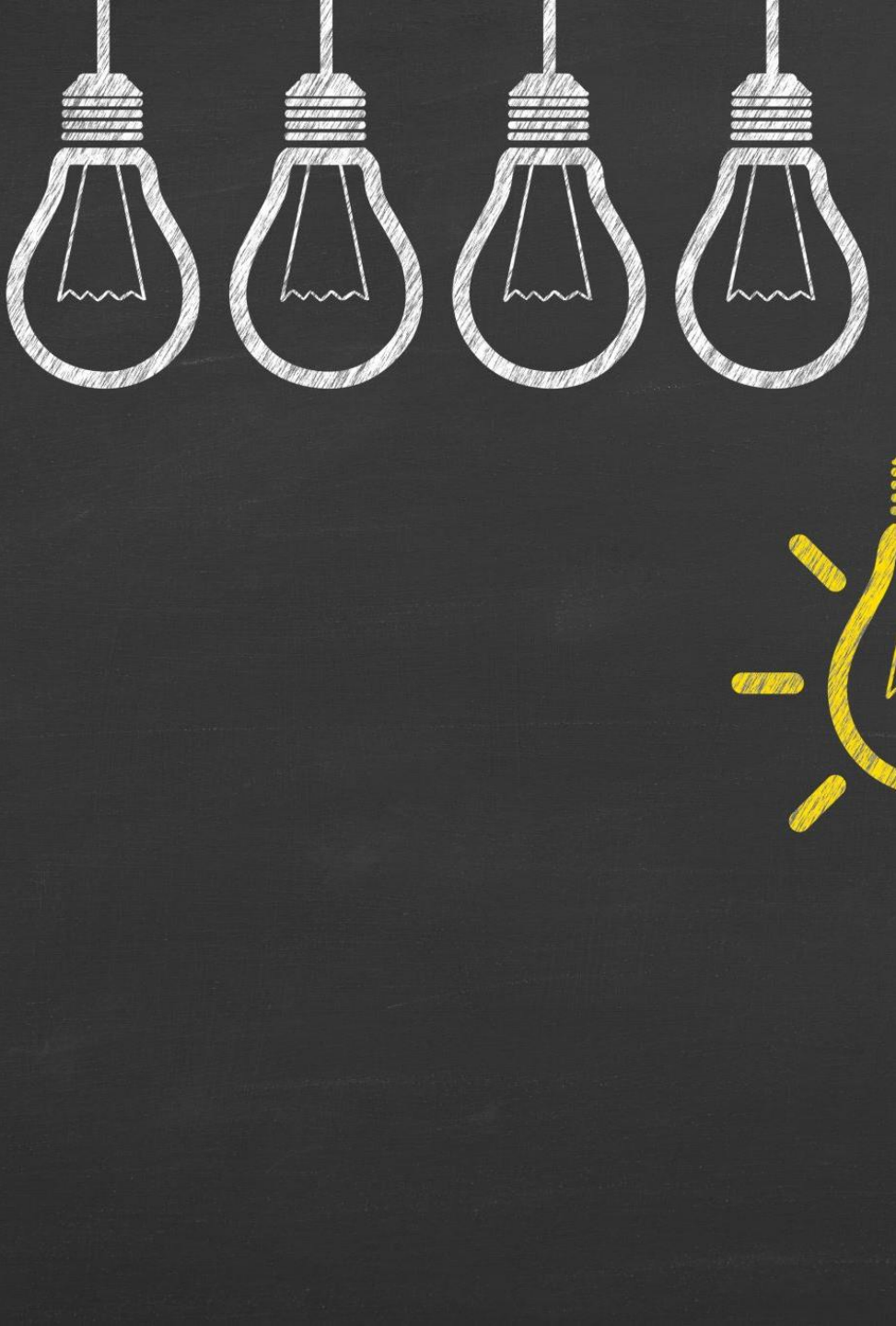




**NANYANG
TECHNOLOGICAL
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SINGAPORE

Module 01: Computational Thinking Problem Solving Techniques (Biology)





Computational Thinking Competencies (4 main)

- Computational: Involving the calculation of answers, amounts, results(e.g., calculations, order)
- Thinking: The activity of using your mind to consider something (e.g., reasoning, questioning)
- Competencies: Important skills that are needed to do a job (e.g., managerial competencies)

Abstraction

Algorithms

Decomposition

Pattern
Recognition



Abstraction: Biology

- Abstraction: 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

The abstraction process – *deciding what details we need to highlight and what details we can ignore* – underlies computational thinking.

- Jeannette Wing



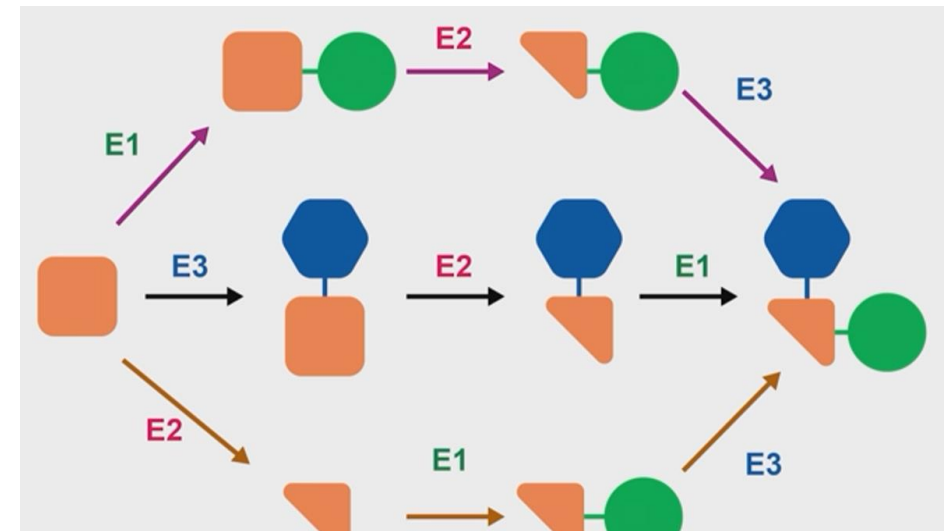
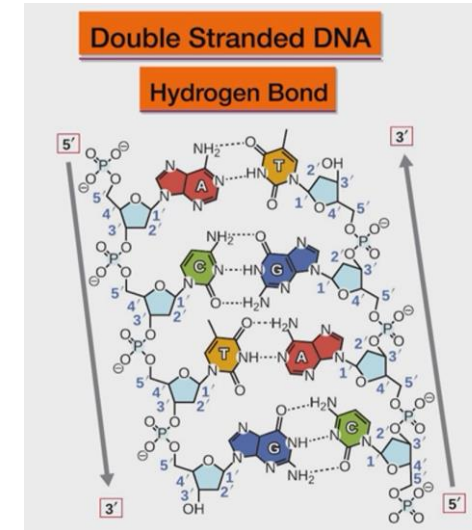
Bioinformatics

- Combines different fields of study, including computer sciences, molecular biology, biotechnology, statistics and engineering
- Large amount of data: Genomics, Proteomics

Pseudocode: An informal description of the steps involved in executing a computer program, often written in something similar to plain [in designed language]

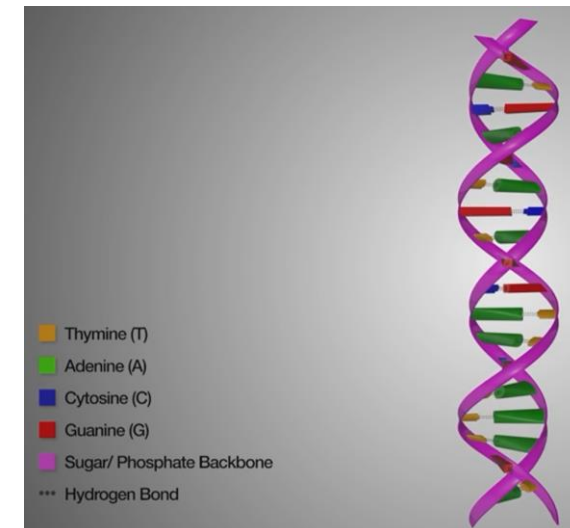
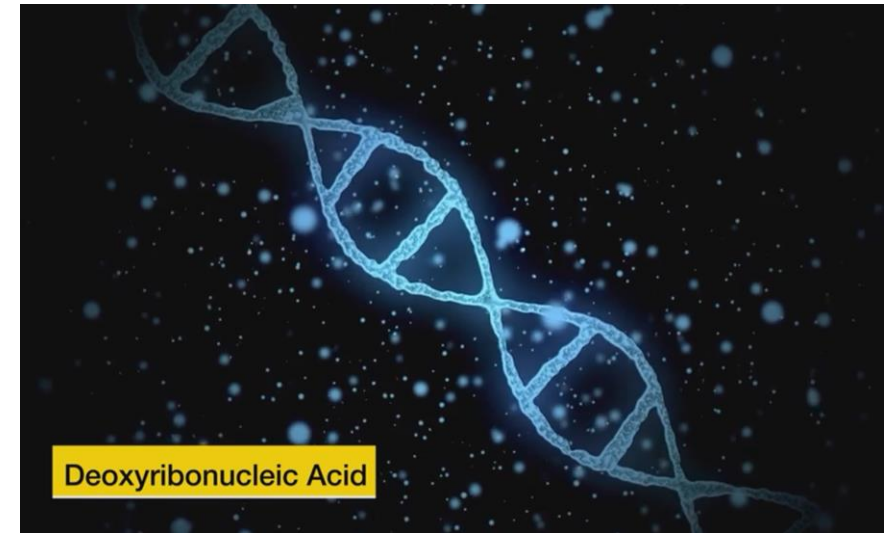
Human Genomes (Abstraction)

- Structure of cell:
 - Incredibly crowded
 - Incomprehensible for humans
- Question:
 - How to simplify the representation of cells?
 - How to make it readable?
- Answer:
 - By **abstraction**: labelling, lettering, shaping, colouring, etc.



Human Genomes (Abstraction)

- Formulating in pseudo level can enable us to understand concepts more clearly.
- Abstraction simplifies complex life phenomenon to something readable and understandable.



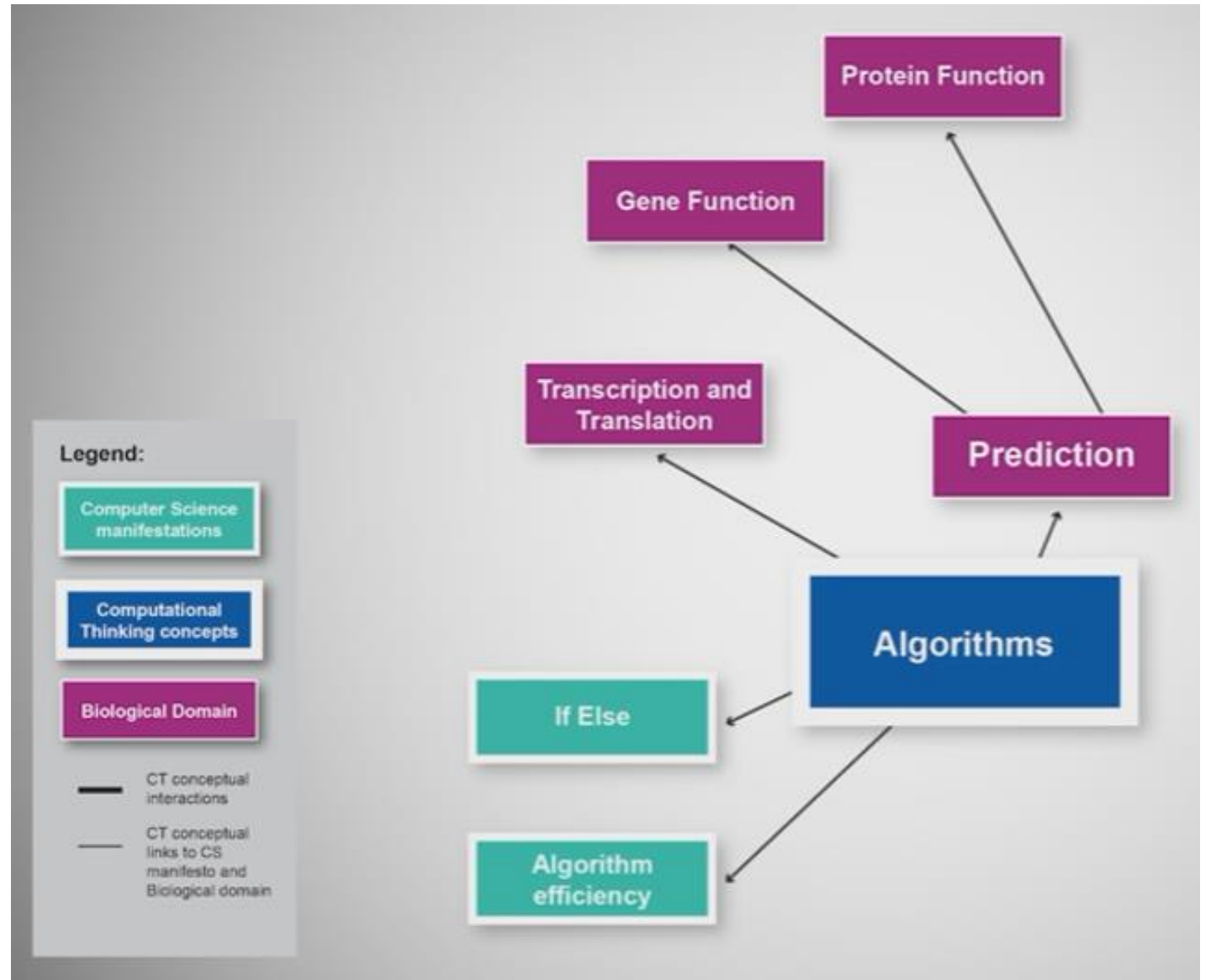
Algorithms in Biology

Algorithm

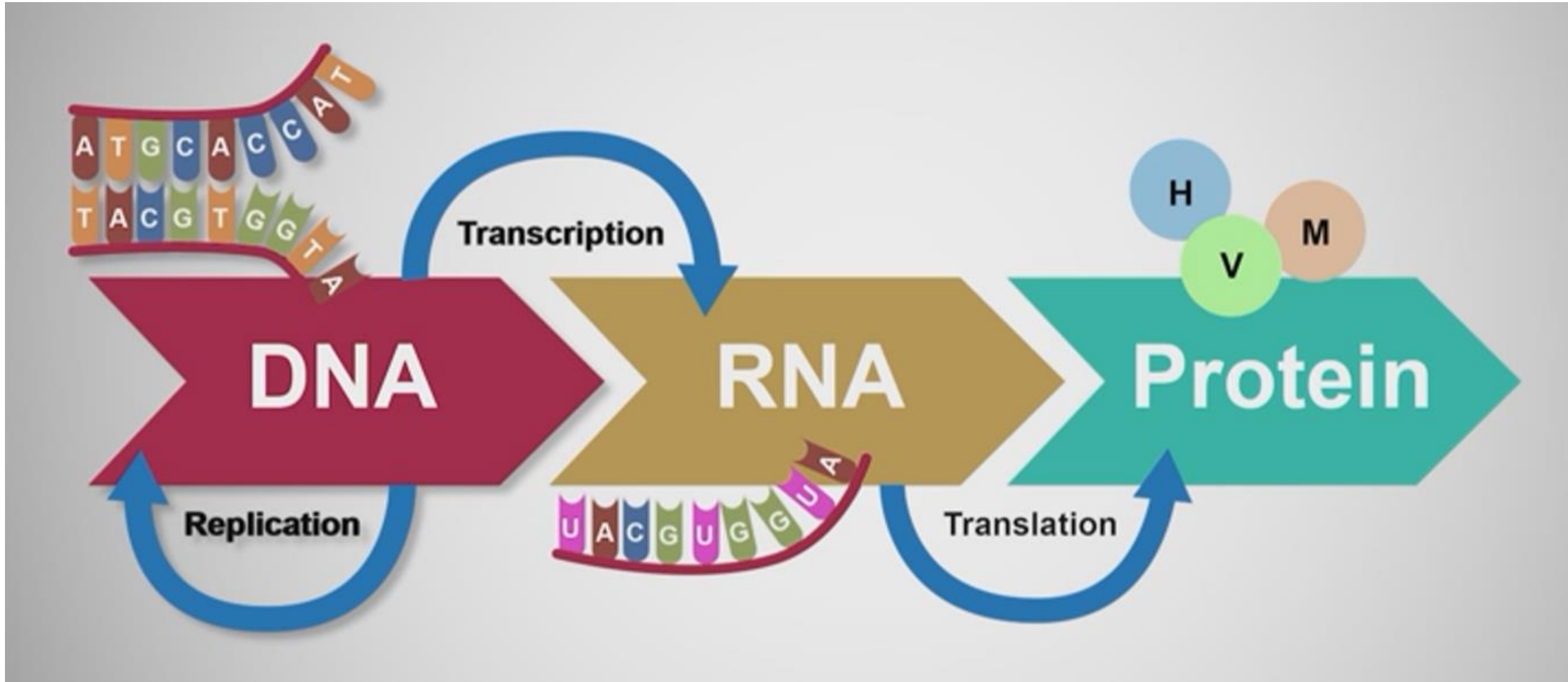
- is about following, identifying, using, and creating an ordered set of instructions
- ordering things
 - ascending order (e.g., from 1 to 5, or from A B C to X Y Z)
 - descending order (e.g., from 5 to 1, or from Z Y X to C B A)
- Allows us to order the complexity of the context or content



Algorithms Biology (overview)



Algorithms Biology (overview)

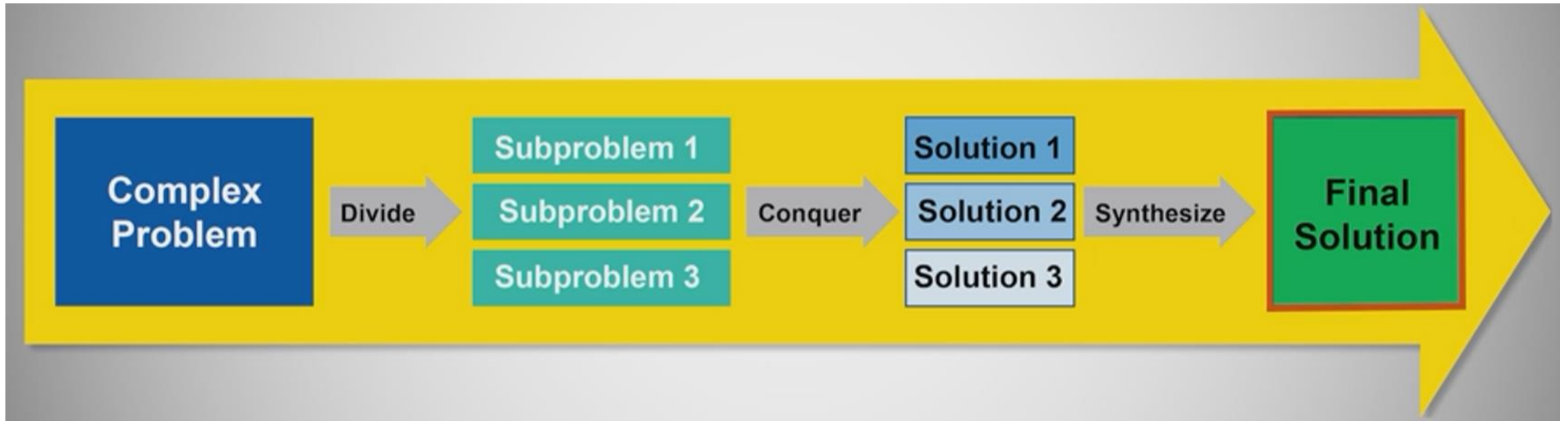


Decomposition in Biology

Decomposition is about:

- 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 divide-and-conquer

Decomposition (divide and conquer)





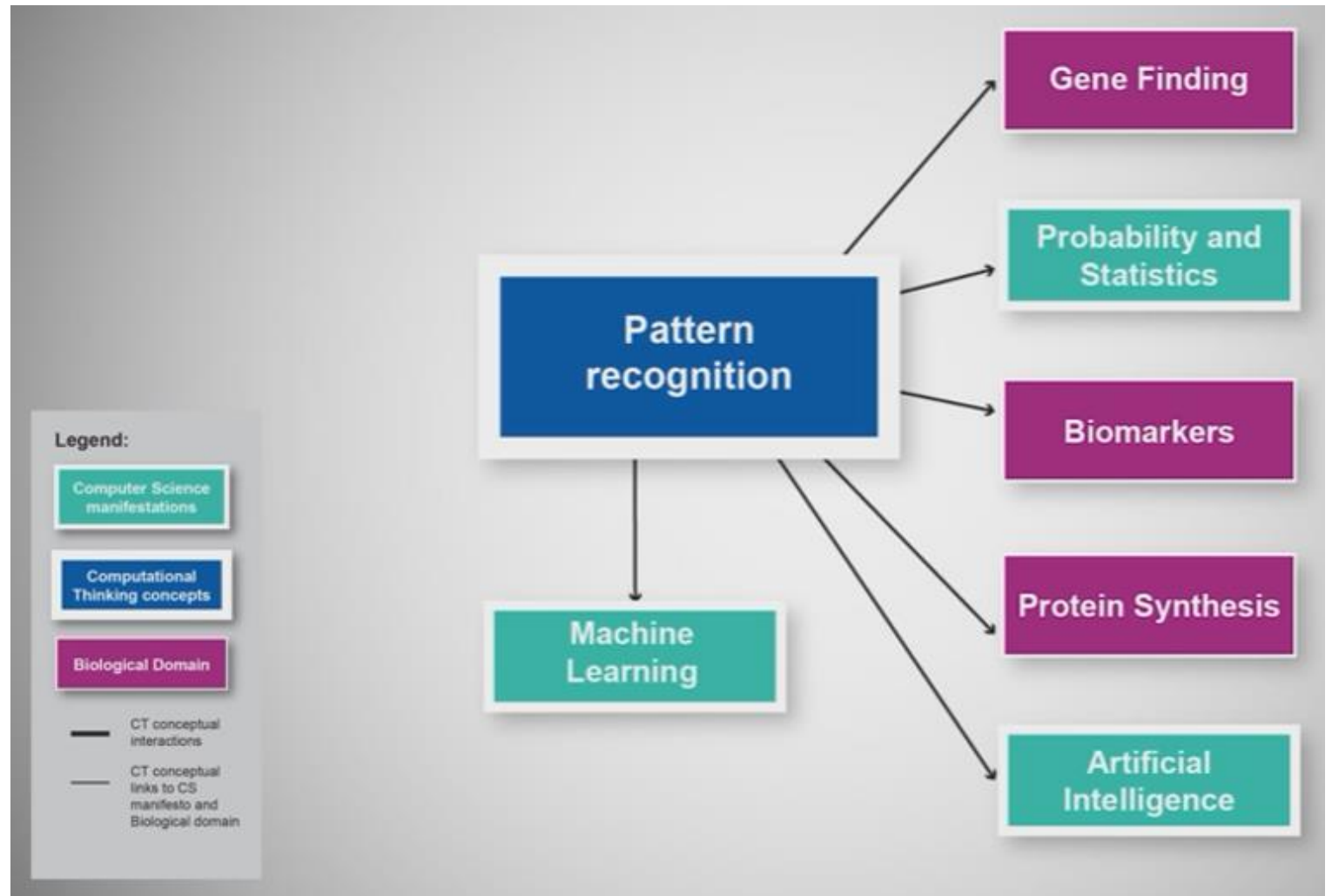
Decomposition

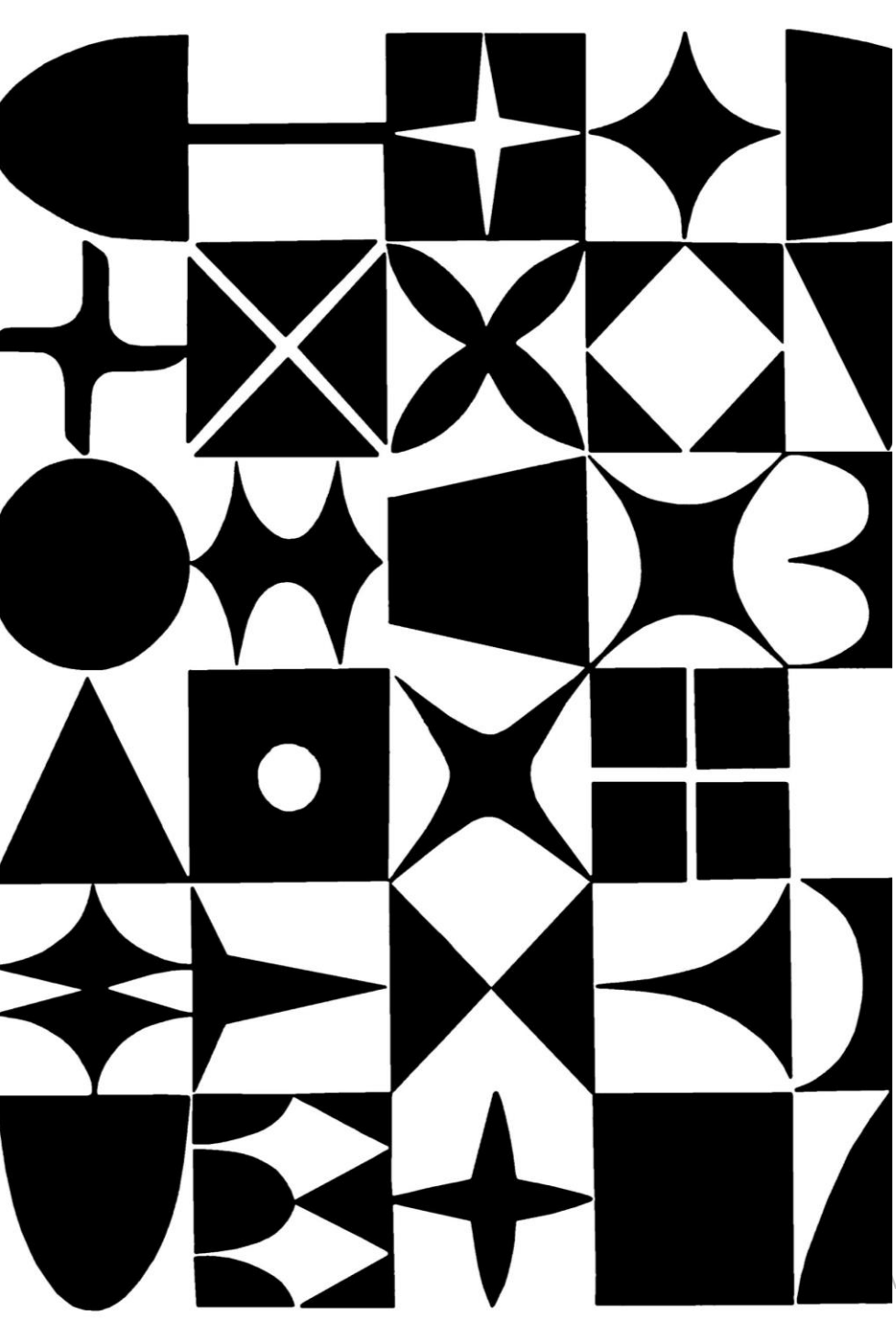
- Solve complex problems
 - If a complex problem is not decomposed, it is much harder to solve at once. Subproblems are usually easy to tackle
- Each subproblem can be solved by different parties of analysis
- Decomposition forces you to analyze your problem from different aspects

Pattern Recognition

- is about observing patterns, trends and regularities in data
- 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 in Biology





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