



COMP1002

Computational Thinking and Problem Solving

Lecture 6

Computation IV

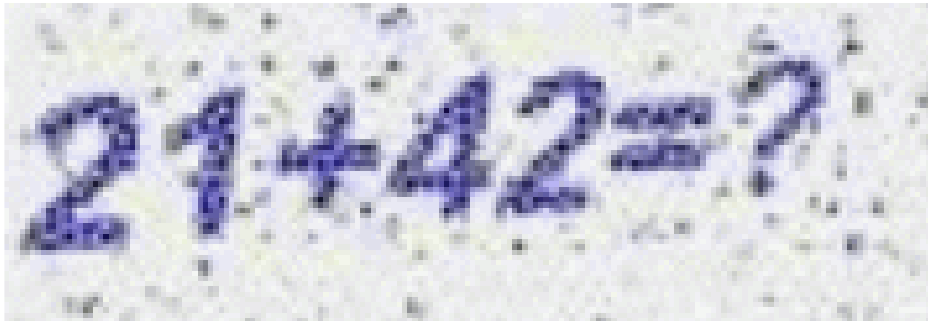


# Lecture 6

- › Recap Easy and Hard Problems
- › Examples
  - Domino Matching
  - Game of Life
- › More on Computation

# Easy and Hard Problems Recap

- ›  $12345 * 54321$
- › Solve  $2x^4 + 3x^3 - 6x^2 + 5x - 8 = 0$



# Domino Matching

## › Dominos

- There are two parts of a domino: upper half and lower half
- Each part contains some pattern
- There are an infinite supply of each domino type
  - › i.e., you can repeat using each domino type for many many times

## › Problem

- Given a set of domino types, is it possible to arrange them so that the combined pattern on upper half is the same as the combined pattern on the lower half?

## › Examples

b	abc	a	ca
ca	c	ab	a

010	111	001	11
0	000	0101	10110

# Domino Matching

› Example 1

b	abc	a	ca
ca	c	ab	a

› Solution

- With 1 dominos of first type, 1 domino of second type, 2 dominos of third type, and 1 domino of fourth type
- Order: 3, 1, 4, 3, 2

a	b	ca	a	abc	abcaabc
ab	ca	a	ab	c	abcaabc

# Domino Matching

› Example 2

010	111	001	11
0	000	0101	10110

› Here is a solution

- With 2 dominos of first type, 1 domino of third type and 2 domino of fourth type
- Order: 1, 4, 3, 1

010	11	001	010	01011001010
0	10110	0101	0	01011001010

# Domino Matching

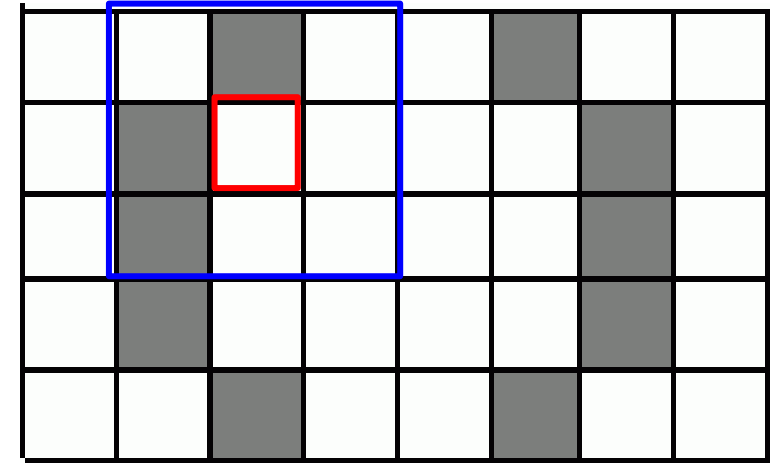
- › There can be no solution!
- › For example

001	0
00	100

- › Is it possible to write a program?
  - Input: a set of domino types
  - Output: **yes** or **no** for existence of solution

# Game of Life

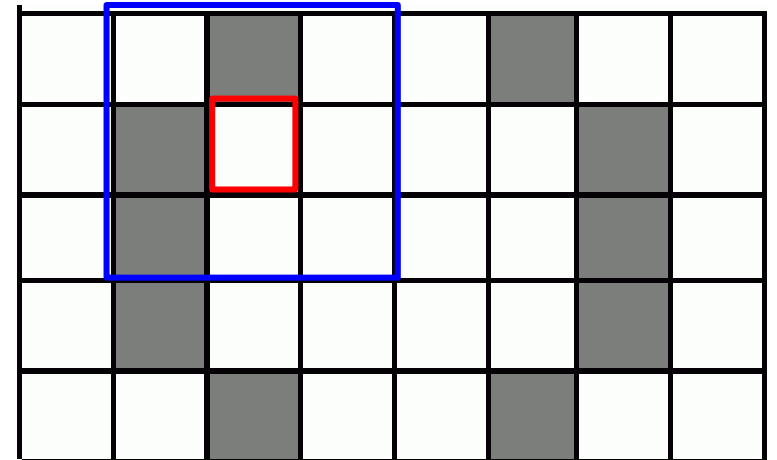
- › A classical problem in computing
  - There are infinite square cells in rectangular shape
    - › Each cell has 8 neighbors
  - Each cell either has an organism (e.g., amoeba) or not
    - › A cell with an organism is called a live cell
  - On each generation (e.g., each clock tick)
    - › The organism in a cell may die or survive
    - › An empty cell may give birth to an organism and become live





# Game of Life

- Rules for next generation
  - › The organism in a live cell with 2 or 3 live neighbors survives
  - › The organism in a live cell with less than 2 or more than 3 live neighbors dies (lack of food or over-crowded)
  - › An empty cell with exactly three live neighbors will give birth to an organism and become live

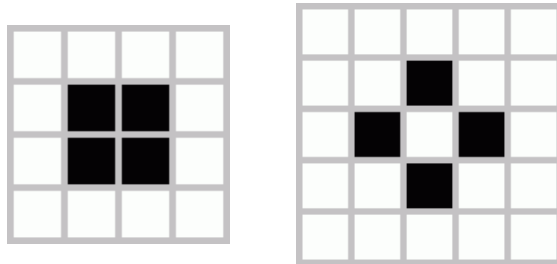


# Game of Life

## › Examples and evolutions

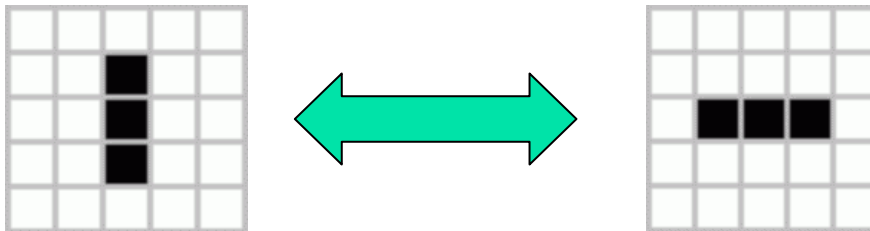
### – Stable patterns

› Will not change



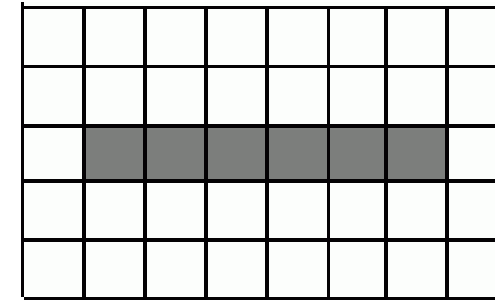
### – Pattern with cycle

› Cycle = 2 to ...



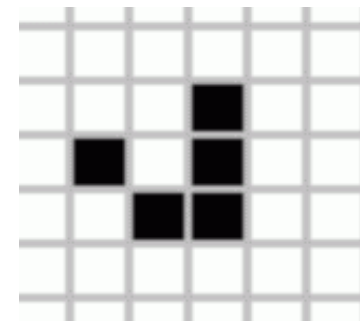
### – A dying pattern

› Die after 12 rounds



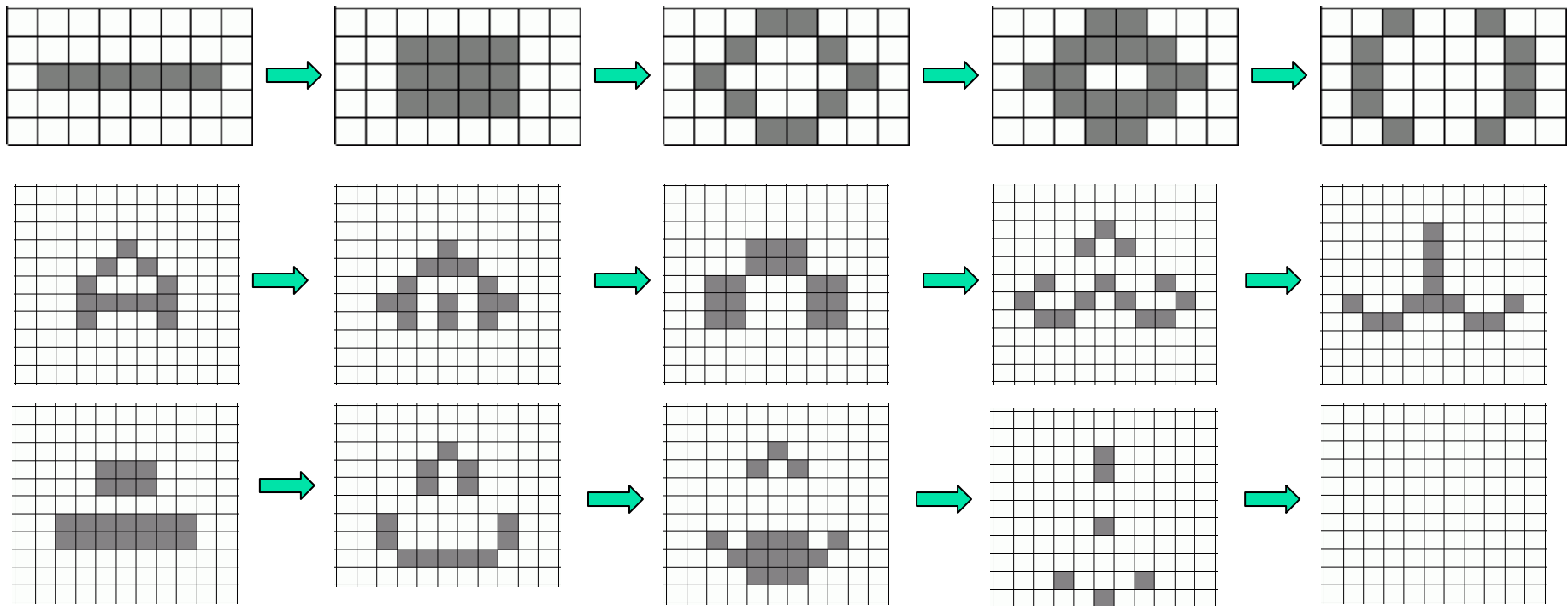
### – A moving pattern

› Move towards south-east



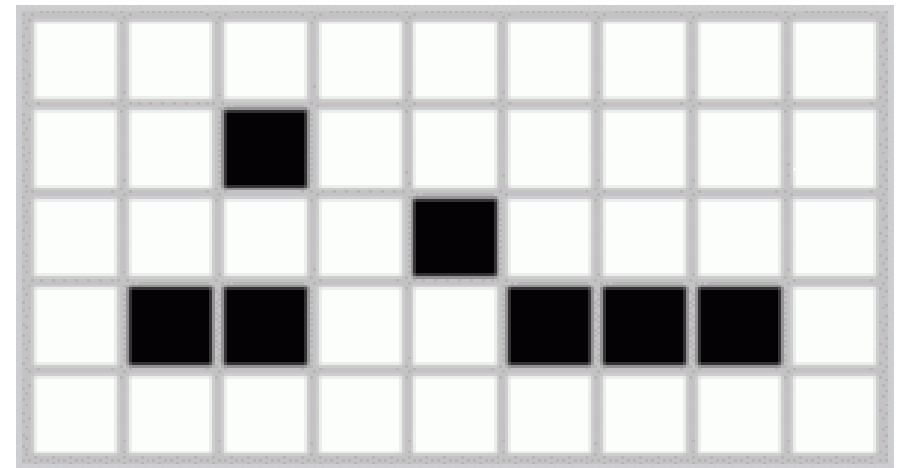
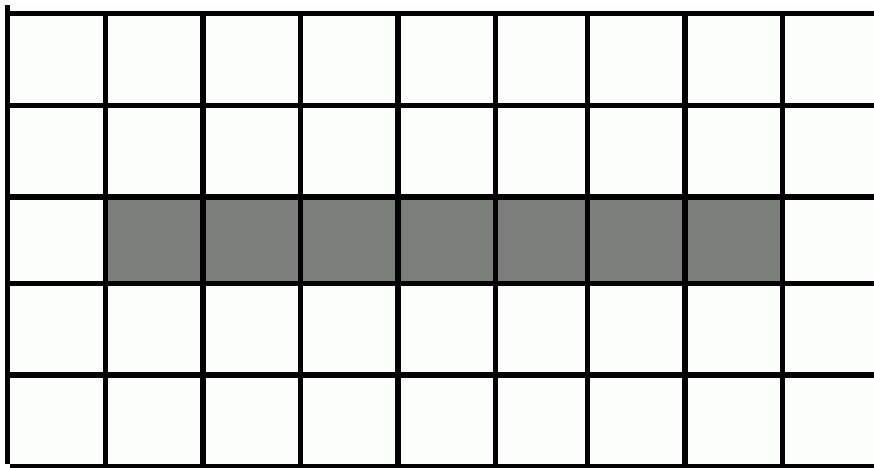
# Game of Life

- › Given a certain pattern, game of life will evolve to show different patterns as time goes on
- › Examples:



# Game of Life

- › Home Exercises
  - How about these?

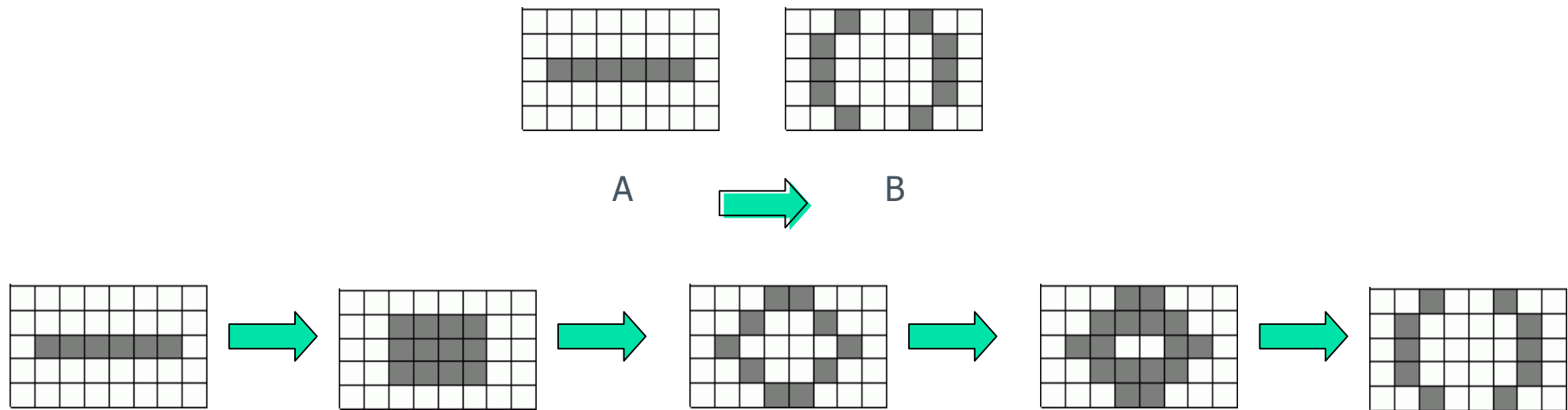


<https://playgameoflife.com/>

# Game of Life

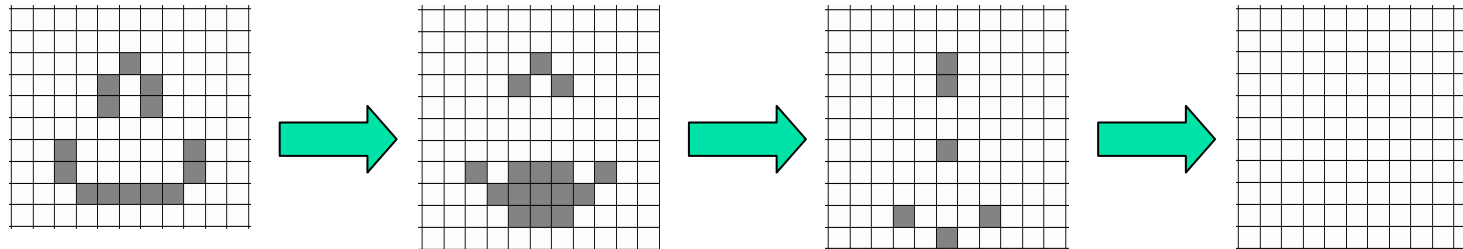
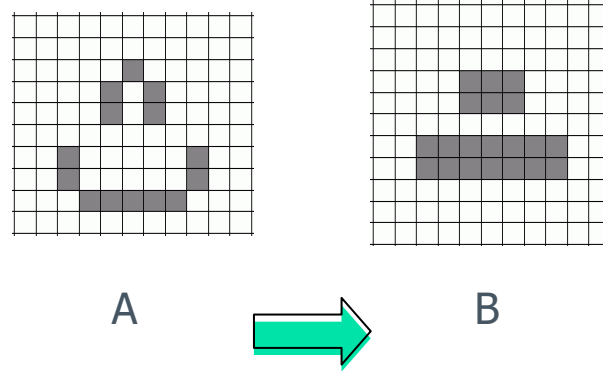
› Here is the problem

- Given a pattern A and another pattern B, is it possible for A to evolve into B after some steps?
- For example,



# Game of Life

## › Another Example



# Game of Life

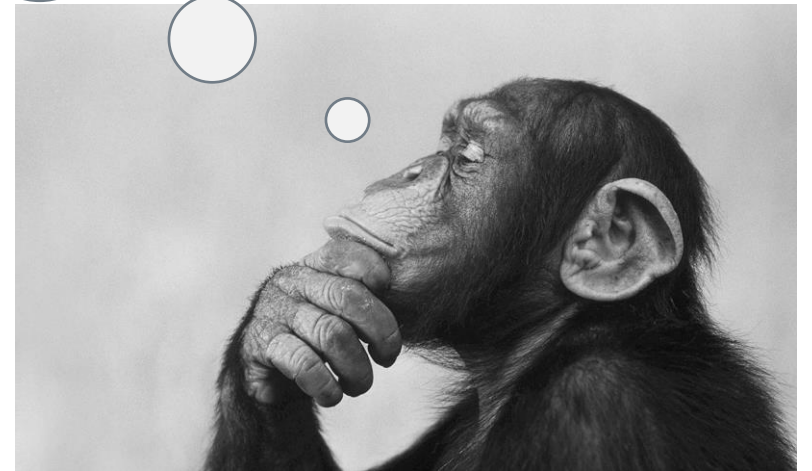
- › Is it possible to write a program?
  - Input: given input patterns A and B
  - Output: output “yes” if A can evolve into B and output “no” if it is not possible for A to evolve into B
- › Closely related to the *halting problem*

# More on Computation

- › Computers can tirelessly execute programs
- › But bad programs will take too long to run!
- › Is it always possible to find a fast solution?
  - Sometimes yes, but unfortunately, not always.
  - Some problems always take long time to run!
- › Some problems even cannot be solved!
  - Examples: domino matching, game of life evolution
  - No need to attempt solving them
- › For problems with solution, one should look at the efficiency, at least not too worse
  - › Easy problems: should find efficient solutions
  - › Hard problems: should find some solution



But still, you should be able to write programs to verify the domino matching solutions as well as demonstrate the game of life!



# Summary

- › Recap Easy and Hard Problems
- › Examples
  - Domino Matching
  - Game of Life
- › More on Computation