

**National University of Singapore  
School of Computing  
CS3243 Introduction to Artificial Intelligence**

**Tutorial 1: Introduction to AI**

Issued: January 12, 2021

Discussion in: Week 3

**Important Instructions:**

- **Assignment 1** consists of **Question 3** from this tutorial.
- Your solutions for this tutorial must be TYPE-WRITTEN.
- You are to submit your solutions on LumiNUS by **Week 2, Saturday, 2359 hours**.
- Refer to LumiNUS for submission guidelines

Note: you may discuss the content of the questions with your classmates (outside your group). But each group should work out and write up ALL the solutions individually. If caught plagiarising, you may be awarded an F Grade for the module.

1. What determines the rationality of an agent? Define a rational agent.
  
2. Consider the games: (i) Sudoku, and (ii) Hanabi - refer to the appendix. Define the task environment properties of these games by completing the following tables.

Environment Characteristic	Sudoku	Hanabi
Fully vs Partially Observable		
Single vs Multi-Agent		
Deterministic vs Stochastic		
Episodic vs Sequential		
Static vs Dynamic		
Discrete vs Continuous		

3. Define an agent program (in English, not code) for a Tic-Tac-Toe reflex agent that will always either win or draw. You may use the table structure below to help you organize your answer.

Priority	Percepts	Action
1		
2		

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## Appendix: The Hanabi Game

Hanabi <sup>1</sup> is a cooperative card game in which players, aware of other players' cards but not their own, attempt to play a series of cards in a specific order to set off a simulated fireworks show. Players are limited in the types of information they may give to other players, and in the total amount of information that can be given during the game. In 2013, Hanabi won the Spiel des Jahres, a prestigious industry award for best board game of the year. <sup>2</sup>

The challenge of Hanabi is that it requires agents to coordinate with others in a partially-observable environment with limited communication. As humans, we are constantly confronted with those types of situations and we typically address them by formulating a mental model of how other agents will behave in different situations. This is typically known as the theory of mind. To solve Hanabi, AI agents would need to develop communication mechanisms that allows them to cooperate effectively in order to achieve a specific goal. Recently, Facebook's AI has mastered Hanabi, which has long been cited as a big hurdle for the field. <sup>3</sup>

### Gameplay <sup>4</sup>

The Hanabi deck contains cards in five suits (white, yellow, green, blue, and red): three 1's, two each of 2's, 3's, and 4's, and one 5. The game begins with 8 available information tokens and 3 fuse tokens. To start the game, players are dealt a hand containing five cards (four for 4 or 5 players). Players can see each other's cards but they cannot see their own. Play proceeds around the table; each turn, a player must take one of the following actions:

1. *Give information*: The player points out all the cards of either a given number or a given suit in the hand of another player (examples: "This card is your only red card," "These two cards are your only 3's"). The information given must be complete and correct. Giving information consumes one information token.
2. *Discard a card*: The player chooses a card from his hand and adds it to the discard pile, then draws a card to replace it. The discarded card is out of the game and can no longer be played. Discarding a card replenishes one information token.
3. *Play a card*: The player chooses a card from his hand and attempts to add it to the cards already played. This is successful if the card is a 1 in a suit that has not yet been played, or if it is the next number sequentially in a suit that has been played. Otherwise a fuse token is consumed and the misplayed card is discarded. Successfully playing a 5 of any suit replenishes one information token. Whether the play was successful or not, the player draws a replacement card.

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<sup>1</sup>fireworks in Japanese

<sup>2</sup>You can play Hanabi online at <https://hanabi.live/>

<sup>3</sup><https://bit.ly/2Lg86mh>

<sup>4</sup>[https://en.wikipedia.org/wiki/Hanabi\\_\(card\\_game\)](https://en.wikipedia.org/wiki/Hanabi_(card_game))

Players lose immediately if all fuse tokens are gone, and win immediately if all 5's have been played successfully. Otherwise play continues until the deck becomes empty, and for one full round after that. At the end of the game, the values of the highest cards in each suit are summed, resulting in a total score out of a possible 25 points.