CS380
Artificial Intelligence for Games

Introduction

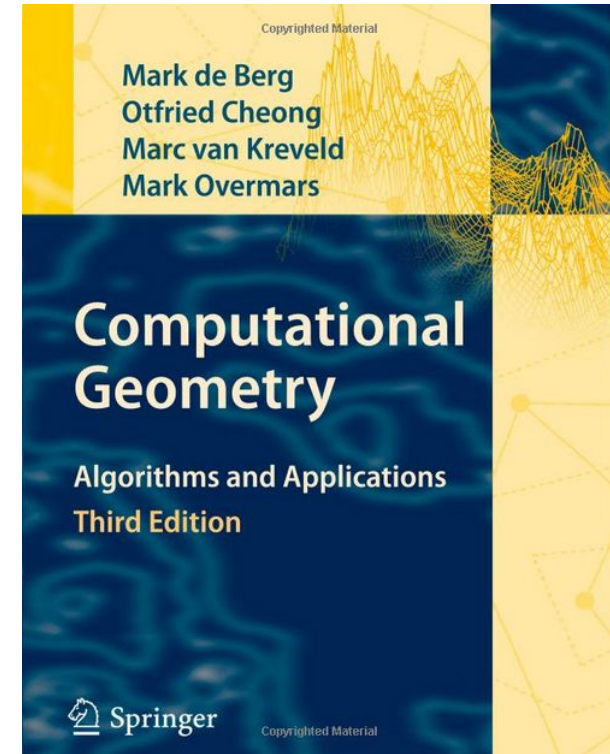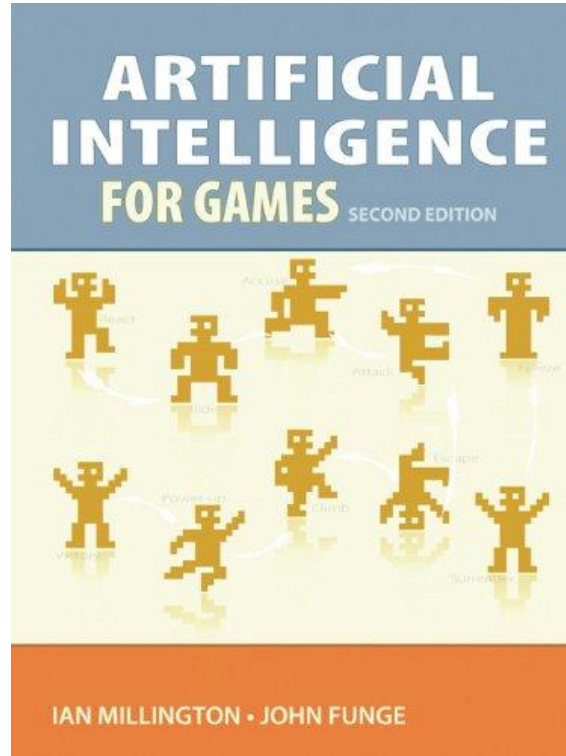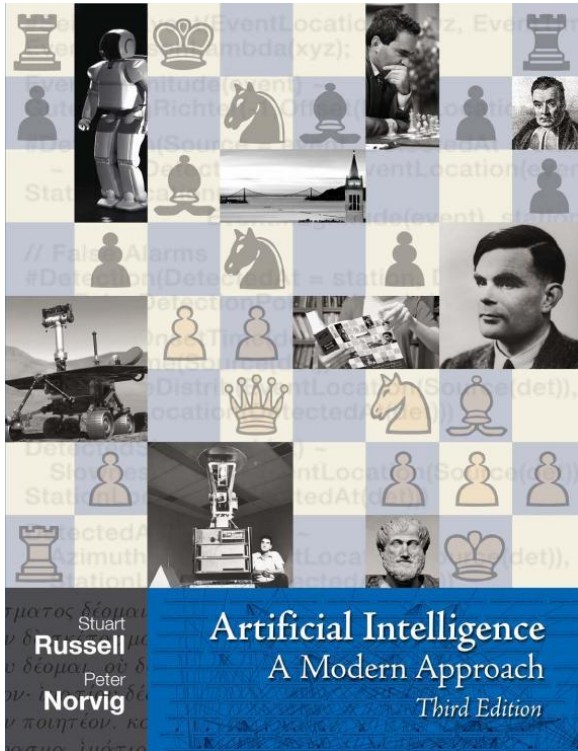# Outline

- Course information
- Artificial Intelligence
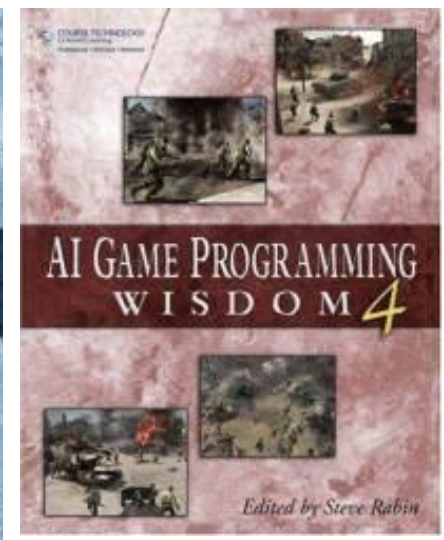- Artificial Intelligence for games

Course Logistics
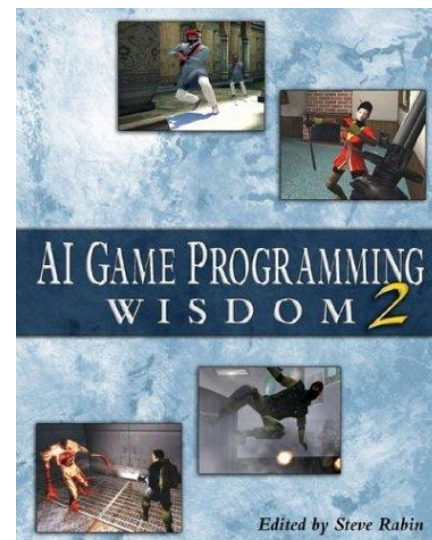
- Class time: Friday (a) 9:00am–12:20pm,

    (b) 1:30pm–4:50pm

- Class location: (a) LT6D, (b) Edison
- Instructor: Vadim Surov
- Email: vsurov@digipen.edu
- Include "[CS380]" in email subject
- Office Phone Number: 1940
- Office Hours: Thu 1pm – 3pm or by appointment

Textbooks

Reference Books
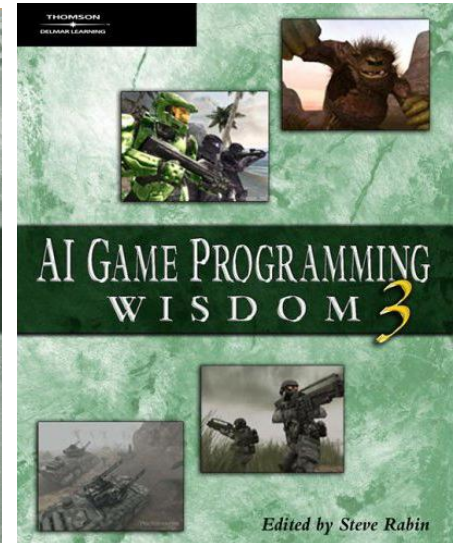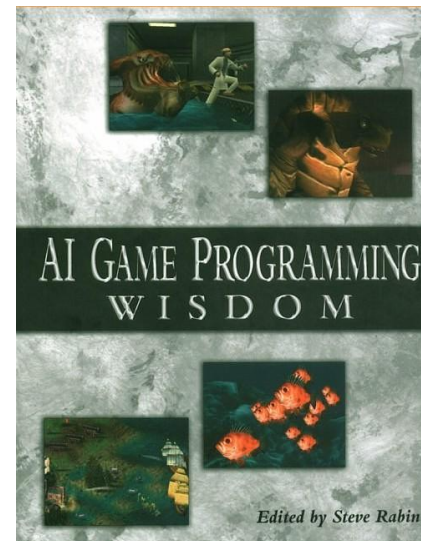
Assessment

- Quizzes: 10%
- Programming Assignments: 40%
- Midterm: 20%
- Final exam: 30%

Pre-requisites

- CS225, CS280
- Good implementation skills (C/C++)
- Enthusiasm to learn!
- ~~Build your own GUIs using the game engine that supports C/C++~~
- All your AI algorithms need to be implemented in C/C++ only

Interaction

- Moodle & Teams: main interaction medias
- https://distance3.sg.digipen.edu
- Team A: cs380su21-a.sg
- Team B: cs380su21-b.sg
- SVN (for projects): https://svn.sg.digipen.edu/projects/team_cs380

Class Policies 1/2

- Attendance is compulsory - please refer to syllabus for attendance policy
- Be on time for class - no attendance for latecomers
- No talking in the class during lecture
- No sleeping and crunching of food

Class Policies 2/2

- You are encouraged to ask/answer questions during the lectures

- Students are expected to take notes during lecture

- No cheating, copying, plagiarizing, or any other form of academic dishonesty – refer to syllabus for academic integrity policy

Assignments

- Ten small weekly assignments, each focusing on one AI technique, such as path finding, fuzzy logic, genetic algorithm, minimax search, etc.

- Assignments are set up as Virtual Programming Labs on the Moodle with automatic evaluation and plagiarism checking tools

Outline

- Course information
- **Artificial Intelligence**
- Artificial Intelligence for games

Today's applications of AI

- [Boston Dynamics – military robots](#)
- Google map's navigation
- Iphone Siri – personal assistant
- [Autonomous Driverless car in crowd](#)
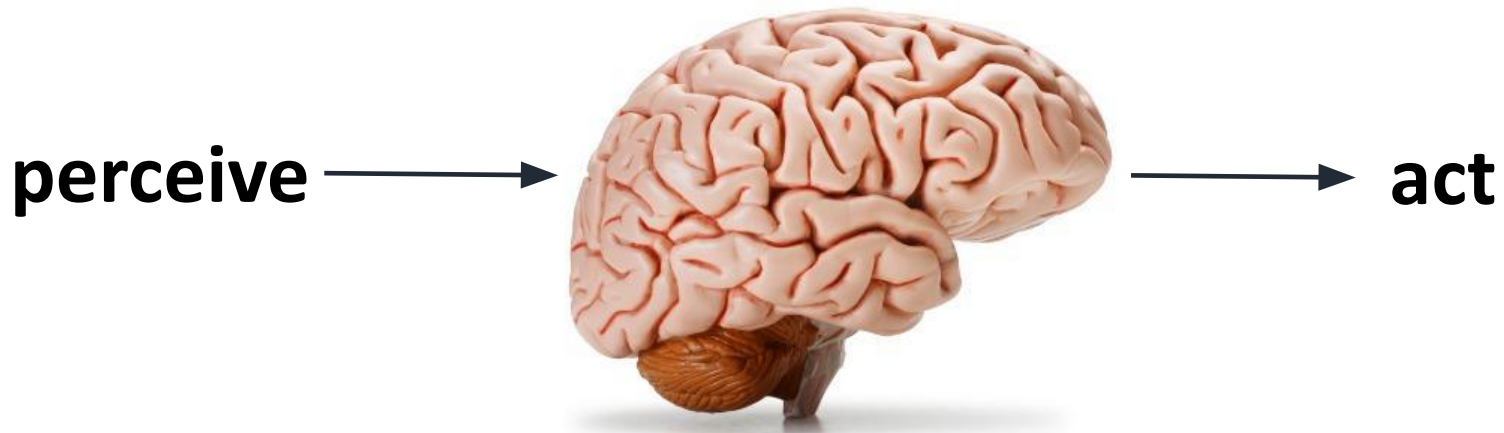
What is AI?

In-Class Activity 1

What is your definition of "AI"?

Intelligence

- Human Intelligence – natural mental ability for reasoning, problem solving, and learning.
- Characterized by perception, consciousness, self-awareness, and will power.
- Can we imitate human intelligence in machines?

think/solve/learn

perceive → → **act**

Artificial Intelligence

- A branch of Computer Science that examines how we can achieve intelligent behavior in machines through computation
- AI is the attempt of reproduction of human reasoning and intelligent behavior by computational methods

analyze/compute/learn

perceive ⟶ ⟶ **act**

What is AI?

- Computers are fast/good at solving many problems
  - Arithmetic
  - Sorting
  - Searching
  - Some board games, such as Reversi

- Computers feel it difficult to do
  - Face recognition, or more generally object recognition
  - Understand/speak natural languages
  - Decision making
  - Creativity

Artificial Intelligence - History

- Before Computers – philosophy of mind

- After 1940's – programmable computers

- 1940's to 1950's – AI thrust began with symbolic systems/expert systems

- 1980's to now – modern statistical AI, SVM, GP, etc.

Artificial Intelligence

Alan Mathison Turing (1912-1954)
Father of Computer Science and
Artificial Intelligence

Turing Award is recognized as the "highest distinction in Computer science" and "Nobel Prize of computing".
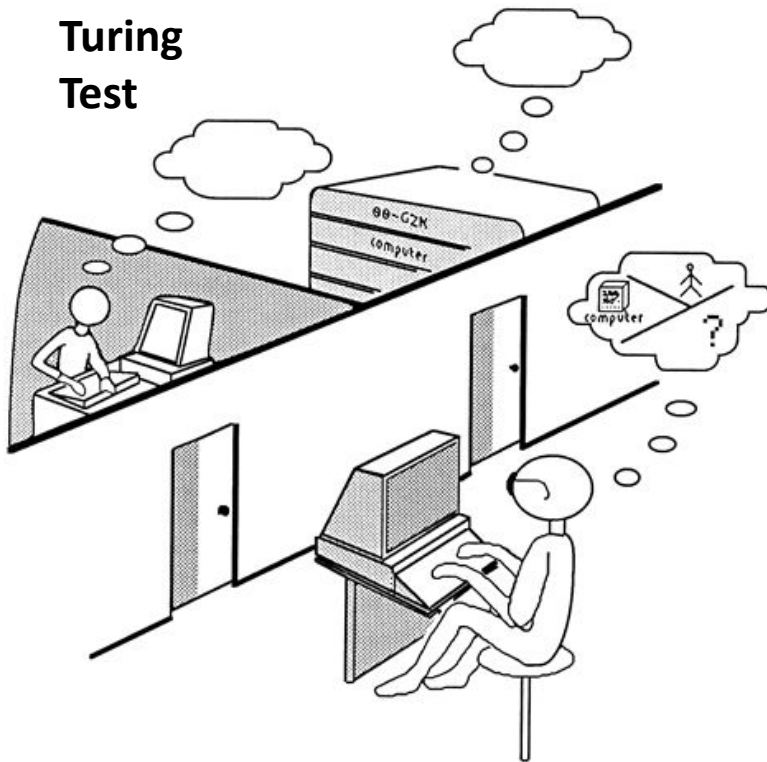
Artificial Intelligence

| Thinking Humanly	Thinking Rationally
Acting Humanly	Acting Rationally

Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" => "Can machines behave intelligently?"
- For computers to pass the test, they need
  - Natural language processing
  - Automated Knowledge representation
  - Automatic Reasoning
  - Machine learning

Branches of AI

Source: http://legalexecutiveinstitute.com/artificial-intelligence-in-law-the-state-of-play-2016-part-1/
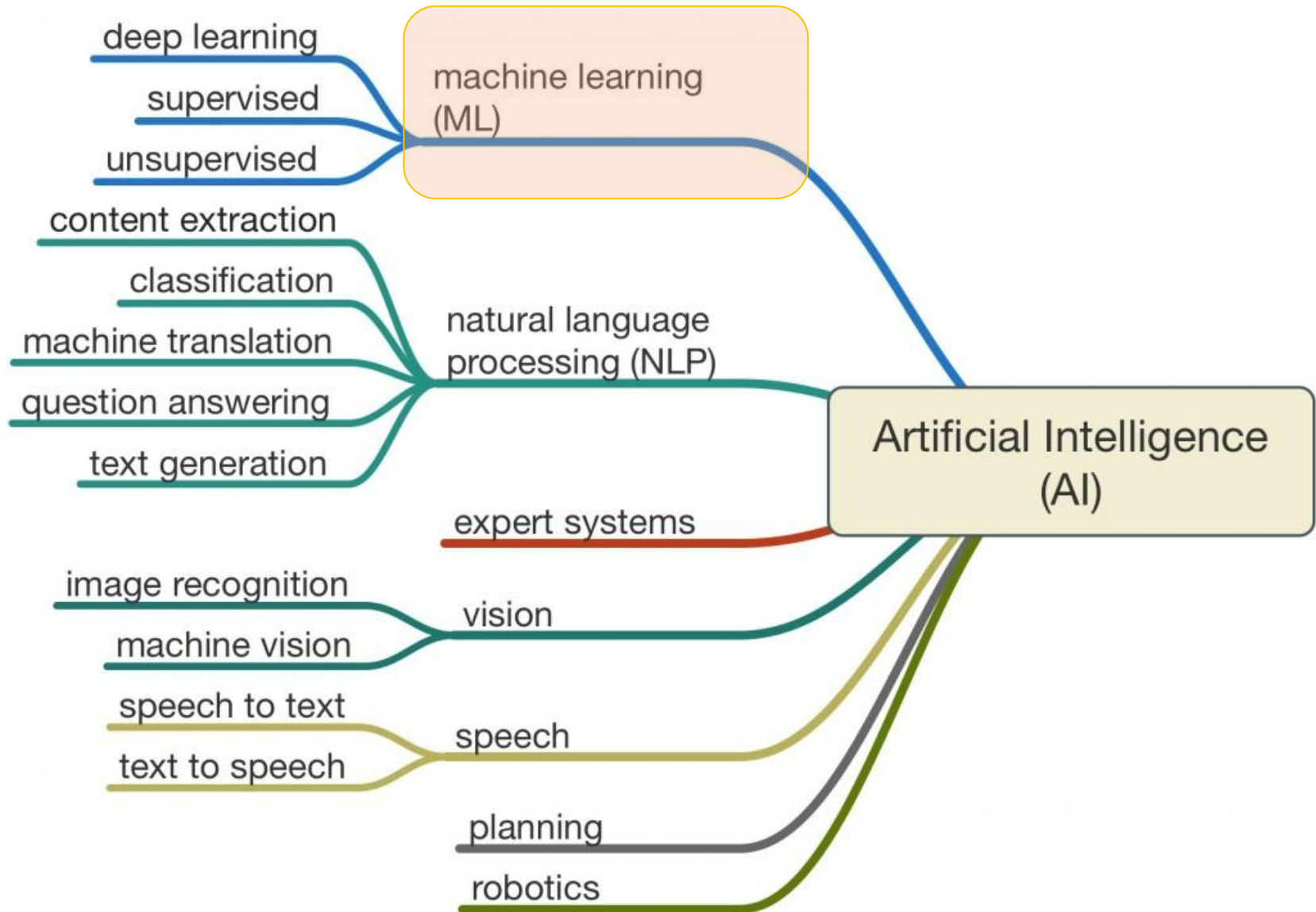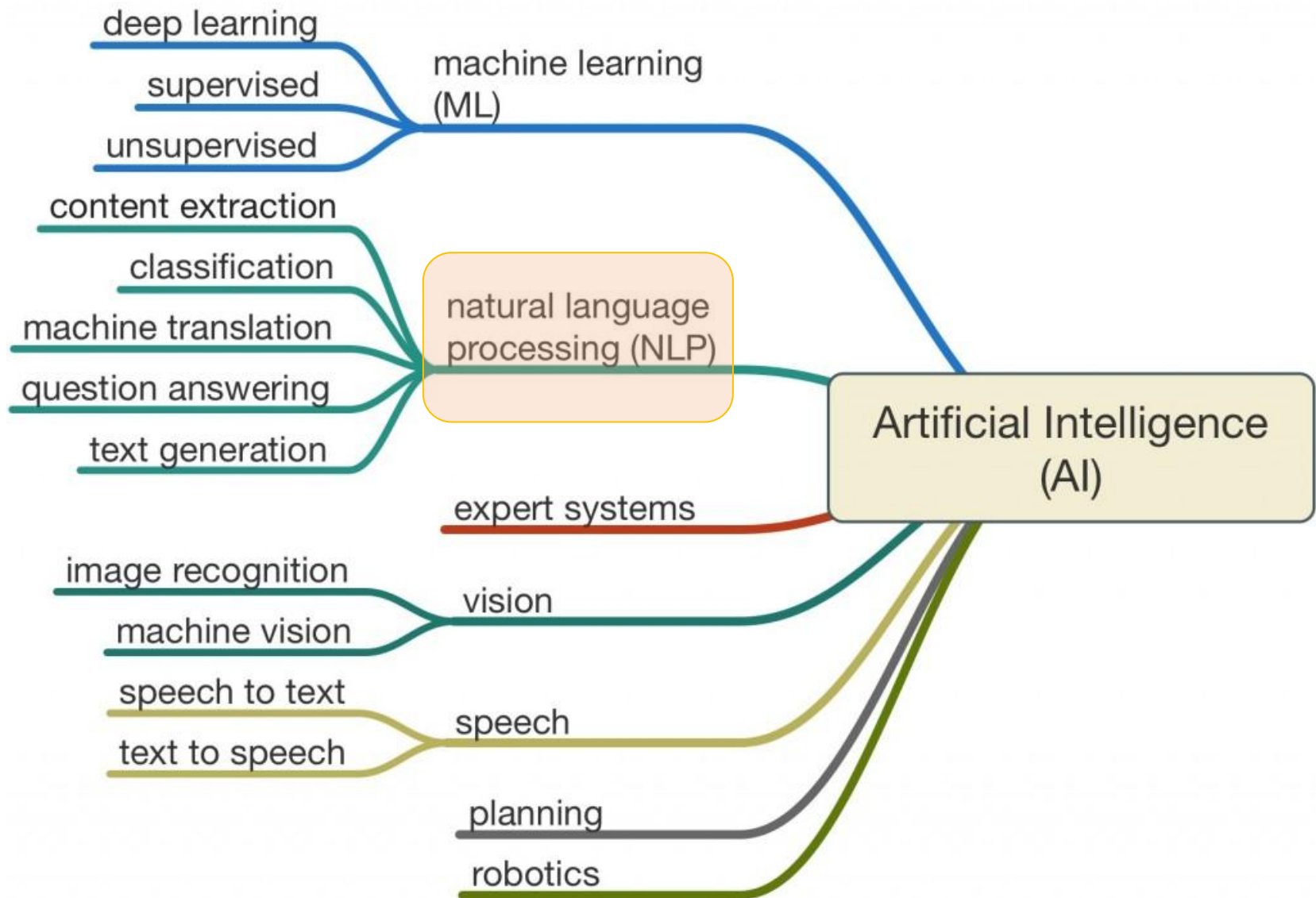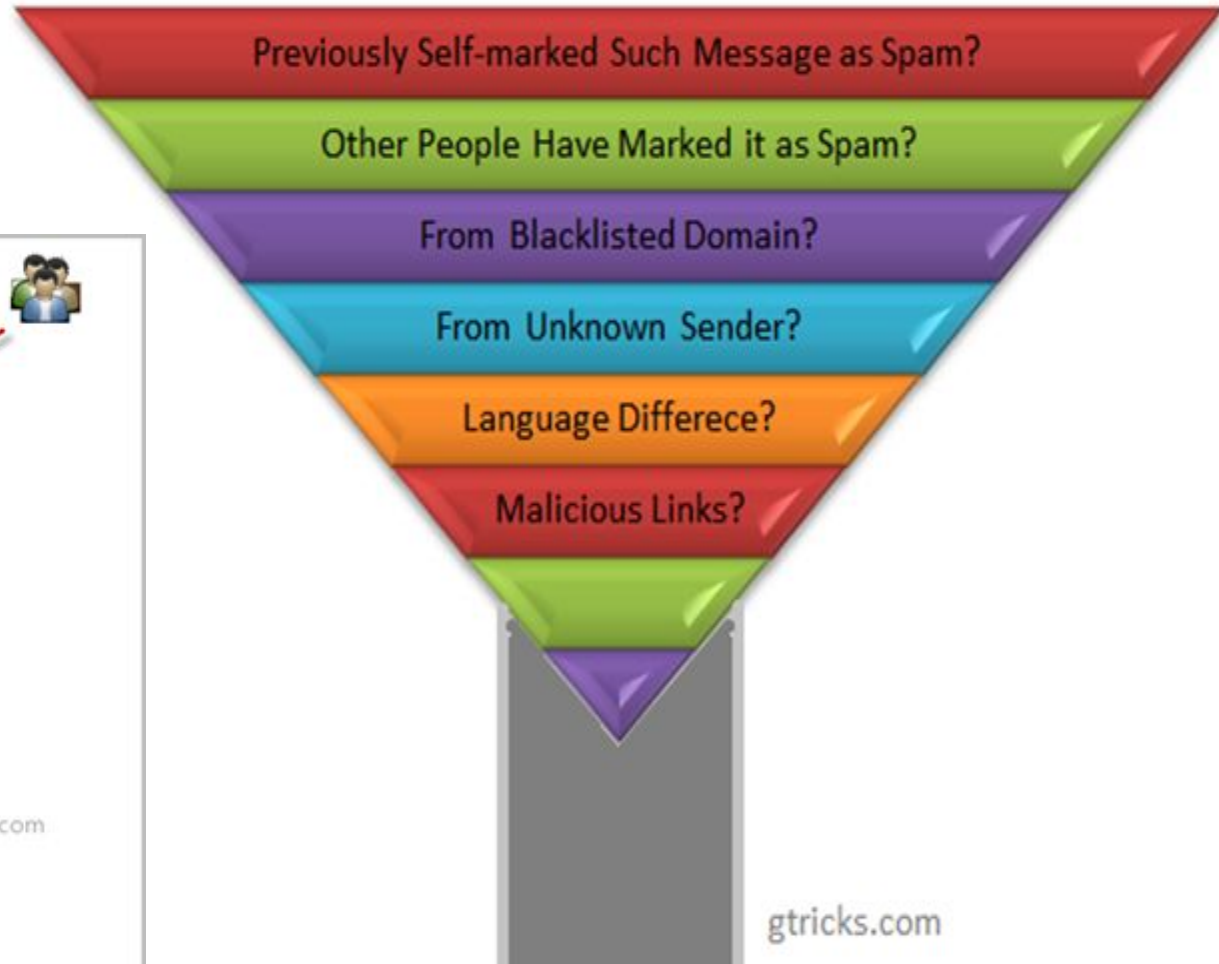
Deep Learning - AlphaGo 2016

- Go is an ancient Chinese board game that requires intuition, creative and strategic thinking

- AlphaGo defeated Lee Sedol who is 18-time world champion professional Go player in 4 out of 5 matches

- After the first two moves of a Chess game, there are 400 possible next moves. In Go, there are close to 130,000 moves.

Branches of AI

Source: http://legalexecutiveinstitute.com/artificial-intelligence-in-law-the-state-of-play-2016-part-1/

Gmail Spam filter

Previously Self-marked Such Message as Spam?

Other People Have Marked it as Spam?

From Blacklisted Domain?

From Unknown Sender?

Language Differece?

Malicious Links?

gtricks.com

gtricks.com

25

Branches of AI

Source: http://legalexecutiveinstitute.com/artificial-intelligence-in-law-the-state-of-play-2016-part-1/

Expert System

Branches of AI

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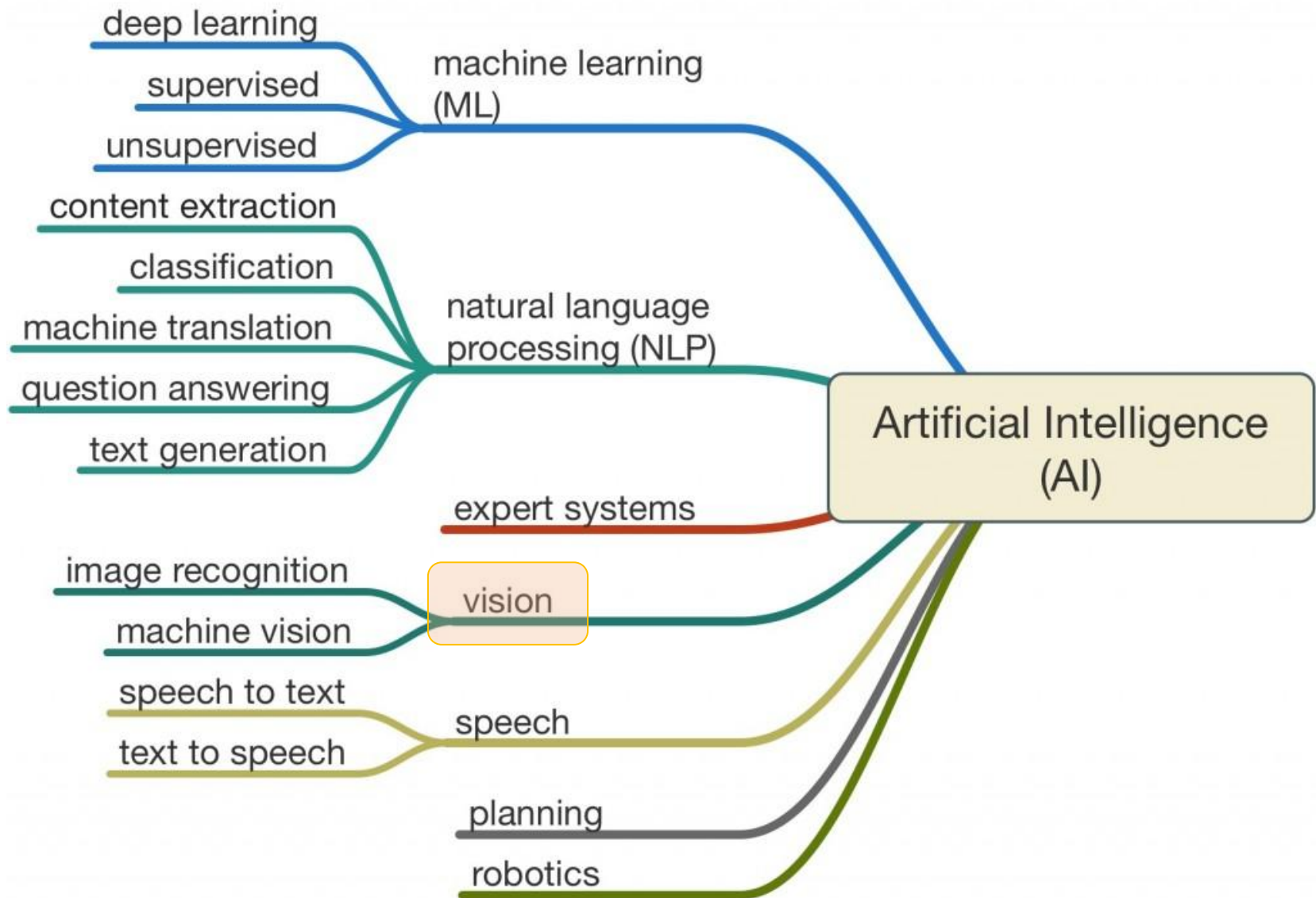
Industrial Machine Vision

Branches of AI

Source: http://legalexecutiveinstitute.com/artificial-intelligence-in-law-the-state-of-play-2016-part-1/

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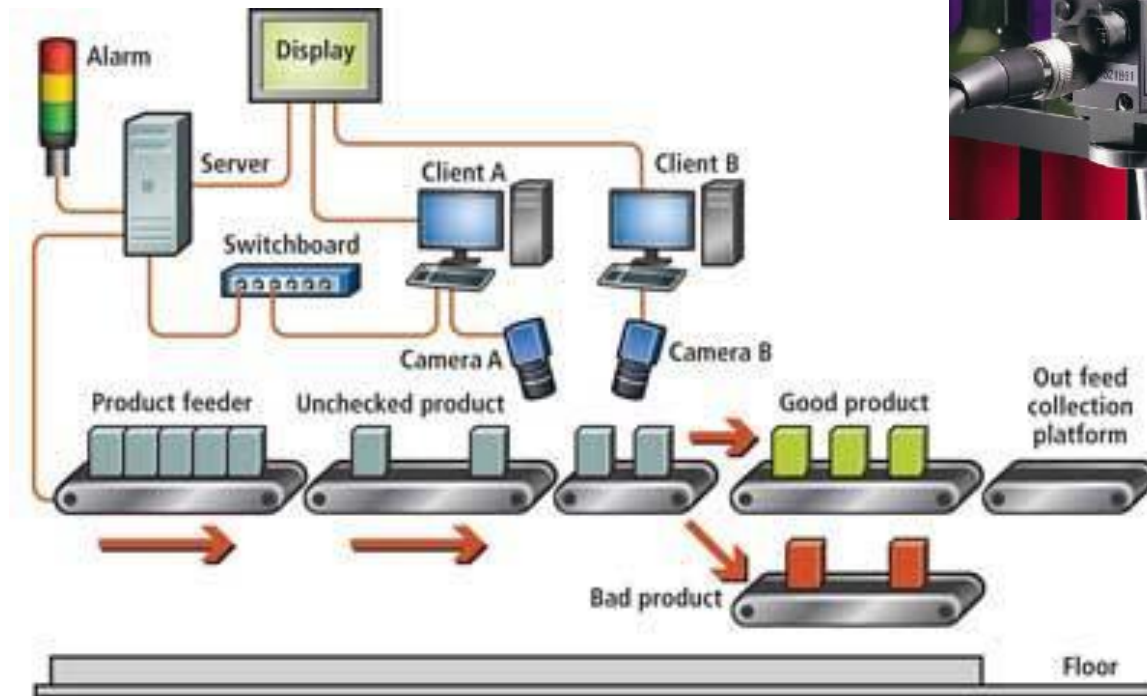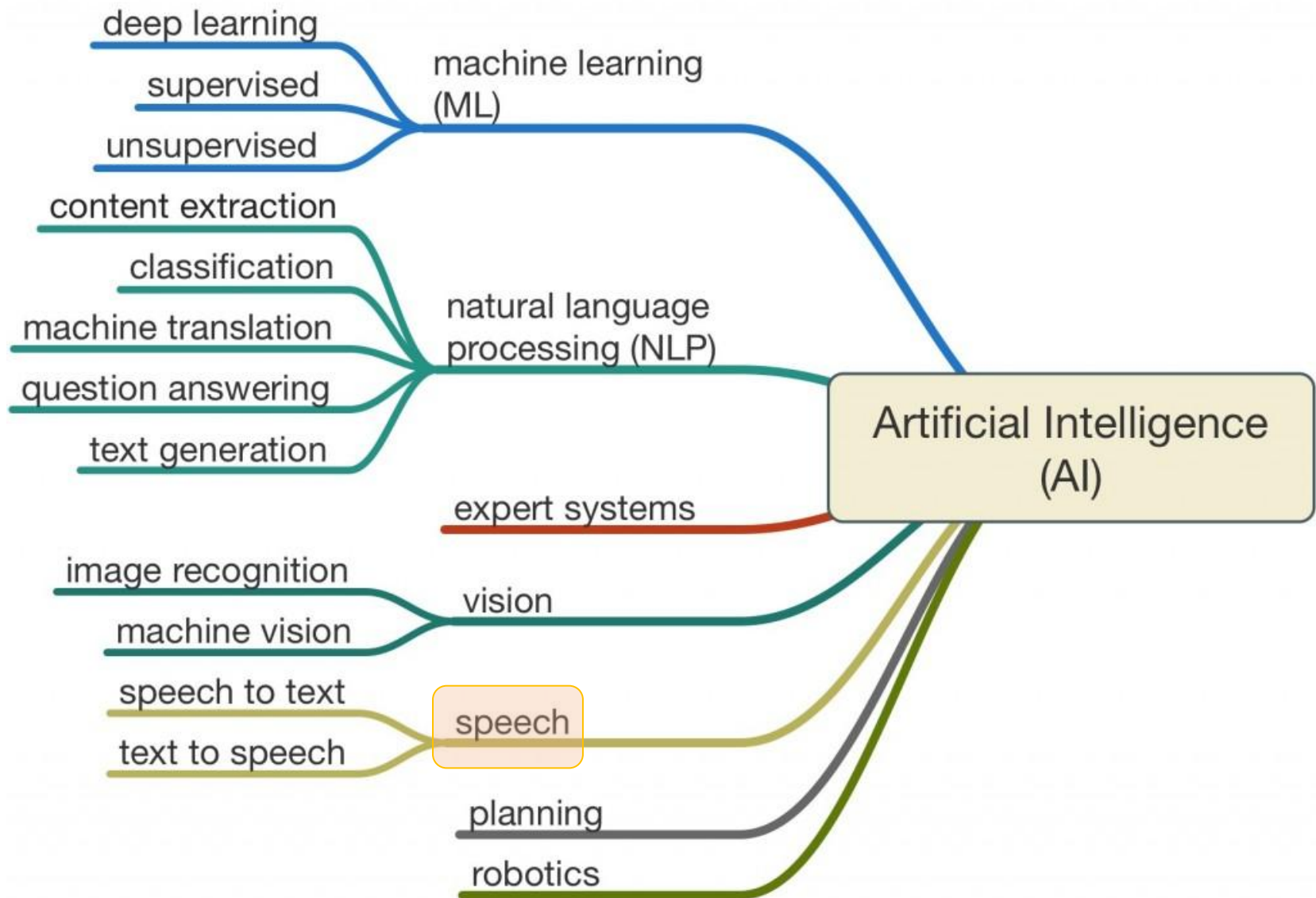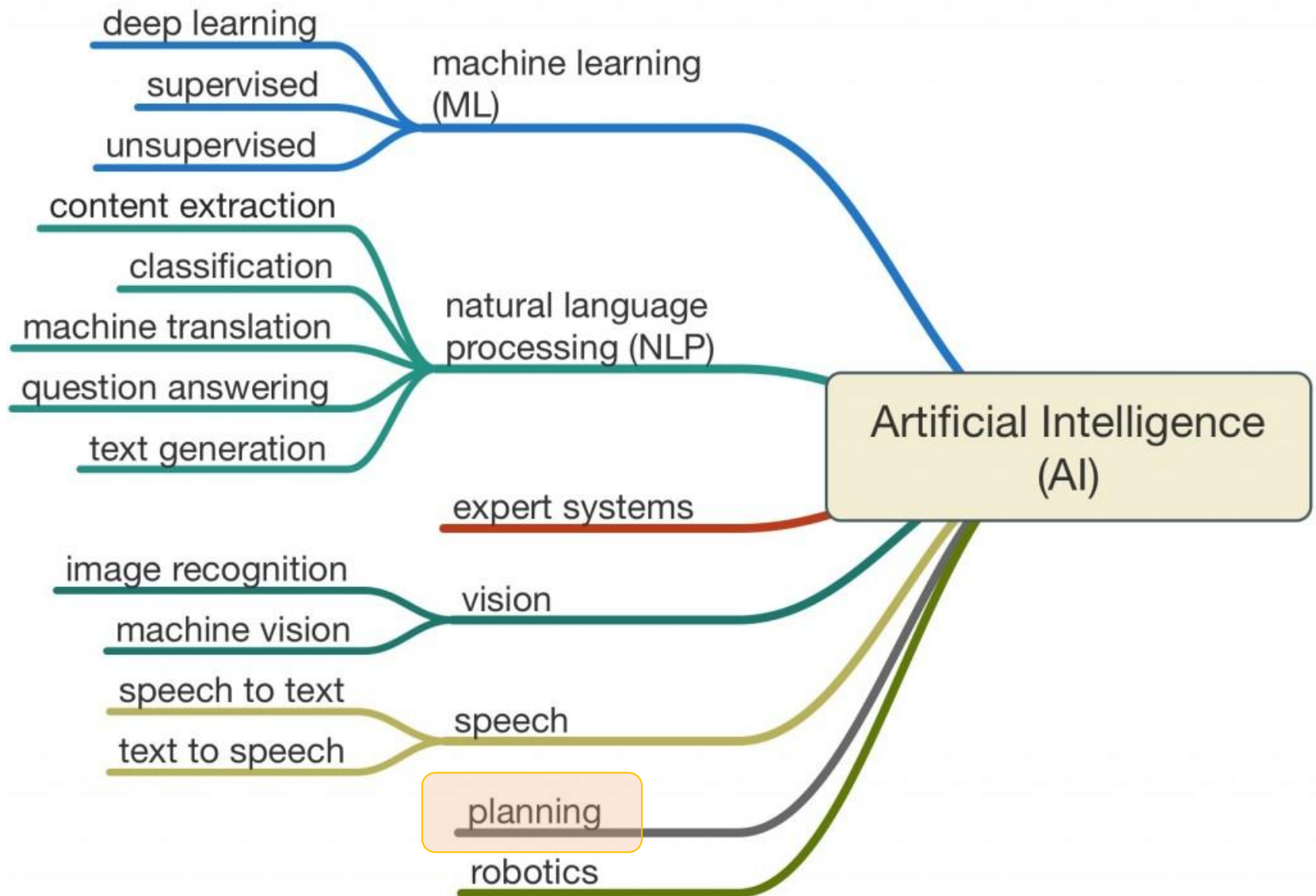
Path Planning in Robots
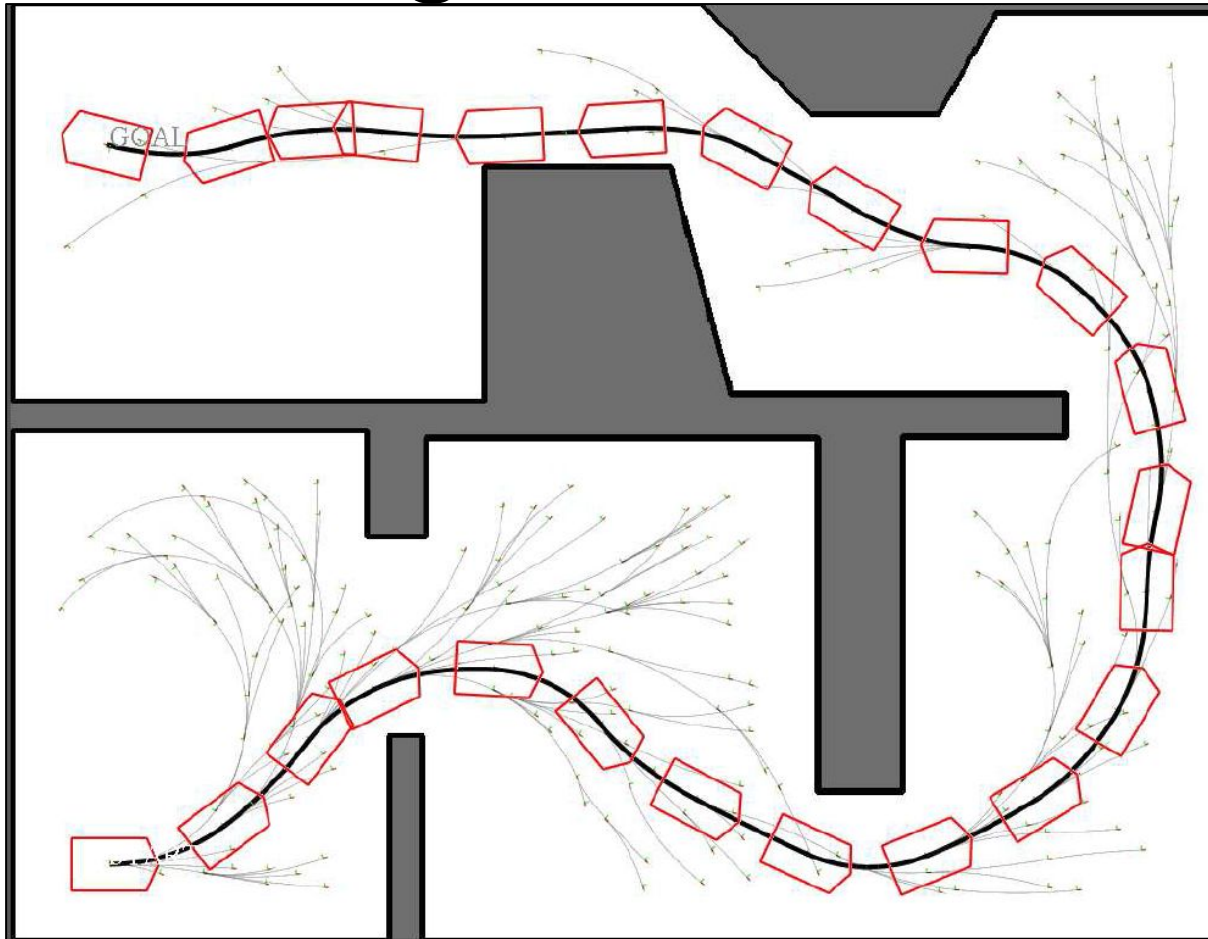
Path planning in robot to reach the goal state
(Search tree for the given map is also shown)

Branches of AI

machine learning (ML)
- deep learning
- supervised
- unsupervised

natural language processing (NLP)
- content extraction
- classification
- machine translation
- question answering
- text generation

expert systems

vision
- image recognition
- machine vision

speech
- speech to text
- text to speech

planning

robotics

Artificial Intelligence (AI)
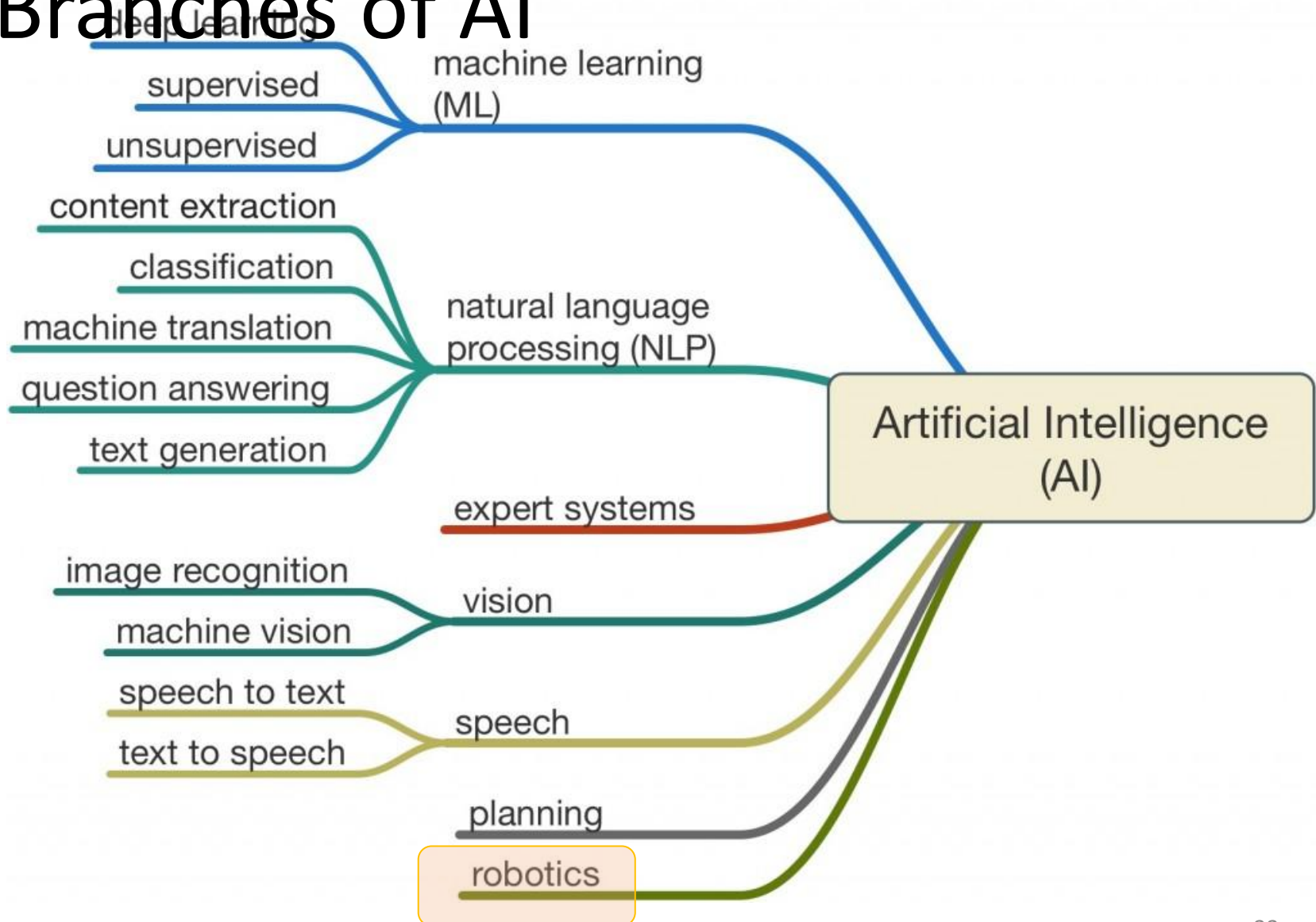
Active Cameras

- Manual control of these cameras is not possible - large number of targets and cameras
- We need an efficient automated mechanism to coordinate and control these cameras' actions

Axis 214 PTZ Cameras

Active Camera Coordination & Control
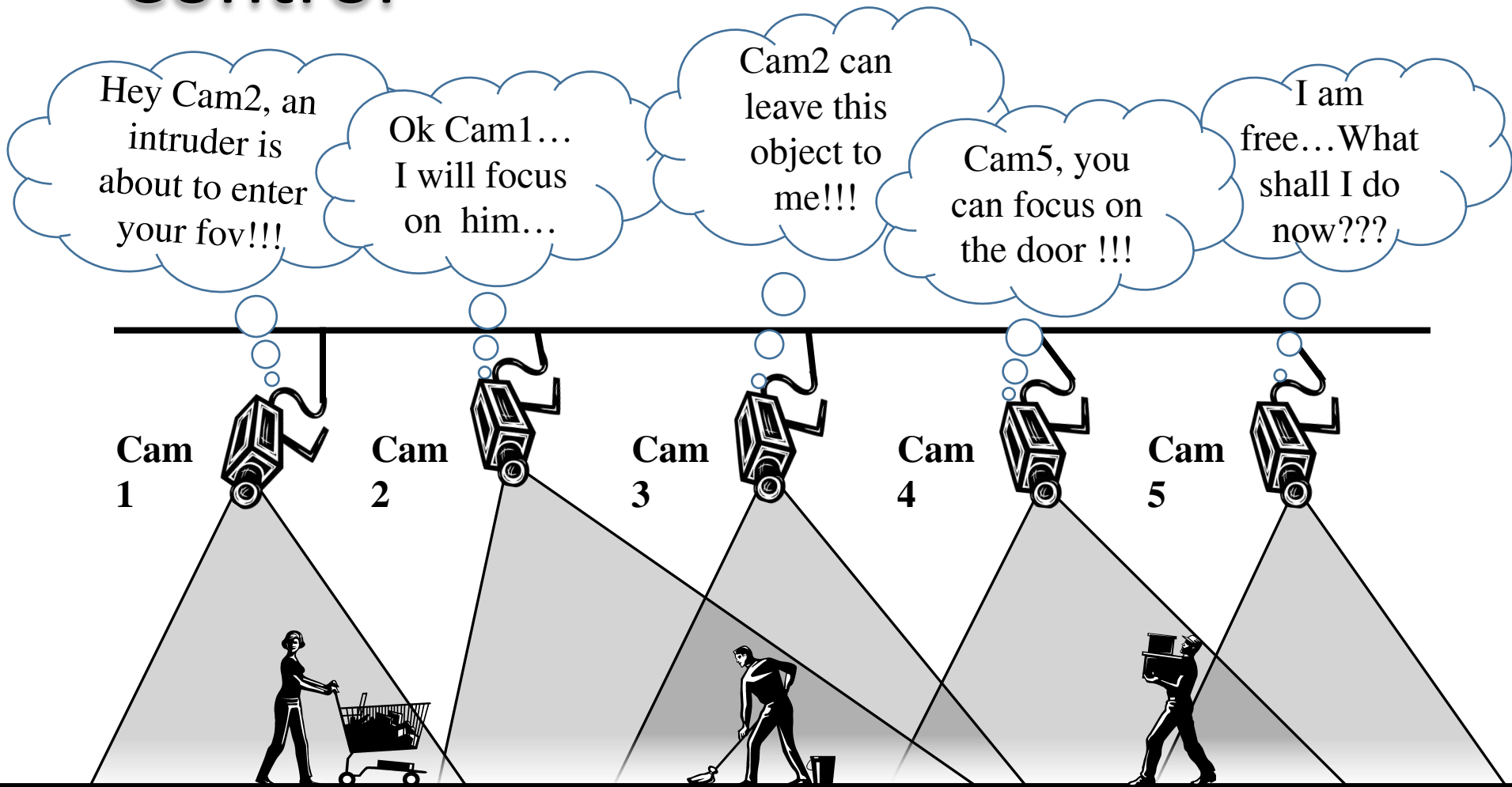
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- **Artificial Intelligence for games**

Let's consider: What is game AI?

In-Class Activity: Part 2

What is your definition of "Game AI"

Definitions

- "In video games, artificial intelligence is used to produce the illusion of intelligence primarily in the behavior of non-player characters (NPCs). " - Wikipedia

- Any technique that contributes to the perceived intelligence/behavior of a **computer controlled game character**
  - Techniques to detect player's intent or what they are doing
  - Techniques to mine player data

- Techniques to automatically **generate game contents** (at runtime or offline)

Purpose of Game AI?

- To make games fun
    - Reasonable challenges with natural behavior
- No cheating
- AI has bonuses over human players like:
    - Having more health/life
    - Driving faster
    - Increase difficulties on the fly
- Run faster
- Use minimal memory

Game Industry is the largest area where AI is applied

Computer Game Types

- Real Time Strategy (RTS)

- Role Playing Games (RPG)

- First person shooter (FPS)

- Sports games

AI in Different Game Types

- FPS & RPG
  - AI is in opponents, teammates, and extra characters
- RTS
  - AI on all sides
- Sports Games
 - AI is in opponents and teammates

Game AI History

- 1960's
  - First computer games (SpaceWar)
  - Board games against the computer (Chess)
- 1970's
  - Atari (1972)
    - Nolan Bushnell
    - Pong game
  - First AI implemented into games
    - Stored patterns
    - Space Invaders (1978)
      - Distinct moving patterns
    - Galaxian (1979)
      - More complex and varied enemy movements
 - 1-2% of CPU time spent on AI

Game AI History 1980's

- Pac-Man (1980)

- Fighting games
  - Karate Champ (1984)

- AI defeated a human player in chess for the first time (1983)
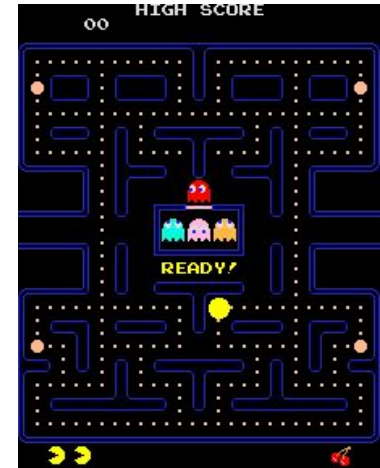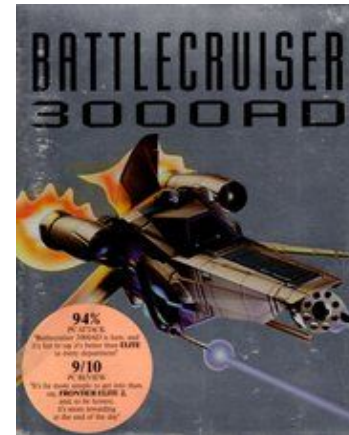
Game AI History 1990's

- ## Sports games
  - Madden Football
- ## FPS and RTS games
  - RTS games had problems
    - Path finding
    - Decisions
    - Many more
    - Dune II: Enemy attacked in a bee line and used cheats
  - RTS games did get better
    - WarCraft
      - First game to implement path-finding at such a large scale
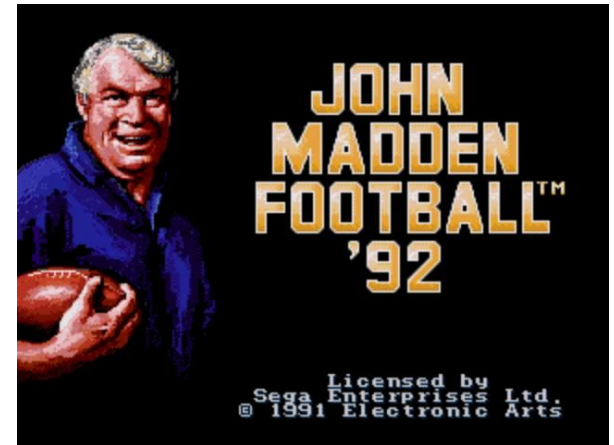
Game AI History 1990's

- Finite state machines
- Neural networks
  - Battlecruiser 3000AD (1996)
- Deep Blue defeats chess champ Gary Kasparov (1997)
  - Chess playing computer developed by IBM
  - Inspires AI developers
  - Graphic cards allowing for more CPU time
- 10-35% of CPU time spent on AI

Game AI History 2000's

- ## More games using neural networks
  - Black & White (2001)
  - Collin McRae Rally 2 (2001)

- ## Hyperthreading
  - More sophisticated AI engines while simultaneously creating a more realistic 3D environment

- ## Core Duo
  - Even more complex AI engines

Promising AI Techniques

- Bayesian network
- Decision tree
- Fuzzy logic
- Genetic algorithm
- N-Gram statistical prediction
- Neural Networks
- Behavior Tree

Bayesian network

- A probabilistic graphical model with variables and probable influences

- Example - calculate probability of patient having a specific disease given symptoms

- Example – AI can infer if player has warplanes, etc. based on what it sees in production so far

- Can be good to give "human-like" intelligence without cheating or being too dumb

Decision tree learning

- Series of inputs (usually game state) mapped to output (usually thing want to predict)

- Example – health and ammo → predict bot survival

- Modify probabilities based on past behavior

- Example – Black and White could stroke or slap creature. Learned what was good and bad

Filtered randomness

- Want randomness to provide unpredictability to AI

- But even random can look odd (ie: if 4 heads in a row, player think something wrong. And, if flip coin 100 times, will be streak of 8)
  - Example – spawn at same point 5 times in a row, then bad

- Compare random result to past history and avoid

Fuzzy logic

- Traditional set, object belongs or not.

- In fuzzy, can have relative membership (ie-hungry, not hungry. Or "in-kitchen" or "in-hall" but what if on edge?)

- Cannot be resolved by coin-flip

- Can be used in games – ie: assess relative threat

Genetic algorithms

- Search and optimize based on evolutionary principles

- Good when "right" answer not well-understood

- Example – may not know best combination of AI settings. Use GA to try out

- Often expensive, so do offline

N-Gram statistical prediction

- Predict next value in sequence (ie- 1818180181 … next will probably be 8)

- Search backward n values (usually 2 or 3)

- Example
  - Street fighting (punch, kick, low punch…)
  - Player does low kick and then low punch. What is next?
  - Uppercut 10 times (50%), low punch (7 times, 35%), sideswipe (3 times, 15%)
  - Can predict uppercut or, proportionally pick next (ie- roll dice)

Next Lecture

- Problem solving by searching