Introduction

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Chapters 1 & 2, Russell & Norvig

Intelligence per Merriam Webster

1 a : 1) the ability to learn or understand or to deal with new or trying situations **:** REASON; *also* **:** the skilled use of reason

2) the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (as tests)

b *Christian Science* **:** the basic eternal quality of divine Mind

c : mental acuteness **:** SHREWDNESS

2 a : an intelligent entity; *especially* **:** ANGEL

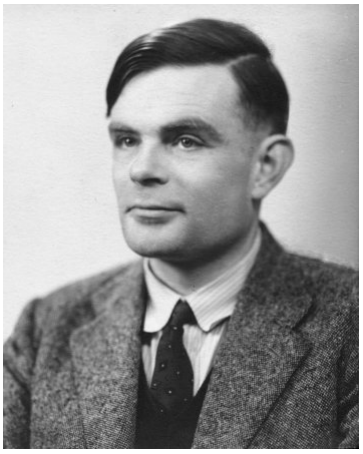
b : intelligent minds or mind <cosmic *intelligence*>

3 : the act of understanding **:** COMPREHENSION

What does it mean for a machine to be intelligent?

Turing Test – Can a human tell that they are interacting with a computer?

Variant of this competition occurs today with Loebner Prize (very restricted Turing test for chatbots)



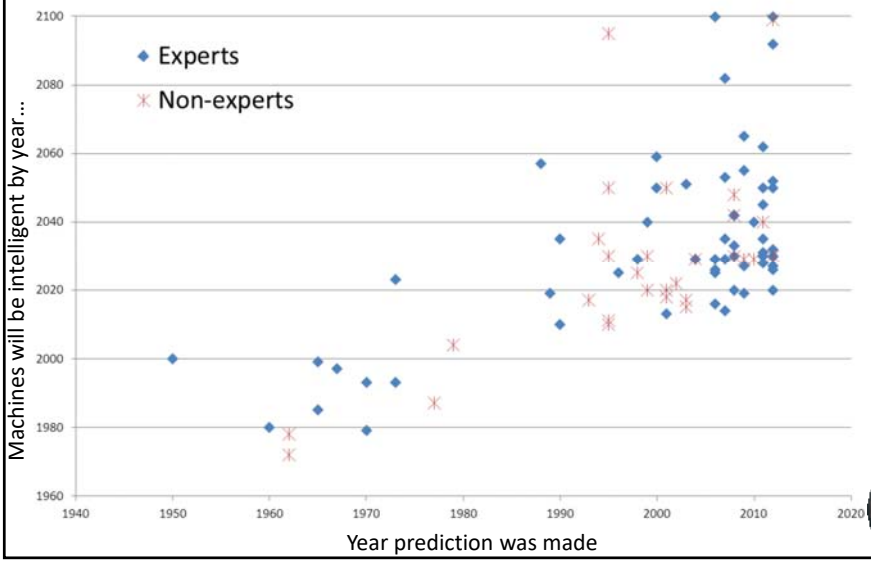
Alan Turing 1912-1954
(see *The Imitation Game* 2014 historical for a dramatization of his life)

Artificial intelligence

- Turing test - acting intelligent is sufficient
- Congnitive approach – Model the thinking of humans or other animals
- Laws of thought – Set of logic rules
  drawback: difficult to model informal/general knowledge
- Rational agent – Logical inference is good, but not always applicable.

When will machines be intelligent?

(Armstrong, et al. 2014)



Eliza (Weizenbaum, 1966)

young woman: Men are all alike.
eliza: In what way?
young woman: They're always bugging us about something specific or other.
eliza: Can you think of a specific example?
young woman: Well, my boyfriend made me come here.
eliza: Your boyfriend made you come here?
young woman: He says I'm depressed much of the time.
eliza: I am sorry to hear you are depressed.
young woman: It's true. I'm unhappy.
eliza: Do you think coming here will help you not to be unhappy?
young woman: I need some help, that much seems certain.
eliza: What would it mean to you if you got some help?
young woman: Perhaps I could learn to get along with my mother.

Simple rules ---> disappointment

(X me Y) ---> (X you Y)

(I remember X) ---> (Why do you remember X just now?)

(My {family-member} is Y) ---> (Who else in your family is Y?)

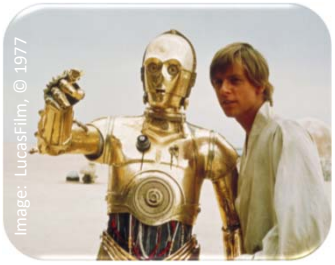
(X {family-member} Y) ---> (Tell me more about your family)

Areas contributing to AI

- Philosophy
- Mathematics
- Neuroscience
- Psychology
- Linguistics
- Computer science

- Many application areas contribute as well (e.g. economics)

Intelligent agents



- Sensors provide perceptual input (percepts) of environment

- Agent makes decisions
- Actions carried out through actuators that may affect the environment

Intelligent agents

- Softbot – Software only agent
  - Available data are percepts
  - Examples: web-based reputation monitoring, game opponent

Task Environments

In what environment will the agent be operating?

- fully vs. partially observable
  partially observable → uncertain state
- Rules are
  - known: Outcome (or outcome probabilities) are known
  - unknown – Outcomes must be learned

Task environments

- single- vs. multi- agent
- multiagent issues
  - cooperative vs. competitive
  - communication
  - randomization to prevent predictability

Task environments

- What happens when an agent acts?
  - deterministic – we know next state
  - stochastic
    - nondeterministic factors may influence (stochastic →probabilities) leading to an *uncertain* state

- Decisions are
  - episodic – Next decision only depends on state
  - sequential – Next decision dependent on previous ones

Task environments

- State can be
  - static – does not change while agent is deciding next action
  - dynamic – Environment constantly changing
  - semidynamic – Environment static, but performance is time dependent

See p. 45 Figure 2.6 for example task environments

Quick and dirty Python 3.x

- About the language
  - Interpreted high level language
  - Reasonably simple to learn
  - Rich set of libraries
- For details, see texts in syllabus or www.learnpython.org or www.diveintopython.net
- Python comment
  # comment from hash character to end of line

Python data types

- Numbers: 42.8 or 9
- Strings: single or double quote delimited
  'hi there' "Four score and seven years ago…"
- Dictionaries: Python's hash table

```
quotes = dict()  # new dictionary
quotes["Lincoln"] = "Four score and seven years ago…"
OR
quotes = {"Lincoln" : "Four…",
          "Roosevelt": "The only thing we have to fear…"}
```

Python data types

- Sequences
  - Lists ["Four", "score", "and"]
  - tuples ("Four", "score", "and")
- Difference between tuple and list
  - List – can grow or shrink
  - Tuple – Fixed number of elements
    - Faster
    - Can be used as hash table indices

Python data types

- None – special type for null object
- Booleans: True, False

- Variables are untyped

Python Expressions

- assignment: count = 0
- list membership: value in [4, 3, 2, 1]
- indexing: listvar[4], tuplevar[2]
- slices:
  listvar[0:N] → items 0 to N-1
  listvar[:N] → items 0 to N-1
  listvar[3:] →items 3 to end
  listvar[0:2:N] → even items at 0, 2, 4, …
  listvar[-4:-1] → 4th to the last to 2nd to the last
- logical operators: and, or, not

Python expressions

- comparison operators: < > >= <= !=
- basic math operators: + - / *
- exponentation: x ** 3 # x cubed
- bitwise operators: & | ~ and ^ (xor)

Python control structures

- Use indentation to denote blocks
- Conditional execution

```
if expression:
        statement(s)
elif expression:
        statements(s)
else:
        statement(s)
```

Python control structure

- Iteration

```
done = False
while not done:
        statements(s)
        done = expression

for x in range(10):  # 0 to 9
        print(x)
        print("x={}".format(x))
```

alter iteration with reak and continue

Python functions

def foobar(formal1, formal2, formal3=None):
    "foobar doesn't do much" # doc string
    statement(s)
    return value

- formal3 defaults to None if not supplied
- Variable scope rules
    local, enclosing function, global, builtin names

Python objects

```
class Board:
   "Grid board class"
   def __init__(self, rows, cols):  # constructor
      "construct a board with specified rows and cols"
      self.rows = rows
      self.cols = cols
      # list comprehension example
      self.board = [[None for c in range(cols)] for r in range(rows)]
   def place(self, row, col, item):
      "place an item at position row, col"
      self.board[row][col] = item
   def get(self, row, col):
      "get an item from position row, col"
      return self.board[row][col]
```

Python objects

- Create: b = Board(8,8)
- b.place(2, 7, 'black-king')
- b.get(2,7)
  "black-king"

Python

- Integrated development environments
  - Eclipse with PyDev ← what I use
  - Komodo (ActiveState)
  - Pycharm
  - others (see Python.org)
- Versions of Python
  - Python.org – stock Python
  - PyCharm
  - Anaconda – bundles with lots of libraries and and ID

Agent structure

- An agent's architecture consists of
  - data structures
  - code
- Simplest agent: table driven

What's wrong here?

```
function table-driven-agent(percept) returns action
  persistent: percepts (sequence, empty at first)
              table of actions indexed by
                    percept sequence

  percepts.append(percept)
  return lookup(percepts, table)
```

Simple-reflex agents

- Ignores percept history, uses the current one
- Productions (aka conditions-action) decide action, e.g.

  person waving → wave

  person smiling → smile

  person swinging hammer towards me → duck!

Model-based reflex agents

- Add internal state
- New percepts update the state
- Productions based on percept and state

Goal-based agents

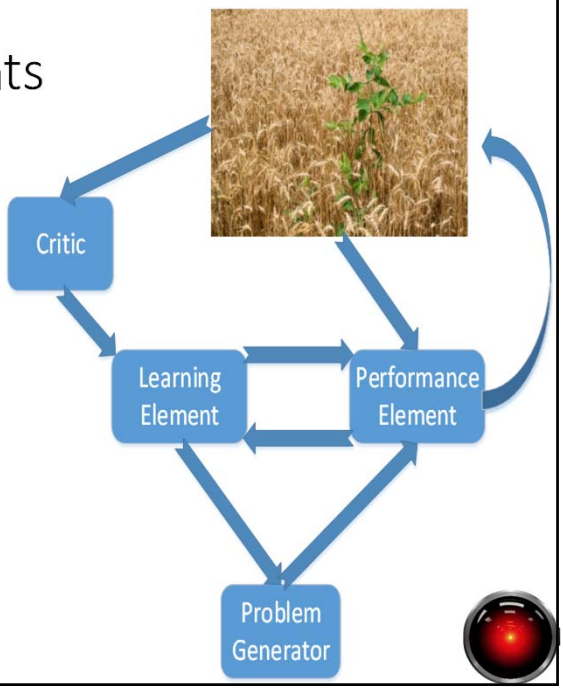
- Agent works to achieve a specific state
- Usually requires: Search and Planning

Utility-based

- Based on utility theory: The idea of how useful or happy something makes you.
- Decisions are made to maximize the expected utility.

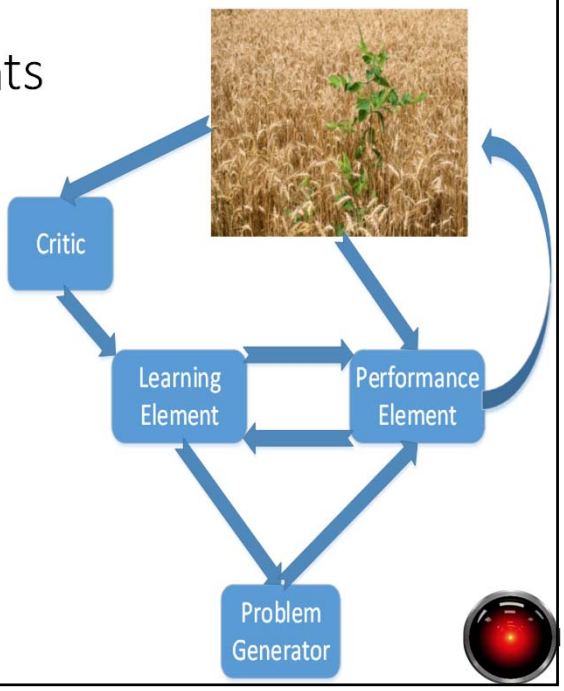
Learning agents

- Decision rules are adjusted based on performance over time



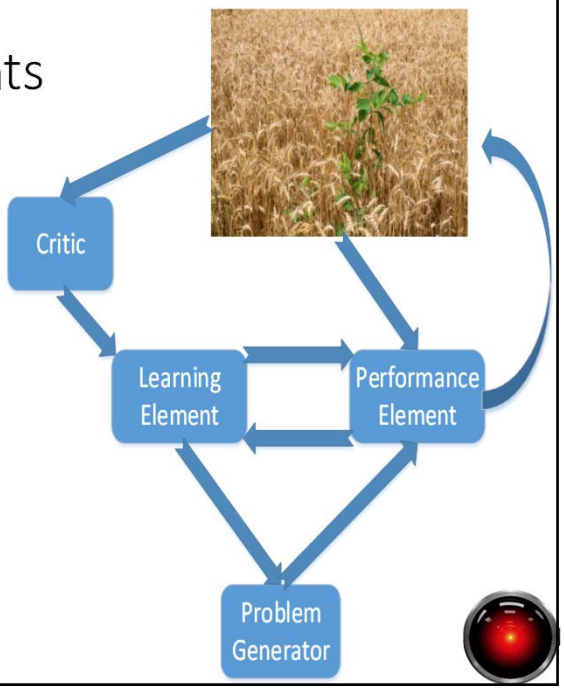
Learning agents

- Learning element uses knowledge from performance element to modify rules



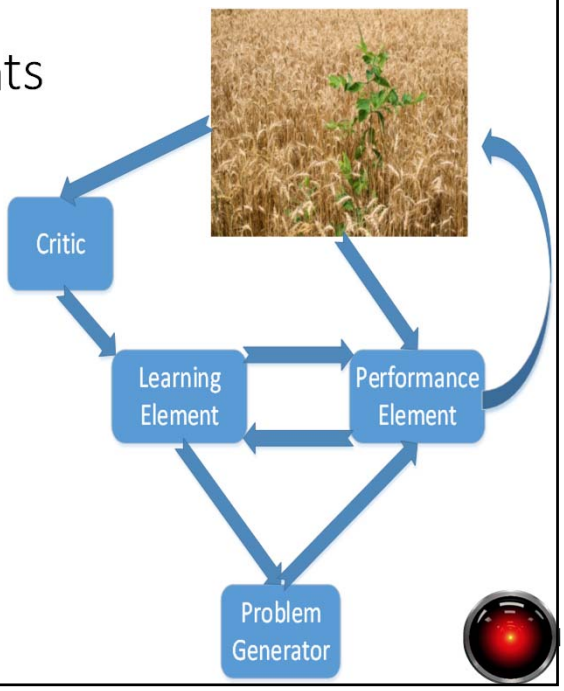
Learning agents

- Critic monitors the environment to see how the system is doing and keeps learning element from going off track.



Learning agents

- Critic monitors the environment
  - Provides utility of the current percepts
  - Allows learning element to learn useful goals



Learning agents

- Problem generator
  - Uses learning element's goals to suggest experiments
  - Experiments may lead to the learning element improving the performance element