From Steve Austin to Peter Norvig

Engineering AMEE, the Simple Autonomous Agent

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@mamund
youtube.com/mamund

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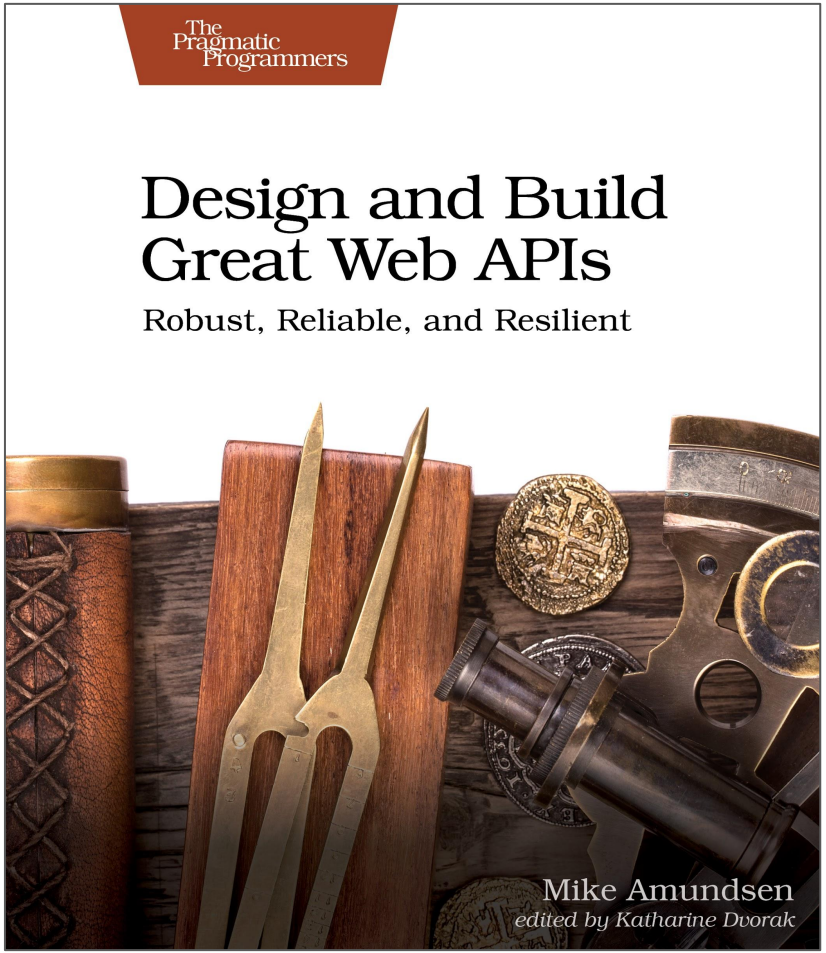
g.mamund.com/GreatWebAPIs

"From design to code to test to deployment, unlock hidden business value and release stable and scalable web APIs that meet customer needs and solve important business problems in a consistent and reliable manner."

-- Pragmatic Publishers



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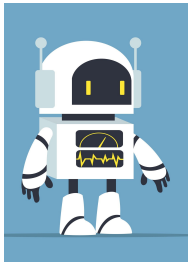
- Steve Austin & Peter Norvig
- Turing's Imitation Game
- About Agents
- Engineering AMEE
- So...



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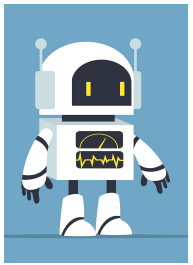

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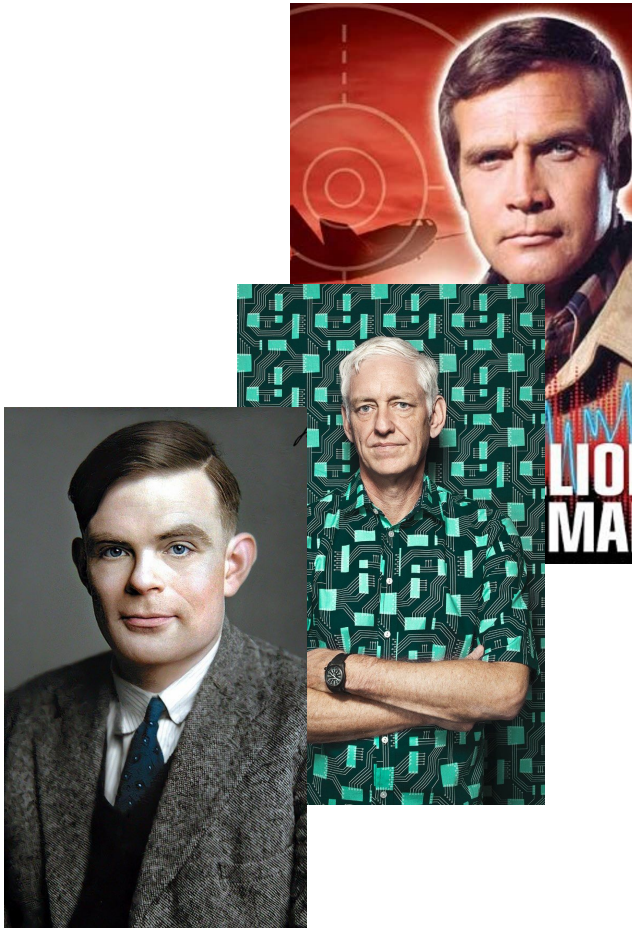

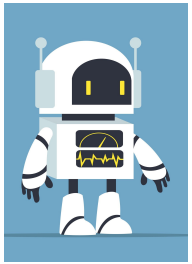

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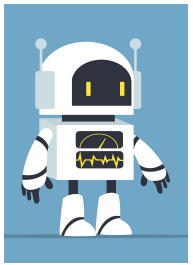

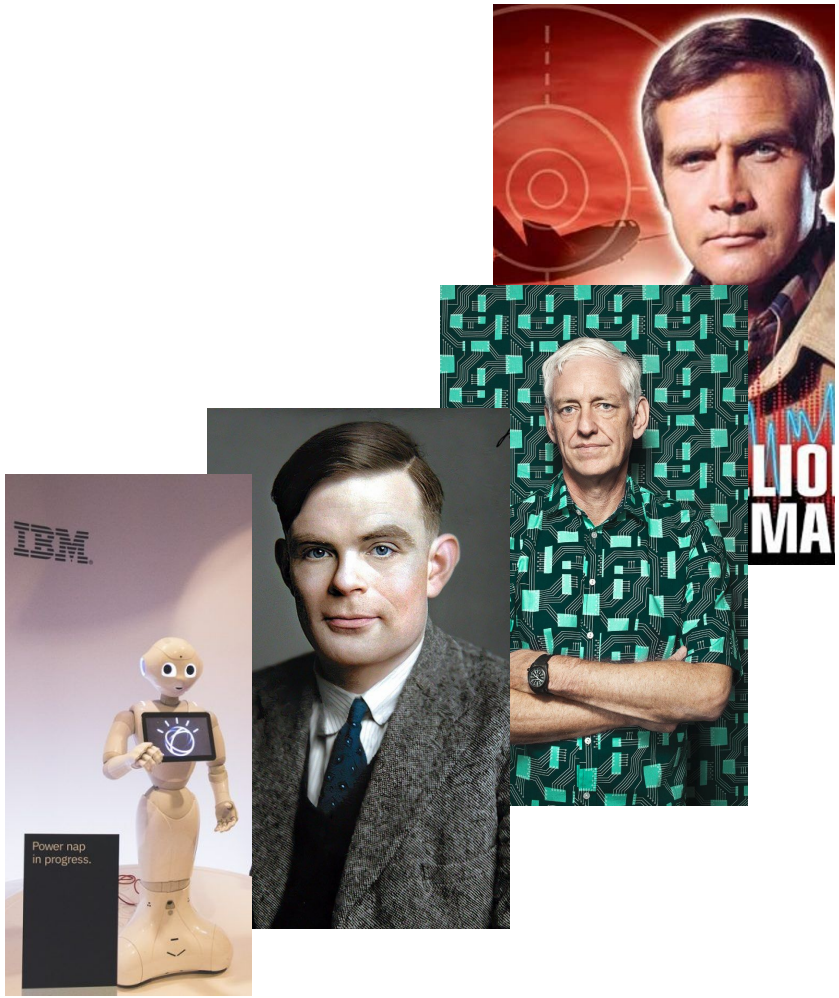

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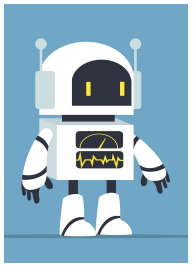

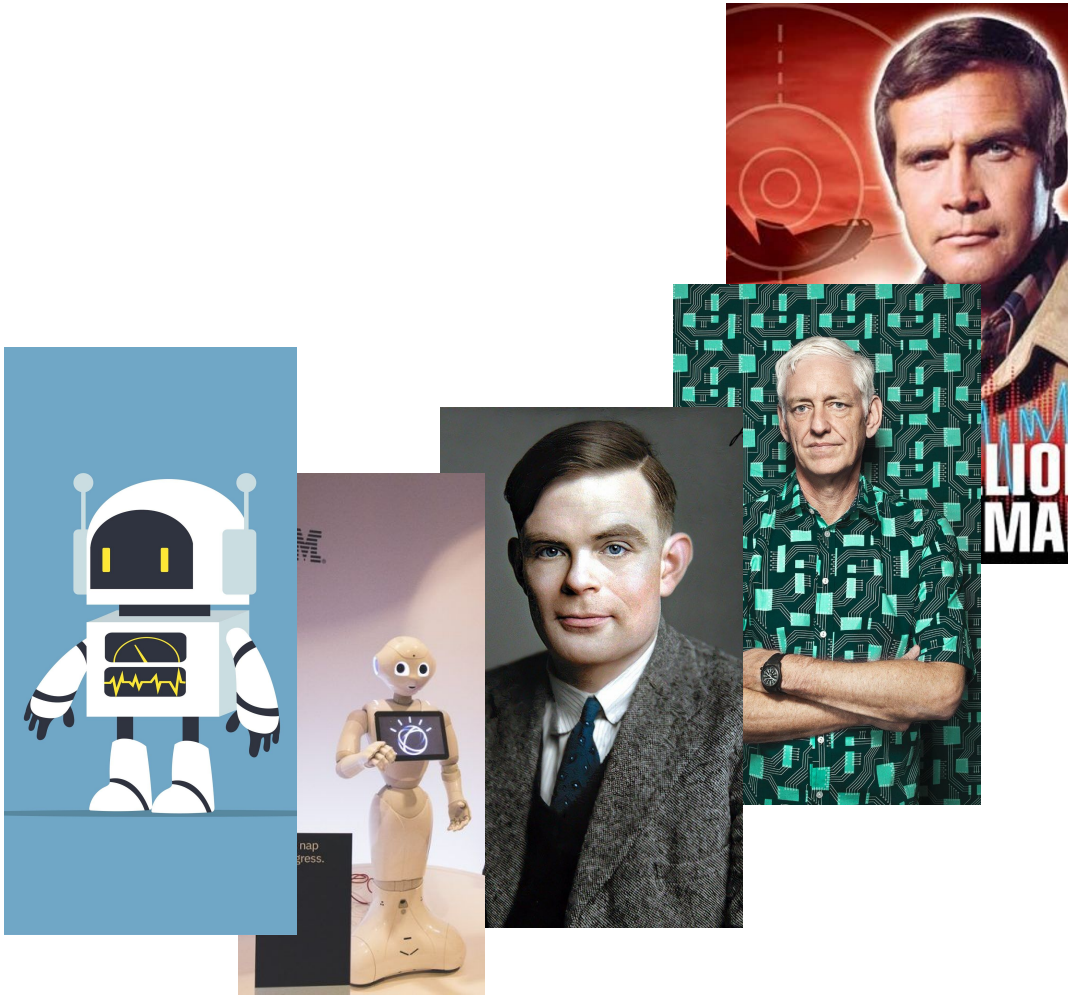

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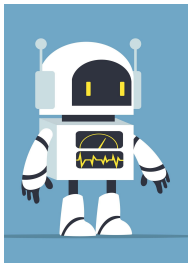
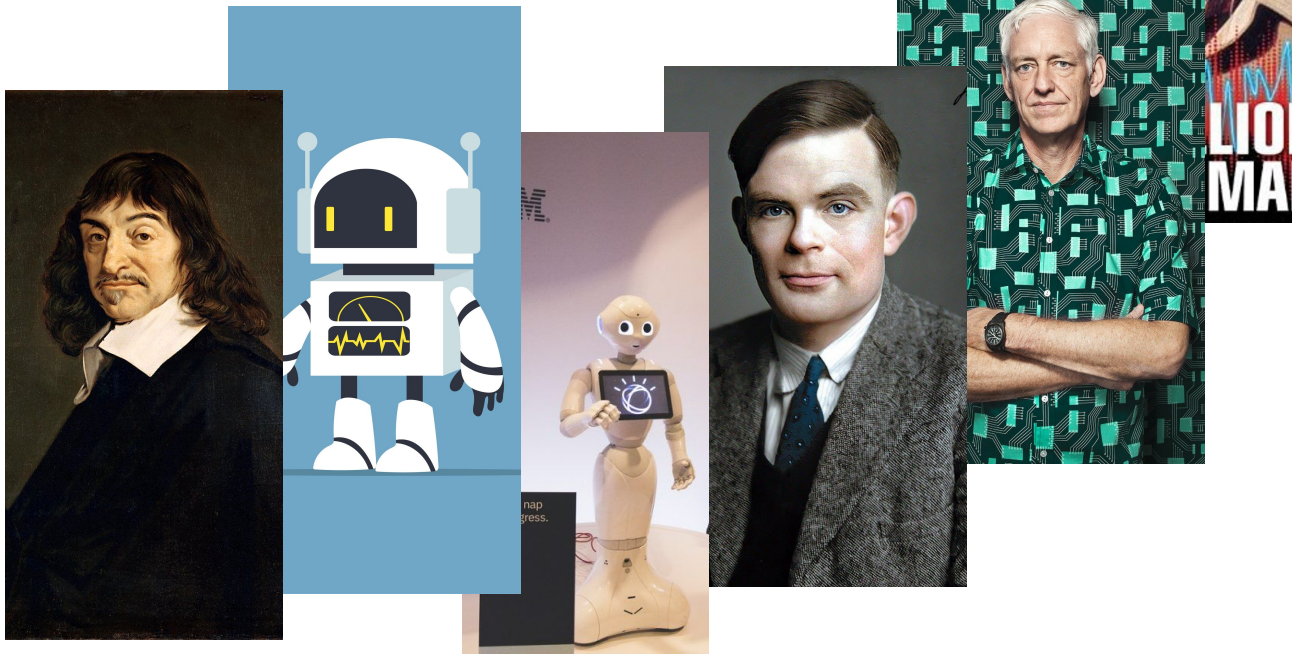
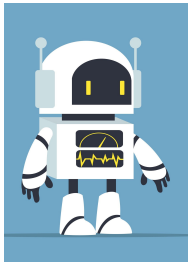




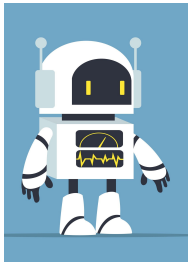
Steve Austin
Peter Norvig

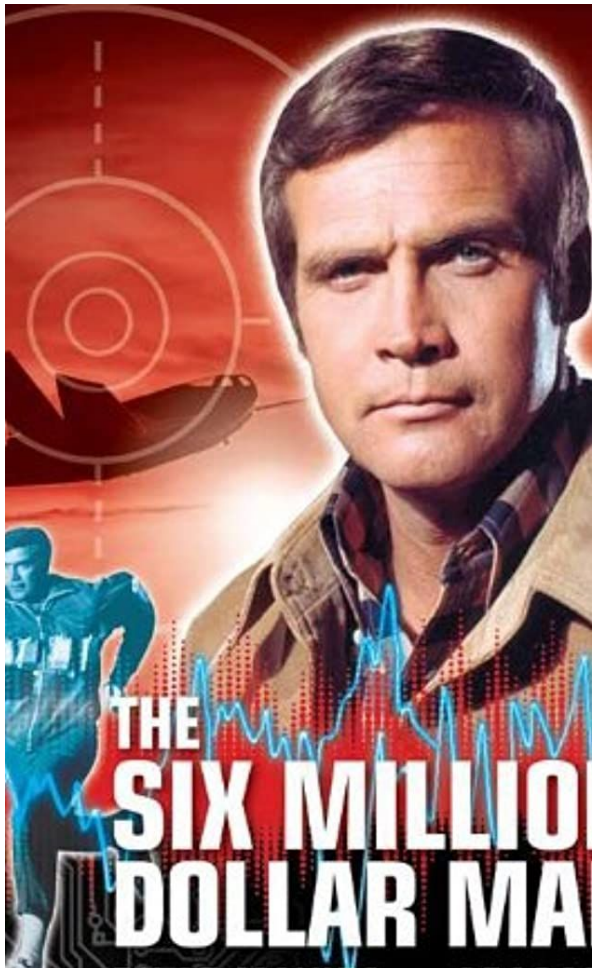


Steve Austin

"We can rebuild him. We have the technology. We can make him better than he was. Better...stronger...faster."

-- The Six Million Dollar Man, 1973

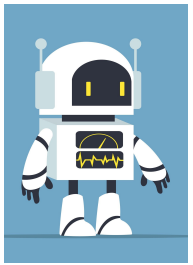


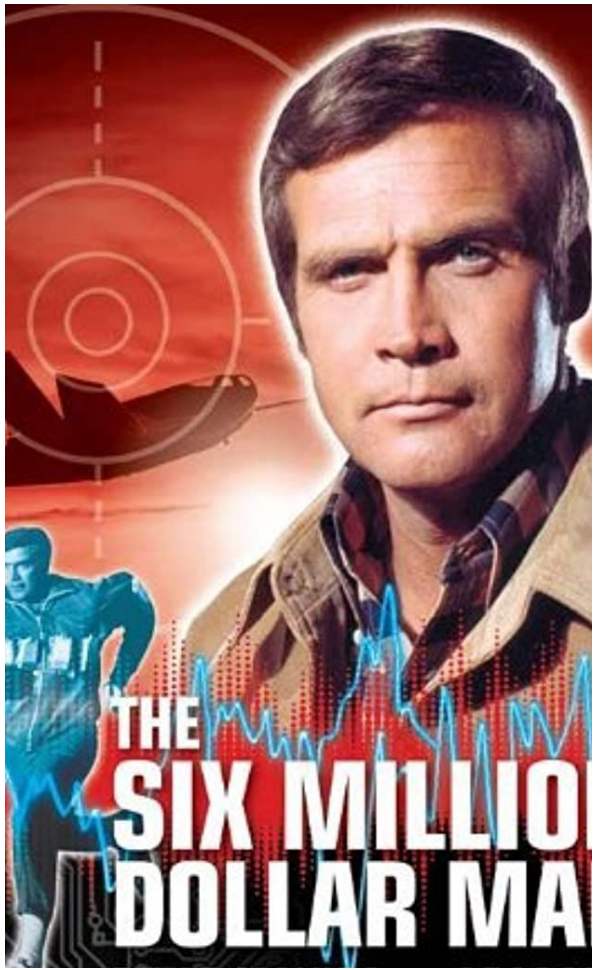


Steve Austin

"We can rebuild him. We have the technology. We can make him better than he was. Better...stronger...faster."

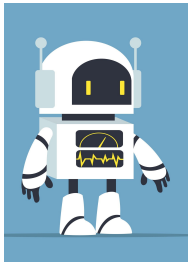
-- The 35 Million Dollar Man, 2021

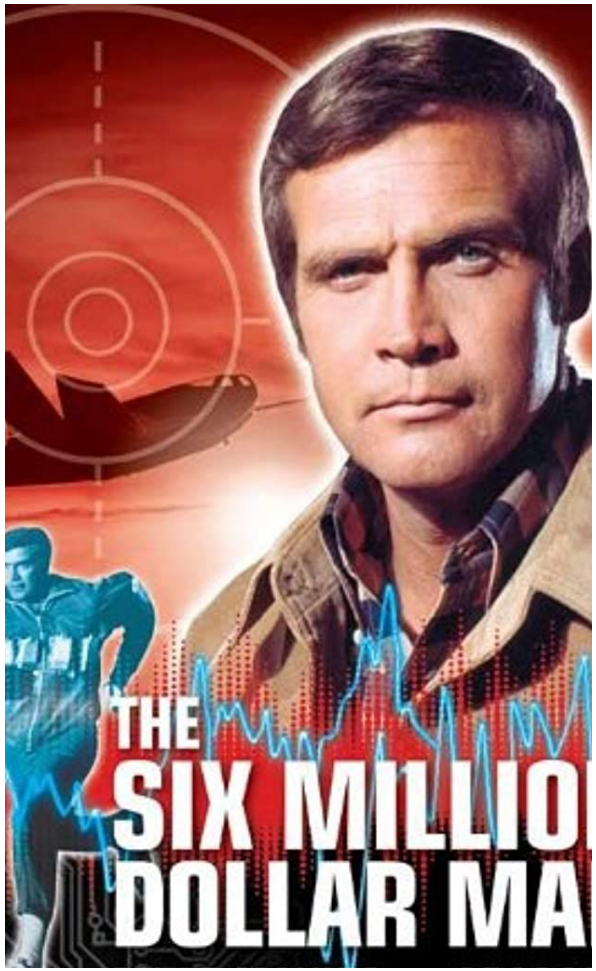




Steve Austin

- The technology of the day
- The power of a machine
- The brain of a human

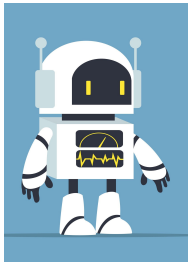




Peter Norvig

"More data beats clever algorithms,
but better data beats more data."

-- Peter Norvig



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Q&A: Peter Norvig '78 P'16 P'18 ...
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AI Course with Sebastian Thrun and ...
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Fireside Chat with Peter Norvig - YouTube
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Stanford Univ, California ...
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The 100,000-student classroom ...
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Peter Norvig, Google - Stanford Bi...
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Stanford Medicine | Flickr
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AI Programming: So Much Uncertainty ...
thenewstack.io

Artificial Intelligence in Stevens Talk...
stevens.edu

Peter Norvig (2007)

How to Write a Spelling Corrector

```
import re
from collections import Counter

def words(text): return re.findall(r'\w+', text.lower())

WORDS = Counter(words(open('big.txt').read()))

def P(word, N=sum(WORDS.values())):
    "Probability of `word`."
    return WORDS[word] / N

def correction(word):
    "Most probable spelling correction for word."
    return max(candidates(word), key=P)

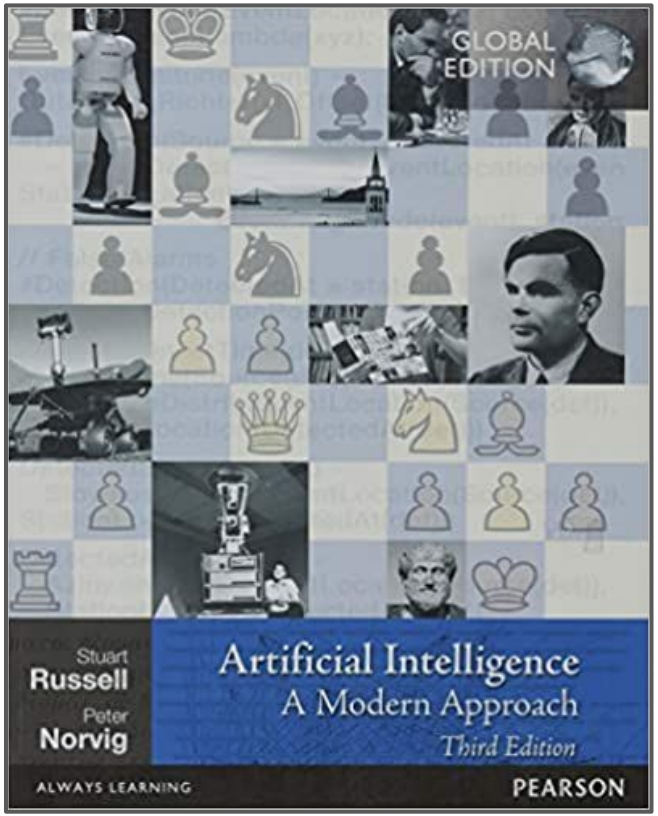
def candidates(word):
    "Generate possible spelling corrections for word."
    return (known([word]) or known(edits1(word)) or known(edits2(word)) or [word])

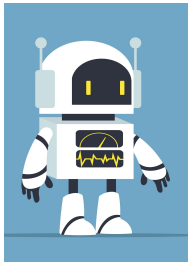
def known(words):
    "The subset of `words` that appear in the dictionary of WORDS."
    return set(w for w in words if w in WORDS)

def edits1(word):
    "All edits that are one edit away from `word`."
    letters    = 'abcdefghijklmnopqrstuvwxyz'
    splits     = [(word[:i], word[i:])    for i in range(len(word) + 1)]
    deletes    = [L + R[1:]               for L, R in splits if R]
    transposes = [L + R[1] + R[0] + R[2:] for L, R in splits if len(R)>1]
    replaces   = [L + c + R[1:]           for L, R in splits if R for c in letters]
    inserts    = [L + c + R               for L, R in splits for c in letters]
    return set(deletes + transposes + replaces + inserts)

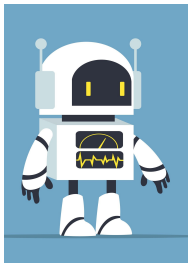
def edits2(word):
    "All edits that are two edits away from `word`."
    return (e2 for e1 in edits1(word) for e2 in edits1(e1))
```

Russell & Norvig (1994)





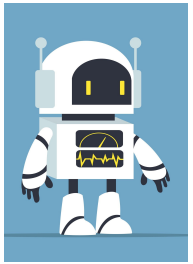
Turing's Imitation Game

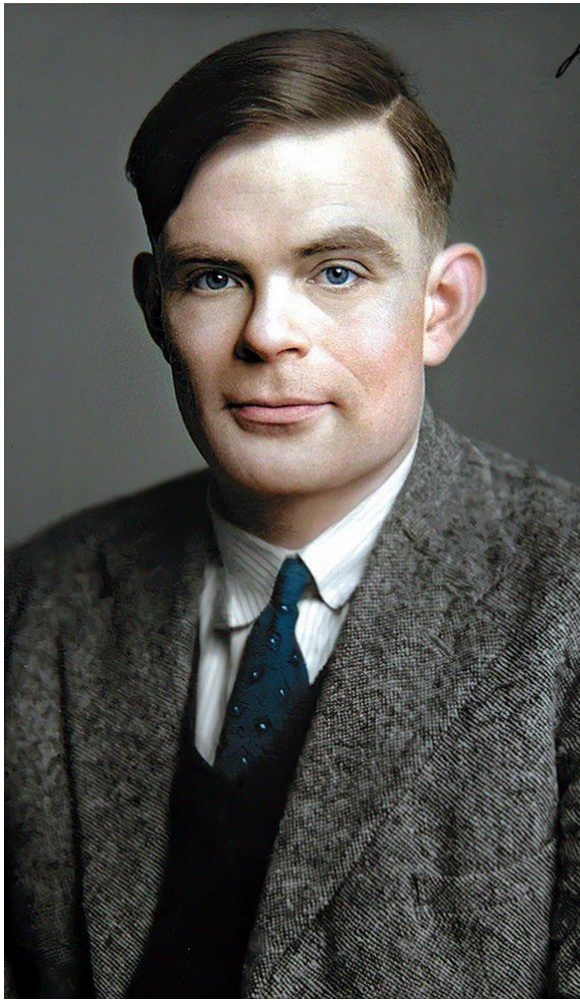


Alan Turing

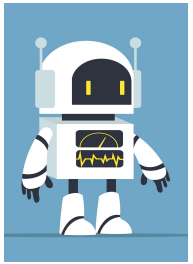
"Are there imaginable digital computers which would do well in the imitation game?"

-- Alan Turing, 1950





Alan Turing



VOL. LIX. NO. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

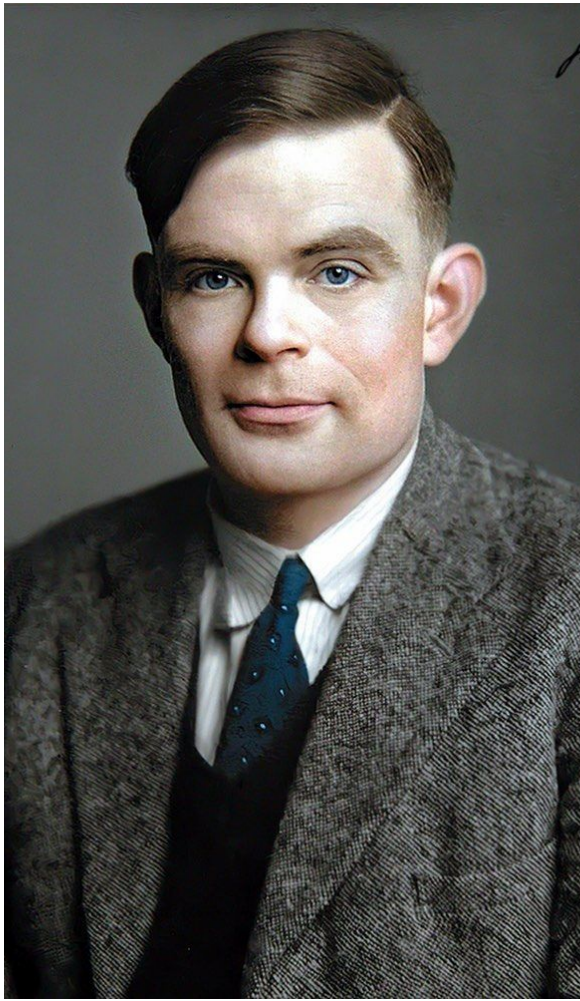
BY A. M. TURING

1. *The Imitation Game.*

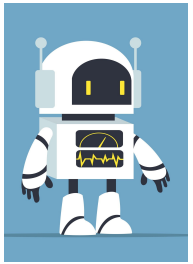
I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

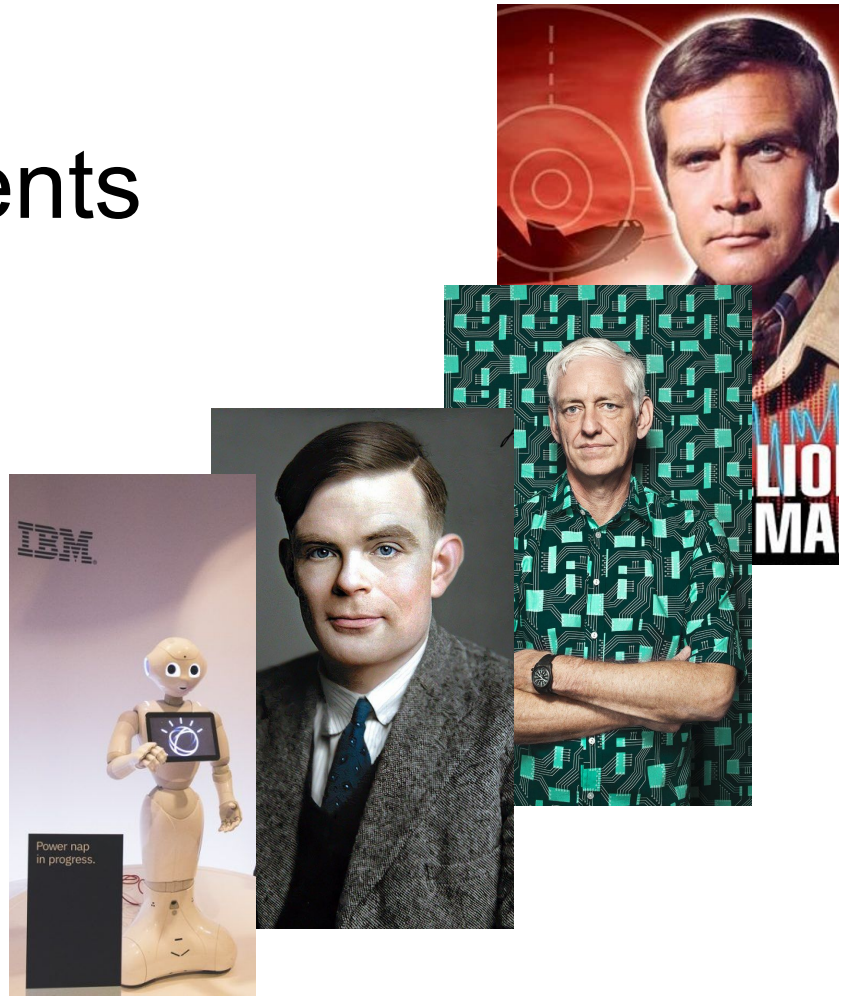
The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?



About Agents



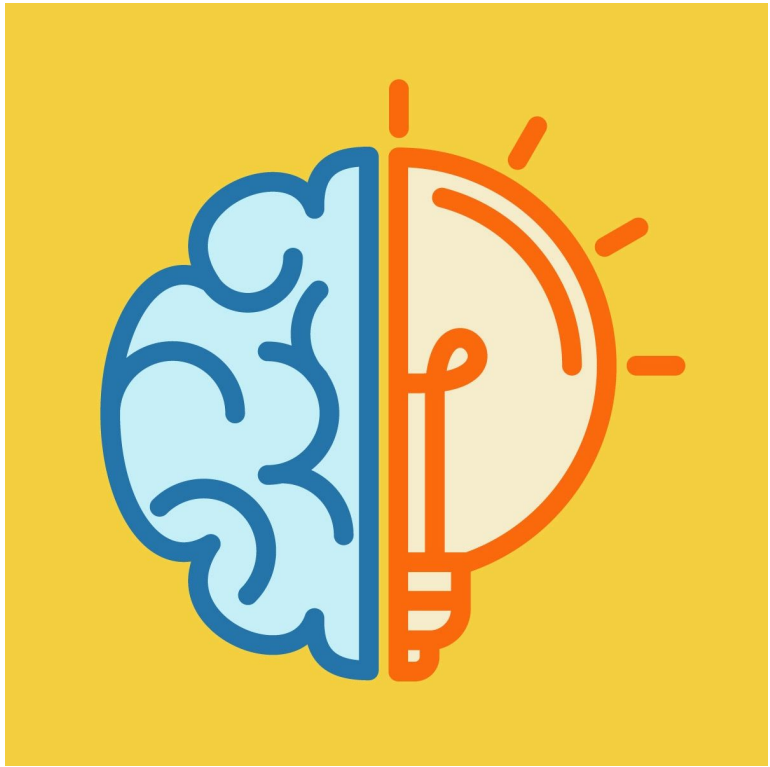


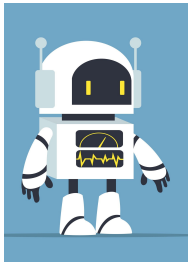
Intelligent Agent

"Anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators"

-- Russell & Norvig

"Artificial Intelligence: A Modern Approach" (1994)

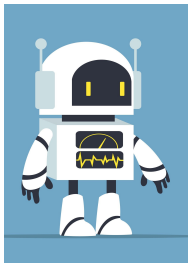


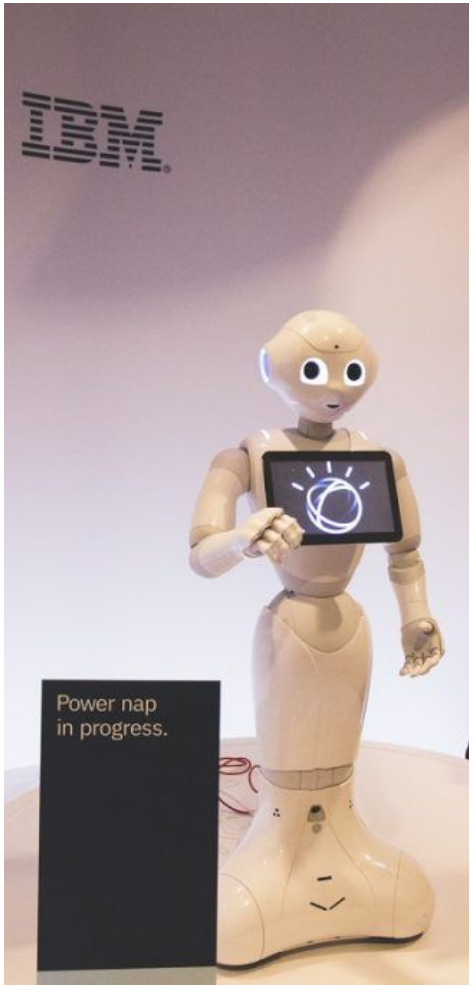


Autonomous Agents

"Software entities that carry out operations on behalf of a user with independence and employ knowledge of the user's goals."

-- a multiply cited statement in an IBM white paper no longer accessible





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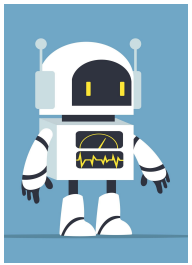
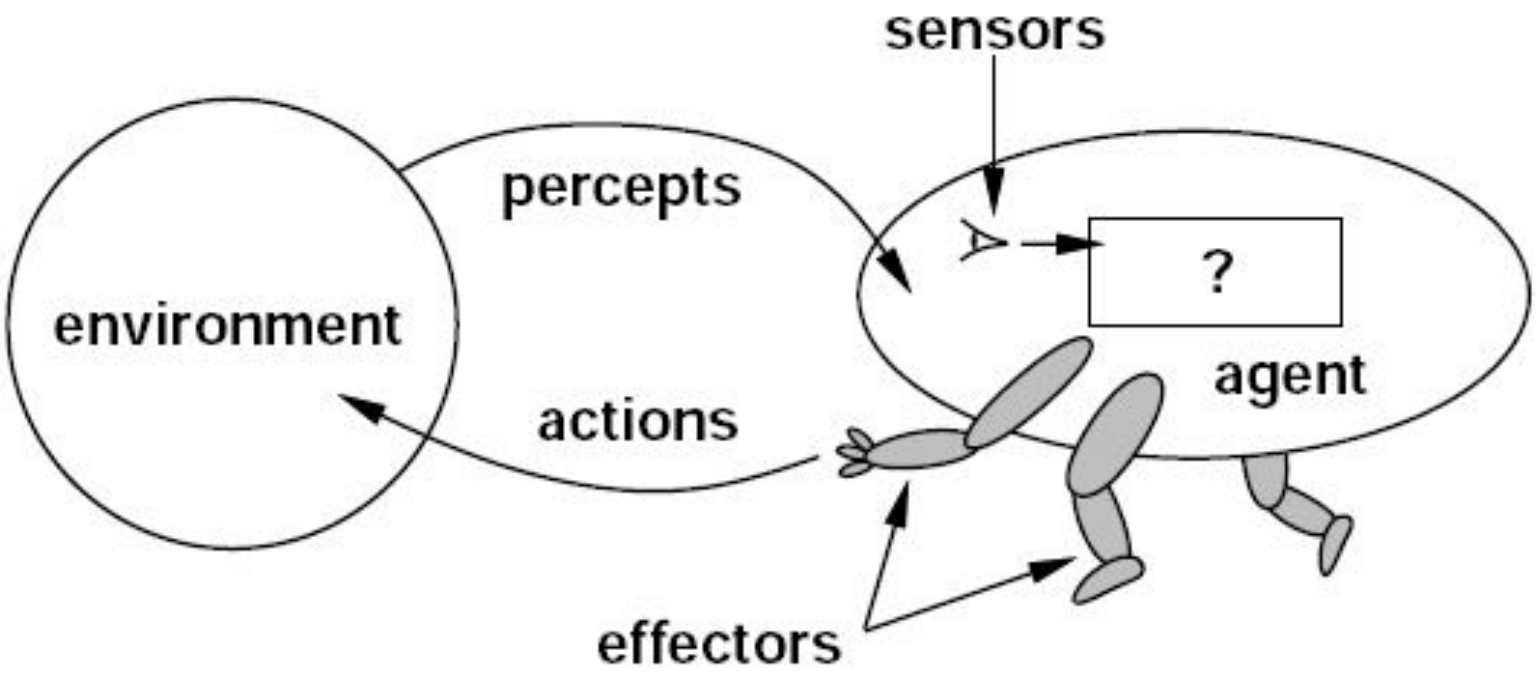
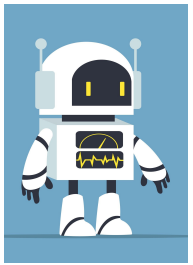


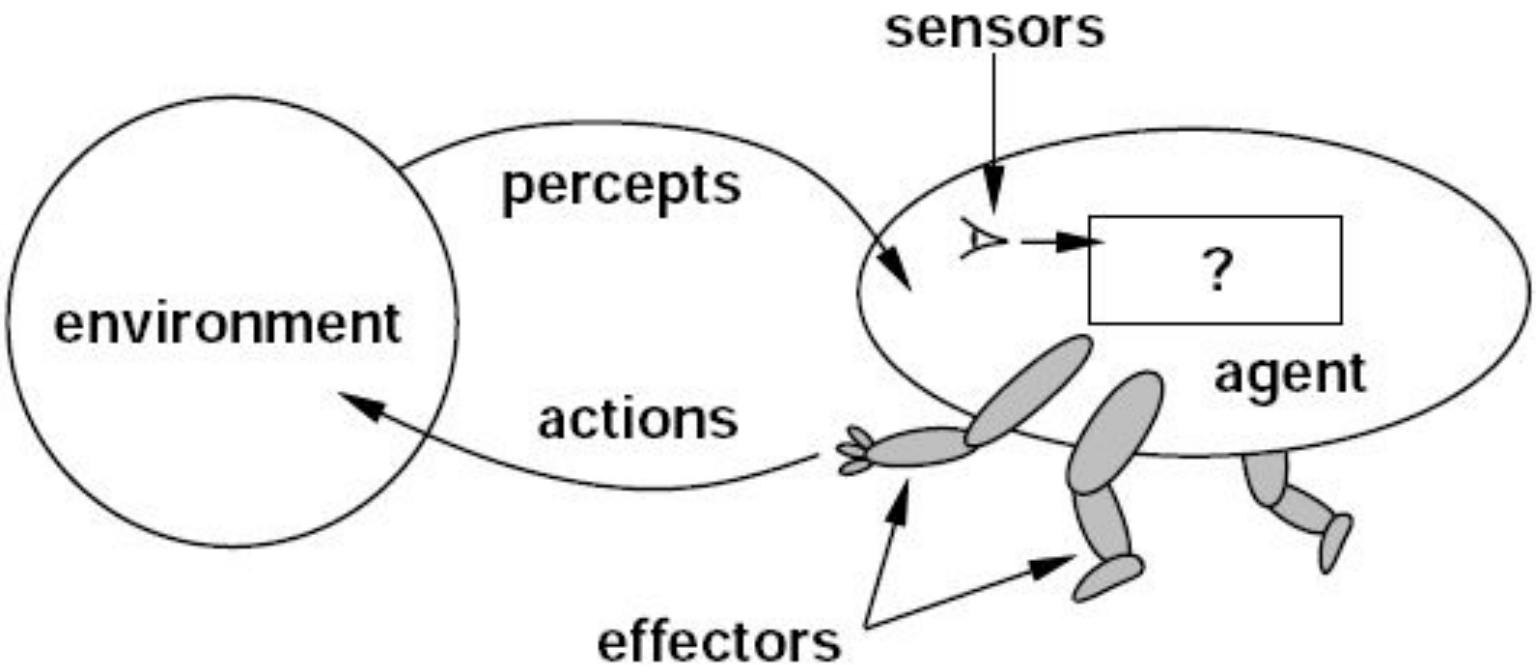
Percepts, Actions, Goals, Environment

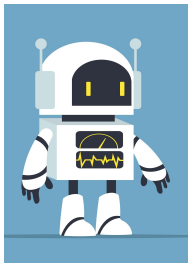




Percepts, Actions, Goals, Environment

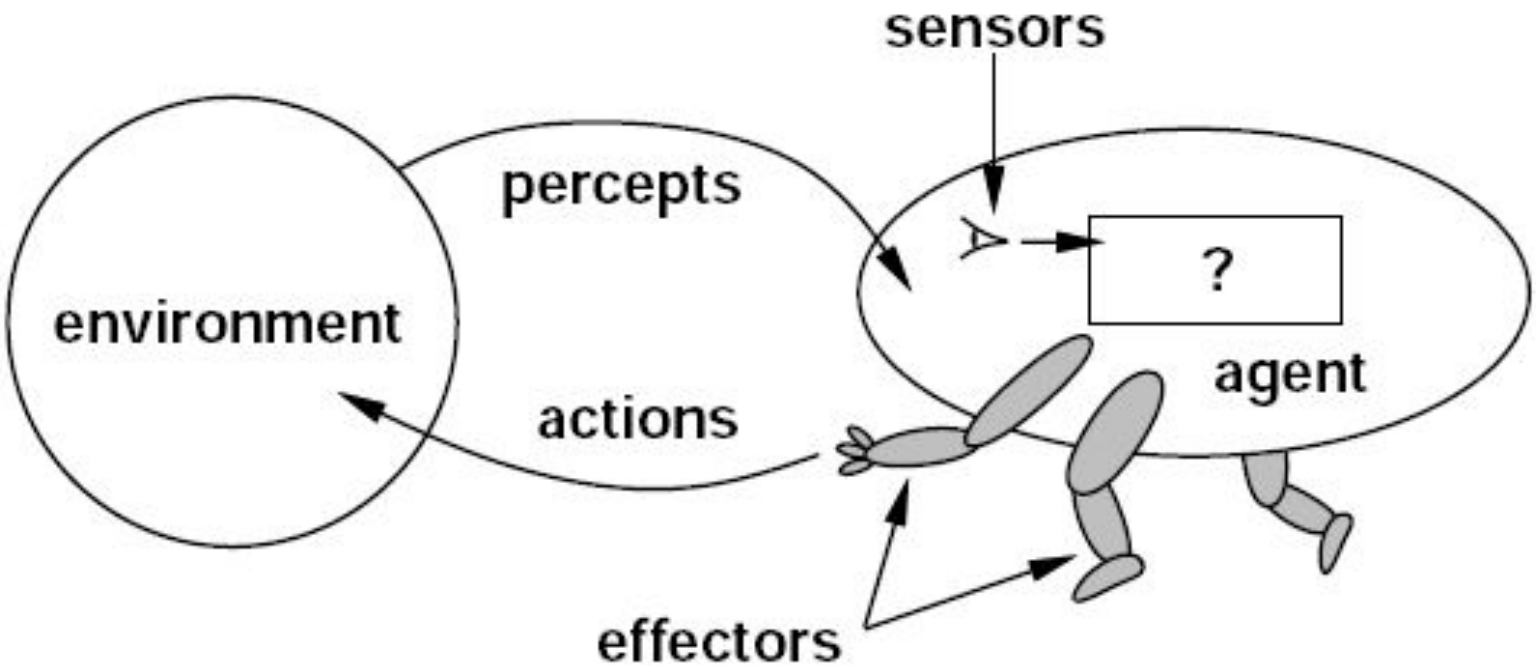
Something that is perceived.

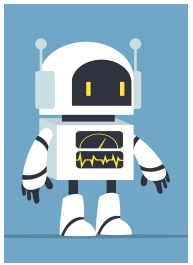




Percepts, **Actions**, Goals, Environment

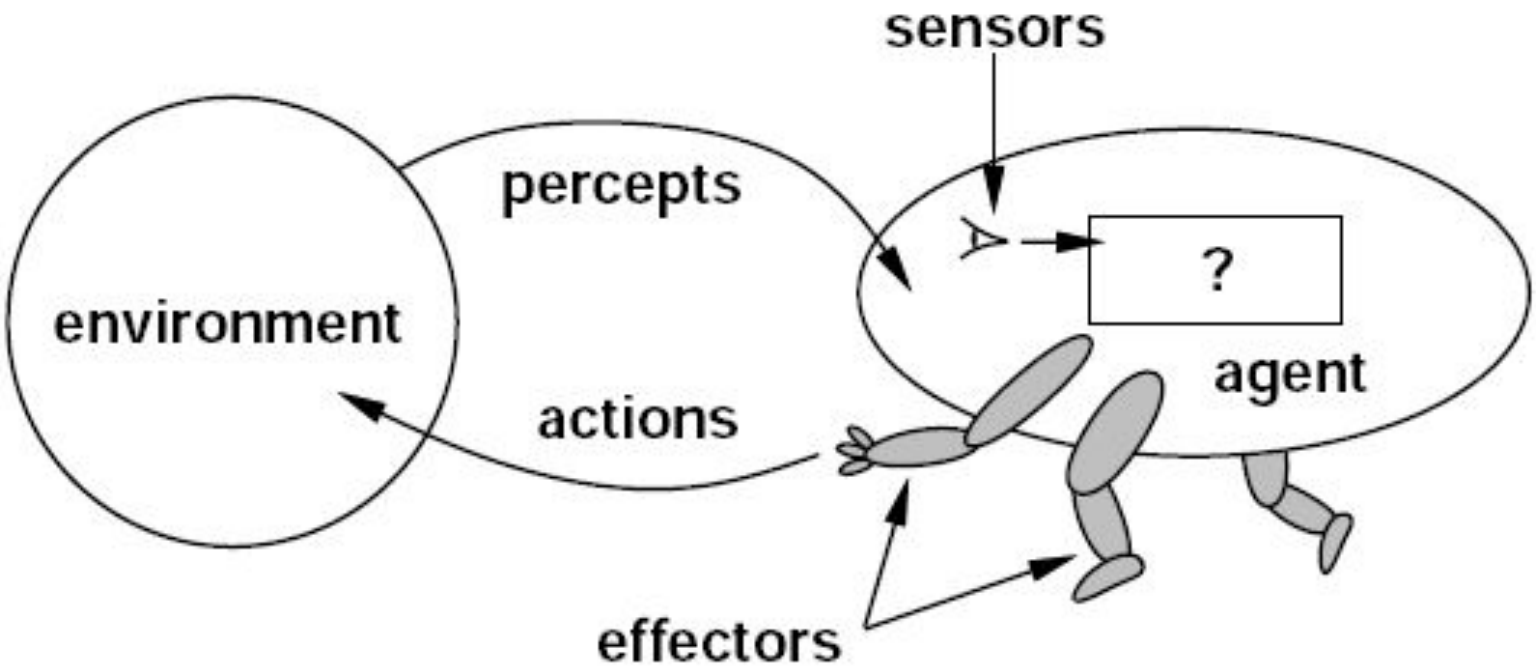
Something that is done; an act.

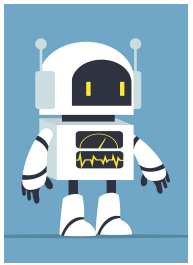




Percepts, Actions, **Goals**, Environment

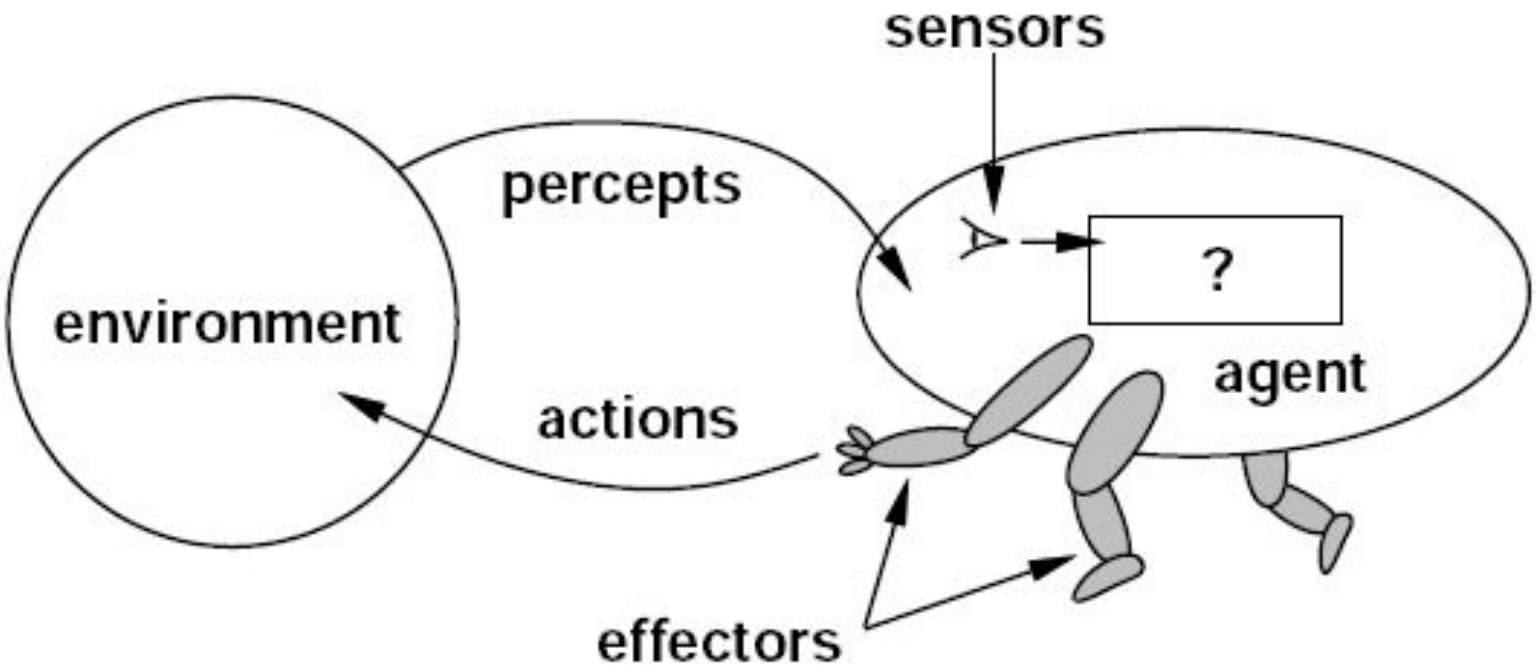
A desired result.

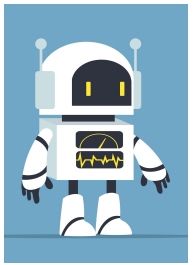




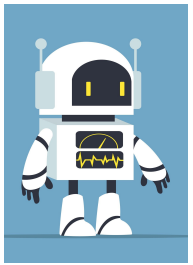
Percepts, Actions, Goals, **Environment**

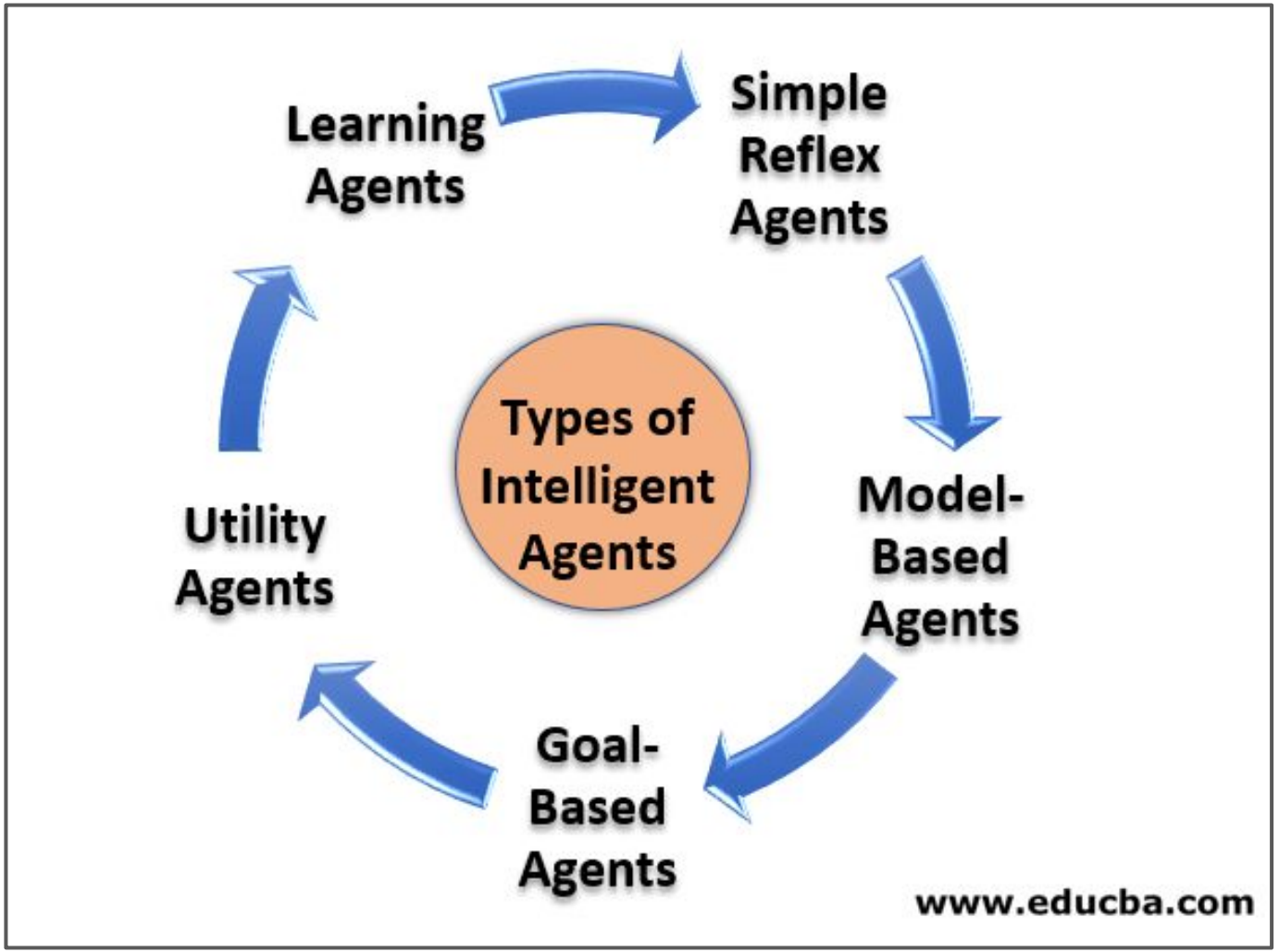
Conditions under which you operate.

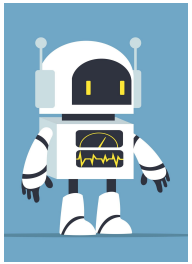


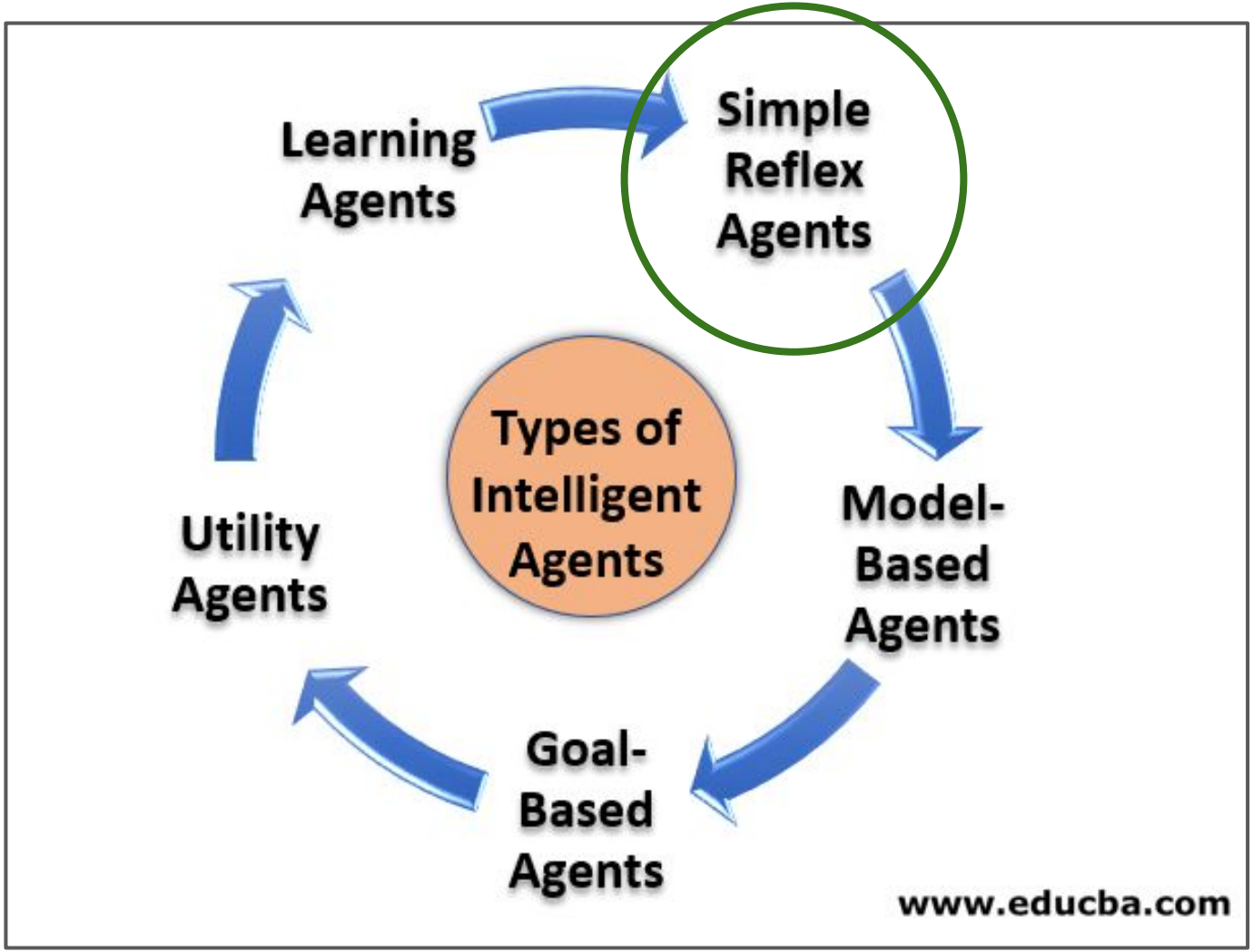


Classes of Agents




Learning Agents
Simple Reflex Agents
Types of Intelligent Agents
Model-Based Agents
Utility Agents
Goal-Based Agents
www.educba.com

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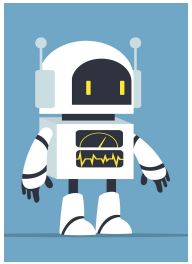

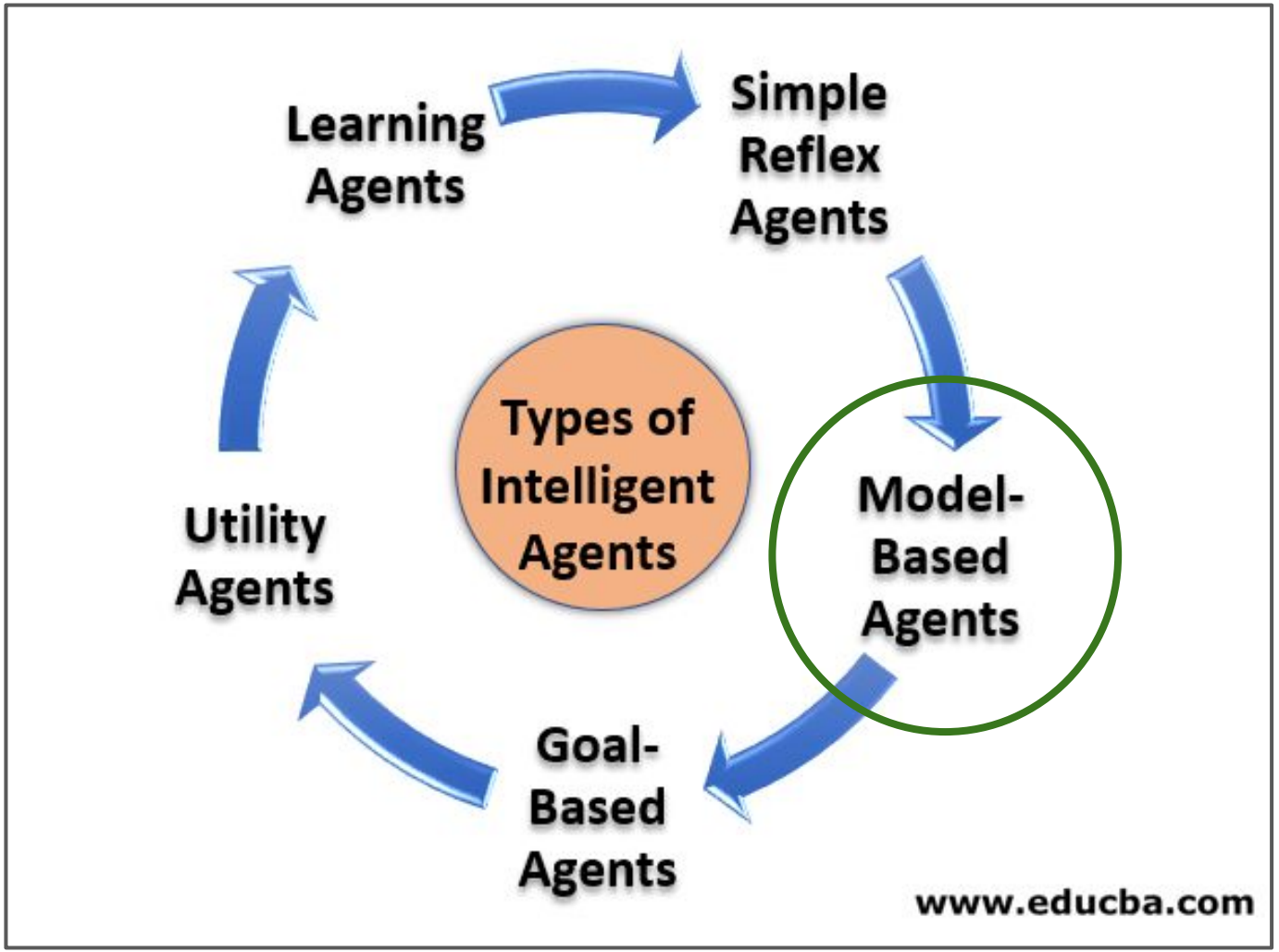
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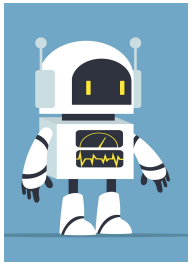

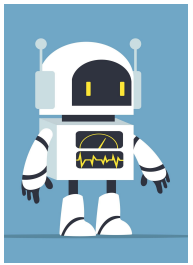

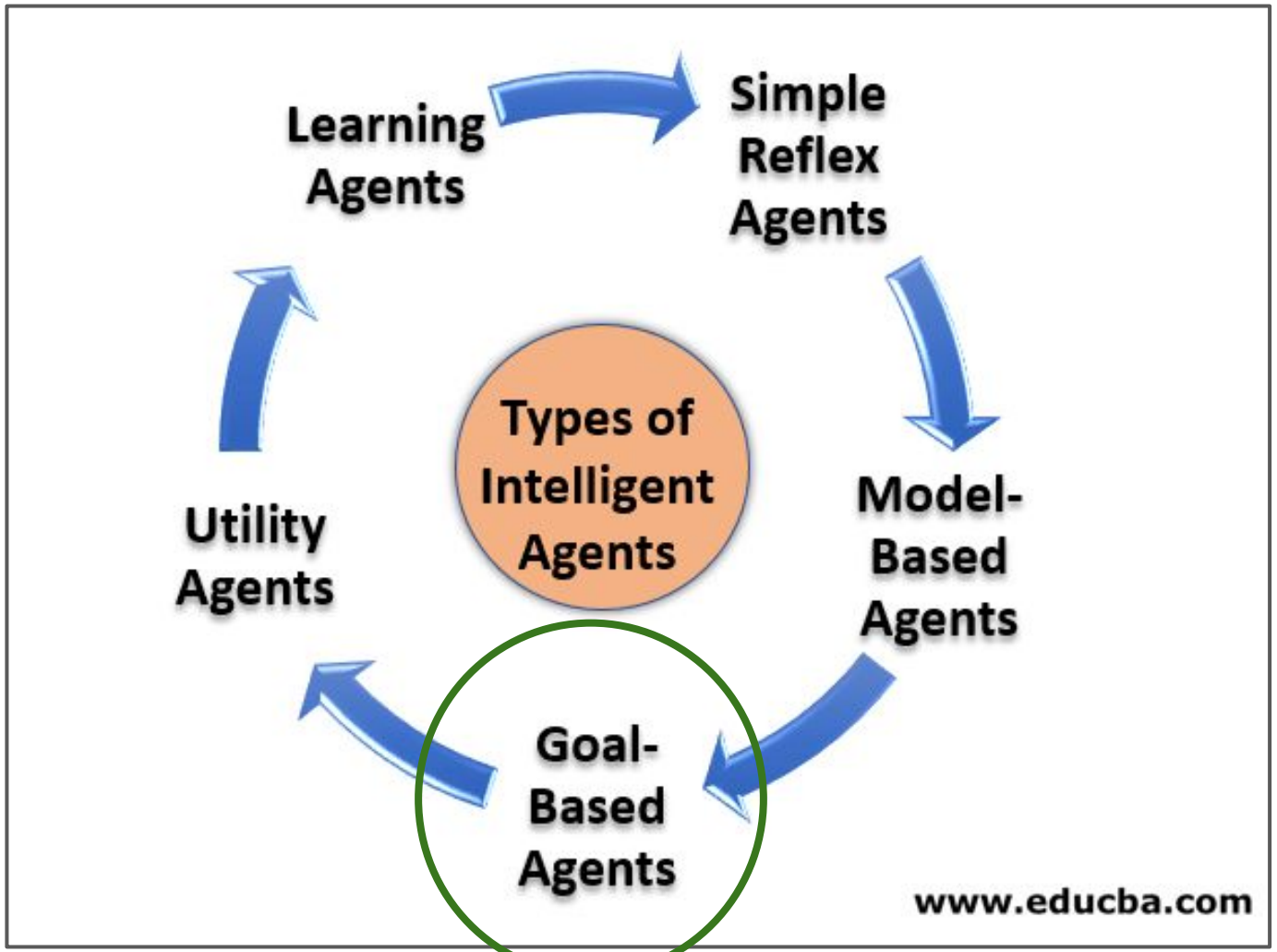
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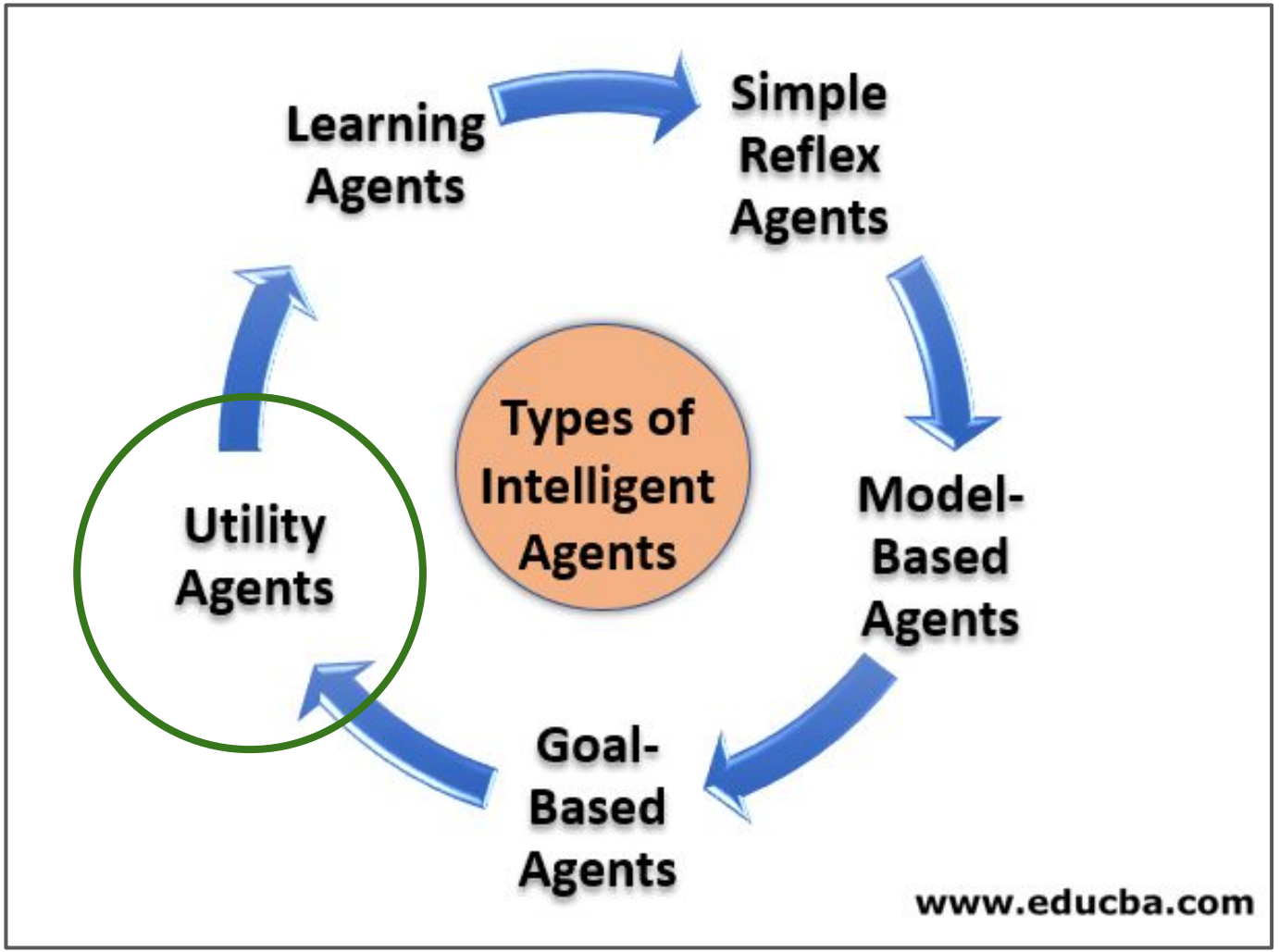
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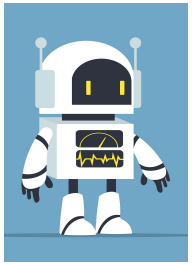

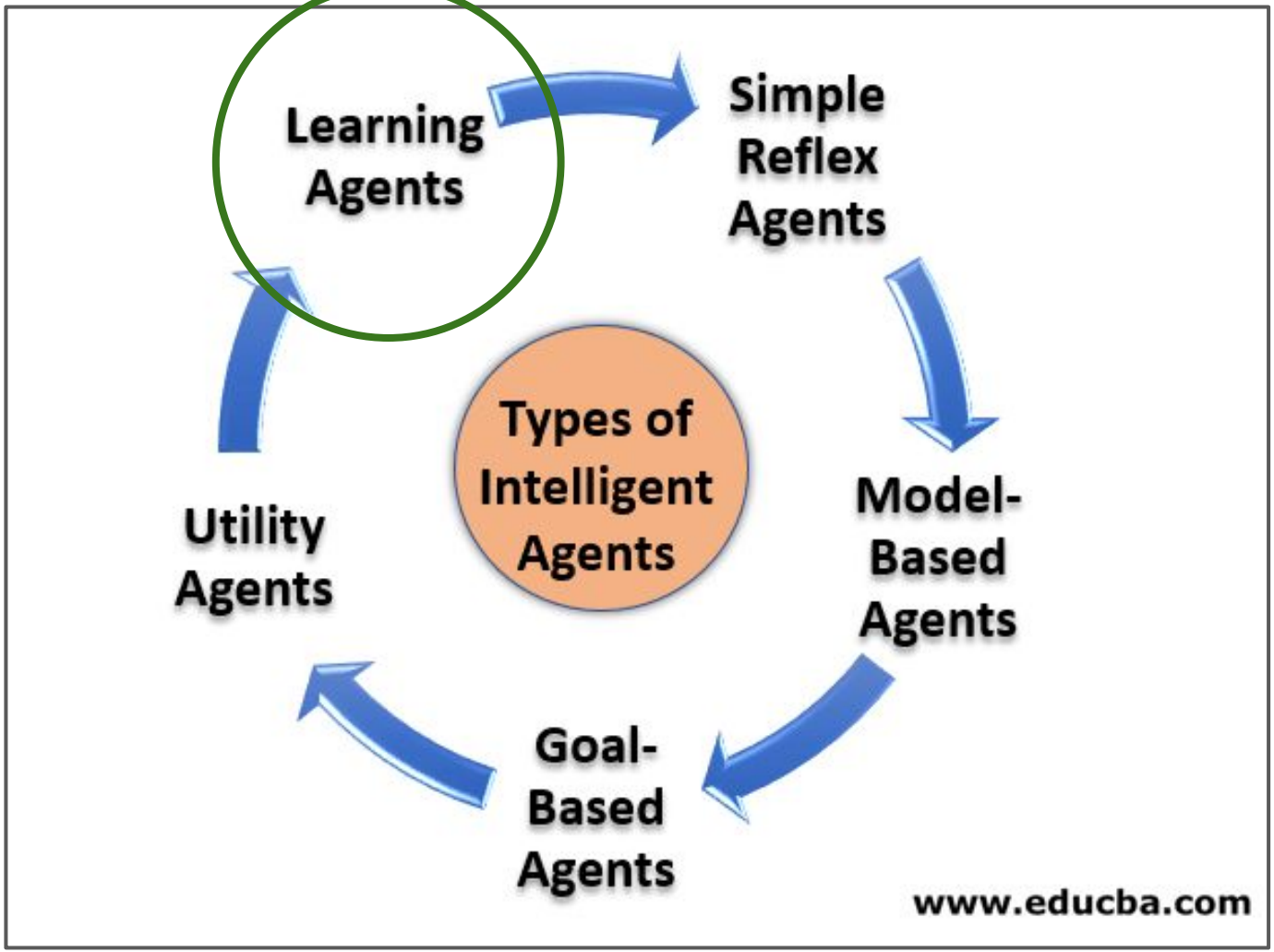
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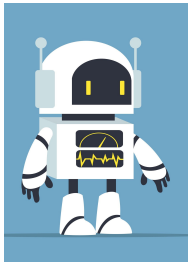
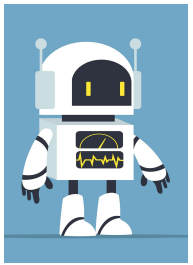
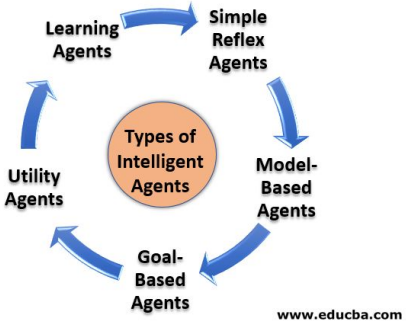
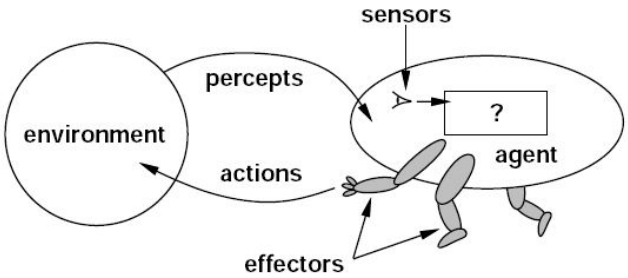


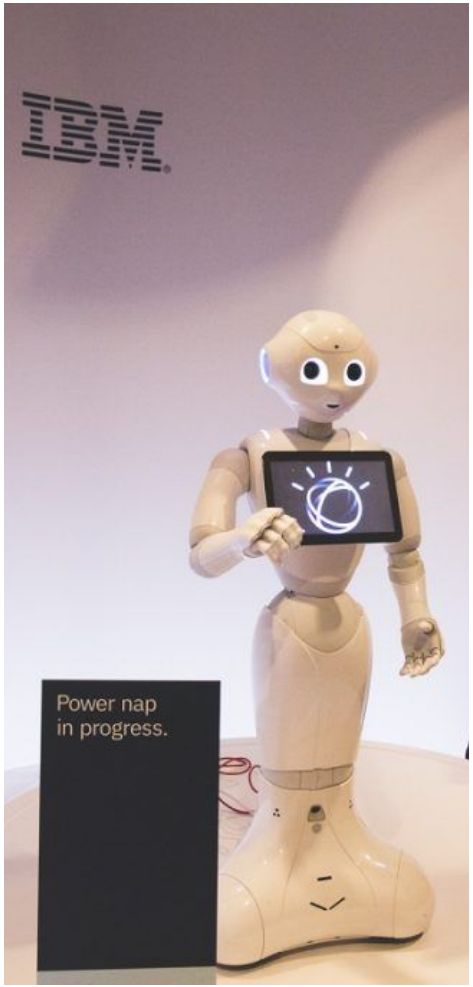
Intelligent Autonomous Agents

- Imitating users
- Carrying out tasks
- Using *percepts, actions, goals, and environment*
- Via *reflex, model, goal, utility, learning*

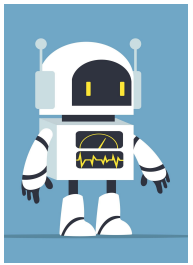


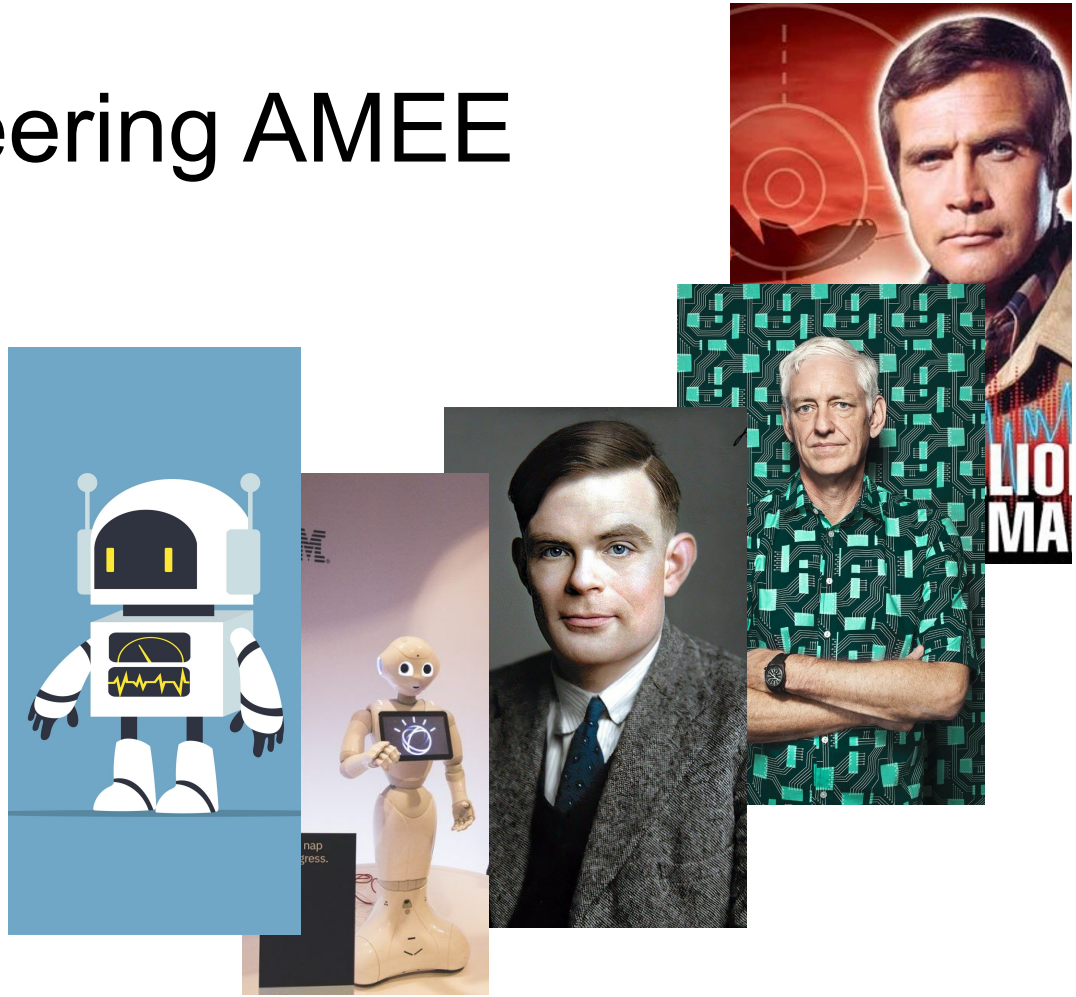




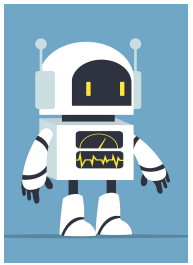


Engineering AMEE





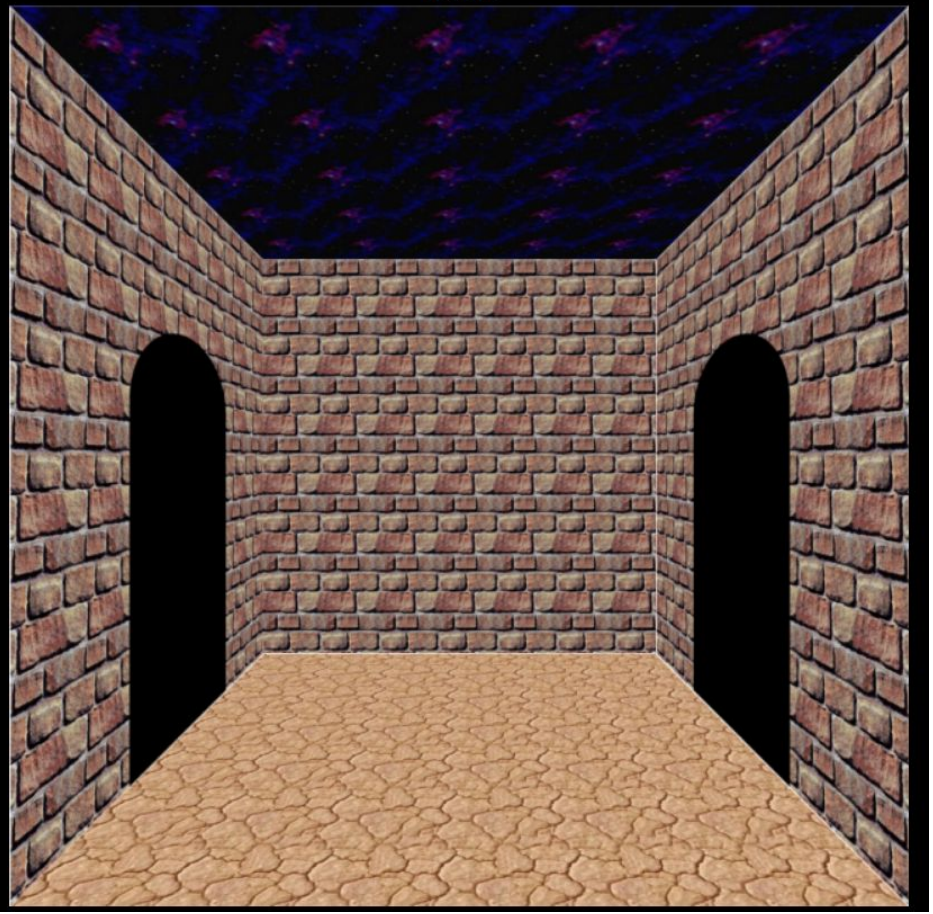
AMEE :
The Autonomous Maze Environment Explorer



start current north west south

You are facing:

east



start current north west south
You are facing:

east

The Game

```
4:south
3:east
2:east
1:start
```

You are in the: **`Laundry Room`**.
You have the following options: **`north, east, maze, clear`**

What would you like to do?

Go

Maze XML Examples

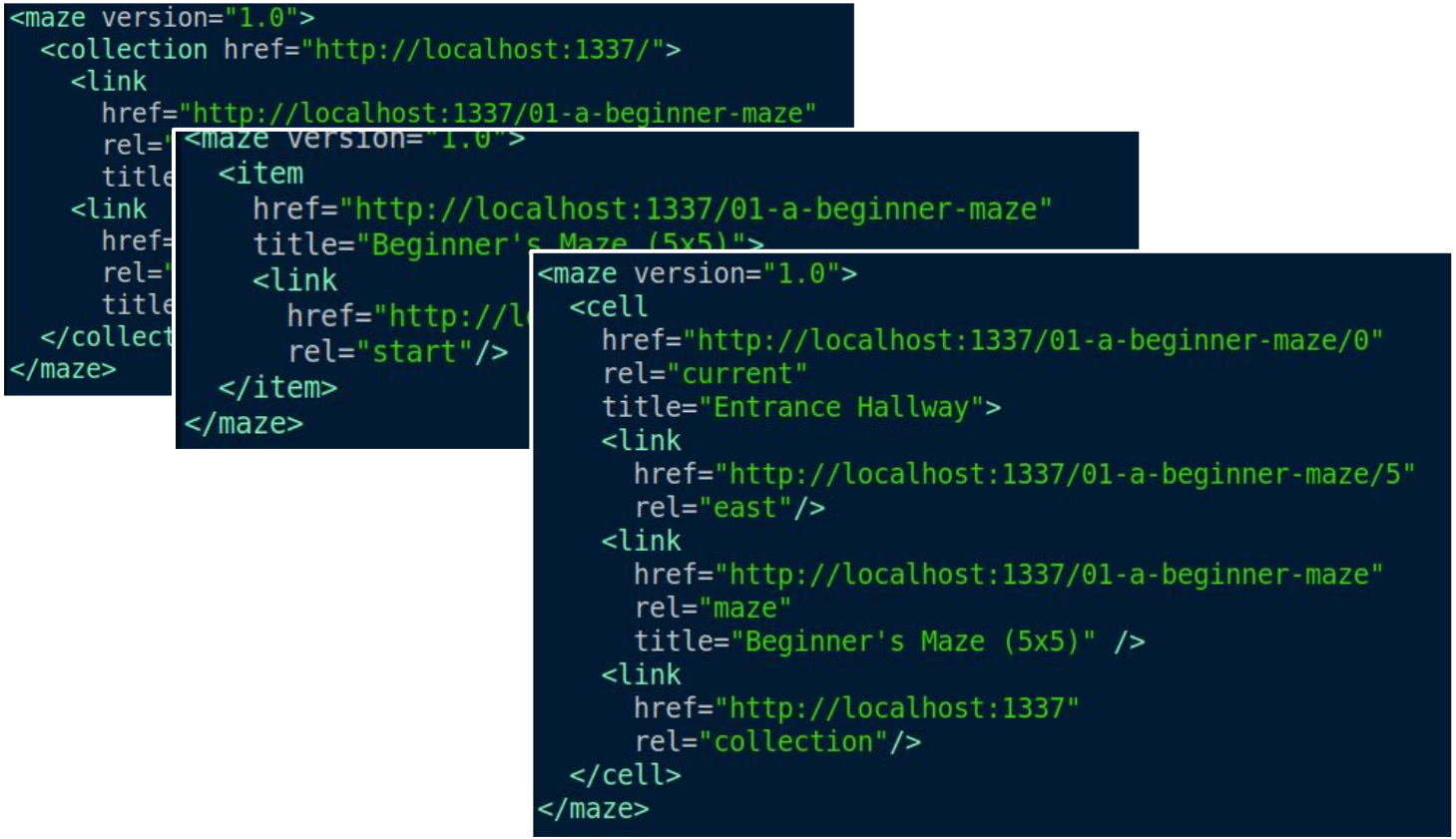
```
<maze version="1.0">
  <collection href="http://localhost:1337/">
    <link
      href="http://localhost:1337/01-a-beginner-maze"
      rel="maze"
      title="Beginner's Maze (5x5)" />
    <link
      href="http://localhost:1337/02-for-experts-only"
      rel="maze"
      title="For Experts Only" />
  </collection>
</maze>
```

Maze XML Examples

```
<maze version="1.0">
  <collection href="http://localhost:1337/">
    <link
      href="http://localhost:1337/01-a-beginner-maze"
      rel="
      title
    <link
      href=
      rel="
      title
  </collect
</maze>
```

```
<maze version="1.0">
  <item
    href="http://localhost:1337/01-a-beginner-maze"
    title="Beginner's Maze (5x5)">
    <link
      href="http://localhost:1337/01-a-beginner-maze/0"
      rel="start"/>
  </item>
</maze>
```

Maze XML Examples



Maze XML Examples

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<maze version="1.0">
  <collection href="http://localhost:1337/">
    <link
      href="http://localhost:1337/01-a-beginner-maze"
      rel="
      title
    <link
      href=
      rel="
      title
  </collect
</maze>
```

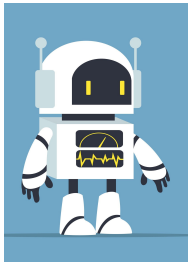
```
<maze version="1.0">
  <item
    href="http://localhost:1337/01-a-beginner-
    title="Beginner's Maze (5x5)">
    <link
      href="http://l
      rel="start"/>
  </item>
</maze>
```

```
<maze version="1.0">
  <cell
    href="http://localhost:
    rel="current"
    title="Entrance Hallway
    <link
      href="http://localhos
      rel="east"/>
    <link
      href="http://localhos
      rel="maze"
      title="Beginner's Maze (5x5)" />
    <link
      href="http://localhost:1337"
      rel="collection"/>
  </cell>
</maze>
```

```
<maze version="1.0">
  <cell
    href="http://localhost:1337/01-a-beginner-maze/24"
    rel="current"
    title="Spoon Storage">
    <link
      href="http://localhost:1337/01-a-beginner-maze/23"
      rel="north"/>
    <link
      href="http://localhost:1337/01-a-beginner-maze/19"
      rel="west"/>
    <link
      href="http://localhost:1337/01-a-beginner-maze/999"
      rel="exit"/>
    <link
      href="http://localhost:1337/01-a-beginner-maze"
      rel="maze"
      title="Beginner's Maze (5x5)" />
    <link
      href="http://localhost:1337"
      rel="collection"/>
  </cell>
</maze>
```

AMEE : Agent for Maze Environment Exploration

- What is AMEE?
- Design
- Build
- Demo



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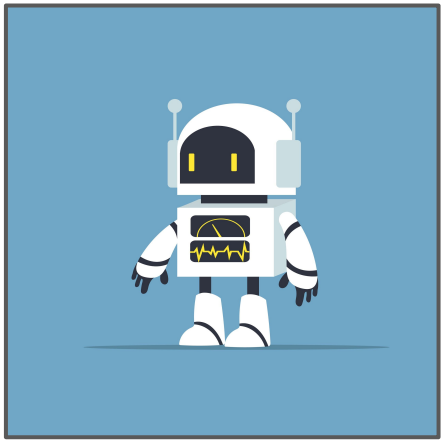

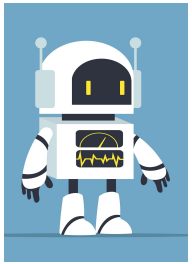

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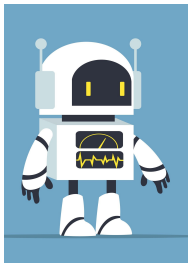

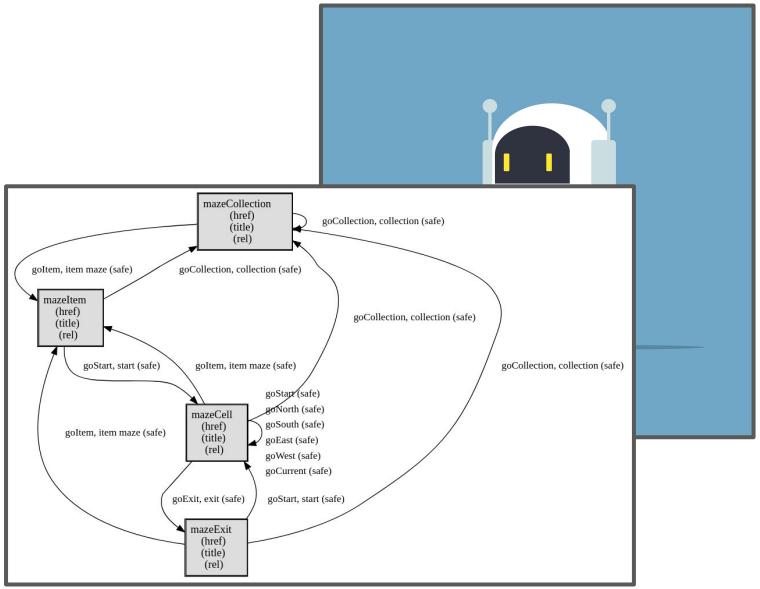

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- What is AMEE?
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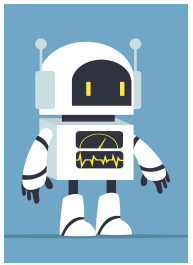
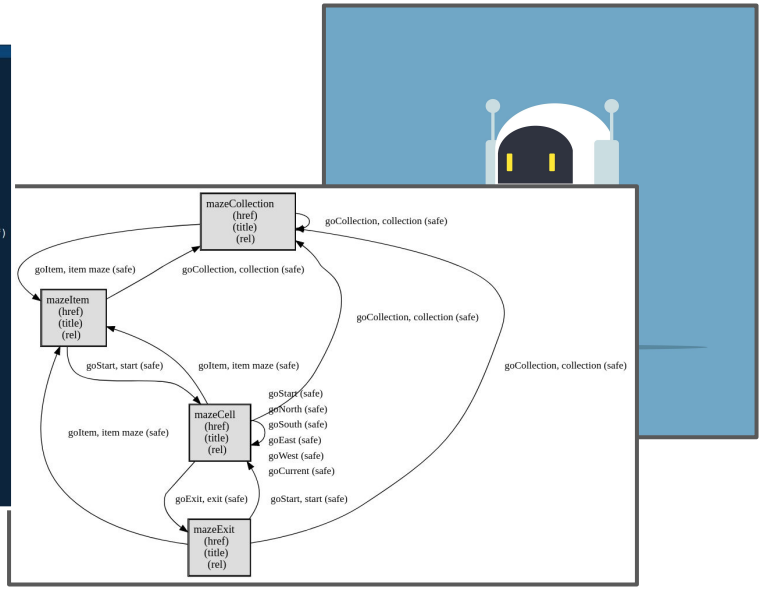


```
// check for exit link
href = findLink(links,'exit');
if(href) {
    m.done = true;
    console.log(m.winner.replace('{m}',m.moves));
    return;
}

// check for entrance link
if(m.start===false) {
    href = findLink(links, 'start');
    if(href) {
        flag = true;
        m.start = true;
        m.facing = 'north';
        console.log(m.moves++ + ': I\'m starting the ' + room + '. My first move is:' + href)
    }
    // ok, see if we can find a maze link
    if(href===undefined) {href = findLink(links, 'maze');}
    // well, is there a collection link?
    if(href===undefined) {href = findLink(links, 'collection');}
    // ok, i give up!
    if(href===undefined) {console.log(m.quitter);return;}
}

// ok, try to move to new room
if(href===undefined) {
    choices = m.rules[m.facing];
    for(i=0, x=choices.length; i<x; i++) {
        href = findLink(links, choices[i]);
        if(href) {
            flag = true;
            m.facing = choices[i];
            console.log(m.moves++ + ': I\'m in the ' + room + '. My next move is:' + href);
            break;
        }
    }
}
```



AMEE : Agent for Maze Environment Exploration

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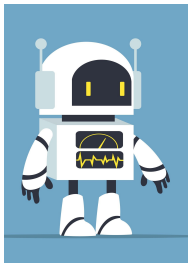
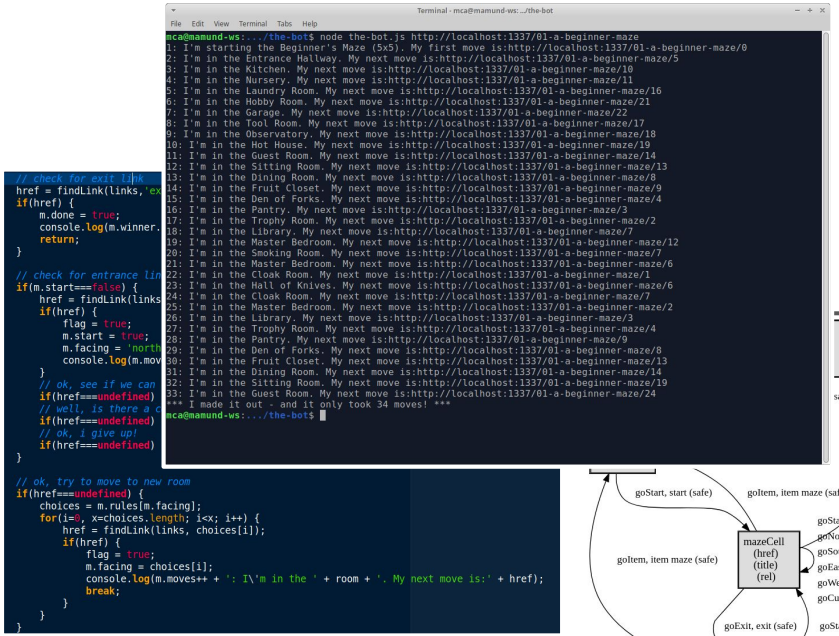
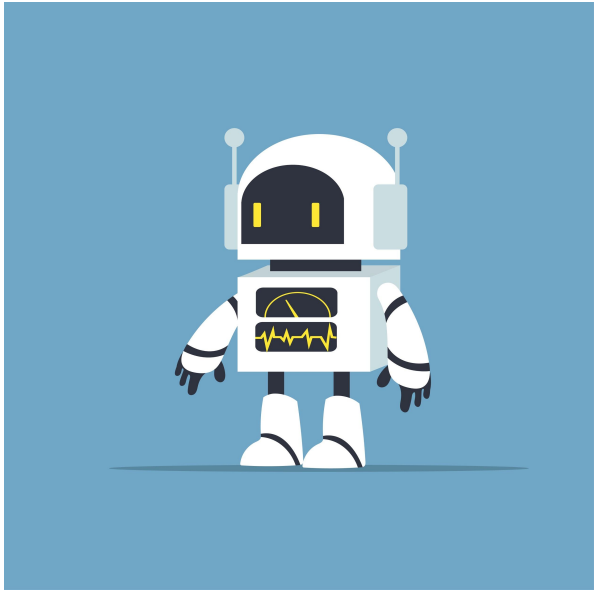


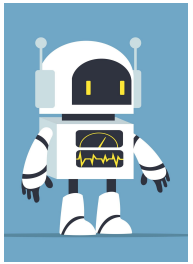


AMEE : What is it?

AMEE can successfully navigate any 2-dimensional maze of arbitrary size.

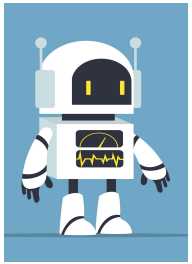
- Agent Class: ***Goal****-based*
- Percepts: *Various kinds of* ***doors***
- Actions: ***Affordances*** *to view, turn, and move*
- Goals: ***Escape!***
- Environment: ***XML*** *messages via* ***HTTP*** *protocol*



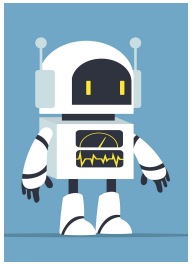


AMEE : How do we build it?

- Designing AMEE
  - What does she recognize? (Percepts)
  - What can she do? (Actions)
  - What is her job? (Goal)
  - Where does she operate? (Environment)
- AMEE's algorithm (Model)
- Coding AMEE (Sensors & Actuators)



AMEE : Design



```
{
  "alps" : {
    "version" :"1.0",
    "doc" : {
      "contentType" : "text/plain",
      "value" : "ALPS Profile for AMEE : Automated Maze Environment Exploration"
    },

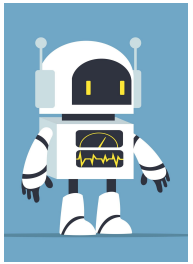
    "descriptor" :
    [
      {"id" : "href", "type" : "semantic", "def" : "https://schema.org/url"},
      {"id" : "rel", "type" : "semantic", "def" : "https://schema.org/linkRelationship"},
      {"id" : "title", "type" : "semantic", "def" : "https://schema.org/title"},

      {"id" : "goCollection", "type" : "safe", "rt" : "#mazeCollection", "rel" : "collecti
      {"id" : "goItem", "type" : "safe", "rt" : "#mazeItem", "rel" : "item maze", "def" :
      {"id" : "goStart", "type" : "safe", "rt" : "#mazeCell", "rel" : "start", "def" : "ht
      {"id" : "goCurrent", "type" : "safe", "rt" : "#mazeCell", "rel" : "current", "def" :
      {"id" : "goNorth", "type" : "safe", "rt" : "#mazeCell", "rel" : "north", "def" : "ht
      {"id" : "goSouth", "type" : "safe", "rt" : "#mazeCell", "rel" : "south", "def" : "ht
      {"id" : "goEast", "type" : "safe", "rt" : "#mazeCell", "rel" : "east", "def" : "http
      {"id" : "goWest", "type" : "safe", "rt" : "#mazeCell", "rel" : "west", "def" : "http
      {"id" : "goExit", "type" : "safe", "rt" : "#mazeExit", "rel" : "exit", "def" : "http

      {"id" : "mazeCollection", "type" : "semantic", "rel" : "collection",
        "descriptor" :
        [
          {"href" : "#href"},
          {"href" : "#title"},
          {"href" : "#rel"},
          {"href" : "#goItem"},
          {"href" : "#goCollection"}
        ]
      },

      {"id" : "mazeItem", "type" : "semantic", "rel" : "item maze",
        "descriptor" :
        [
          {"href" : "#href"},
          {"href" : "#title"}
```

AMEE : Design



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  "alps" : {
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    "doc" : {
      "contentType" : "text/plain",
      "value" : "ALPS Profile for AMEE : Automated Maze Environment Exploration"
    },

    "descriptor" :
    [
      {"id" : "href", "type" : "semantic"},
      {"id" : "rel", "type" : "semantic"},
      {"id" : "title", "type" : "semantic"},

      {"id" : "goCollection", "type" : "safe", "rt" : "#mazeCollection", "rel" : "collection"},
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AMEE : Design

[Docs] [txt|pdf|xml|html] [Tracker] [Email] [Diff1] [Diff2] [Nits]

Versions: 00 01 02 03 04 05 06

Network Working Group
Internet-Draft
Intended status: Informational
Expires: July 27, 2021

M. Amundsen

L. Richardson

M. Foster

January 23, 2021

Application-Level Profile Semantics (ALPS)
draft-amundsen-richardson-foster-alps-06

Abstract

This document describes ALPS, a data format for defining simple descriptions of application-level semantics, similar in complexity to HTML microformats. An ALPS document can be used as a profile to explain the application semantics of a document with an application-agnostic media type (such as HTML, HAL, Collection+JSON, Siren, etc.). This increases the reusability of profile documents across media types.

Editorial Note (To be removed by RFC Editor)

Distribution of this document is unlimited. Comments should be sent to the IETF Media-Types mailing list (see <https://www.ietf.org/mailman/listinfo/media-types>).

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any

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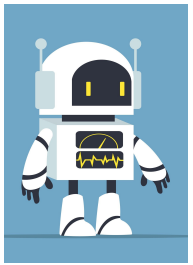
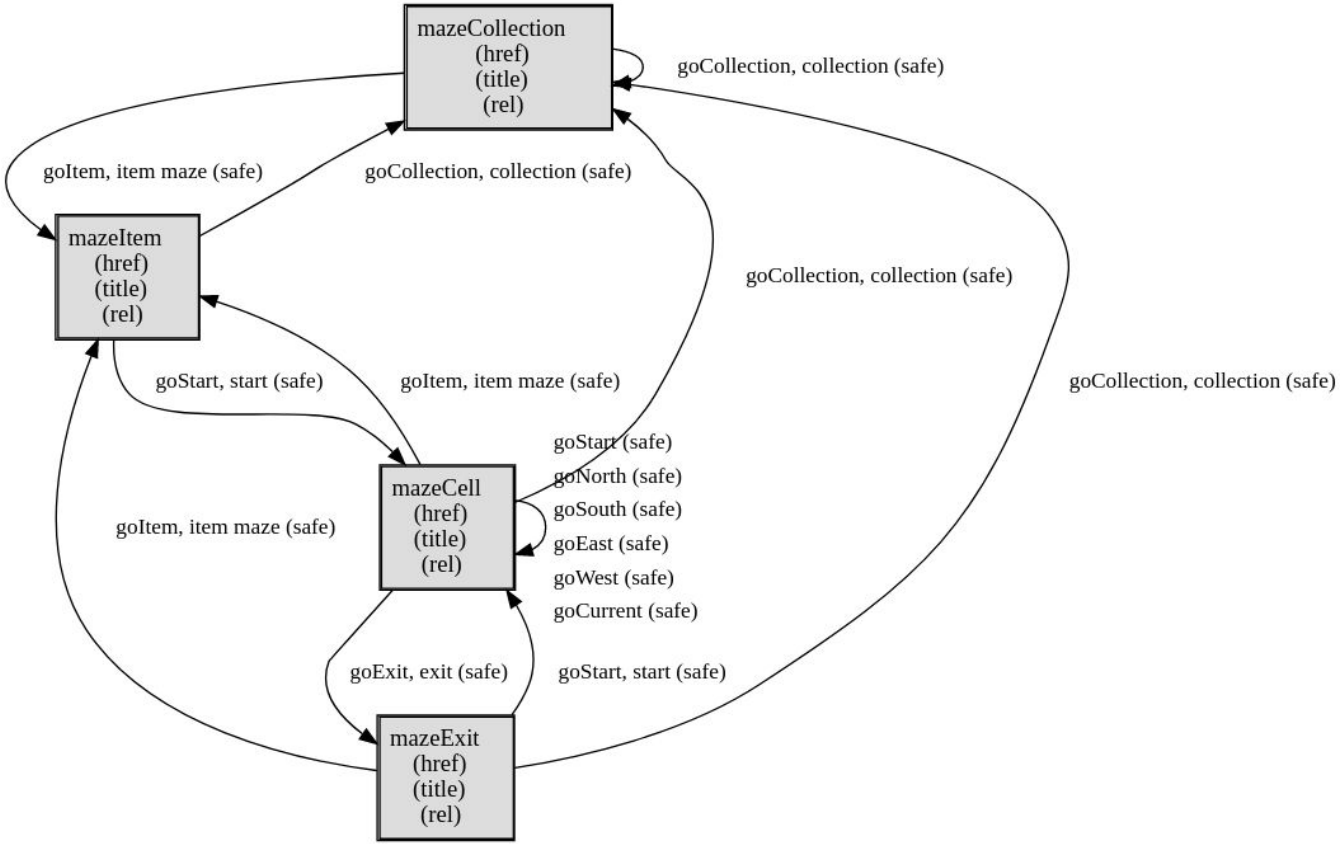
AMEE : Design

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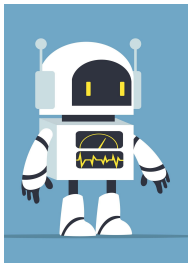
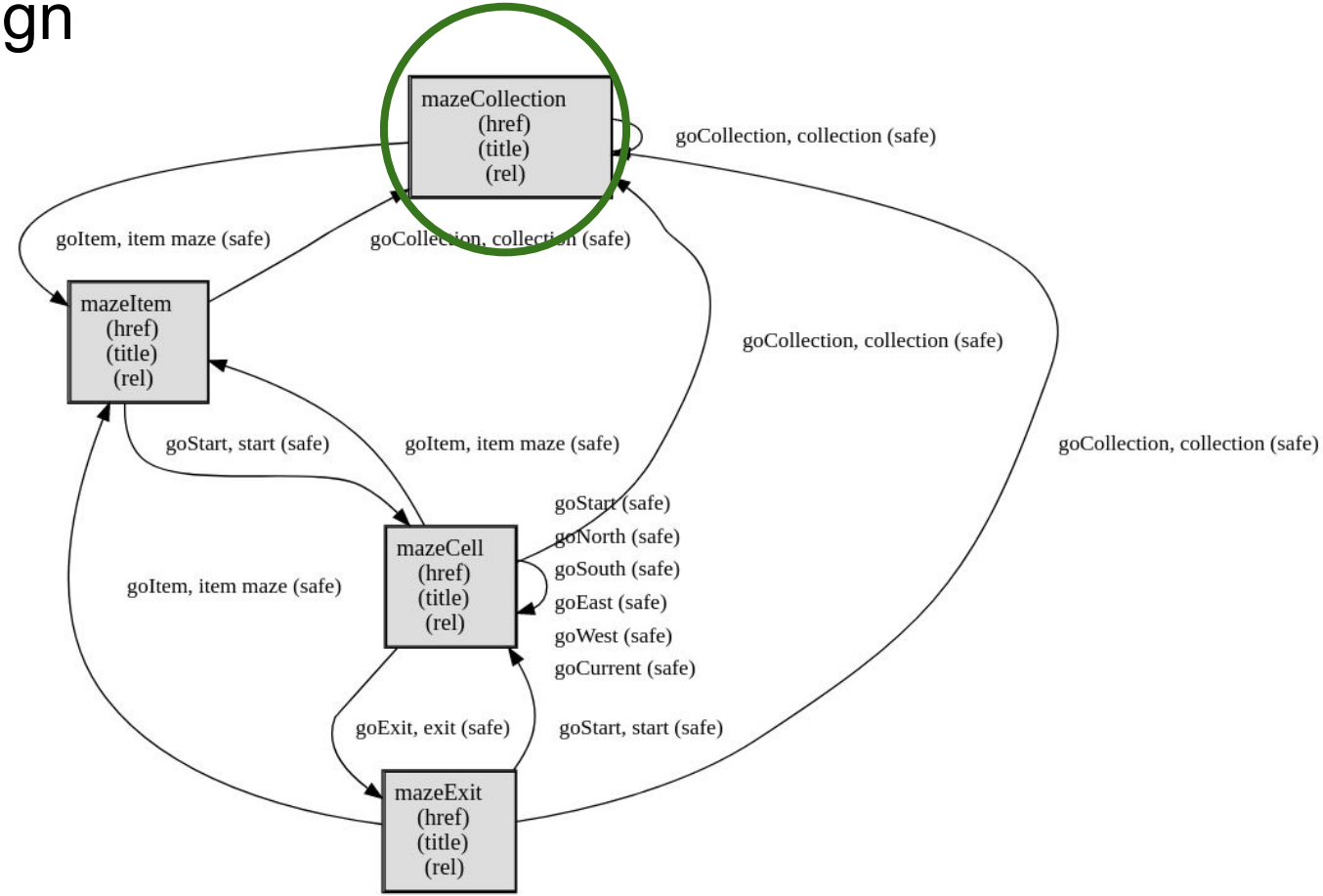
AMEE : Design

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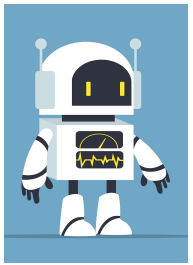
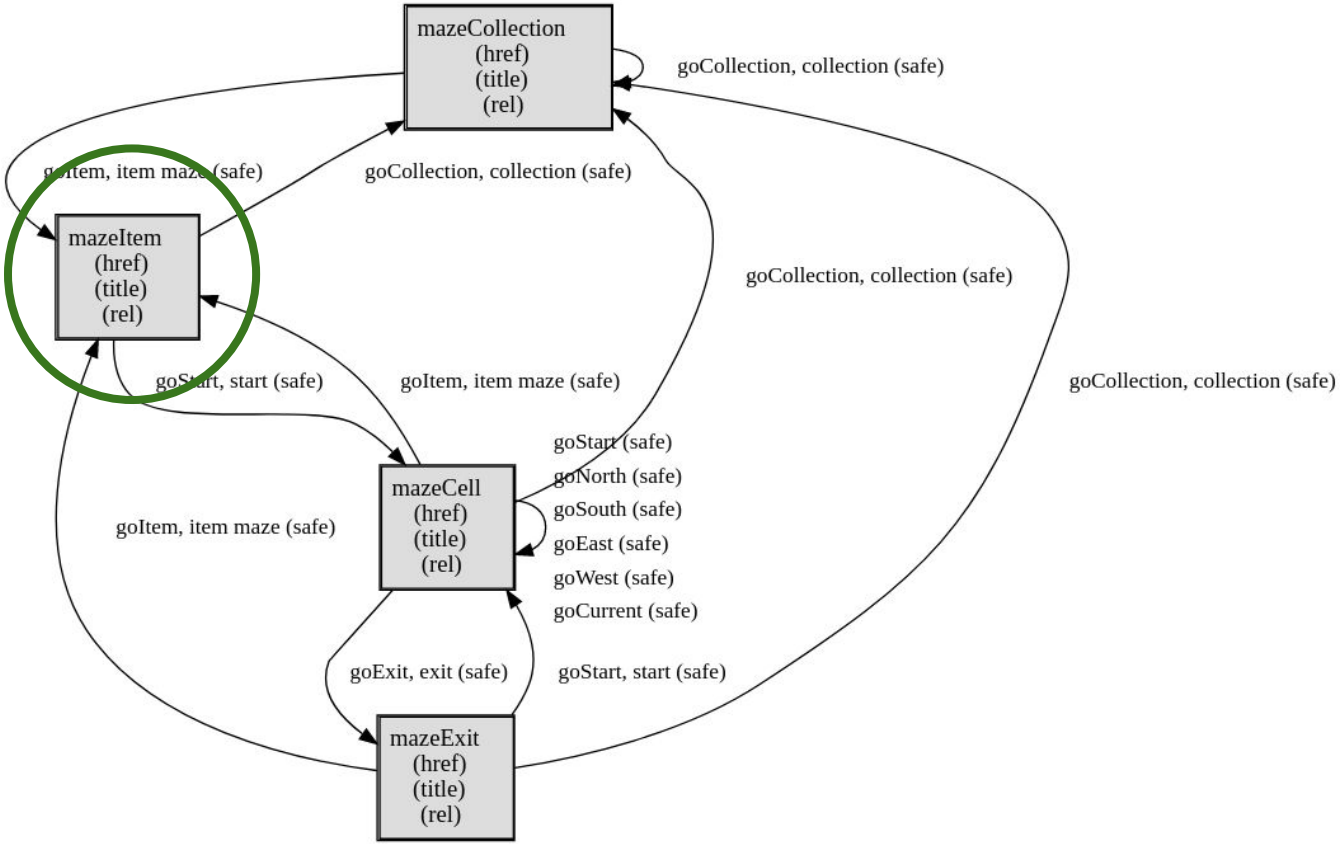
AMEE : Design

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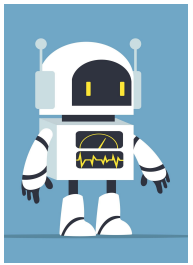
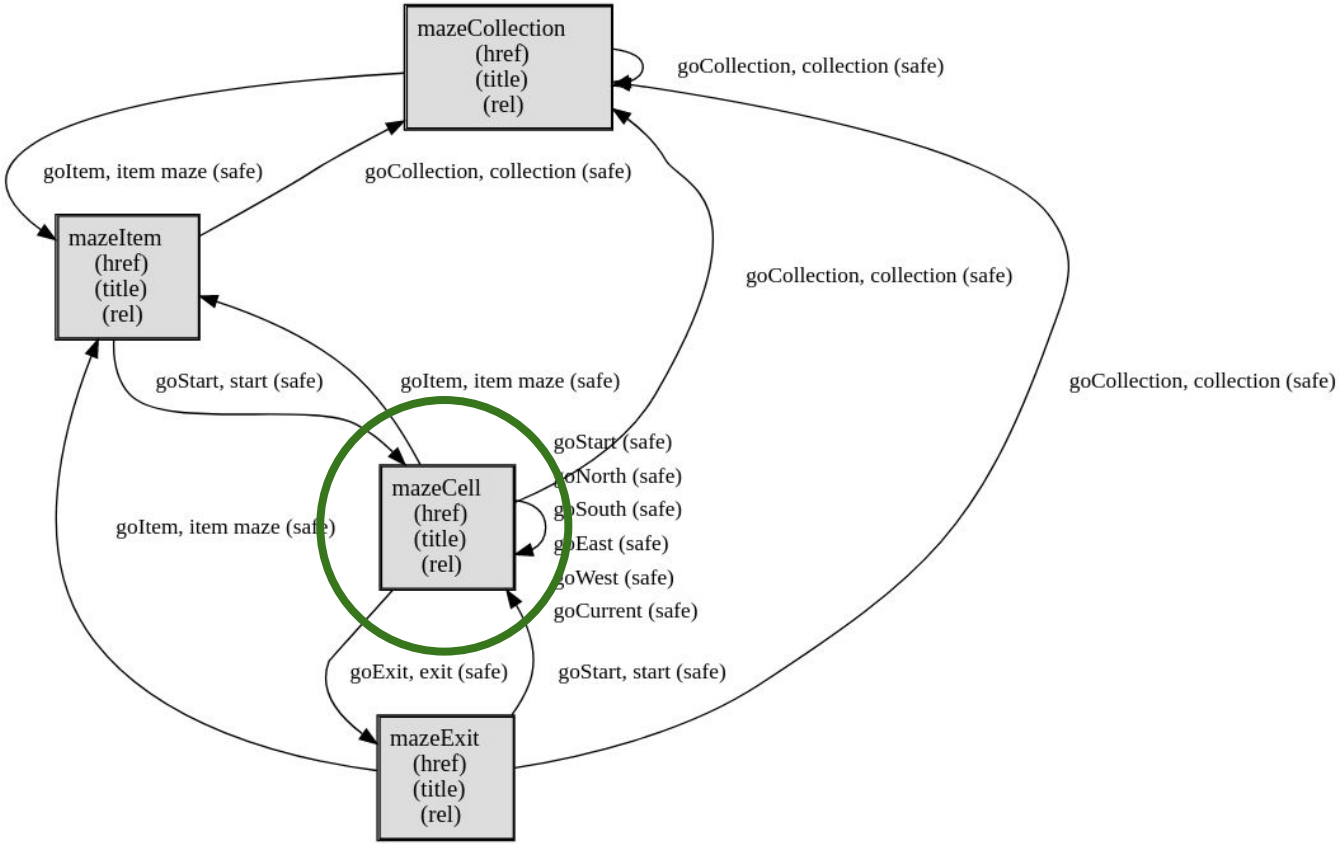
AMEE : Design

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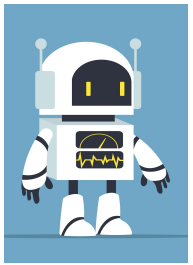
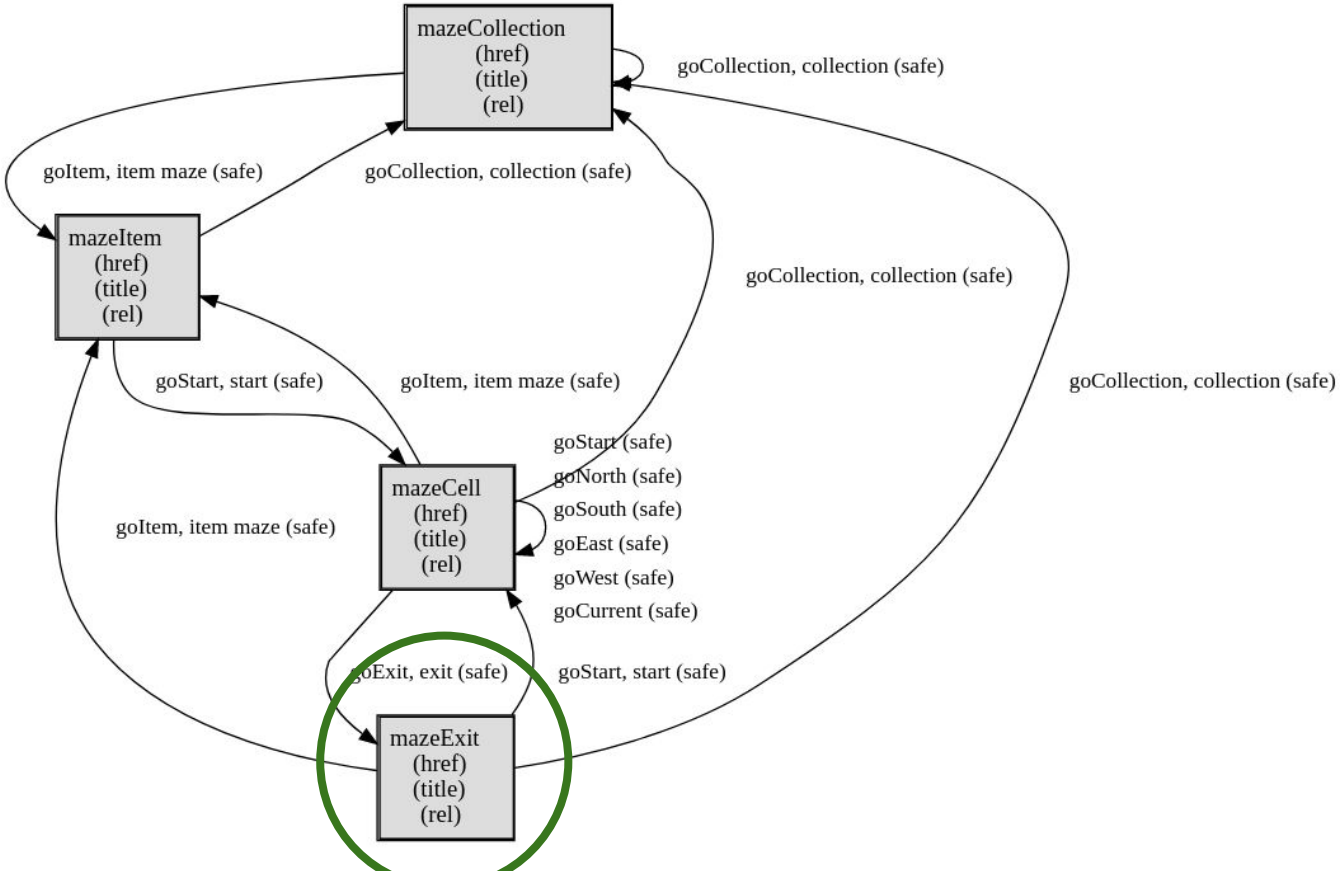
AMEE : Design

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(rel)

AMEE : Documentation

ALPS Profile for AMEE : Automated Maze Environment Exploration

- ALPS
- Application State Diagram
- Semantic Descriptors
  - goCollection (safe)
  - goCurrent (safe)
  - goEast (safe)
  - goExit (safe)
  - goItem (safe)
  - goNorth (safe)
  - goSouth (safe)
  - goStart (safe)
  - goWest (safe)
  - href (semantic)
  - mazeCell (semantic)
  - mazeCollection (semantic)
  - mazeExit (semantic)
  - mazeItem (semantic)
  - rel (semantic)
  - title (semantic)

AMEE : Documentation

ALPS Profile for AMEE : Automated Maze Exploration

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  - goWest (safe)
  - href (semantic)
  - mazeCell (semantic)
  - mazeCollection (semantic)
  - mazeExit (semantic)
  - mazeItem (semantic)
  - rel (semantic)
  - title (semantic)

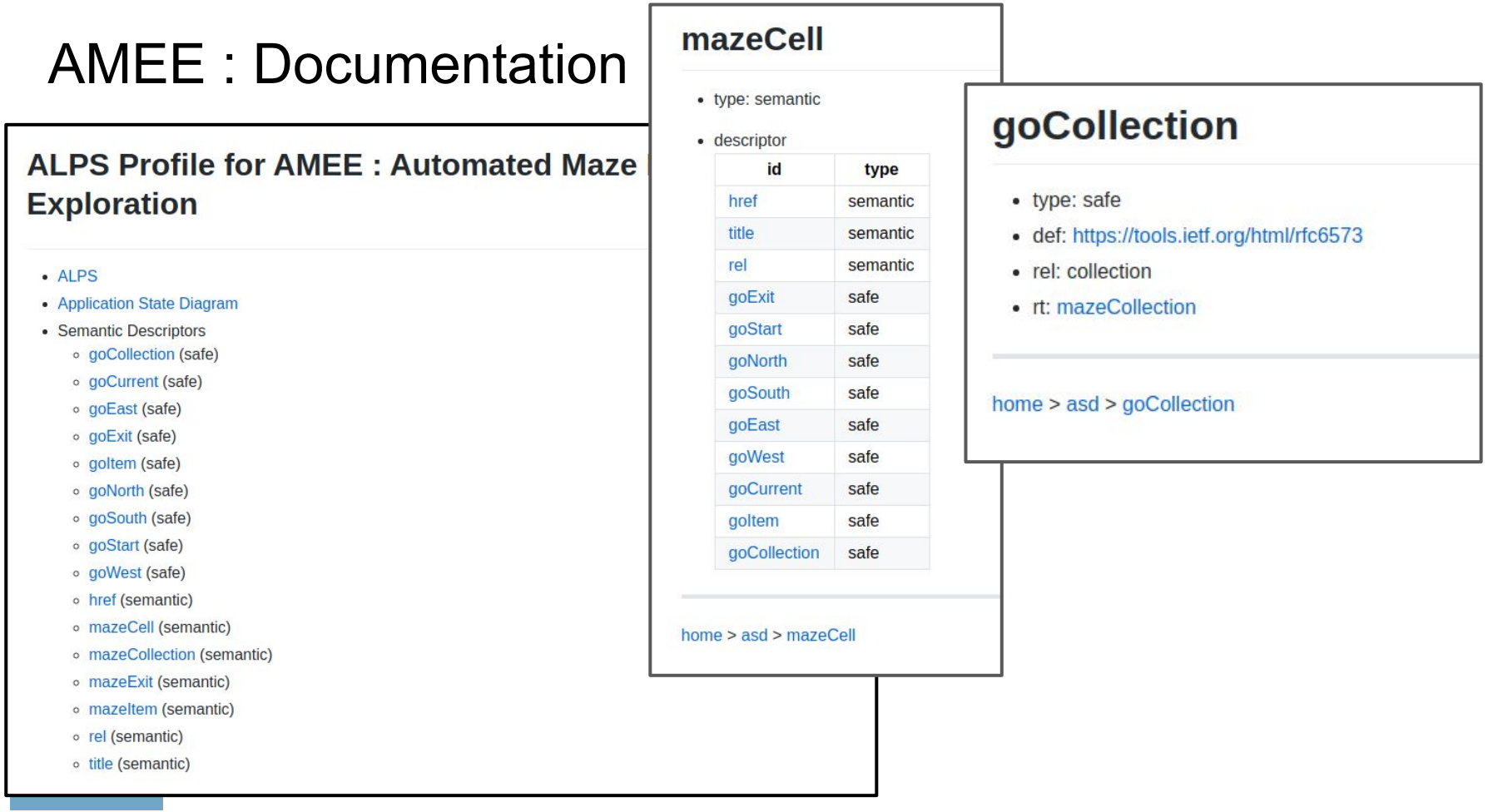
mazeCell

- type: semantic
- descriptor

id	type
href	semantic
title	semantic
rel	semantic
goExit	safe
goStart	safe
goNorth	safe
goSouth	safe
goEast	safe
goWest	safe
goCurrent	safe
goItem	safe
goCollection	safe

home > asd > mazeCell

AMEE : Documentation



ALPS Profile for AMEE : Automated Maze Exploration

- ALPS
- Application State Diagram
- Semantic Descriptors
  - goCollection (safe)
  - goCurrent (safe)
  - goEast (safe)
  - goExit (safe)
  - goItem (safe)
  - goNorth (safe)
  - goSouth (safe)
  - goStart (safe)
  - goWest (safe)
  - href (semantic)
  - mazeCell (semantic)
  - mazeCollection (semantic)
  - mazeExit (semantic)
  - mazeItem (semantic)
  - rel (semantic)
  - title (semantic)

mazeCell

- type: semantic
- descriptor

id	type
href	semantic
title	semantic
rel	semantic
goExit	safe
goStart	safe
goNorth	safe
goSouth	safe
goEast	safe
goWest	safe
goCurrent	safe
goItem	safe
goCollection	safe

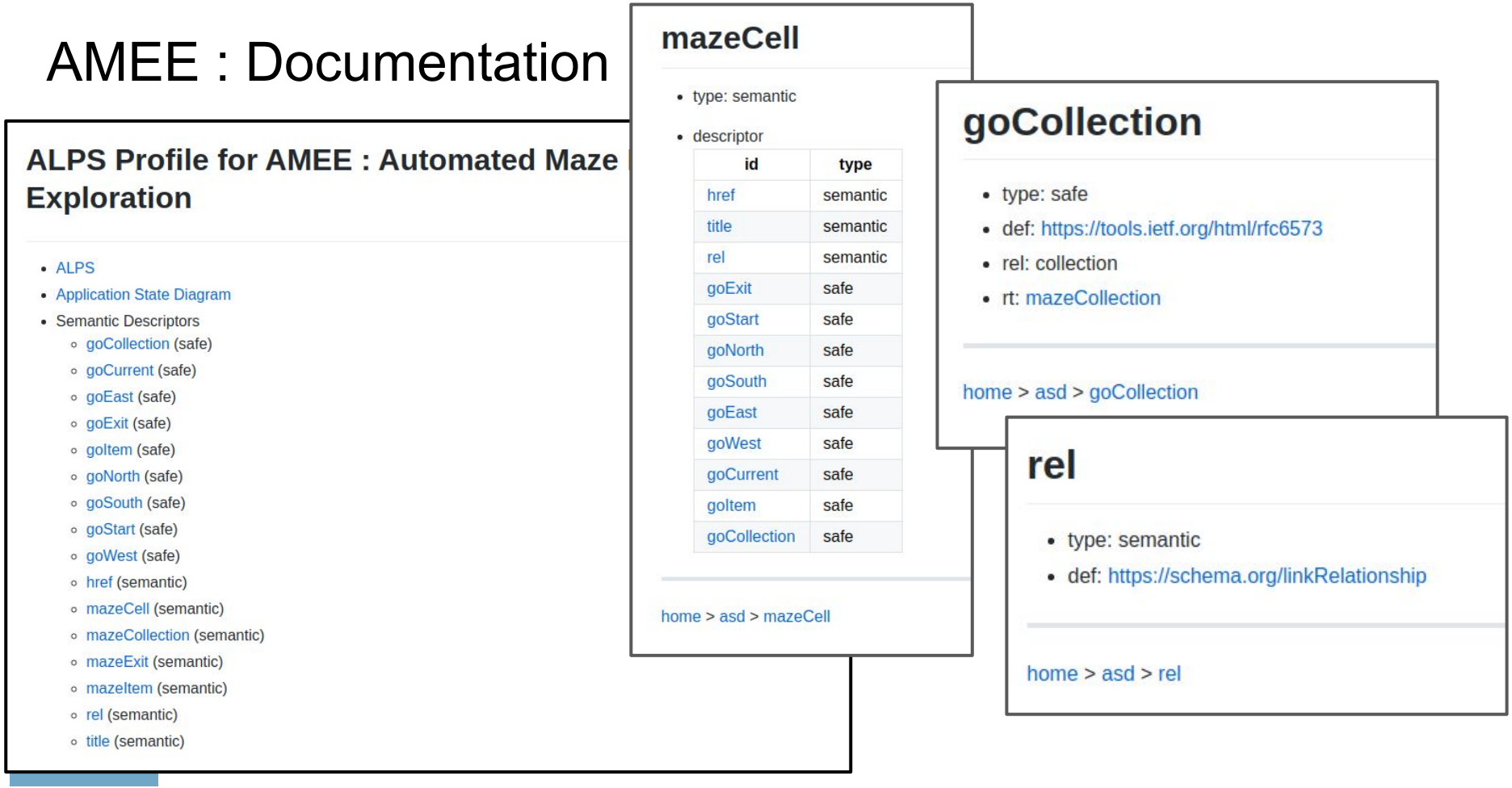
home > asd > mazeCell

goCollection

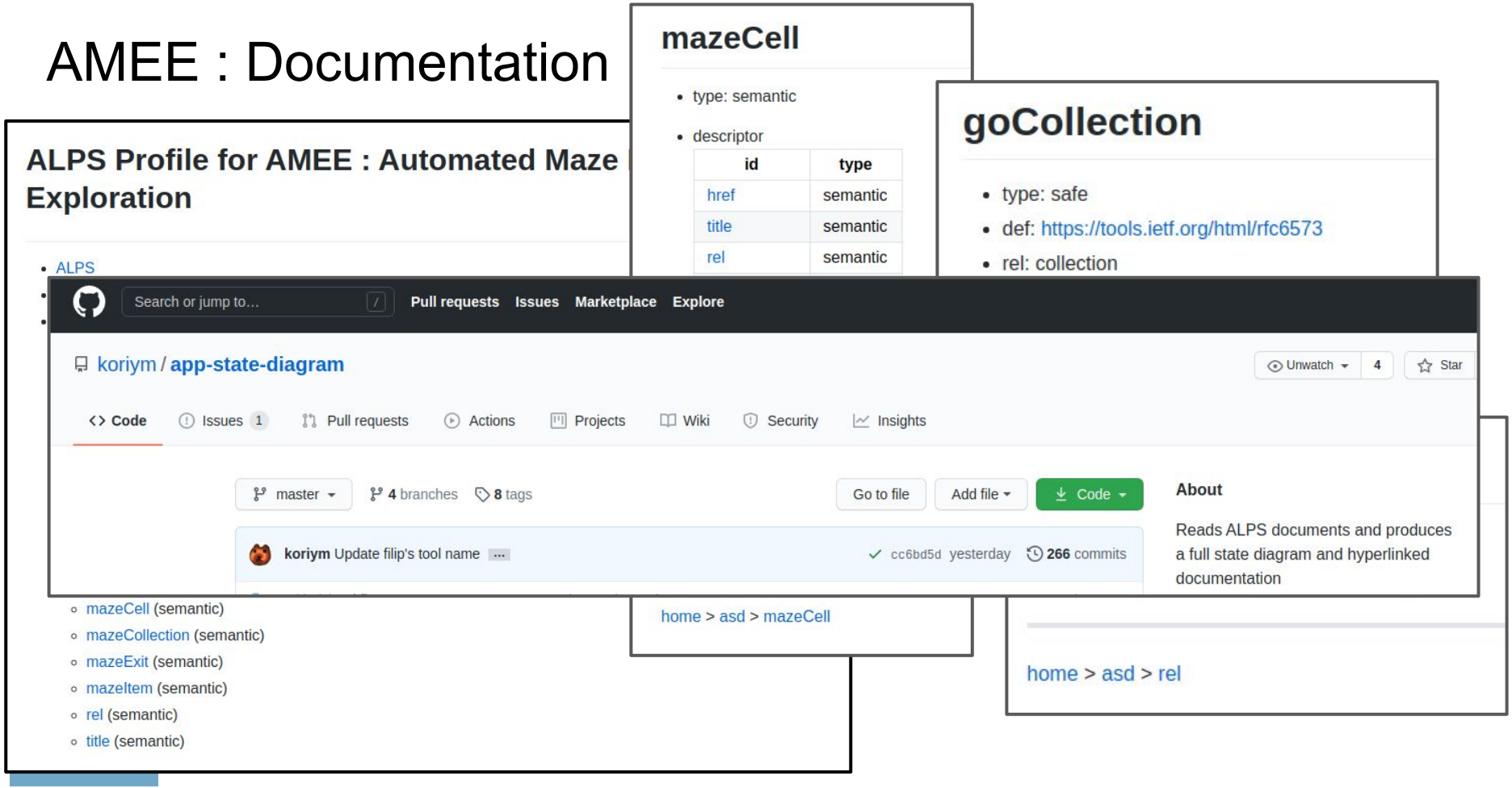
- type: safe
- def: https://tools.ietf.org/html/rfc6573
- rel: collection
- rt: mazeCollection

home > asd > goCollection

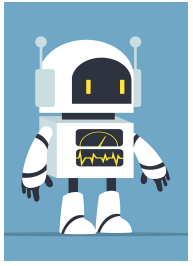
AMEE : Documentation



AMEE : Documentation



AMEE : Code



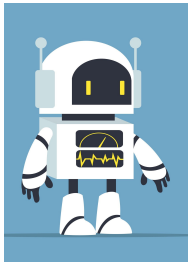
```
// check for exit link
href = findLink(links,'exit');
if(href) {
    m.done = true;
    console.log(m.winner.replace('{m}',m.moves));
    return;
}

// check for entrance link
if(m.start===false) {
    href = findLink(links, 'start');
    if(href) {
        flag = true;
        m.start = true;
        m.facing = 'north';
        console.log(m.moves++ + ': I\'m starting the ' + room + '. My first move is:' + href)
    }
    // ok, see if we can find a maze link
    if(href===undefined) {href = findLink(links, 'maze');}
    // well, is there a collection link?
    if(href===undefined) {href = findLink(links, 'collection');}
    // ok, i give up!
    if(href===undefined) {console.log(m.quitter);return;}
}

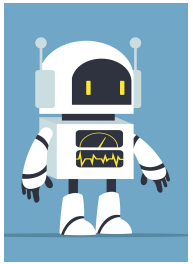
// ok, try to move to new room
if(href===undefined) {
    choices = m.rules[m.facing];
    for(i=0, x=choices.length; i<x; i++) {
        href = findLink(links, choices[i]);
        if(href) {
            flag = true;
            m.facing = choices[i];
            console.log(m.moves++ + ': I\'m in the ' + room + '. My next move is:' + href);
            break;
        }
    }
}
```

AMEE : Algorithm (Model)

```
m.rules = {
    'east' : ['south','east','north','west'],
    'south' : ['west','south','east','north'],
    'west' : ['north','west','south','east'],
    'north' : ['east','north','west','south']
};
```



AMEE : Demo

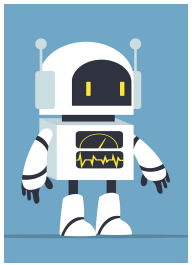


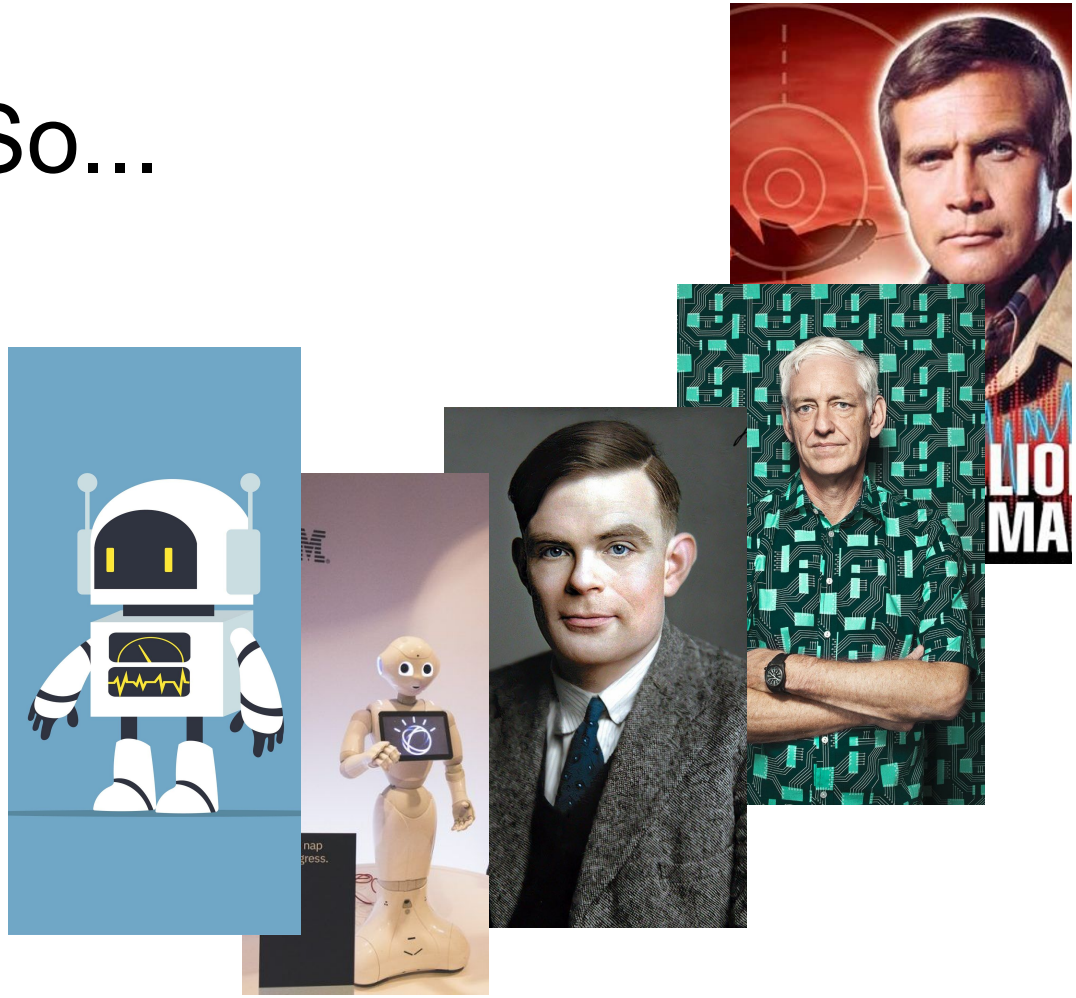
Terminal - mca@mamund-ws: .../the-bot

File Edit View Terminal Tabs Help

```
mca@mamund-ws:.../the-bot$ node the-bot.js http://localhost:1337/01-a-beginner-maze
1: I'm starting the Beginner's Maze (5x5). My first move is:http://localhost:1337/01-a-beginner-maze/0
2: I'm in the Entrance Hallway. My next move is:http://localhost:1337/01-a-beginner-maze/5
3: I'm in the Kitchen. My next move is:http://localhost:1337/01-a-beginner-maze/10
4: I'm in the Nursery. My next move is:http://localhost:1337/01-a-beginner-maze/11
5: I'm in the Laundry Room. My next move is:http://localhost:1337/01-a-beginner-maze/16
6: I'm in the Hobby Room. My next move is:http://localhost:1337/01-a-beginner-maze/21
7: I'm in the Garage. My next move is:http://localhost:1337/01-a-beginner-maze/22
8: I'm in the Tool Room. My next move is:http://localhost:1337/01-a-beginner-maze/17
9: I'm in the Observatory. My next move is:http://localhost:1337/01-a-beginner-maze/18
10: I'm in the Hot House. My next move is:http://localhost:1337/01-a-beginner-maze/19
11: I'm in the Guest Room. My next move is:http://localhost:1337/01-a-beginner-maze/14
12: I'm in the Sitting Room. My next move is:http://localhost:1337/01-a-beginner-maze/13
13: I'm in the Dining Room. My next move is:http://localhost:1337/01-a-beginner-maze/8
14: I'm in the Fruit Closet. My next move is:http://localhost:1337/01-a-beginner-maze/9
15: I'm in the Den of Forks. My next move is:http://localhost:1337/01-a-beginner-maze/4
16: I'm in the Pantry. My next move is:http://localhost:1337/01-a-beginner-maze/3
17: I'm in the Trophy Room. My next move is:http://localhost:1337/01-a-beginner-maze/2
18: I'm in the Library. My next move is:http://localhost:1337/01-a-beginner-maze/7
19: I'm in the Master Bedroom. My next move is:http://localhost:1337/01-a-beginner-maze/12
20: I'm in the Smoking Room. My next move is:http://localhost:1337/01-a-beginner-maze/7
21: I'm in the Master Bedroom. My next move is:http://localhost:1337/01-a-beginner-maze/6
22: I'm in the Cloak Room. My next move is:http://localhost:1337/01-a-beginner-maze/1
23: I'm in the Hall of Knives. My next move is:http://localhost:1337/01-a-beginner-maze/6
24: I'm in the Cloak Room. My next move is:http://localhost:1337/01-a-beginner-maze/7
25: I'm in the Master Bedroom. My next move is:http://localhost:1337/01-a-beginner-maze/2
26: I'm in the Library. My next move is:http://localhost:1337/01-a-beginner-maze/3
27: I'm in the Trophy Room. My next move is:http://localhost:1337/01-a-beginner-maze/4
28: I'm in the Pantry. My next move is:http://localhost:1337/01-a-beginner-maze/9
29: I'm in the Den of Forks. My next move is:http://localhost:1337/01-a-beginner-maze/8
30: I'm in the Fruit Closet. My next move is:http://localhost:1337/01-a-beginner-maze/13
31: I'm in the Dining Room. My next move is:http://localhost:1337/01-a-beginner-maze/14
32: I'm in the Sitting Room. My next move is:http://localhost:1337/01-a-beginner-maze/19
33: I'm in the Guest Room. My next move is:http://localhost:1337/01-a-beginner-maze/24
*** I made it out - and it only took 34 moves! ***
mca@mamund-ws:.../the-bot$
```

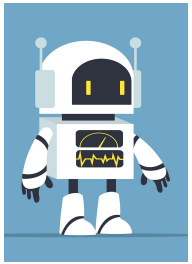
So...





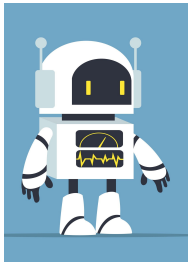
The Future of AMEE

- AMEE's Environment
  - Include rewards (added points) and dangers (lost points)
- Agent Class
  - Level up to utility[L4] (scoring) and learning[L5] (improving score)



Imitating AMEE in the real world

- Navigation
- Selection
- Acquiring
- Remembering
- Learning



Imitating AMEE in the real world

- Navigation
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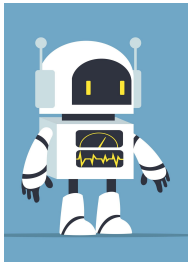
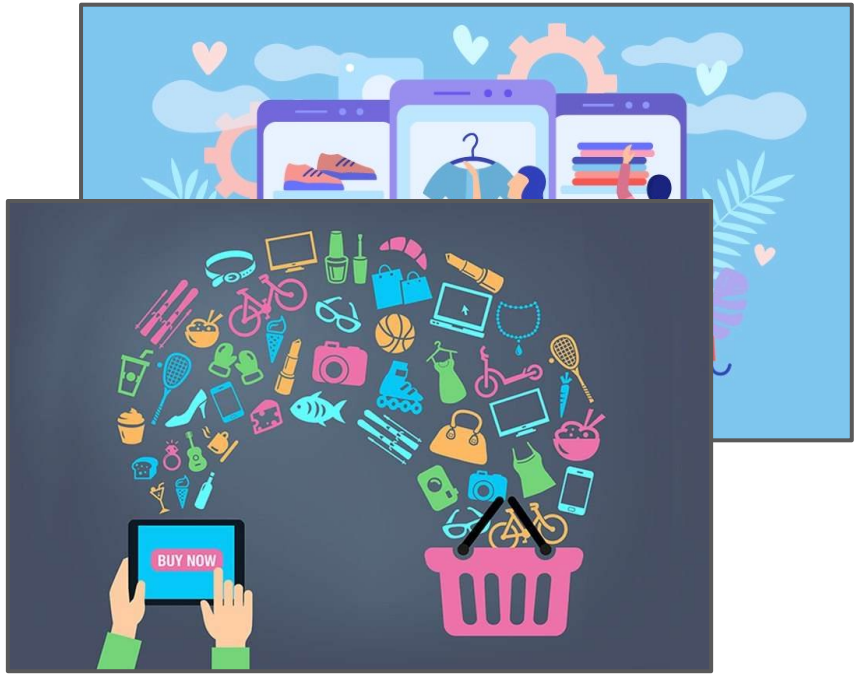
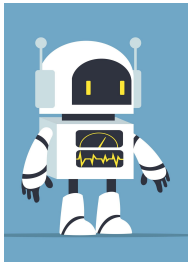
- Remembering
- Learning



Imitating AMEE in the real world

- Navigation
- Selection
- Acquiring
- Remembering
- Learning





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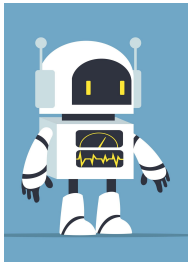

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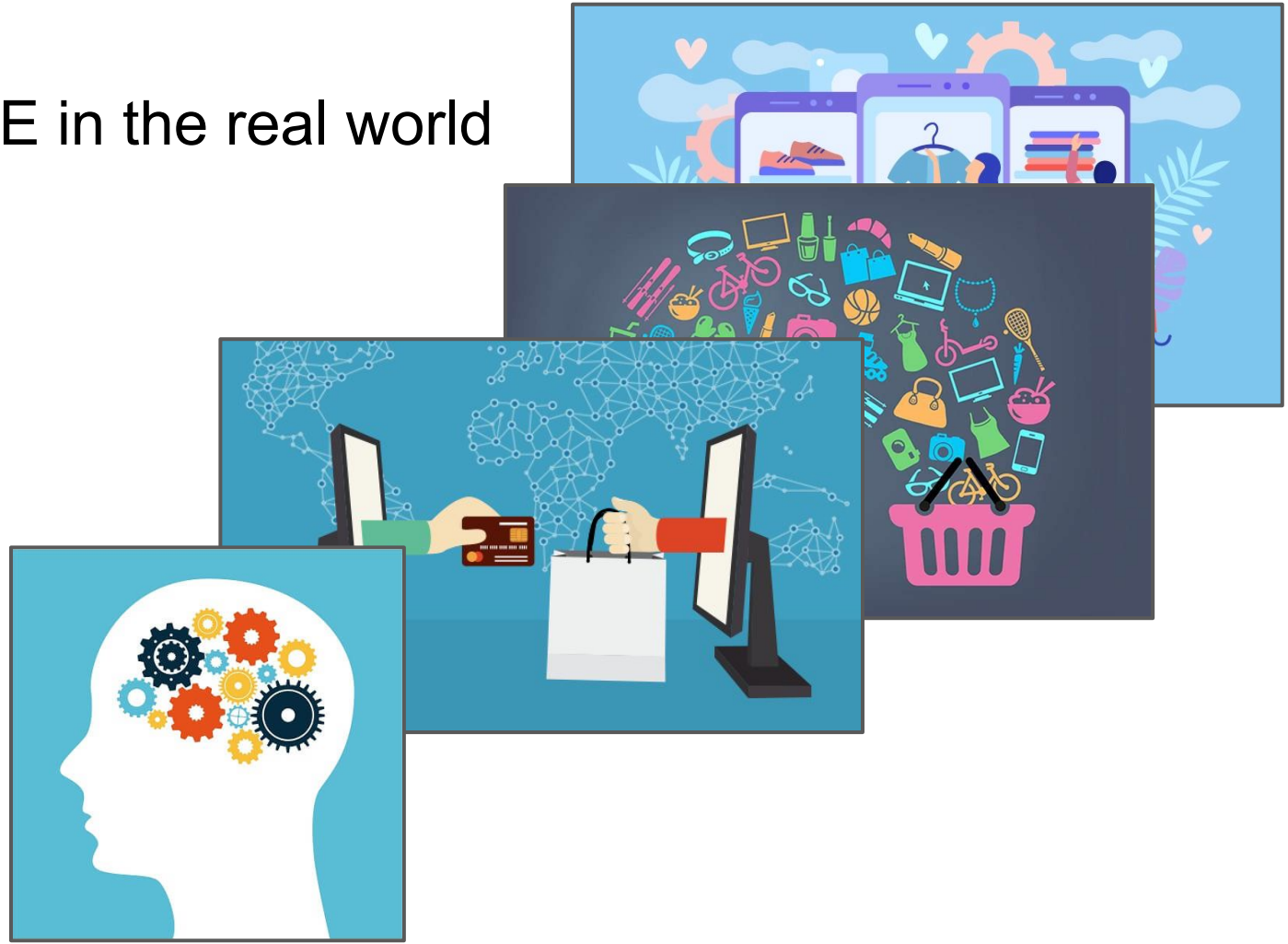

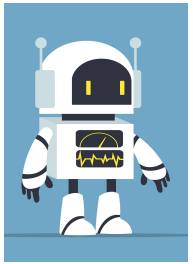

Imitating AMEE in the real world

- Navigation
- Selection
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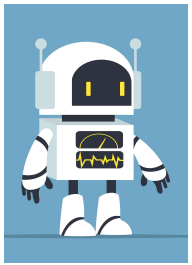
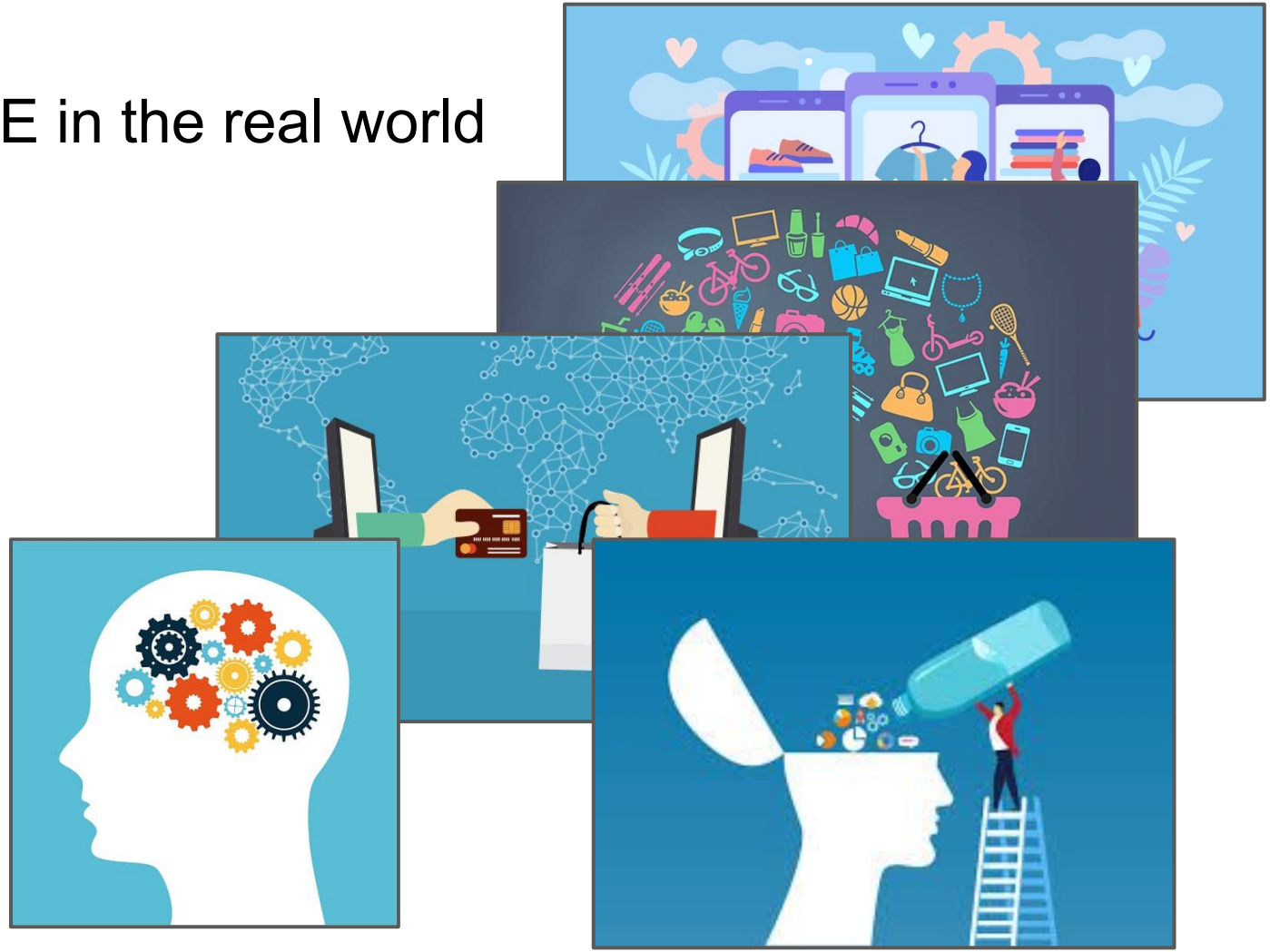
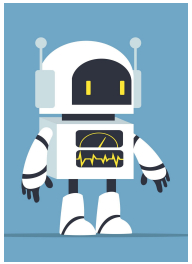




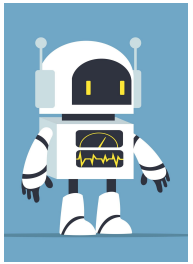
One more thing...



Rene Descartes

"It is impossible for a machine to have enough different organs to make it act in all the contingencies of life in the way in which our reason makes us act."

-- Rene Descartes,
Discourse on Method (1637)



Rene Descartes

*"It is impossible for a machine to have **enough different organs** to make it act in all the contingencies of life in the way in which our reason makes us act."*

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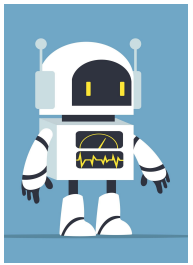
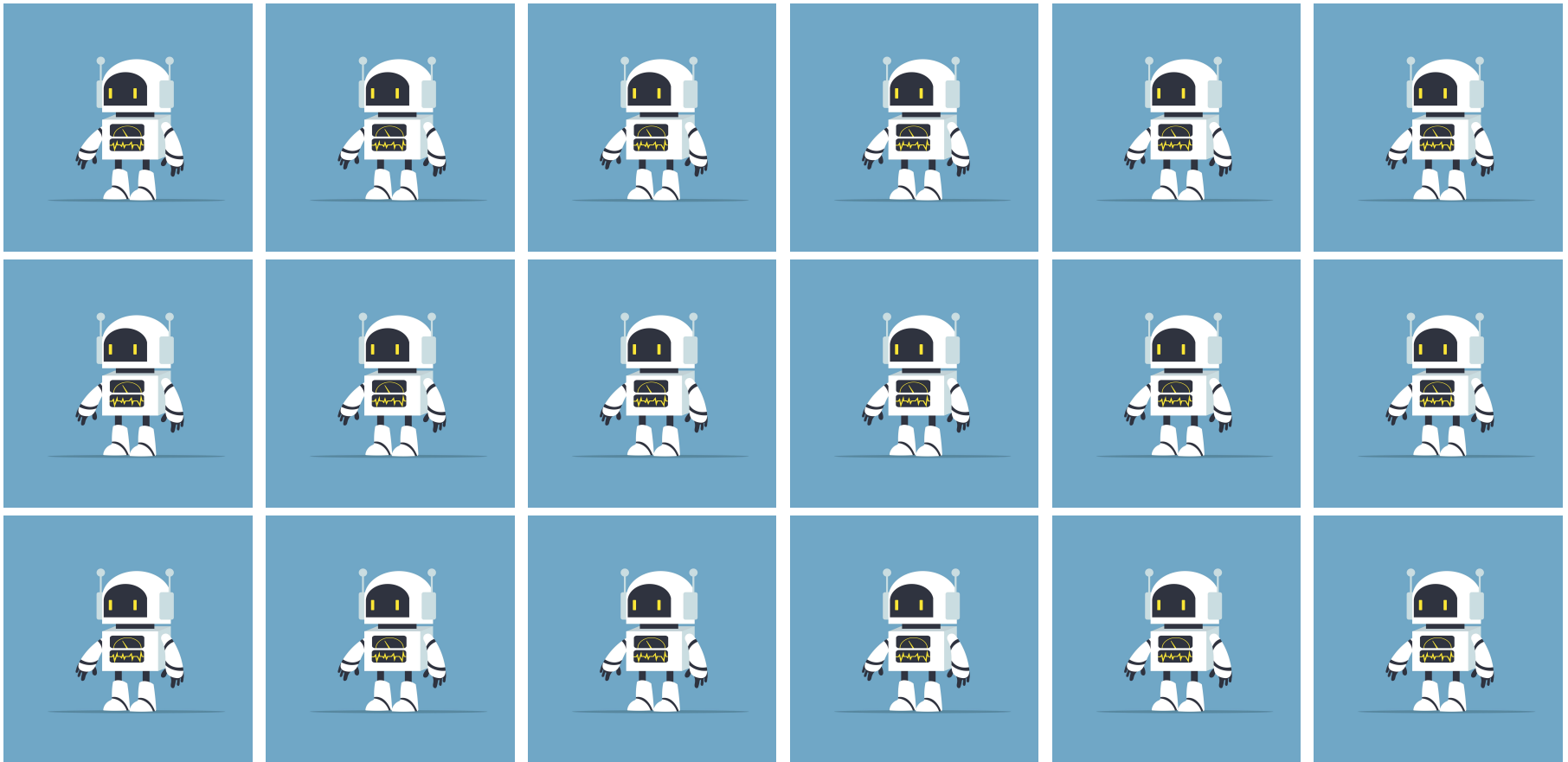
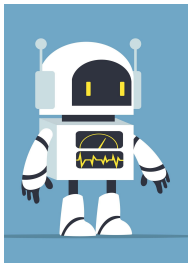


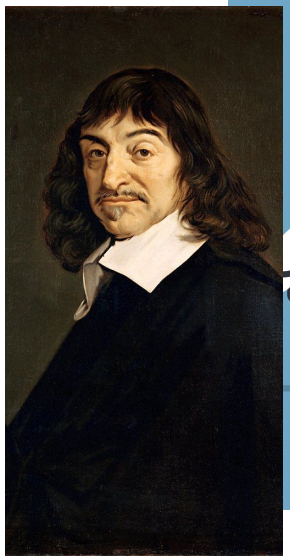
We need lots of AMEEs!

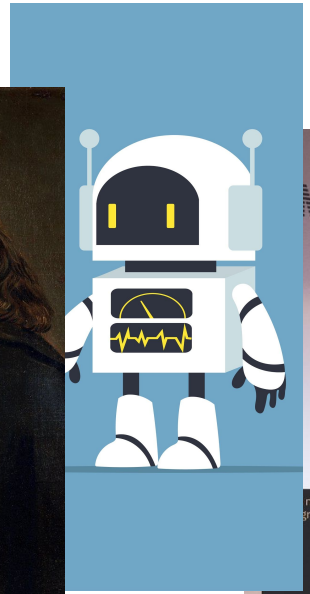


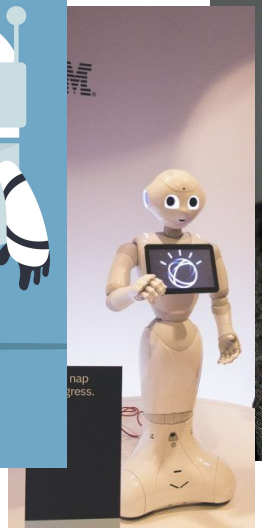
Thank you!

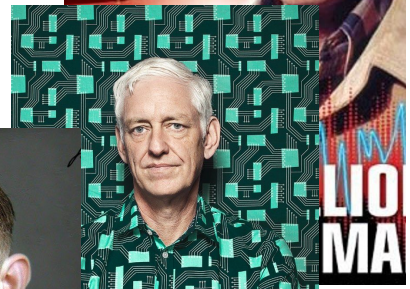
- "We can built it, we have the technology…"
- "Imaginable digital computers…"
- PAGE & Agent Classes
- Engineering AMEE
- "Enough different AMEEs …"











From Steve Austin to Peter Norvig

Engineering AMEE, the Simple Autonomous Agent

Mike Amundsen
@mamund
youtube.com/mamund