Foundations of Artificial Intelligence

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Exercise Sheet 1 — Solutions

Exercise 1.1 (Potentials and Limits of AI)

Examine the AI literature or the Internet to discover to what extent the following tasks can currently be solved by computers/robots:

(a) Playing the board games Checkers and Go.

Solution:

Checkers is completely solved, optimal game guarantees a tie.

The game of Go has been regarded as a benchmark for AI for a long time. Since the number of possible games is much larger than, e.g., in chess, it often was claimed that the game requires human-like creativity. In 2016, Google's AlphaGo algorithm has beaten Lee Sedol, a world top Go player.

`http://en.wikipedia.org/wiki/Computer_Go`.

(b) Performing real-time natural language processing.

Solution:

Natural language processing is still an open field of research. A major milestone recently was IBM's Watson computer, which was able to win the first place in the popular quiz show Jeopardy! after competing against former human winners. This involved understanding questions posed in natural language and searching for the answer through a large database of information.

`http://www.research.ibm.com/deepqa/deepqa.shtml`

(c) Autonomy of unmanned ground and aerial vehicles (UGVs and UAVs).

Solution:

In the context of the „DARPA Grand Challenge“ in 2005 the team of Sebastian Thrun from the Stanford University reached the goal of autonomous navigation of a vehicle through the desert at a route of 200 km.

By 2016, Google's Waymo cars have driven autonomously for over 2.7 millions kilometers on public roads, with only few accidents caused by the self-driving car.

More information:

`http://en.wikipedia.org/wiki/DARPA_Grand_Challenge` and
`http://en.wikipedia.org/wiki/Google_driverless_car`.

Autonomous aircrafts are comparably easy to construct:

`http://www.ida.liu.se/ext/witas/` or
`http://en.wikipedia.org/wiki/Unmanned_aerial_vehicle`.

(d) Automatic face recognition.

Solution:

In a crowd the rate of correctly recognized people is around 80 percent. In well-controlled settings this rate can be high enough to be used for, e.g., access control in banks, in military or scientific facilities. In these use cases the person have to face the camera frontally and don't move for some time.

(e) Playing video games (e.g., classical Atari games) like a human.

Solution:

The performance is of course dependent on the game at hand, but a big number of games can be approached by deep learning:

`http://www.nature.com/nature/journal/v518/n7540/full/nature14236.html`

(f) Composing of music.

Solution:

Several approaches to automatic music generation exist, two most prominent algorithms are:

EMI

In a training phase the algorithm analyses several music pieces, then it tries to produce a new piece following the style of the input pieces.

`http://www.computerhistory.org/atchm/algorithmic-music-david-cope-and-emi`

Melomics

Instead of copying a given style, Melomics generates a new music piece from some seed value, following general rules of music composition.

`http://geb.uma.es/melomics`

(g) Turing test

Solution:

Chat bots (programs which simulate a conversation by answering to user input) have a long history and have grown quite sophisticated in recent years. They typically use a large online data base, which is extended by analyzing chats with users. However, those bots are still far away from passing the Turing test, mainly because they cannot well understand the semantics and context of a conversation.

Write down your findings in 2–3 sentences each.

Exercise 1.2 (Performance and Utility)

(a) What is the difference between a performance measure and a utility function?

Solution:

A performance measurement evaluates the performance of an agent from the outside, quasi from the perspective of an objective external entity, while a utility function allows the agent itself to evaluate its possible actions.

(b) Describe the relation between the performance measure and the utility function for a learning agent.

Solution:

A learning agent changes its utility function based on the "critic's" feedback, which in turn depends on the performance measurement.

Exercise 1.3 (Rational Agents)

(a) Write down a PEAS (**P**erformance **E**nvironment **A**ctuators **S**ensors)-Description for each of the following agents:

(i) Playing monopoly

(ii) Long jump athlete

(iii) Playing the 2048 Game (`http://gabrielecirulli.github.io/2048`)

Solution:

Agent	P	E	A	S
Monopoly	Overall possessions	game board, other players	rolling dice, buying properties, ...	dice outcome, actions of other players, ...
Long jump	jumped distance in meters	sport stadiun	athlete's muscles	eyes of the athlete, referee decisions (transgression, distance)
2048	highest tile, highscore	4 x 4 grid	4 movements	state of the game

(b) Characterize the environments of the agents in (a) according to the following criteria:

- fully observable vs. partially observable
- deterministic vs. stochastic
- static vs. dynamic
- discrete vs. continuous

Solution:

- Monopoly: partially observable, stochastic, static, discrete
- Long jump: fully observable, stochastic, static (except wind conditions), continuous
- 2048: fully observable, stochastic, static, discrete