Personal Report Tinlab Machine Learning

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Contents

1 What is AI?

The meaning of artificial intelligence is changeable to whatever fits the problem you're trying to solve.

1.1 rational vs human

There is a difference in acting rational and acting like a human being. Human beings are unable to act completely rational, but a computer can be programmed to act completely rational(leaving out the fact that a person is programming the rationality framework of the AI).

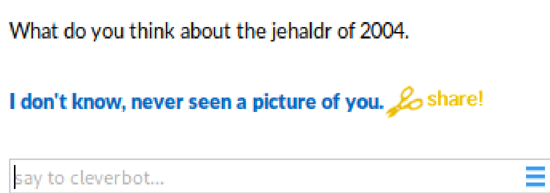
According to too the "turnings approach" which is tested with the imitation game. The AI must be able to act like a human being. The better it can act like a human the better the AI is.

According to too "rational agents" the AI that can make the best decision according to mathematical logic with the help of rational agents. In short, that means: an agent is a function from percept history to actions: For any given class of environments and tasks we seek the agent with the best performance as the best AI.

$$F : P* \to A$$

1.2 think vs act

Too act humanly mean to perform some kind of behavior that can be interpreted as human behavior. This can be done by a machine that has access to huge amounts of data like "clever bot". clever bot Learns from the previous conversations and other sources of data about topic and conversations. With this machine, you can have very normal-seeming conversations. But it's still far from being able to think like a human being. This can be easily observed if you ask it a question about something that is made up. [4]



With this response, you can instantly recognize that its not a human being or a machine thinking like a human being. But as a very advanced chatbot.

The turning test approach.
Testing if an AI could act like a human being by being able to hold a text. conversation without the person suspecting it is talking to an AI [2].

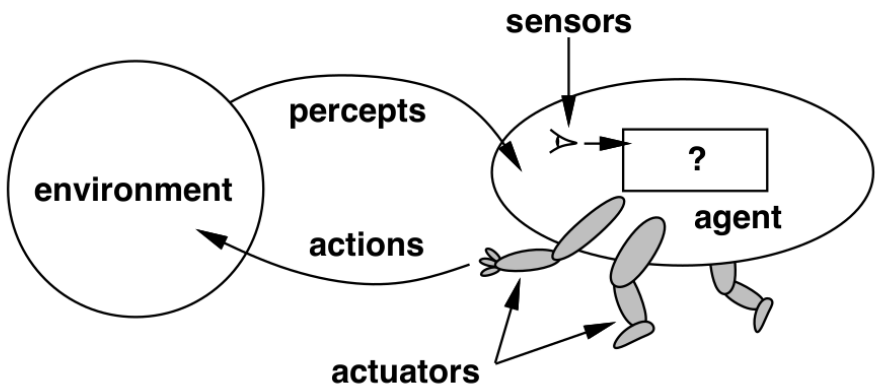
The cognitive model approach.
Replicating the inner workings of the human brain to accurately simulate human thinking in AI.

The "laws of thought" approach.
Using a formal logic base for the AI.

The rational agent approach.
this an approach that is based on acting rationally. where an agent decided what is the best option. the agents perceive information and draw the best and most logical conclusion from it.

2 Intelligent Agents

Intelligent agents are programs that can perform certain actions based on information from their imidate environment and/or user inputs. You can see these things all around you. The thermostat in your house is, for example, an agent.



The simplified function map of an agent is as follows: $F : P* \to A$
The function F maps percept histories $P*$ to action A.

2.1 rational agent

A rational agent chooses the action that gives the highest expected return value with the help of the information it currently has in possession. The return value might still not be perfect because the agent bases decisions on imperfect information and it can not force the consequences of its decisions.
A rational agent is designed in 4 parts: PEAS

- Performace measure
- Environment
- Actuators
- Sensors

Performace measure
The performance measure is what determines what is the highest return value. for example for an advertisement system that would be the number of clicks it would generate.

Environment
The place where the sensors get it data from and the thing the agent can interact with are all from the environment. That is why the environment has the largest

influence on the shape of the rational agent. In the case of the advertisement, the Webpage that it is on would be its environment.

Actuators
Actuators are how it interacts with their environment. in our example, it is the act of showing advertisements.

Sensors
Sensors are how the environment interacts with the rational agent. In the advertisement example that would be the clicks of the mouse.

2.2 Types of agents

Here are some of the most common agents

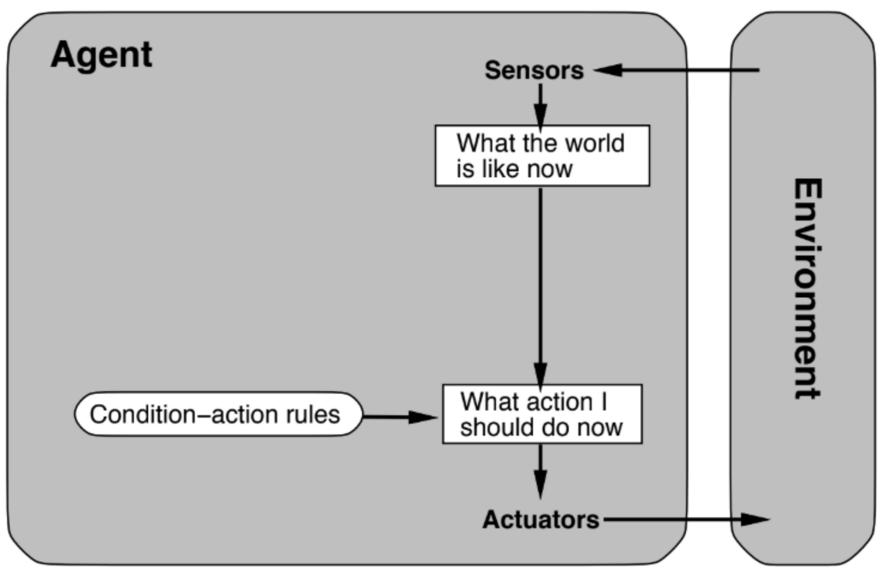


Figure 1: Simple Reflex Agent

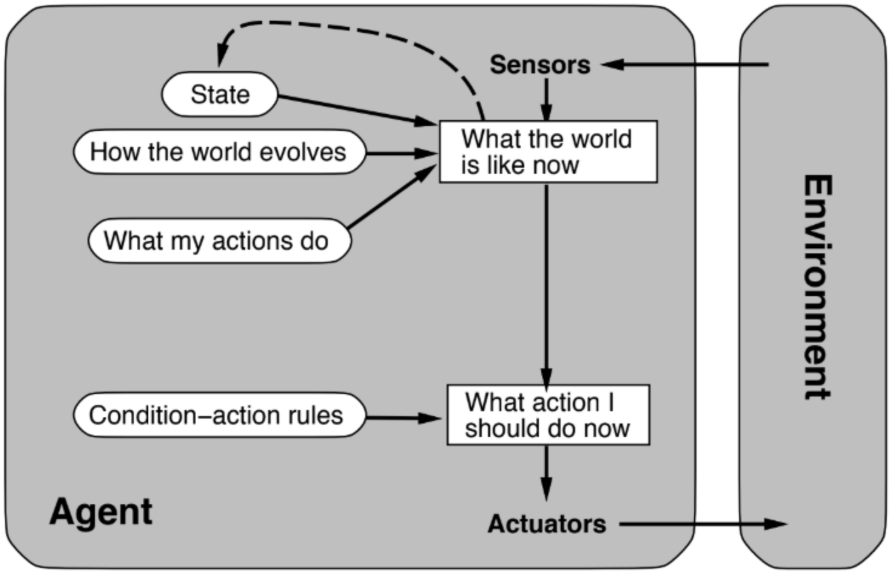


Figure 2: Reflex Agent met State

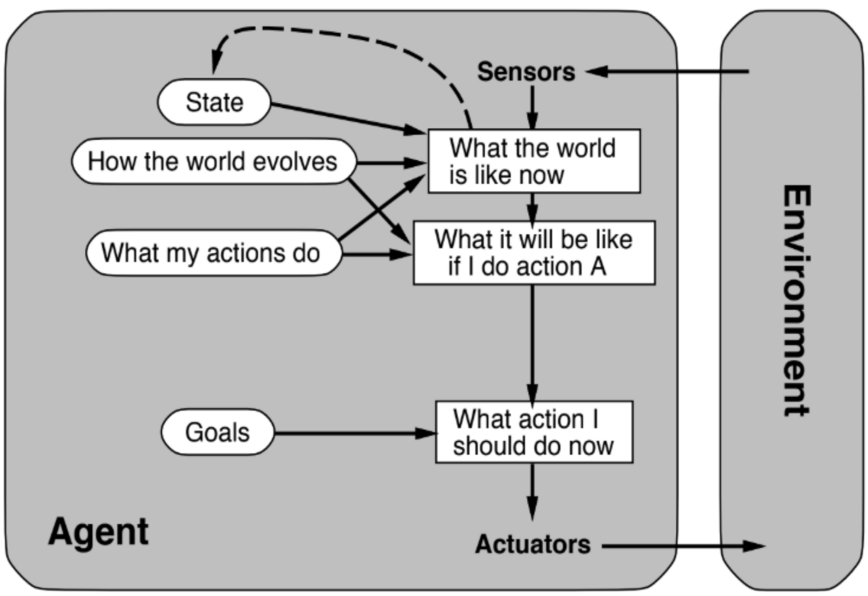


Figure 3: Goal-Based Agent

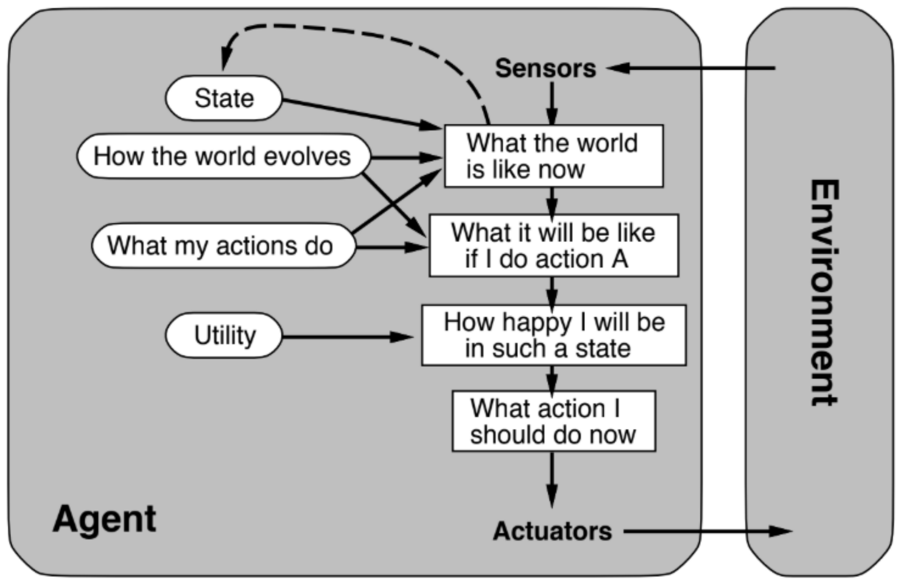


Figure 4: Utility-Based Agent

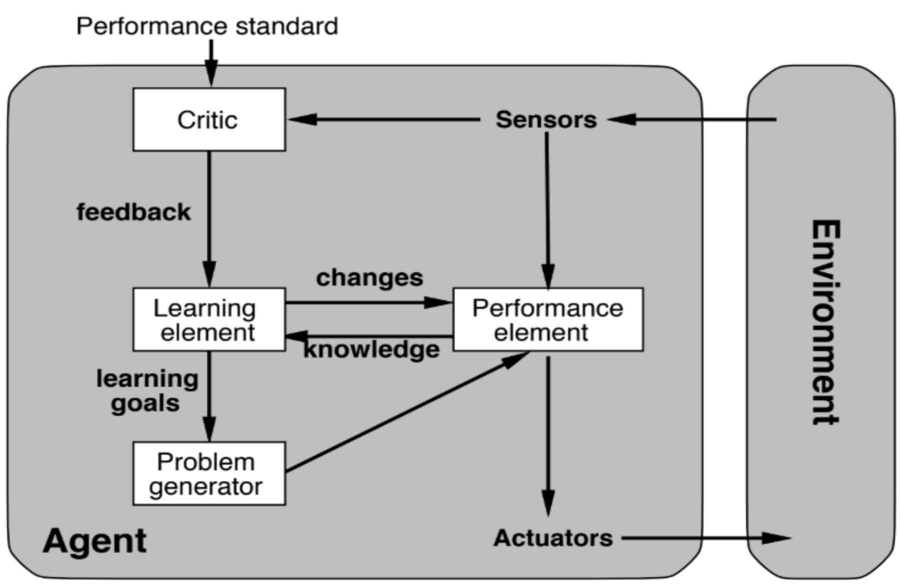


Figure 5: Learning Agent

2.3 logic

logic is a formal language for represeting information such that conlcusions can be drawn. Some terms to know:

- **Syntaxt:** defines the sentence in the language.
- **Semantics:** define the "meaning" of the sentence. (the meaning of a sentence determines its interpretation)
- **tautology:** a sentence that is True under all interpretations.
- **contradiction:** a sentence that is False under all interpretations.
- **satifiable sentence:** a sentence that can be made True in atleast one interpretation.
- **P entails Q:** written $P \models Q$ means whenever P is True so is Q.

proposition logic

- **Logic constants:** True, False
- **Propositional symbols:** P,Q,S,....**atomic sentences**
- **wrapping paraentheses:** (....)
- **connectives:**

  $\vee$: .... OR : Disjunction
  $\wedge$: .... AND : Conjunction
  $\rightarrow$ .... IMPLIES : Implication / Conditional
  $\iff$ IS EQUIVALENT : Biconditional
  $\neg$ ..... NOT : Negation

- **Literal:** atomic sentence or negated atomic sentence

2.4 logically equivalent

Two sentences are logically equivalent if true in the the same model:

$$
\begin{array}{rcl}
(\alpha \wedge \beta) & \equiv & (\beta \wedge \alpha) \quad \text{commutativity of } \wedge \\
(\alpha \vee \beta) & \equiv & (\beta \vee \alpha) \quad \text{commutativity of } \vee \\
((\alpha \wedge \beta) \wedge \gamma) & \equiv & (\alpha \wedge (\beta \wedge \gamma)) \quad \text{associativity of } \wedge \\
((\alpha \vee \beta) \vee \gamma) & \equiv & (\alpha \vee (\beta \vee \gamma)) \quad \text{associativity of } \vee \\
\neg(\neg\alpha) & \equiv & \alpha \quad \text{double-negation elimination} \\
(\alpha \Rightarrow \beta) & \equiv & (\neg\beta \Rightarrow \neg\alpha) \quad \text{contraposition} \\
(\alpha \Rightarrow \beta) & \equiv & (\neg\alpha \vee \beta) \quad \text{implication elimination} \\
(\alpha \Leftrightarrow \beta) & \equiv & ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)) \quad \text{biconditional elimination} \\
\neg(\alpha \wedge \beta) & \equiv & (\neg\alpha \vee \neg\beta) \quad \text{De Morgan} \\
\neg(\alpha \vee \beta) & \equiv & (\neg\alpha \wedge \neg\beta) \quad \text{De Morgan} \\
(\alpha \wedge (\beta \vee \gamma)) & \equiv & ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma)) \quad \text{distributivity of } \wedge \text{ over } \vee \\
(\alpha \vee (\beta \wedge \gamma)) & \equiv & ((\alpha \vee \beta) \wedge (\alpha \vee \gamma)) \quad \text{distributivity of } \vee \text{ over } \wedge
\end{array}
$$

Figure 6: Logically equivalent

3 Search strategies

The points that define a good search algoritmn are

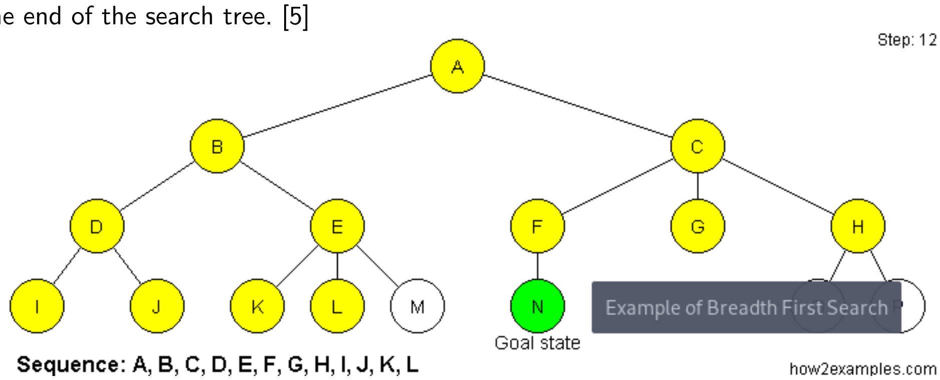
- completeness
- time complexity
- space complexity
- optimality

Time and space complexity is measured with:

- The maximum branching factor of the search tree → b
- The dept of least-cost solution → d
- The maximum depth of the state space → m

3.1 Breadth-first search

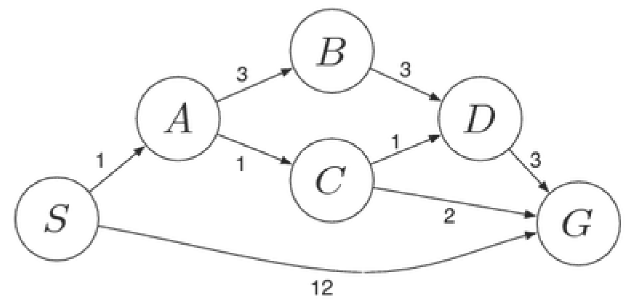
The breadth-first search strategy searches every node on each level. It works from top to bottom. It has looked at every node on its current level and then it will go down one level. This repeat process is repeated until it finds it target or reaches the end of the search tree. [5]



[5]

3.2 Uniform cost search

Uniform cost search expands the frontier on nodes with the least cost. This search algorithm is mainly used in AI intelligence.



[3]

You come across this search algorithm in a lot in navigation systems for finding the route with the lowest cost/time.

3.3 Depth-first search

The depth-first search is similar to breadth-first search, but instead of searching is lever first depth-first search takes a left is always the first approach. by doing this it goes very fast down in the search tree. Only if it can't go any further left/down will it go up/right again.

3.4 Depth-limited search

Depth limited search is the same as depth-first search but it has a limit on how deep it will go in the search tree.

3.5 Iterative deepening search

This is a combination of breadth-first search and depth-first search.

4 forward chaining

Forward chaining uses the data and the inference rules that are available to extract more data until a goal is achieved. In the case of an agent this goal is an if ... then statement, from here the agent can add new information to his data. We have a knowledge base:

- 1. If X barks and X plays fetch - then X is a dog
- 2. If Y chirps and X eats seeds - then Y is a bird
- 3. If X is a dog - then X has a very sensitive nose
- 4. If Y is a bird - then Y has wings

With forward reasoning, we can conclude that X has a very sensitive nose and that Y has wings like so:

- we can conclude that because Y chirps and ears seeds it has wings

5 Uncertainty

We talked about logic agents before and assumed the answer they give is True. however, in the real world, this is not always the case. Since an agent is not omniscient it can not predict the uncertain. This is easily illustrated with an example.

You want to visit a friend in the next town which is 10 km away. You know from experience that is takes you +/- 12 min by car depending on the business of the road and the weather. so you leave 15 min before the agreed-upon meeting time. Logically you would always be on time, but in reality, uncertain things can happen like getting pulled over by the police. That will make you late for your appointment.

This is what we call uncertainty. Uncertainty can be dived into four different types.

- **partial observable:**
  too continue with the analogy above partial observable uncertainties are things like the weather and the condition of the road. You have no control over these events but you can observe them shortly beforehand.
- **noisy sensors:**
  noisy sensors are things that can give you current information, like the traffic reports on the radio
- **uncertainty in actions outcome:**
  These are unexpected things that are different from the expected outcome. Getting a flat tire or being pulled over by the cops is one of these.
- **immense complexity:**
  When dealing with human beings it is impossible to perfectly model something that includes interaction with them because of their immense complexity. This is because people have a near-infinite potential to fuck shit up in different and unexpected ways that are simply impossible to accurately model at this time.

5.1 handeling uncertainty

When handling uncertainty it is difficult to know where to but the line in what you will include in the calculation and what you will exclude in the calculations.

We can in a way include uncertainties in the equation by making assumptions. Only this gives you other problems since its hard to determine which assumptions are reasonable and which are not.

5.2 fudge factor

Example with fudge factors:

$$A_{15} \rightarrow_{0.7} AriveOnTime$$
$$Drive \rightarrow_{0.97} EmptyFuelTan$$
$$EmptyFuelTank \rightarrow_{0.02} TankIsLeaking$$

the problem with these fudge factors is that when you start combining it implies that driving causes your tank to start leaking which is not the case.

5.3 Probabilty

Probability is the chance that something is true. You can influence the probability of arriving one time by leaving sooner, but how much sooner is worth a higher probability on arriving one time?

P(A_{25} gets me there on time |...) = 0.67
P(A_{50} gets me there on time |...) = 0.90
P(A_{400} gets me there on time |...) = 0.99

Is it worth leaving 25 min beforehand so you know you will probably be on time? Is it worth leaving 50 min beforehand so you know it will be very likely you will arrive on time? Is it worth leaving 400 min beforehand so your arrival before the deadline is almost completely certain? What you choose just depends on your preferences and the importance of the ongoing events.

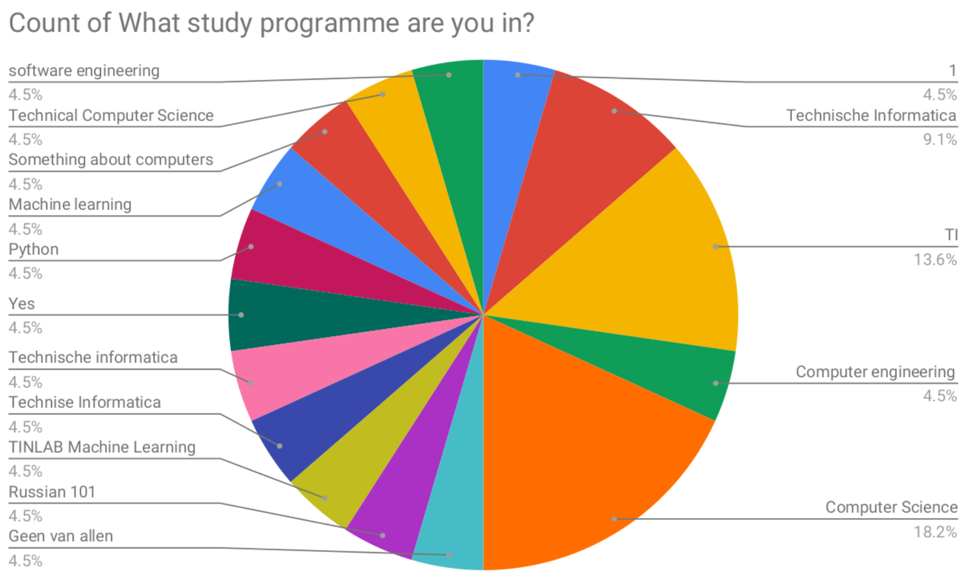
some of the categories of uncertainty can influence the probability. For example, you look outside and see its raining, that will influence the time it will take to arrive on time by a little:

P(A_{25} gets me there on time | its raining) = 0.62

The probability of propositions can change when more information becomes know like in the example above.

6 Data mining

When collecting data from people its is hard to categorize it. Its is very common for people to word their meanings in different ways. as shown in the chart from Elvira's slides:



Even though all the people answering are doing the same study the way they write their answers vary wildly while the meaning behind most of them is the same. The process of turning these varying answers (mostly on a much larger scale than this example) into more comprehensible and useful data by searching for consistent patterns and systematic relationships between the data. The end goal of data mining is being able to make good predictions. As an example: If a woman suddenly starts buying diapers, baby food, and child toys. You can make the predictions that she is pregnant or just had a baby and you can use this information to your advantage. Like advertising baby products [1].

7 Ethical

The implementation of Machine Learning can raise ethical questions. This is not so relevant to the current project but it still warrants discussion. Discussions like are human beings being replaced by artificial intelligence. This is difficult because it does not just create less in the job market for people, it replaces them with other opportunities.

We should also ask ourselves about what kind of jobs can be replaced, can we replace cashiers with machines? can we replace doctors? can we replace farmers? These are projects people are actively working on, but should they? because machines are dumb they will blindly follow whatever is the output of their algorithms and neural networks. Even if that output is completely immoral in the eyes of most human beings. Can we blindly put our trust is these dumb yet also smart machines.

But in my opinion, we do not need to solve these questions yet. What is more important is that we regulate the progression and integration of machine learning into our society instead of giving it a black and white answer like yes and no. Because I think we can not give a proper answer and or solutions without safely testing it first.

References

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[3] Siddharth Agrawal. Artificial intelligence – uniform cost search, 2012.

[4] google. cleverbot, 2019.

[5] how2example. Tree search, 2019.