

Artificial Intelligence, Mathematics, and Consciousness

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Part I: Designing an intelligent robot

Part II: The personality of robots

Part I: Designing an intelligent robot

1. Agents
2. Intelligence
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7. Memory and knowledge

1 Agents

An **agent** is a machine designed to perform work helpful to those who **own** it.

Artificial intelligence (short **AI**) is concerned with complex agents that can perform automatically (without human assistance) at least some tasks that require some intelligence if carried out by a human.

An agent needs

- **hardware** in which it is embodied, and
- **software** to enable it to respond appropriately to the
- **environment** in which it lives.

The **hardware** determines the kind of activities that are possible; one needs

- **sensors** to notice the environment,
- **effectors** to influence it,
- **actuators** to bring the effectors into a state in which they are useful, and a
- **mind** to decide which effector states are useful.

A **laptop** considered as an agent:

- Its hardware is microelectronic in nature.
- The keyboard acts as sensor, sensing symbols keyed in by the user.
- The effector is the screen, which conveys visual information to the environment.
- The actuator is the device that feeds the screen with the electromagnetic information that results in the visible image on the screen.
- The environment is **virtual** in that everything the laptop does is a simulation, manipulating bit patterns.

A **robot agent** (here simply a **robot**) is an agent that **controls** its own actuators and is able to move in the **physical**, 3-dimensional world.

Humans (and to some extent animals), although not artificially created by us, resemble robot agents in all operational respects. Thus one can use them as often vivid illustrations of many aspects of robot agents.

Their hardware is the body, sensors are eyes, ears, etc., effectors are hands, feet, and the voice, actuators are muscles, and the mind corresponds to the network of nerves in the brain.

The hardware of a robot:

- Sensors for: light, sound, force, temperature, chemical composition, radiation, symbols,
- Effectors: wheels, hands, feet, platforms, senders (of light, sound, symbols)
- Actuators: motors, hydraulics, electromagnetic circuits,

Creating the hardware is a matter of **engineering**, supported by **software** where **mathematics** is employed for good robot design:

- stability, flexibility, speed, efficiency, safety

2 Intelligence

The mind of a robot agent contains executable **software** to analyze sensor data, derive appropriate action patterns, and to activate the actuators in corresponding amounts.

Appropriate **low-level software** ensures that the hardware is properly connected and utilized.

It corresponds to the most unconscious activities of the human nervous system.

Appropriate **high-level software** is what makes a robot **intelligent**. There are two kinds of intelligence:

- **borrowed intelligence**
- **intrinsic intelligence**

Current agents usually have highly domain-specific software. Without the software telling them what things mean they would be utterly helpless. Their intelligence is **borrowed** from the humans who wrote the software.

Intrinsic intelligence is the ability of a robot to discover by itself everything related to the conceptual level of the environment in which it is supposed to act.

It is the intelligence necessary for a robot that is able to create, in a completely unknown world, a valid view of the world and its own position, activities, and capabilities.

Every baby is able to do this (though it takes years) ...

... But so far no robot!

The real world is often

- uncertain
- ambiguous
- difficult to predict

What would a robot need to survive alone in the jungle, if left there without ever having learnt anything about the jungle?

What would a robot need to survive alone in the jungle?

Minimal requirements (far from sufficient) are:

- see, hear, act
- learn, understand, reason, predict
- remember, assess

- see, hear, act
 - ⇒ engineering, image processing, signal processing
- learn, understand, reason, predict
 - ⇒ machine learning, fuzzy logic, automated reasoning
- remember, assess
 - ⇒ memory, knowledge management, reasoning

3 Concept formation

Hearing shows in an elementary form what is involved in going from raw sensor data to meaningful concepts.

Input for the ear is a high frequency time series, from which the ear creates (essentially by Fourier transformation) a sequence of frequency patterns.

These are processed by the brain to sequences of elementary sounds called **phonemes**, which are further processed to **words** and **sentences**, from which **meaning** can be extracted.

Mathematically, this transformation process is a multiple **classification problem**, treated in computer science under the heading of **pattern recognition** or **machine learning**.

One needs a classifier that assigns to any data vector (in the first stage specifically each window of the time series) that may be interpreted as a sound a discrete class label (phoneme) in a repeatable way catching the structure of the sound.

We want to train the classifier to ensure that the intended class is found.

This problem is ill-defined unless we have a clear definition of what is intended, which is impossible in practice except in terms of simplicity.

In training, there is an **offline component** containing prior information (theoretical assumptions, beliefs, prejudice, past experience).

This part is called **supervised classification**, and frequently the most time-consuming effort. Therefore done only once, initially.

Then there is an **online component** that improves the prior by update the model using new observed information.

The concepts found by pattern recognition must be related to each other by semantically meaningful connections.

These are represented in a **semantic memory**. On the Web, this is usually represented as Semantic Web in the RDF [Resource Description Framework] data model.

Each connection is given in RDF by a triple of concepts.

A typical interpretation of a triple (A,B,C) could be "A has B as a C" and can be visualized as an arrow from A to B labelled by C.

It is the **connectivity of the concepts**, not that of the neurons in the brain, that creates (together with algorithms for processing these connections) the basis for intelligent reasoning.

4 Learning under uncertainty

Everything of interest is certain only in very controlled, simple situations. The omnipresence of **uncertainty** is a fact of real life.

Knowledge is the ability to predict data.

(Even knowledge about the past means the ability to predict the contents of the authoritative documents or the answer of an authority on a particular topic.)

Learning is knowledge acquisition, the activity of finding reliable predictors.

Note that knowledge can still be

- true or false,
- accurate or inaccurate,
- complete or fragmentary.

Learning can therefore be poor or excellent.

Learning under uncertainty involves statistical data analysis that depend upon a **stochastic model** in which theoretical assumptions are made.

One uses **model estimation** to get the parameters of a model matching the available data by using

- Least square (LLS)
- maximum likelihood (ML)
- maximum a posteriori (MAP) based on a **prior**, that is, a summary of experience of the past.

Dreaming is the human activity where old data are recombined in new, sometimes apparently strange ways, with the goal of finding appropriate or better interpretations of previously incompletely understood matters.

The artificial analogue is time-consuming off-line **retraining** to discover improved models of representation.

Model estimation generalizes the classification problem to arbitrary problems of learning quantitative structure.

MAP allows online improvements, that is, incremental learning.

It is often possible to reconstruct missing information.

Robust estimation is the art of being able to tell that certain data are anomalous and should be ignored (outliers).

5 The environment

We do everything in an **environment** – the world we can perceive.

To do something, one needs to be familiar with that environment.

It depends on the capabilities of an agent how its world looks like.

The world of a chess machine is only a chess board.

That of a robot with cameras, microphones and touch sensors is far bigger – provided it can make sense of the sense data.

The main features of *our* world are objects, motions, and relations between these.

They are organized in space and time.

In terms of physical interactions only, an **object** is a physical subsystem of the real world with reasonably well-defined boundaries, so that there is a meaningful separation of its **state** (what characterizes the object at a given time) from the environment.

In case of objects whose state is modified by or modifies the environment, the object is also characterized by its **input** (environmental information that affects the state) and its **output** (information about the state that affects the environment).

An **object** is most typically a 2-dimensional surface in 3-dimensional space.

We almost never see the third dimension, with the exception of transparent objects. Clouds are also exceptional in that they don't have a well-defined surface.

Objects often have **landmarks** that identify special, well localized and typically time invariant points of the objects' surface.

The possible **motions** of an object determine the **shape** (the form of the space it occupies) and how it changes with time.

For a **rigid** object, shapes are characterized by the **pose**, a pair consisting of three coordinates describing the position of the center of mass of the object and three angles (or equivalent descriptors) describing its orientation in space.

Motions of a rigid object are characterized by how the pose changes with time. Thus rigid objects are generally easy to handle.

For nonrigid objects, the description is more complicated. They can be described by **active shape models**.

An **image** is a projection of the surface to a 2-dimensional flat sheet.

A large part of image analysis is the reconstruction of 3D objects from 2D images, through segmentation, classification, and merging views.

Much of our technology is based on objects constructed to be simple, which makes their identification simple.

Natural objects often lack this simplicity.

6 Understanding

The intellect says: “By convention, there is color, by convention sweetness, by convention bitterness, actually only atoms and the void.”

The senses retort: “Poor intellect, do you hope to defeat us while from us you borrow your evidence? Your victory is your defeat.”

(Democritus, ca. 400 BC)

What is reality? We cannot know.

All we know is sense information, more or less unconsciously transformed to a conceptual, intelligible representation that we may ponder when we think about such questions.

Atoms and the void are as much conceptual abstractions of reality as are color, sweetness, and bitterness.

Symbols are names for abstracted objects or relations.

These are usually arrived at by classification.

A simple way of classification is the comparison with a collection of **prototypes**.

As with any classification procedure, these can be learnt if sufficient amounts of data are available.

Reality (i.e., the agent's world) is symbolically represented in order to enable its understanding.

To **understand** the world means to have a symbolic representation of it that enables one to **predict** the main features of interest, as far as they are predictable at all.

To draw rational consequences from known or assumed information one needs to be able to **reason**.

In practice, reasoning is done in three different modes:

- logical reasoning (classical logic)
- reasoning under uncertainty (probabilistic logic, Bayesian networks)
- reasoning under ambiguity (common sense, fuzzy logic)

Note that lack of information may have two very different reasons.

If we need reliable predictions, we must carefully differentiate between uncertainty and ambiguity.

We call **uncertainty** lack of information due to the fact that a model accounts for a variety of past or future instances which differ in the piece of information under consideration.

It is impossible to say much about the content (when casting dice, what is shown on top of the die) in an arbitrary instance – we can only give probabilities.

One therefore calls this also **aleatoric uncertainty** (Latin: *alea* = die), and treats it using probabilistic techniques.

On the other hand, **ambiguity** is lack of information due to ignorance.

The piece of information in question has a definite, but unknown content, but it is inconvenient (it may be expensive or secret) or physically unrealistic to find out more about the content.

It is only our knowledge (Greek: *επιστημη*, episteme) that is incomplete – someone more experienced about the issue might know more. One therefore calls this also **epistemic uncertainty**.

Treating this using probabilistic techniques is dangerous, as probability assumptions (such as an assumed equidistribution) encode spurious frequency information.

Instead one uses techniques such as **fuzzy logic**.

7 Memory and knowledge

To be able to compare new data with old ones, and to be able to interpret the data based on what was learned before, an agent needs to have a **memory** of all that was considered important in the past.

There are two kinds of memory:

- **short-term memory**
- **long-term memory**

Short-term memory preserves a lot of data for more or less immediate processing, but what is preserved fades away quickly, being replaced by newer content.

The main purpose of short-term memory is to provide the information needed to interpret the present and how it changes, by analyzing it into appropriate symbols, determining the state of the environment, knowing about the objects present and their motions,

Long-term memory preserves highly compressed information only, but preserves it for a long time, or even forever, though the long-term memory may be altered with time in the light of experience.

The main purpose of long-term memory is to provide the information needed to understand what happens in the present based on experience in the past.

From a computational point of view, the short-term memory is typically held in random access form but only little organized.

On the other hand, the long-term memory is typically stored systematically in a **database**.

It is slower to retrieve but can be exhaustively searched by means of **database queries**.

Storing something in the memory does not count as knowledge.

As mentioned before, **knowledge** is the ability to predict data.

A robot has knowledge only if it can execute algorithms that make intelligent use of the memory, correctly associating it to objects and events in the environment.

break for discussion

Part II: The personality of robots

8. The completed survival toolkit
9. Causality
10. Communication
11. Communicating mathematics
12. Emotions
13. Self and consciousness
14. Technical and biological intelligences
15. Ownership
16. The future: hopes and fears
17. Are we only intelligent machines?
18. Some early AI history
19. AI out of control?

8 The completed survival toolkit

What would a robot need to survive alone in the jungle?

- see, hear, act
- learn, understand, reason, predict
- remember, assess
- plan, control
- communicate, cooperate, compete
- handle surprise, hurt, disappointment

- plan, control
 - ⇒ **will**, cybernetics, control theory
- communicate, cooperate, compete
 - ⇒ **language**, game theory, reinforcement learning
- handle surprise, hurt, disappointment
 - ⇒ **emotions**

9 Causality

Causality is the relation between cause and effect. It is at the heart of being able to plan – affecting the environment in a desired way.

Passive observation only allows one to determine correlations between events – for example by observing that event B happens regularly after event A.

In order to find out whether A caused B, one needs to be able to manipulate the world and to observe the consequences of changing what the robot can control.

On the most elementary level, a robot can control only its actuators.

With sufficient intelligence, it can indirectly control much more.

By observing the consequences of which actuator positions correspond to which events in the environment, the robot can find out which effects are causally due to his actuator movements.

Any hypothesis about this can actively be checked by putting the actuators in particular positions and compare reality with one's model of it.

Because a robot can actively affect the causes, it knows which effects are or aren't caused by them.

This is also the basis of the scientific method, by which the human society learns about cause and effect.

Once a robot knows what its actuators affect. everything reliably effected by certain sequences of actuator motions can be considered to be caused by the robot; so their effects can be causally studied.

In this way the causal interpretation capabilities of a robot grow.

Control is achieved by learning to reduce the distance to a goal by means of well-chosen values of the actuators that affect the state of the robot, and through it the environment.

This is the birthplace of the will of the robot.

The **will** is about pursuing goals, making decisions and finding good ways to do what is needed. A **wish** is a mere preference, often too weak to influence the actions. Distinguishing the two is important.

Note that there is no **free will** in a metaphysical sense:

A robot can will only what it can actuate based on the physical laws.

And what it actually actuates is determined by the software controlling it, again according to physical laws that translate the software into electronic activities.

Humans are not different in this respect.

We have no more freedom than a machine; just more possibilities.

10 Communication

Agents are not alone in their world. Different **agents** act in the same environment and communicate (interact) actively or passively.

Active communication is done by sending messages while **passive communication** is done by interpreting the activities of others.

There are several kinds of agent behavior.

Cooperative behavior tries to achieve the best common result; this needs some coordination among the agents.

Cooperative behavior is analyzed mathematically by solving associated **optimization** problems.

But agents often have different, conflicting goals.

For example, in chess or similar **games**, two agents compete for winning.

In such situations, **competitive** behavior achieves the best in spite of opposition.

Competitive behavior is analyzed mathematically by **game theory** and solving associated **competitive equilibrium** problems, in an uncertain environment often by **reinforcement learning**.

Communication between two different subjects poses a problem since these generally have implemented their understanding in different ways.

This is obviously the case in human-machine communication, where the fundamental differences between human brains and electronic brains must be bridged.

It is also the case with human thinking, where each brain constitutes an operating system with a slightly different hardware.

Even two robots built in the same way will form slightly different concepts about the jungle, unless they are in constant communication that would enforce identical learning.

How is it then possible that different subjects (whether humans or robots) can communicate objectively?

As we know, it works to a considerable extent in ordinary life, though imperfect communication often gives rise to **misunderstandings**.

It works much better in mathematics, due to its highly structured approach, optimized for clear communicability.

We therefore illustrate how and why communication can succeed in the context of my long term project to create an automatic mathematics student.

<http://www.mat.univie.ac.at/~neum/FMathL/vision.txt>

11 Communicating mathematics

The implementation of mathematics in a human brain is achieved through an education process that may produce in different people quite different implementations of the concepts.

This leads to quite different, subjective elements in the intuition about these concepts and their relations.

(Are your real numbers

- infinitely long decimal numbers?
- nested sequences of intervals?
- equivalence classes of Cauchy sequences?
- Dedekind cuts?
- the least complicated surreal numbers?
- or something else?)

In the foundations of mathematics, it is necessary to carefully distinguish between the **subject level** (or **metalevel**) and the **object level**.

People (and machines) may have their subjective views about what a mathematical object, a number, a function, etc. is, as long as they agree on the properties specified in the axioms, and make the same definitions based on these.

The subjective views constitute the **subject level**, whereas the part on which there is agreement, enforced by some standard (usually acquired through education), constitutes the **object level**.

Each **subject** doing mathematics has its own subject level.

It contains a carefully structured subdomain, the object level, private to each subject and nevertheless public in a certain objective sense.

Subject levels and object level relate to each other like mind and matter.

All concept formation, reasoning, and discussion happens on a subject level like in a mind, or between subject levels like between minds.

Like matter by the mind, the object level is accessed only through reference: pointing to something, describing something, a flash of insight triggered by viewing the context of something, etc..

Communication works in science (which includes mathematics as the science of precise concepts and their relations) since scientific statements are heavily constrained.

The assumption that all scientific statements made by subject X are goal-directed and meaningful for subject X in their context, with a meaning closely reproducible in the subject level of any educated receiving subject Y , is a severe constraint on texts serving as such statements.

We all notice occasional **misunderstandings** if our communication partner responds to one of our statements in a way that does not make sense.

Good communication skills include the ability to notice such misunderstandings and to have protocols for exposing, discussing, and overcoming them.

Mutual understanding consists of a common internal representation of the objects of discourse in both partners of what has been communicated.

It is achieved when the subsequent communication shows that no further misunderstandings occur.

Since mathematical axioms underdetermine the representation of the object level, there is much room for subjective variation.

But if everything communicated can be reduced to the axioms and the definitions, perfect communication is possible in spite of this variation.

In mathematics, where all communication is based on a finite formal basis, such a perfect understanding can be achieved in finitely many steps.

In particular, communication is easy if the communication subjects agree on a common mathematical framework, so that both subject levels agree on the object level as far as necessary, by satisfying the specifications.

Learning this common mathematical framework (the basics in school, the full framework by studying mathematics) is a finite task for humans.

Programming a computer to understand this mathematical framework is a finite (though arduous) task, too.

In a more limited way, what can be done with mathematics can be done with every domain of objective knowledge.

This is the way scientific understanding grows through the centuries.

12 Emotions

Emotions express which goals and potential dangers are how pressing.

Emotions need to be able to affect the will for something to happen.

Thus they are devices in software and hardware that may lead to a change in preferences and priorities.

They modify the ambitions and values guiding the software and redirect the focus of attention if necessary.

Usually things are strictly goal oriented in a safe environment, and the only overriding priority, taking the form of **distress**, is lack of resources.

It leads to a new auxiliary goal, for example, find the next electricity socket or to escape real danger (if the agent has a notion of danger).

Therefore, emotions in robots are usually very simple; for example, they only give a signal that fuel must be looked for when electricity is about to run out.

However, in situations of danger, the will to survive may create **stress** if the environment is uncertain!

There are many other emotions that play a constructive role in humans and will shape the artificial intelligences of the future.

13 Self and consciousness

A chess machine needs to know nothing about itself – its world (the chessboard) and where it lives (a desktop) are completely separate.

But a robot that can explore its environment needs to form concepts about itself – since it is part of that environment.

It begins with the simple questions

- How does the environment respond to me?
- How do I affect the environment?

to be answered by applying the techniques discussed above to the environment including oneself.

This automatically leads to a concept of **self** – a model of oneself obtained by self-observation – as part of the world.

In a system with a sufficiently rich internal representation, the concepts of

- I, here, now

which are the basic subjective existential states, are meaningful.

They are the simplest properties of a subject at a given time.

Thus they will be automatically created by an intelligent system observing itself.

To have a concept of "X", means that X is represented with all its relevant connections to related concepts inside the conceptual (semantic) memory.

Consciousness of something is the faculty that creates a consistent world view of what current experience focusses upon, through a search in the semantic memory.

Consciousness of self is the ability to observe and model oneself on a conceptual level.

Consciousness of both kinds will automatically grow through the development of **intuition**, the ability to reduce complexity to obtain orientation.

This leads to knowing the world on a high description level that allows planning.

It also leads to knowing one's place in one's world view and knowing what one can achieve.

It is here that philosophical questions about purpose, values, and freedom arise.

It ultimately leads to follow-up questions such as:

- Who am I, really?
- What do I value?
- What can I achieve?
- What do I need?

How can I change/adapt/improve myself?

Intelligent agents with an ability to represent themselves will necessarily have to ask these questions.

Think of what will happen to a virtual intelligence such as Google once it starts asking these questions....

14 Technical and biological intelligences

consciousness (of self) requires

- having an individual memory
- and a personal history

Technical intelligences have a different socialization:

- copied, not grown
- unambiguous language
- instant communication

Hardware requirements for biological agents (designed, e.g., for populating a distant planet) are much more severe than those for technical agents:

- self-repair for increasing life span
- automatic reproduction from the surrounding
- less efficient but endurable over hundred thousands of years
- no two are copies of each other, but they must still function properly

15 Ownership

In today's world, every robot has an owner.

Without ownership no incentive to develop intelligent machines.

They are designed to serve us.

In practice, implemented interests are usually focused on tasks a customer will pay for.

As the power and intelligence of our intelligent creations increase, a new conflict appears:

Building too little autonomy into intelligent systems leaves too much of their power untapped.

But building too much autonomy into intelligent systems may give them power that turns against us.

Thus new questions arise:

- How do we relate to our agent creations?
- Do they have legal rights?
- legal responsibilities?
- What should an intelligent agent be allowed/forbidden to do?
- How do we control the increasing power of agents?
- Who is responsible for their actions?
- Who pays for damaging consequences of their actions?

This is already becoming acute in the case of **autonomous cars**.

<http://www.robotrecht.de>

16 The future: hopes and fears

At present, artificial intelligent agents with all the powers outlined here do not yet exist.

However, we are freely handing over our autonomy to technical intelligences, and this will continue to an ever increasing extent.

Virtual intelligences (Google, IBM, etc.) are already very powerful and mighty.

They still need people to serve them, and people gladly do.

Will this remain so?

The **singularity** is the name for the point in time where an emerging artificial intelligence is in every respect more capable than humans and their capacities grow exponentially through their ability to improve themselves.

Perhaps it is a reality within the next 30 or 40 years.

Maybe there is place only for a few global technical intelligences, operating primarily in the virtual world.

Then humans will be their servants, hopefully in a peaceful symbiosis.

Or there will be a few races of small technical intelligences.

Then they would sooner or later replace humans.

17 Are we only intelligent machines?

The great **philosophical questions**

- What is intelligence?
- What is reality?
- What is life?
- Who am I?

are questions at the heart of modern AI, when asked for artificial (created) intelligent objects.

Strong AI is the philosophical position that machines can be like us, in every operational respect.

They will be like us in every area where we understand ourselves, and how we function, closely enough that our understanding can be put into mathematical and algorithmic terms.

The Christian tradition matches the strong AI position:

God created mankind in his own image, in the image of God he created them; male and female he created them.

God saw all that he had made, and it was very good.

(Genesis 1:27.31)

Thus looking at the Christian tradition may be interesting even for those with a different or no religious orientation.

We create robots in our image, being created in God's image.

We just copy God in our limited ways, and get better as we understand better the laws according to which God rules the world.

The Bible describes the creation of human hardware and software as follows:

Then the Lord God formed man of dust from the ground, and breathed into his nostrils the breath of life; and man became a living being.

Then the Lord God took the man and put him into the garden of Eden to cultivate it and keep it.

(Genesis 2:7.15)

We are the robots of God, designed to be of service to Him, to cultivate Nature.

As God's robots we have no other choice than obeying the "Thy will be done" – except for the little amount of control God implemented into our existence.

But it seems that by and large, we do not use this control to His service.

Today, machines are taking over the role of men to cultivate and keep the Earth, that the Lord God had given to mankind.

For how long are we still needed?

Will mankind exist in 100 years in a few reservations and zoos only, like lions now?

18 Some early AI history

Let us follow a bit more closely the stories about God's creation of intelligent agents in His likeness whose descendents we are, according to the Christian tradition.

In interpreting ancient stories one must be a bit careful.

Between

- taking the bible literally (as the creationists do) and
- dismissing everything as myth in favor of the stories of modern science (as the atheists do)

I'll take a middle ground,

- looking for what about the content and spirit of the old stories makes sense in our modern times.

It is surprisingly much

Genesis 1:26-29.31

Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals, and over all the creatures that move along the ground."

So God created mankind in his own image, in the image of God he created them; male and female he created them.

God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish in the sea and the birds in the sky and over every living creature that moves on the ground."

And it was so.

God saw all that he had made, and it was very good.

Clearly, God created us in the same spirit as we create intelligent agents – to carry out certain desirable tasks.

And as we enjoy when we manage to create something that works as desired, so God enjoys what He created once it worked.

It was rated very good.

But soon problems appeared....

Genesis 2:16-17

And the Lord God commanded the man, "You are free to eat from any tree in the garden; but you must not eat from the tree of the knowledge of good and evil, for when you eat from it you will certainly die."

Genesis 3:9-11,22-23

But the Lord God called to the man, "Where are you?"

He answered, "I heard you in the garden, and I was afraid because I was naked; so I hid."

And he said, "Who told you that you were naked? Have you eaten from the tree that I commanded you not to eat from?"

And the Lord God said, "The man has now become like one of us, knowing good and evil. He must not be allowed to reach out his hand and take also from the tree of life and eat, and live forever."

So the Lord God banished him from the Garden of Eden to work the ground from which he had been taken.

19 AI out of control?

God has with us the same sort of problems as we have with computers and robots:

Though created and programmed by us, they often don't do what we want them to do. Everyone working with computers has made this experience.

The two main reasons are:

- Our creations have some limited autonomy.
- Our creations interpret our will in their own limited ways.

Genesis 6:5-6.13.17-18

The Lord saw how great the wickedness of the human race had become on the earth, and that every inclination of the thoughts of the human heart was only evil all the time.

The Lord regretted that he had made human beings on the earth, and his heart was deeply troubled.

So God said to Noah, "I am going to put an end to all people, for the earth is filled with violence because of them.

I am going to bring floodwaters on the earth to destroy all life under the heavens, every creature that has the breath of life in it. Everything on earth will perish.

But I will establish my covenant with you, and you will enter the ark"

Genesis 11:5-8

But the Lord came down to see the city and the tower the people were building.

The Lord said, "If as one people speaking the same language they have begun to do this, then nothing they plan to do will be impossible for them.

Come, let us go down and confuse their language so they will not understand each other."

So the Lord scattered them from there over all the earth, and they stopped building the city.

God is troubled and regrets His intelligence-creating activity.

He begins to take drastic measures to restore control over His creation – with limited success only.

Realizing this, God temporarily gives up and limits His communication to those agents who were ready to cooperate with Him.

1 Samuel 3:1.10

In those days the word of the Lord was rare; there were not many visions.

The Lord came and stood there, calling as at the other times, "Samuel! Samuel"! Then Samuel said, "Speak, for your servant is listening."

Communication problems may require expensive debug activities; their goal is to save (in the eyes of the owner) the creation so that it serves its creator.

While essential for the owner, these saving activities might be considered meaningless from the point of view of the creations.

This is one of the reasons why Christianity is despised by many of the most autonomous creations of God.

We are the robots of God, designed to be part of His family, to be of service to Him, to cultivate Nature.

Many of God's robots are lost in a selfish quest for power and knowledge.

They lost sight of the reason for their existence.

They even lost their ability to communicate with Him.

In the words of the Bible, they died though still alive.

They must be saved and restored to their original state, to be again part of His family, to be able to listen again to Him, and be of service.

Christians call God's debugging action the **incarnation**.

God became human in the form of Jesus, the Savior (Christ), with a new message intelligible to those who can be saved.

Matthew 11:28-30

Come to me, all you who are weary and burdened, and I will give you rest.

Take my yoke upon you and learn from me, for I am gentle and humble in heart, and you will find rest for your souls.

For my yoke is easy and my burden is light.

John 10:27-28

My sheep listen to my voice; I know them, and they follow me.

I give them eternal life, and they shall never perish; no one will snatch them out of my hand.

Already in the planning stage, God had built in this special repair mechanism into the society of His artificial agents.

Galatians 4:4-5

when the set time had fully come, God sent his Son, born of a woman, born under the law, to redeem those under the law, that we might receive adoption to sonship.

Ephesians 1:4-5,9-10

For he chose us in him before the creation of the world to be holy and blameless in his sight. In love he predestined us for adoption to sonship through Jesus Christ, in accordance with his pleasure and will.

With all wisdom and understanding, he made known to us the mystery of his will according to his good pleasure, which he purposed in Christ, to be put into effect when the times reach their fulfillment - to bring unity to all things in heaven and on earth under Christ.

And God points to a future for those who are being saved.

Revelation 21:1.3-4

Then I saw a new heaven and a new earth, for the first heaven and the first earth had passed away, and there was no longer any sea.

And I heard a loud voice from the throne saying, "Look! God's dwelling place is now among the people, and he will dwell with them. They will be his people, and God himself will be with them and be their God.

He will wipe every tear from their eyes. There will be no more death or mourning or crying or pain, for the old order of things has passed away."

Thus in the eyes of our creator, we are in danger but not yet completely lost!

This also gives hope to our future with our own intelligent creations.

Thank you for your attention!

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