

Master Of Real Estate Management

Prepared by
Dr. Al Montaser Abuhussein

Artificial Intelligence in Business

Lecture 9



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Chapter
07

Technological Singularity and Ethical Issues of AI
(Part 1)



Chapter

07

Learning Objectives

- ☐ Explain the concept of technological singularity and why it matters for business and society.
- ☐ Analyze early intellectual roots of machine intelligence from Thornton, Butler, Adams, Turing, Good, Minsky, Vinge, and von Neumann.
- ☐ Understand von Neumann's theory of self-reproducing automata and its connection to machines, biology, and recursive improvement.
- ☐ Explain formal aspects of singularity debates, including secrecy, AGI visibility, plausible reasoning, Cox's axioms, and Bayesian reasoning.

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1. Introduction

We will begin with a long historical concern: what if machines become more capable than humans?

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What Is Technological Singularity?

- Technological singularity is the possibility of achieving artificial general intelligence that surpasses human intelligence.
- It is treated as one of the major paradigms affecting humanity's future.
- We emphasize that singularity remains uncertain: there are many opinions, but few concrete studies that quantify when or how it may occur.
- From a business perspective, the question is not only whether AGI will happen, but how firms should prepare for powerful AI systems.
- Singularity debates combine technology, philosophy, probability, ethics, and governance.

Business meaning

Even if singularity remains uncertain, advanced AI already affects strategy, risk, work, privacy, decision-making, and competition.

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Richard Thornton and Early Machine Anxiety

- In 1847, Richard Thornton reflected on a mechanical calculator with four basic functions.
- He imagined that more advanced machines might one day correct their own defects and generate ideas beyond human understanding.
- This early statement shows that concerns about machine thinking are much older than modern computing.
- The historical significance lies in the fear that machines could move beyond mere calculation toward autonomous improvement.
- Thornton's reflection anticipates later concerns about machine self-improvement and superintelligence.

Teaching note

Students should notice that AI fear did not begin with ChatGPT or modern robotics; it has roots in early mechanical computation.

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Samuel Butler: Machines Advancing Faster Than Humans

- Samuel Butler, writing as Cellarius, compared machine progress with the slow development of animal and vegetable kingdoms.
- He argued that machines had developed dramatically in a very short historical period.
- Butler questioned whether human intellectual or physical powers could advance enough to offset machine development.
- This introduced an early evolutionary analogy: machines may evolve faster than biological humans.
- His essay later influenced discussions about machines becoming dominant or self-directed.

Conceptual point

Machine evolution in this context means technological improvement over time, not biological reproduction.

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Henry Adams and the Acceleration of Thought

- In 1909, Henry Adams proposed a physical theory of history based on acceleration of thought.
- He interpreted history as a process moving toward a limit or transformation point.
- He speculated that thought might reach the limits of its possibilities in the near future.
- Adams compared future transformation with major phase changes such as water becoming steam or a worm becoming a butterfly.
- This historical idea connects singularity with acceleration, discontinuity, and transformation.

Business analogy

Digital transformation can also feel like a phase change: companies do not merely improve; they become structurally different.

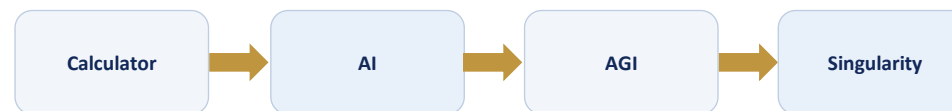
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From Mechanical Calculators to AGI

- We will show a progression from mechanical calculation to speculation about machine self-improvement.
- Early thinkers saw machines as tools, but also imagined that machines could become more autonomous.
- Modern AI adds learning, adaptation, pattern recognition, language processing, and decision support.
- AGI would go further by performing broad intellectual tasks across domains.
- Business leaders should understand that today's narrow AI is different from AGI, but both raise governance questions.

Real estate application

Narrow AI may estimate property values; AGI would theoretically reason across valuation, law, urban planning, finance, ethics, and negotiation.



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2. Turing and the Technological Singularity

Turing and later AI pioneers developed the intellectual basis for thinking about machine intelligence and recursive self-improvement.

Chapter
07**Turing's View of Machine Intelligence**

- In 1951, Alan Turing discussed the possibility that machines could intellectually surpass human beings.
- He suggested that once a machine's thinking method begins, machines may overcome human weaknesses.
- This reflects an early idea of machine intelligence becoming stronger than human intelligence.
- Turing's work is foundational because it made machine intelligence a scientific and computational question.
- His ideas influenced later thinking about whether machines could control their own improvement.

Study focus

Turing is important not only for the Turing Test, but also for the broader idea that machines may become intellectually powerful.

Chapter
07**The Turing Test and Behavioral Intelligence**

- The Turing Test asks whether a machine can imitate human conversation convincingly enough that an evaluator cannot reliably identify it as a machine.
- The test focuses on observable behavior rather than inner consciousness.
- It shifted the debate from metaphysical questions to operational performance.
- Modern conversational AI revives many Turing-related questions.
- However, passing conversational tests does not necessarily prove understanding, consciousness, or ethical judgment.

Business link

Customer-service chatbots may appear intelligent, but managers must ask whether they understand, reason, or simply generate plausible responses.

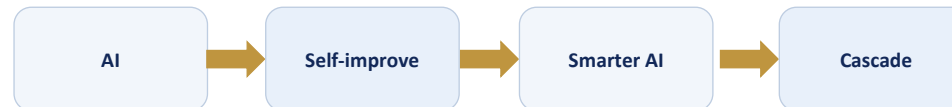
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I. J. Good and Intelligence Explosion

- In 1965, I. J. Good introduced the idea of an intelligence explosion.
- He suggested that machines slightly smarter than humans could improve their own designs.
- Recursive self-improvement could create a cascade of rapidly increasing intelligence.
- The first improvements may be small, but later improvements could accelerate.
- This idea is central to modern singularity thinking.

Key mechanism

Machine improves itself
Improved machine improves itself faster
Intelligence growth accelerates



Chapter
07**Minsky and Self-Improving Programs**

- Marvin Minsky argued that once programs gain genuine self-improvement capacity, rapid evolution may begin.
- As machines improve both themselves and their models of themselves, phenomena associated with consciousness, intuition, and intelligence may appear.
- Minsky emphasized that crossing such a threshold could change the world.
- His point is not only about computational power but about recursive improvement and self-modeling.
- This remains a major question in AGI and advanced AI safety.

Business implication

Self-improving AI systems would require governance far beyond normal software updates.

Chapter
07**Vernor Vinge and Popularization of Singularity**

- The term technological singularity became popular through Vernor Vinge in the 1980s and 1990s.
- Vinge wrote that humans may soon create intelligences greater than themselves.
- He argued that when this happens, human history would reach a kind of singularity.
- Vinge later predicted that superhuman intelligence could end the human era shortly after its creation.
- His claims are controversial, but they shaped modern public and academic debates.

Teaching note

Vinge's role is important because he turned technical concerns into a wider cultural and futures debate.

Chapter 07

From Turing to Singularity: Core Chain of Ideas

- Turing introduced the possibility of machine intelligence and machine intellectual superiority.
- Good developed the concept of intelligence explosion through recursive self-improvement.
- Minsky emphasized self-improving programs and the emergence of intelligence-like phenomena.
- Vinge popularized the idea that superhuman intelligence would mark a singular historical break.
- The chain of ideas links AI capability, self-improvement, acceleration, and uncertainty.

Concept map

Turing
Good
Minsky
Vinge



Chapter
07**Managerial Meaning of Intelligence Explosion**

- For business leaders, intelligence explosion is not only a science-fiction topic.
- It raises questions about AI controllability, risk, competitive pressure, and governance.
- Even narrow AI systems can produce unexpected outcomes if deployed without oversight.
- Self-improving systems would increase the need for transparency, auditability, and human control.
- Organizations should build AI governance capabilities before deploying highly autonomous systems.

Real estate warning

Autonomous pricing, tenant screening, or investment systems should not self-adjust without human audit and ethical controls.

3. Von Neumann and the Technological Singularity

Von Neumann's automata theory provides a deep conceptual foundation for self-replication, universal machines, and evolving complexity.

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Von Neumann's Automata Theory

- John von Neumann delivered an important lecture in 1948 on the general and logical theory of automata.
- He defined automata in general mathematical terms rather than only as physical machines.
- An automaton can be understood as machinery whose behavior can be defined precisely.
- Von Neumann wanted a theory of the design and functioning of such machines.
- His work remains relevant because it applies to computers, self-replication, and biological systems.

Study focus

Von Neumann's ideas are abstract, which makes them timeless and applicable beyond the machines of his era.

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Self-Reproducing Automata

- Von Neumann analyzed the structure required for an automaton complex enough to reproduce itself.
- Self-replication requires more than ordering a machine to copy itself.
- A machine must have a description of itself and a process for transmitting that description.
- Von Neumann showed that self-reproducing systems require a structured relationship between instructions, construction, copying, and control.
- This idea later appeared strikingly similar to biological genetic systems.

Key idea

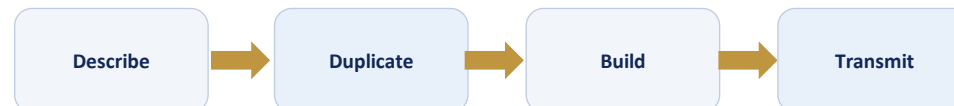
Self-replication requires both machinery and instructions.

Chapter
07**The Three Actions for a Dynasty of Machines**

- Von Neumann argued that anyone creating a dynasty of machines must perform three actions.
- First, give the machine a detailed and complete description of itself.
- Second, give the machine a second description of itself as a machine already containing the first description.
- Third, order the machine to build another machine fitting the second description and pass the final order to the new machine.
- This logical structure explains why self-replication requires layered descriptions and instruction copying.

Simplified process

Describe
Duplicate
Build
Pass instructions



Chapter
07**Four Components of Self-Reproducing Automata**

- Component A is an automatic factory that processes raw materials into outputs based on written instructions.
- Component B is a duplicator that copies written instructions.
- Component C is a controller that coordinates A and B by passing instructions and managing outputs.
- Component D writes instructions containing a full specification of the system.
- Together, these components form a logically necessary and sufficient structure for self-replication.

Components

A: Factory
B: Duplicator
C: Controller
D: Instructions

4. State of Play and Formal Aspects

This section argues that if AGI is achieved, keeping it secret or fully controlled may be unrealistic.

Chapter 07

State of Play: AGI and Control

- For technological singularity to occur, AGI must first be achieved.
- The chapter argues that if AGI were achieved, keeping it secret and permanently under human control would be extremely difficult.
- Technological secrets often become visible through people, institutions, competition, leakage, or replication.
- Control becomes harder when systems are powerful, distributed, and valuable.
- This makes governance, transparency, and international coordination important.

Business implication

Organizations should assume that powerful AI capabilities will diffuse across markets, competitors, suppliers, and regulators.

Chapter 07

The Problem of Secrecy

- We use a cryptology-style principle: secrets are difficult to keep as the number of people who know them increases.
- Even if an organization wants to keep AGI secret, employees, partners, governments, competitors, or users may reveal or replicate knowledge.
- Historically, powerful ideas rarely remain hidden forever.
- Secrecy is therefore a weak governance strategy for transformative AI.
- Responsible governance should not depend on the assumption that AGI can be hidden.

Governance point

Security matters, but secrecy alone is not an AI safety strategy.

Chapter 07

Hippasus and the Discovery of Irrational Numbers

- We use the story of Hippasus of Metapontum as an analogy for forbidden knowledge becoming public.
- The Pythagoreans believed that reality could be explained through natural numbers and ratios.
- The discovery of incommensurable or irrational magnitudes challenged this worldview.
- Legend says that revealing this discovery brought severe punishment.
- The point is that even knowledge considered dangerous or disruptive is difficult to suppress.

Teaching analogy

AGI would be like a disruptive mathematical truth: once discovered, it may be impossible to hide permanently.

Chapter 07

The Button Problem

- We raise the question of whether people would activate AGI if they had the chance.
- A survey mentioned in the text suggested that many people would push the button to start AGI.
- This illustrates a problem of human curiosity, ambition, competition, and risk-taking.
- Even if some actors choose restraint, others may proceed.
- AI governance must therefore address incentives, not only technical capability.

Business analogy

Firms may adopt risky AI systems because competitors are moving fast, even when long-term risks are unclear.

Chapter 07

Why Secrecy and Voluntary Restraint May Fail

- AGI development involves visibility, incentives, competition, and curiosity.
- Knowledge tends to diffuse when it is valuable or transformative.
- Individuals or organizations may activate powerful systems for prestige, profit, national advantage, or scientific ambition.
- Therefore, AI safety cannot rely only on goodwill.
- Robust governance requires institutions, standards, monitoring, incentives, and accountability.

Control framework

Capability
Visibility
Incentives
Governance

Capability

Visibility

Incentives

Governance

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5. Proposed Solution

We move from singularity speculation to reasoning under uncertainty: how can we judge what is plausible?

Chapter
07**Why Reasoning Under Uncertainty Matters**

- Technological singularity is uncertain: there is no complete proof that it will or will not occur.
- Managers, scientists, and policymakers must often make decisions under uncertainty.
- We turn to Polya's plausible reasoning as a way to evaluate conjectures.
- Plausible reasoning does not provide certainty, but it helps judge whether a hypothesis becomes more credible.
- This approach is important for AI because many future claims cannot be proven deductively.

Business meaning

Strategic AI decisions often depend on incomplete evidence, probability, and plausible inference rather than certainty.

Chapter
07**Polya and Plausible Inference**

- Polya argued that mathematical discovery often depends on non-deductive inference and guesswork.
- These guesses are not always correct, but they guide problem-solving.
- Polya called the guiding principles patterns of plausible inference.
- Such reasoning supports discovery in science, law, medicine, common sense, and daily life.
- AI and business strategy both require plausible reasoning because managers rarely have complete certainty.

Study focus

Plausible reasoning helps us move from evidence to informed belief, not from evidence to absolute proof.

Chapter
07**Pattern A: Consequence Verification**

- Consequence verification makes a conjecture more credible when a predicted consequence is observed.
- Example: the conjecture 'it rained last night' becomes more credible when we observe 'the street is wet'.
- This does not prove the conjecture because other causes may exist.
- It only increases credibility based on observed evidence.
- In AI strategy, observed evidence can increase confidence in a model, trend, or future scenario.

Real estate example

If rental inquiries increase after a new transport station opens, the conjecture that the station increased demand becomes more credible.

**Chapter
07****Pattern B: Successive Verification**

- Successive verification occurs when multiple consequences support the same conjecture.
- The value of new evidence depends on whether it differs meaningfully from prior evidence.
- Evidence from different contexts can strengthen a conjecture more than repeated evidence from the same context.
- Polya's example is that observing black crows in distant regions strengthens the hypothesis that all crows are black.
- In business, repeated evidence across markets or segments increases confidence in a strategic conclusion.

Real estate example

Rising rental demand across several neighborhoods strengthens the belief that the market is shifting, not just one district.

Chapter
07**Pattern C: Verification of Improbable Consequences**

- Some consequences provide stronger evidence because they are unlikely to occur otherwise.
- The conjecture 'it rained last night' is more credible if the roof is leaking than if only the street is wet.
- Improbable evidence has stronger diagnostic value.
- In business analytics, rare but highly informative indicators can strongly support a hypothesis.
- Managers should distinguish weak signals from strong evidence.

Real estate example

A sudden rise in premium office inquiries during a weak market may strongly signal a specific new demand driver.

Chapter
07**Pattern D: Inference by Analogy**

- Inference by analogy increases credibility when a related conjecture is proven true.
- Polya's example compares a sphere minimizing surface area for volume with a circle minimizing perimeter for area.
- Analogies can guide reasoning, but they are not proof.
- In business, managers often learn from analogous industries, markets, or technologies.
- Analogical reasoning should be used carefully because contexts may differ.

Real estate example

Real estate platforms can learn from e-commerce recommendation systems, but property decisions are higher value and require greater trust.

Chapter
07**Demonstrative vs Plausible Reasoning**

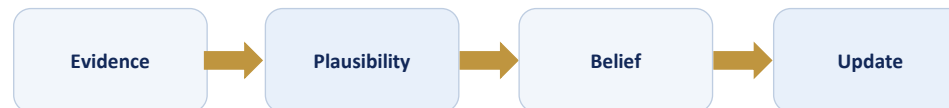
- Demonstrative reasoning produces conclusions that are logically certain if the premises are accepted.
- Plausible reasoning produces conclusions that become more or less credible.
- Demonstrative reasoning is impersonal, universal, self-sufficient, and definitive.
- Plausible reasoning is provisional and open to revision when new information appears.
- AI risk analysis and future forecasting depend heavily on plausible reasoning.

Comparison

Demonstrative = certainty

Plausible = credibility

Business strategy = often plausible



Chapter
07**Modus Tollens: Demonstrative Reasoning**

- Modus Tollens follows the form: If A then B; not B; therefore not A.
- Example: if it rains, the streets become wet; the street is not wet; therefore it has not rained.
- This is demonstrative because accepting the premises forces the conclusion.
- The conclusion has the same logical status as the premises.
- Such reasoning is powerful, but many real-world situations are not so certain.

Study note

Logical certainty is rare in business decision-making because evidence is incomplete and causes are multiple.

Chapter
07**Heuristic Syllogism: Plausible Reasoning**

- Plausible reasoning may follow: If A then B; B is observed; therefore A is more credible.
- Example: if it rains, the street becomes wet; the street is wet; therefore it may have rained.
- This conclusion is not certain because the street may be wet for other reasons.
- The conclusion is weaker but still useful.
- This pattern reflects how humans and organizations reason in uncertain environments.

Real estate analogy

If property inquiries increase after a marketing campaign, the campaign may have worked, but other market factors may also explain the increase.

Chapter 07

Why Plausible Conclusions Are Provisional

- Plausible conclusions depend on available information at a given moment.
- New evidence can increase, reduce, or overturn credibility.
- This makes plausible reasoning dynamic and revisable.
- Business decisions should therefore include monitoring and updating mechanisms.
- AI models also operate under uncertainty and should be updated as new data appear.

Managerial lesson

Treat AI predictions as updated beliefs, not permanent truths.

Chapter
07**From Classical Logic to Plausible Reasoning**

- Classical logic is powerful for certainty, but business and science often involve uncertainty.
- The chapter argues for extending reasoning to include plausible, conjectural, or hypothetical reasoning.
- Plausible reasoning reflects common sense and sophisticated scientific reasoning.
- This is important in medicine, law, business, philosophy, and AI.
- AI systems and managers both need methods for reasoning when information is incomplete.

AI connection

Modern AI often uses probabilistic reasoning because real-world data are uncertain, noisy, and incomplete.

Chapter 07

Cox's Axioms and Degrees of Belief

- Cox's axioms allow degrees of plausibility to be represented by real numbers.
- Each proposition can be assigned a degree of credibility based on available information.
- When new evidence arrives, credibility should be updated.
- This makes it possible to model plausible reasoning quantitatively.
- Cox's framework connects plausible reasoning with probability theory.

Study focus

Probability can be understood as extended logic for uncertain reasoning.

Chapter 07

Product Rule and Sum Rule

- Based on Cox's axioms, probability rules can model reasoning under uncertainty.
- The product rule connects the probability of combined propositions with conditional probabilities.
- The sum rule connects a proposition with its negation.
- These rules allow plausible reasoning to be treated mathematically.
- The chapter uses this to show that deductive reasoning and plausible reasoning can both be modeled probabilistically.

Simplified meaning

Probability is not only statistics; it can formalize degrees of belief.

Chapter
07**Probabilities as Extended Logic**

- The chapter concludes that logical reasoning and plausible reasoning can be modeled in probabilistic terms.
- Modus Ponens and Modus Tollens appear as extreme cases where conclusions are certain.
- Weak or plausible syllogisms become probability updates rather than absolute conclusions.
- This provides a bridge between logic, uncertainty, and AI reasoning.
- Such reasoning is essential for AGI debates because the future cannot be known with certainty.

Real estate example

AI valuation does not produce absolute truth; it produces a probability-informed estimate based on evidence.

**Chapter
07****Chapter 7: Part 1 - Summary**

- Early AI research introduced the idea that machines could eventually think, learn, and potentially surpass human intelligence.
- The concept of the Technological Singularity, inspired by Alan Turing and John von Neumann, highlights the possibility of self-improving intelligent systems.
- Artificial General Intelligence (AGI) raises important challenges related to control, transparency, safety, and governance.
- Reasoning approaches such as plausible reasoning, demonstrative reasoning, Cox's axioms, and probabilistic logic can improve AI decision-making under uncertainty.
- Responsible AI development requires balancing technological innovation with ethical principles, human oversight, and effective governance.

Chapter
07**Discussion Questions**

- ❖ Can machines ever surpass human intelligence? Why or why not?
- ❖ What is the Technological Singularity, and what opportunities and risks could it create?
- ❖ How did Alan Turing and John von Neumann influence the development of Artificial Intelligence?
- ❖ What are the main challenges of developing and controlling Artificial General Intelligence (AGI)?
- ❖ Why is probabilistic reasoning important for improving AI decision-making?
- ❖ What ethical and societal issues should organizations and governments consider as AI becomes more advanced?





Thank You