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# Artificial Intelligence *CS361*





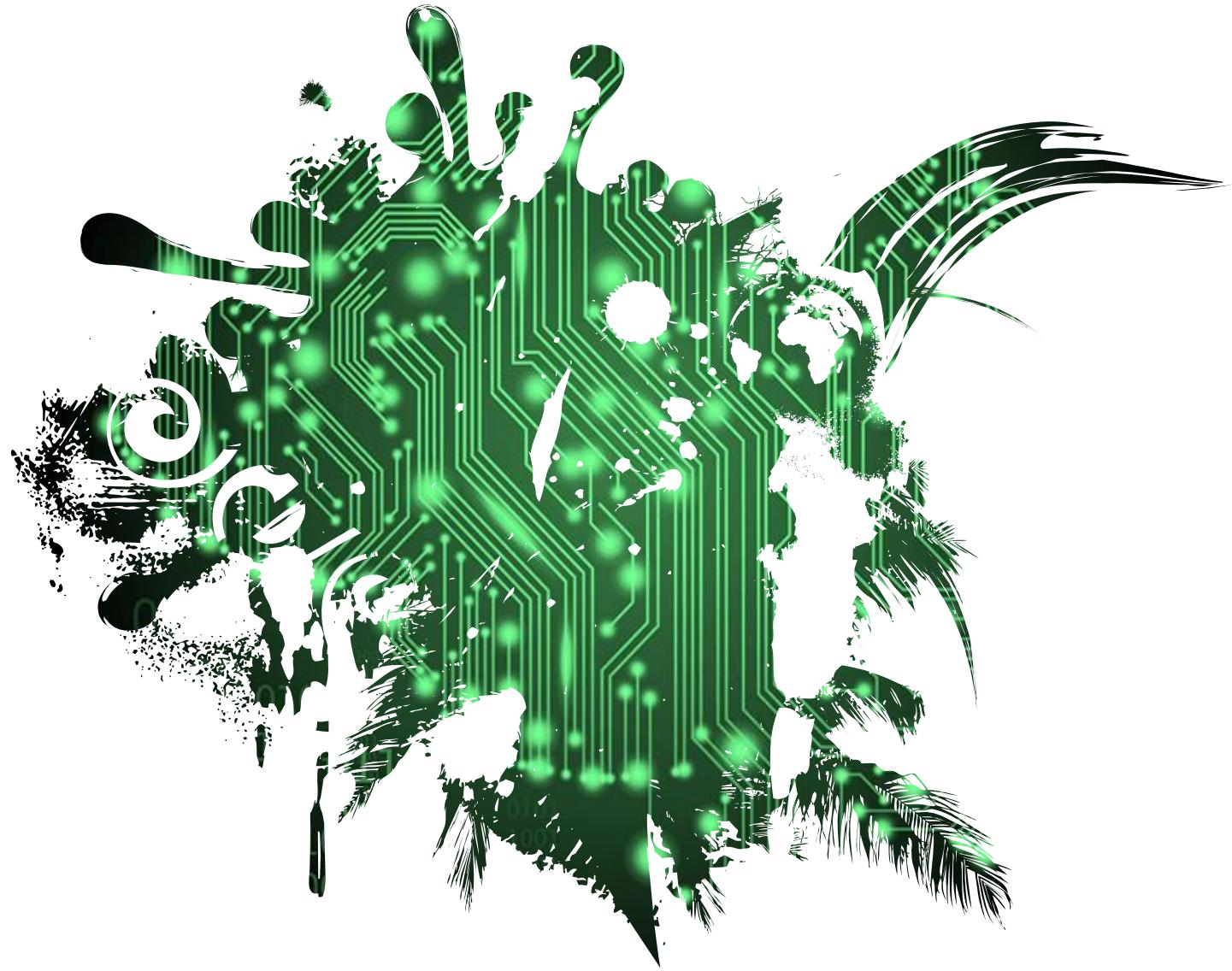
# Introduction

## *Chapter 1*

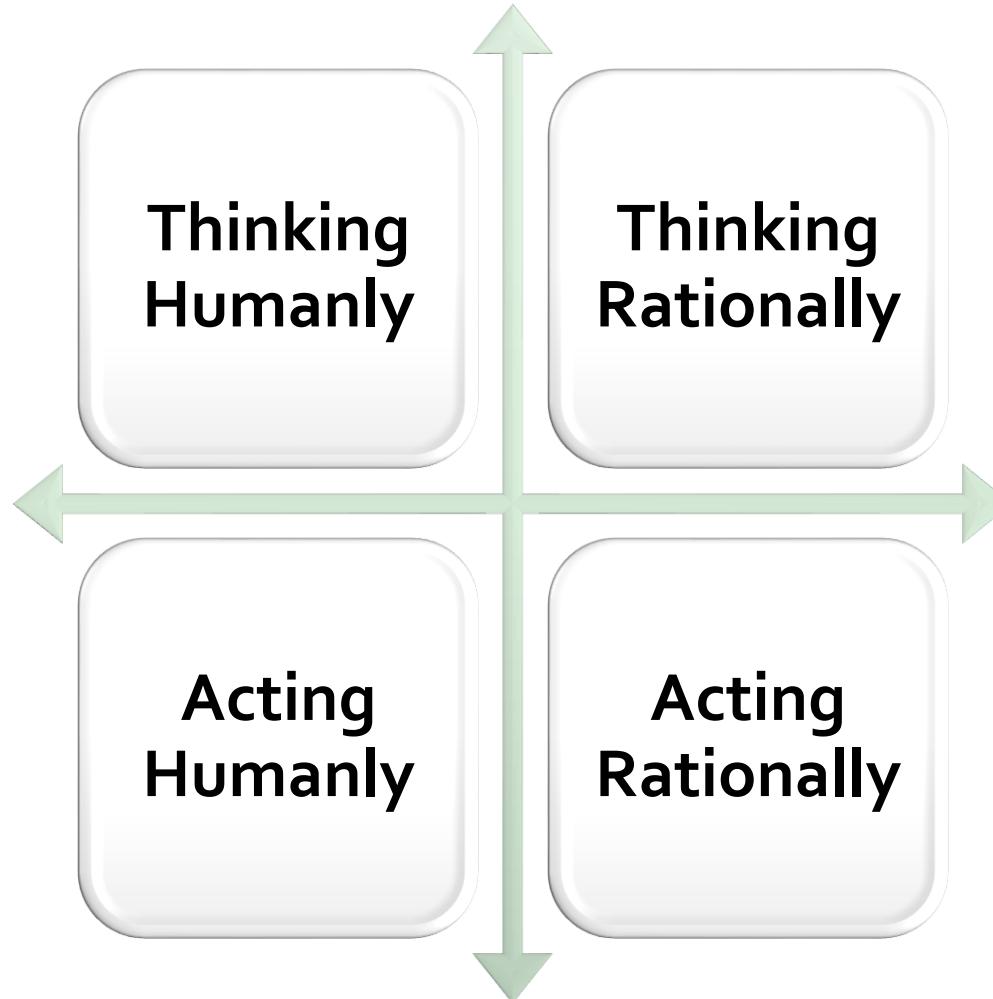
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# What is AI?



# What is AI?



# What is AI?

## Thinking Humanly

"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)

"Activities that we associate with human thinking, activities such as decision-making, problem solving, learning." (Bellman, 1978)

## Thinking Rationally

"The study of mental faculties through the use of computational models." (Charniak & McDermott, 1985)

"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)

## Acting Humanly

"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)

"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)

## Acting Rationally

"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)

"AI ...is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

# Acting Humanly: The Turing Test

- » Alan Turing's 1950 article Computing Machinery and Intelligence discussed conditions for considering a machine to be intelligent.
- » “Can machines think?”  $\Leftrightarrow$   
“Can machines behave intelligently?”
- » The Turing test (The Imitation Game):  
Operational definition of intelligence.
- » Computer needs: Natural language processing,  
Knowledge representation, Automated reasoning, and  
Machine learning



# What would a computer need to pass the Turing test?

- » **Natural language processing:** to communicate with examiner.
- » **Knowledge representation:** to store and retrieve information provided before or during interrogation.
- » **Automated reasoning:** to use the stored information to answer questions and to draw new conclusions.
- » **Machine learning:** to adapt to new circumstances and to detect and extrapolate patterns.
- » **Vision** (for Total Turing test): to recognize the examiner's actions and various objects presented by the examiner.
- » **Motor control** (total test): to act upon objects as requested.
- » **Other senses** (total test): such as audition, smell, touch, etc.

# Thinking Humanly: Cognitive Science

- » 1960 “Cognitive Revolution”: information-processing psychology replaced behaviorism
- » Cognitive science brings together theories and experimental evidence to model internal activities of the brain
  - How to validate models?
    - Predicting and testing behavior of human subjects (top-down).
    - Direct identification from neurological data (bottom-up).
    - Building computer/machine simulated models and reproduce results (simulation).

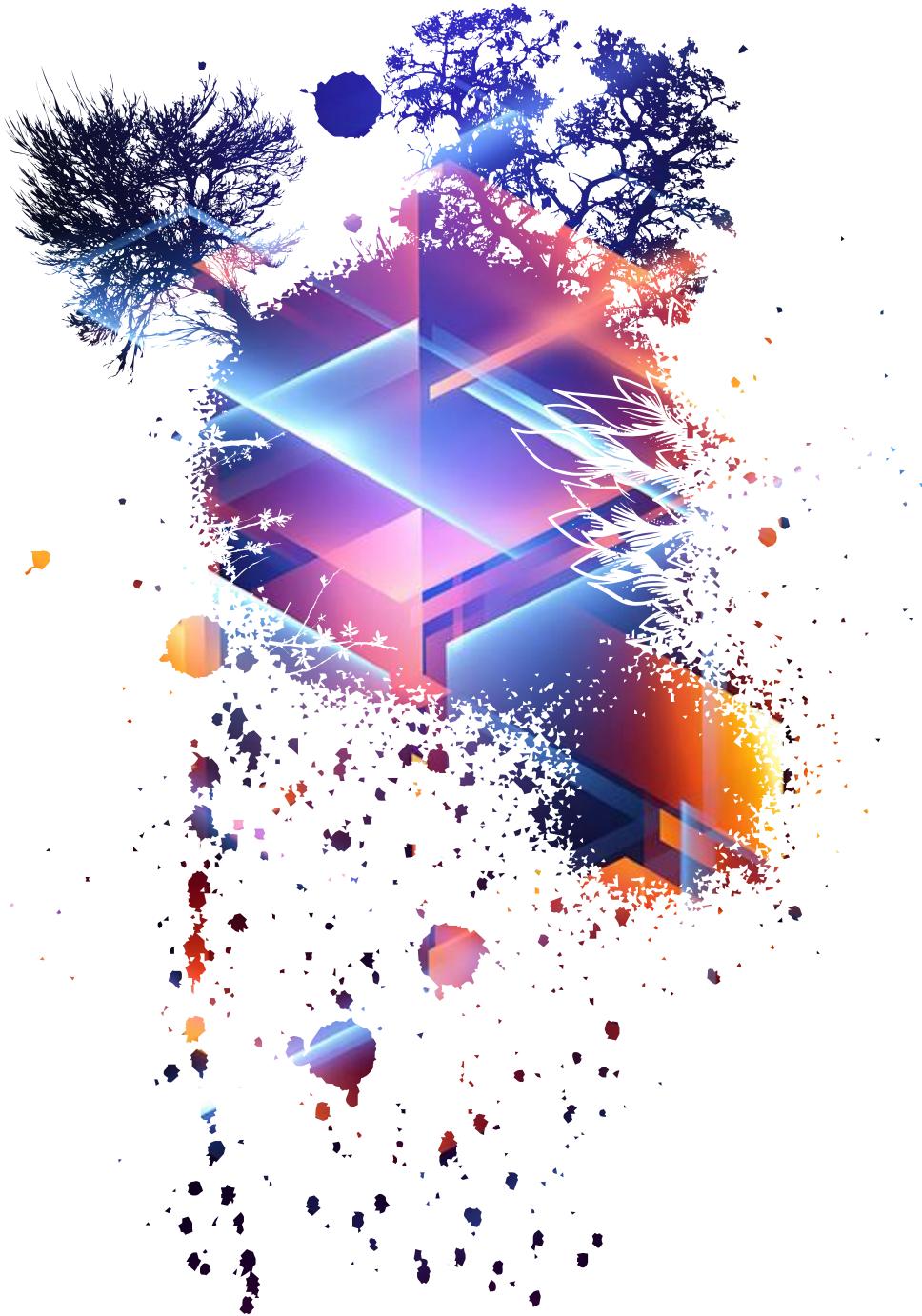
# Thinking Rationally: Laws of Thought

- » Aristotle (~ 450 B.C.) attempted to codify “right thinking”  
What are correct arguments/thought processes?
- » E.g., “Socrates is a man, all men are mortal; therefore, Socrates is mortal”
- » Several Greek schools developed various forms of logic:  
notation plus rules of derivation for thoughts.
- » **Problems:**
  - 1) **Uncertainty:** Not all facts are certain (e.g., *the flight might be delayed*).
  - 2) **Resource limitations:** There is a difference between solving a problem in principle and solving it in practice under various resource limitations such as time, computation, accuracy etc.

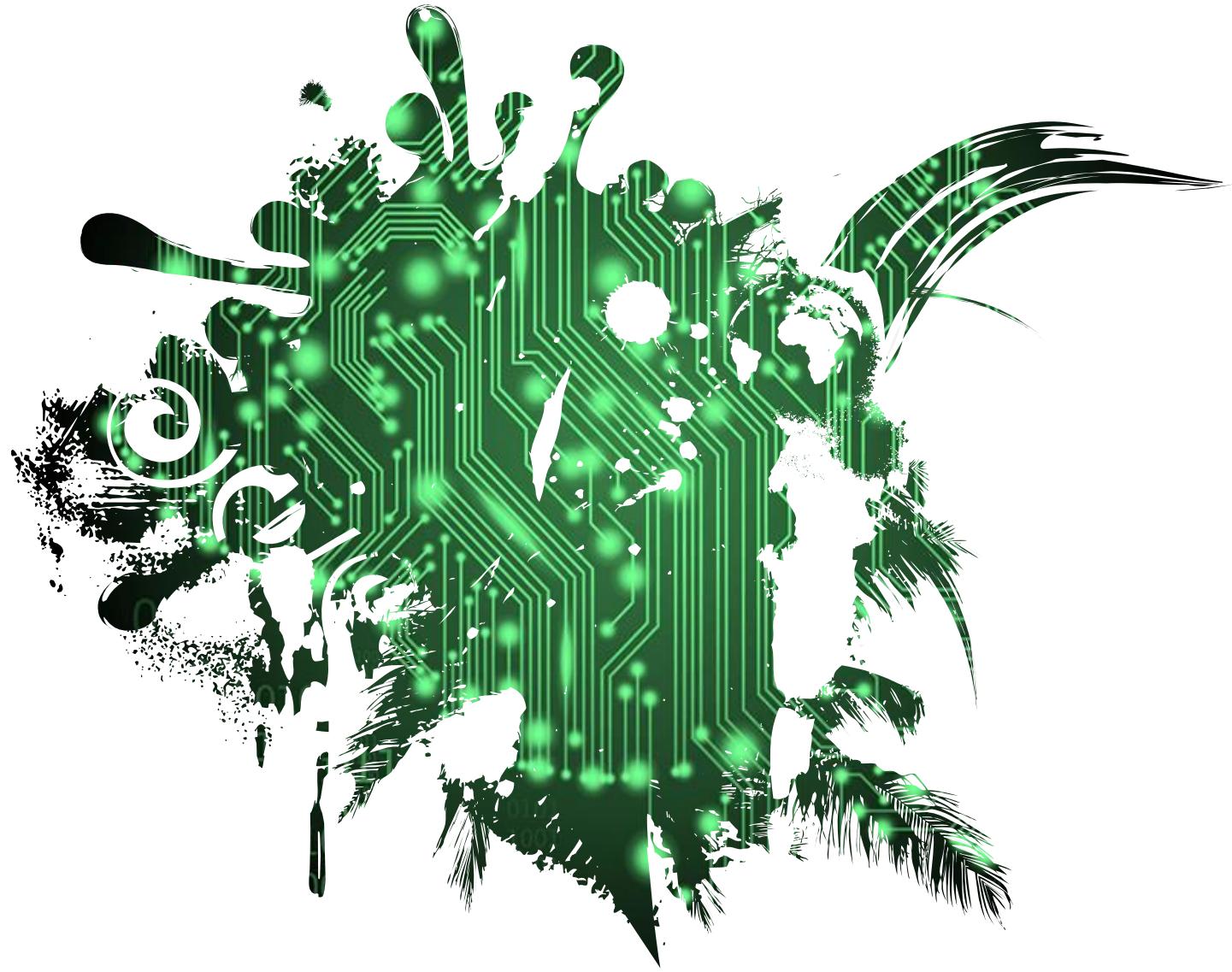
# Acting Rationally: The Rational Agent

- » Rational behavior: Doing the right thing!
- » The right thing: That which is expected to maximize the expected return.
- » Provides the most general view of AI because it includes:
  - Correct inference ("Laws of thought").
  - Uncertainty handling.
  - Resource limitation considerations (e.g., reflex vs. deliberation).
  - Cognitive skills (NLP, knowledge representation, ML, etc.)
- » **Advantages:**
  - 1) More general
  - 2) Its goal of rationality is well defined

AI is the science and engineering of making intelligent machines which can perform tasks that require intelligence when performed by humans ...



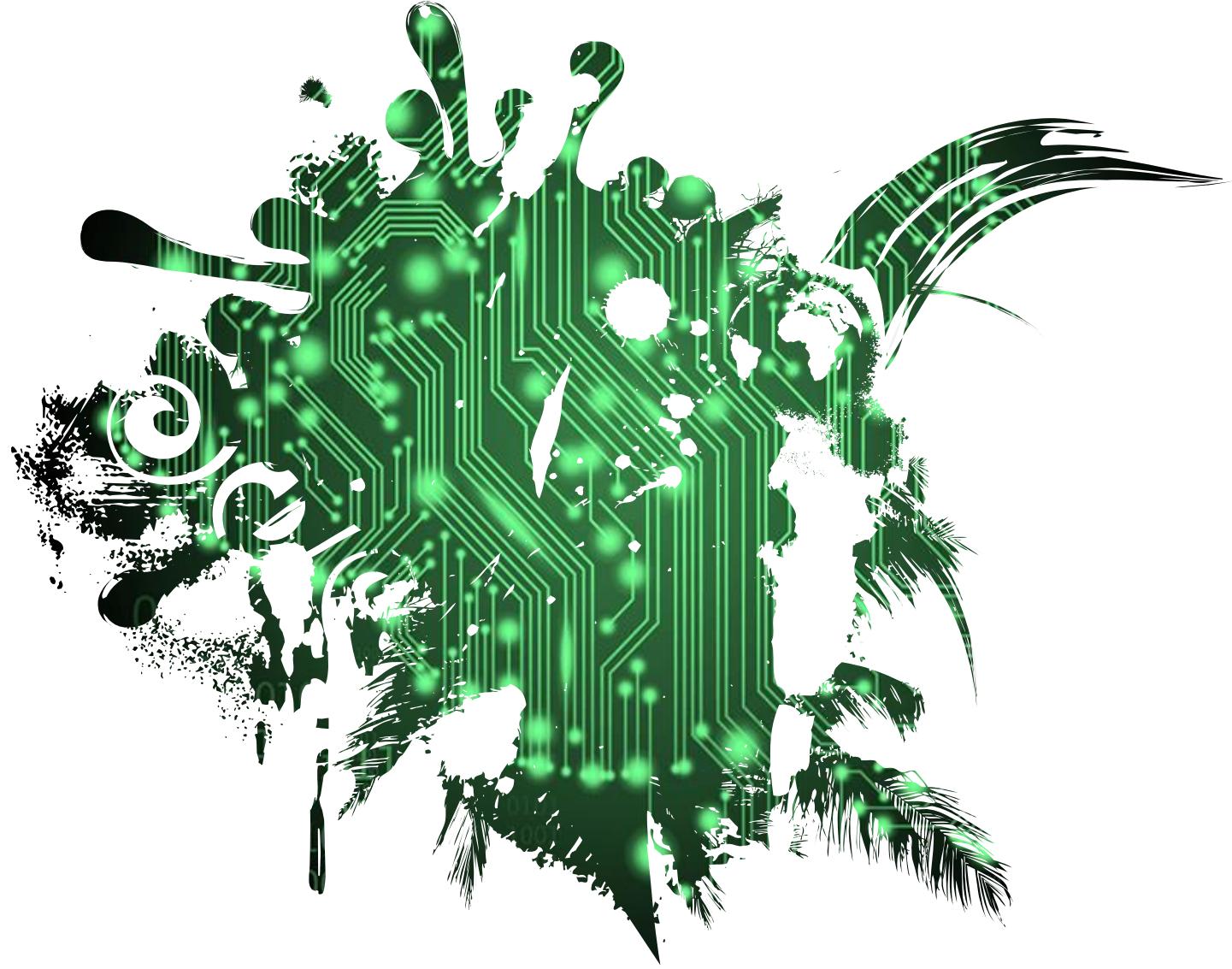
# What tasks require AI?



# Tasks that require AI

- » Solving a differential equation
- » Brain surgery
- » Inventing stuff
- » Playing Wheel of Fortune
- » What about walking?
- » What about pulling your hand away from fire?
- » What about watching TV?
- » What about day dreaming?

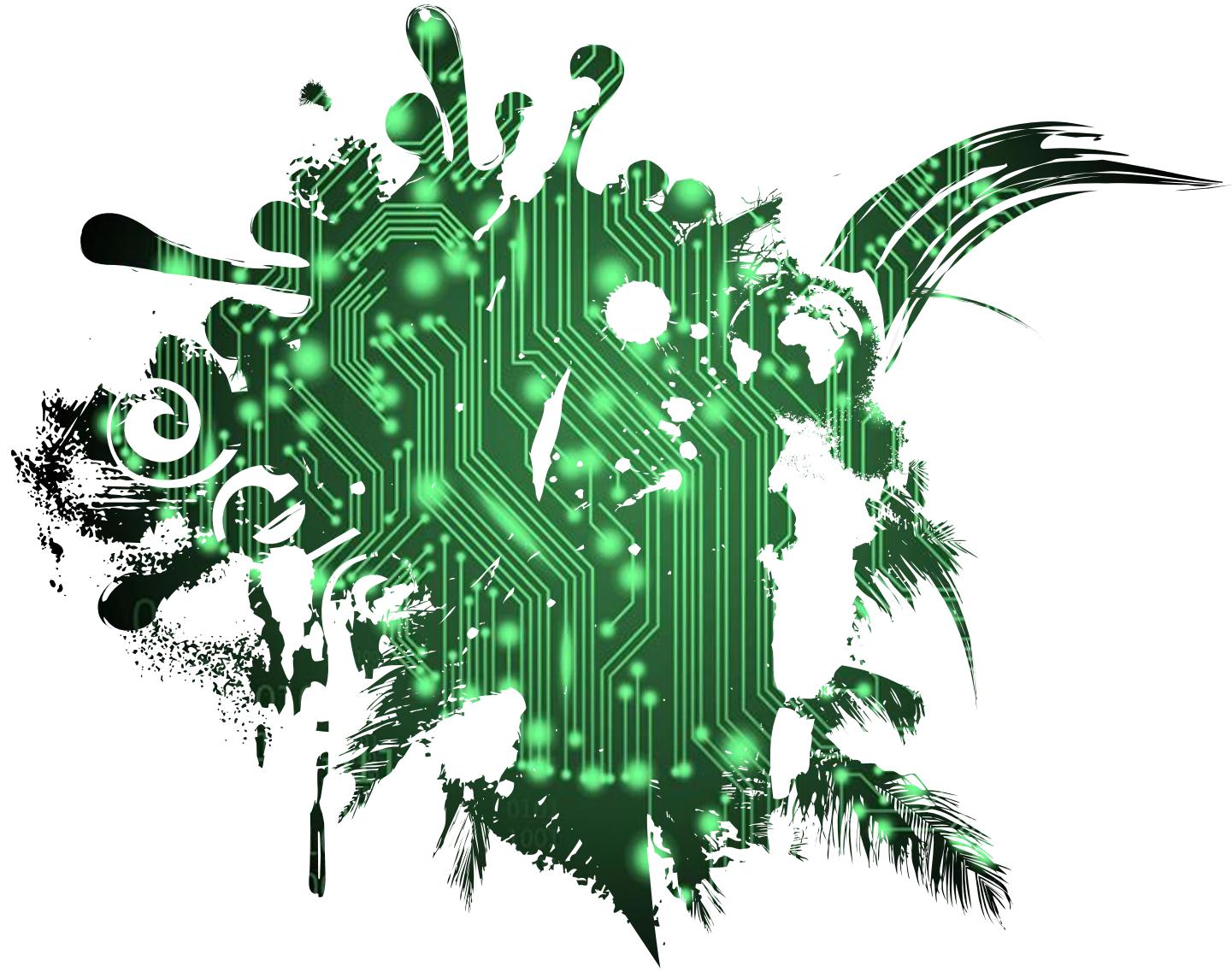
# How to achieve AI?



# How to achieve AI?

- » How is AI research done?
- » AI research has both **theoretical** and **experimental** sides. The experimental side has both basic and applied aspects.
- » There are two main lines of research:
  - One is **biological**, based on the idea that since humans are intelligent, AI should study humans and imitate their psychology or physiology.
  - The other is **phenomenal**, based on studying and formalizing common sense facts about the world and the problems that the world presents to the achievement of goals.
- » The two approaches interact to some extent, and both should eventually succeed. It is a race, but both racers seem to be walking. [John McCarthy]

# Branches of AI



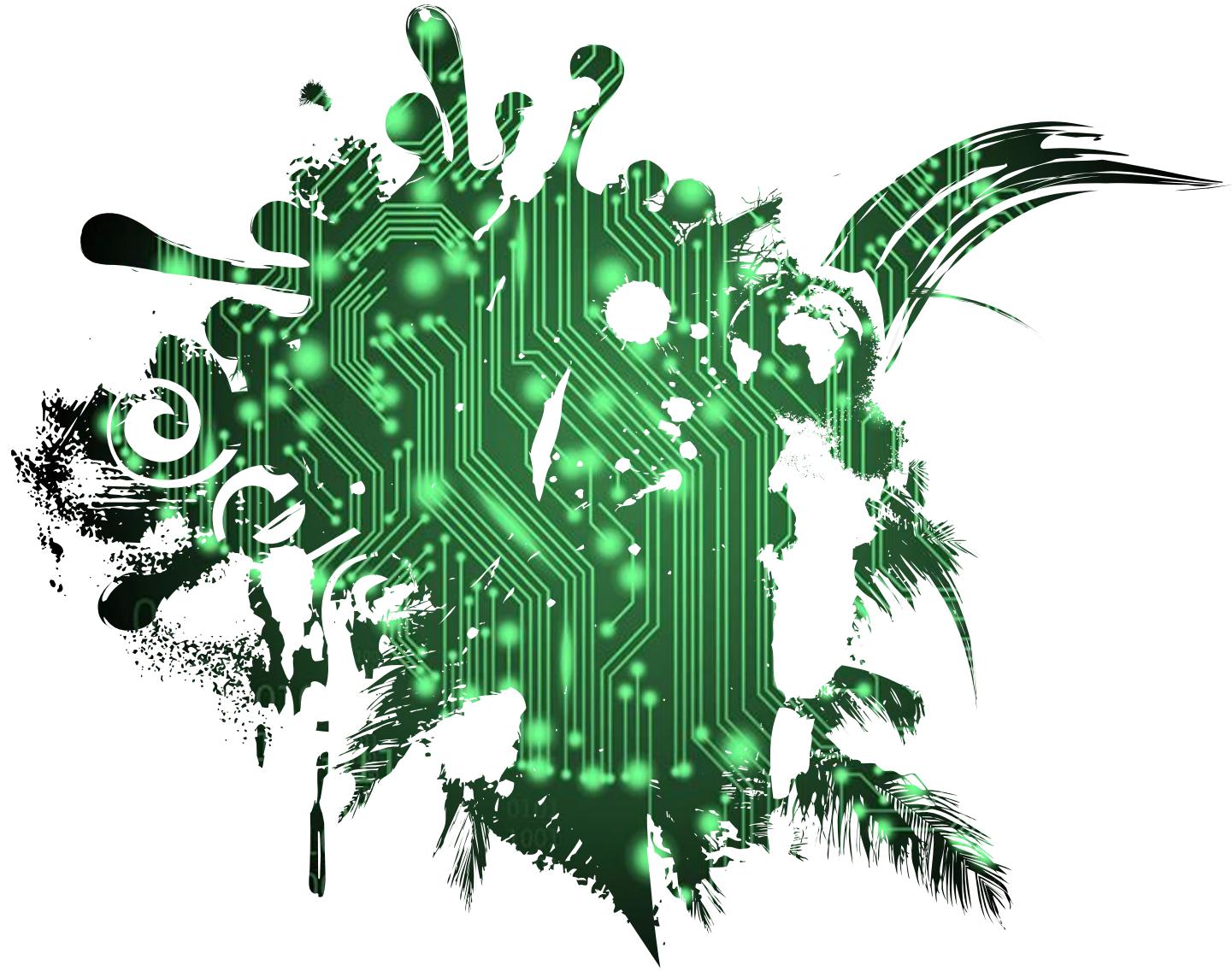
# Branches of AI

- » Logical AI
- » Search
- » Natural language processing
- » Pattern recognition
- » Knowledge representation
- » Inference
  - From some facts, others can be inferred.
- » Automated reasoning

# Branches of AI

- » Learning from experience
- » Planning To generate a strategy for achieving some goal
- » Ontology The study of the kinds of things that exist.
  - In AI, the programs and sentences deal with various kinds of objects, and we study what these kinds are and what their basic properties are.
- » Genetic programming
- » Emotions!
- » ...

# AI foundations



# The foundations of artificial intelligence – Part I

## » Philosophy

- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

## » Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?

# The foundations of artificial intelligence – Part II

## » Economics

- How should we make decisions so as to maximize payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

## » Neuroscience

- How do brains process information?

## » Psychology

- How do humans and animals think and act?

# The foundations of artificial intelligence – Part III

## » Computer engineering

- How can we build an efficient computer?

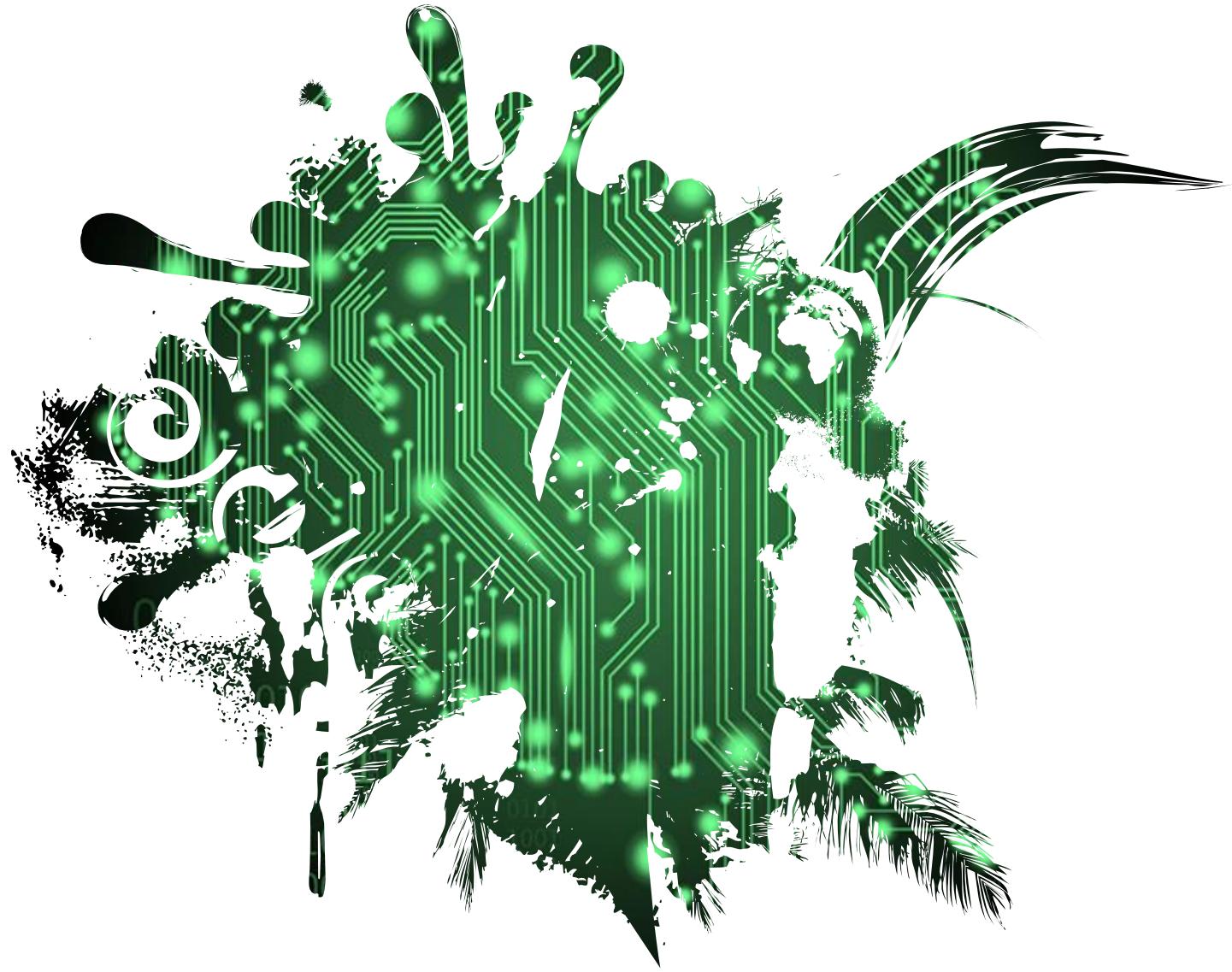
## » Control theory and cybernetics

- How can artifacts operate under their own control?

## » Linguistics

- How does language relate to thought?

# AI History



# The history of artificial intelligence

- » The history of AI has had cycles of success, misplaced optimism, and resulting cutbacks in enthusiasm and funding.
  - There have also been cycles of introducing new creative approaches and systematically refining the best ones.
- » AI has advanced more rapidly in the past decade because of greater use of the scientific method in experimenting with and comparing approaches.
- » Recent progress in understanding the theoretical basis for intelligence has gone hand in hand with improvements in the capabilities of real systems.
  - The subfields of AI have become more integrated, and AI has found common ground with other disciplines.

# Potted history of AI – Part I

**1943**

- McCulloch & Pitts: Boolean circuit model of brain

**1950**

- Turing's "Computing Machinery and Intelligence"
- Neural network

**1952—69**

- Look, Ma, no hands!

**1950s**

- Early AI programs, including Samuel's checkers program

**1956**

- Dartmouth meeting: "Artificial Intelligence" adopted

# Potted history of AI – Part II

**1965**

- Robinson's complete algorithm for logical reasoning

**1966–74**

- AI discovers computational complexity
- Neural network research almost disappears

**1969–79**

- Knowledge-based systems

**1980–88**

- Expert systems industry booms

**1988–93**

- Expert systems industry busts: "AI Winter"

# Potted history of AI – Part III

**1985—95**

- Neural networks return to popularity

**1988**

- Probability
- ALife, GAs, soft computing
- Machine learning

**1995**

- Agents, agents, everywhere
- ...

**2003**

- Human-level AI back on the agenda

**2001-**

- Big data

**2011-**

- Deep Learning



# Conclusion

- » Different people approach AI with different goals in mind. Two important questions to ask are:
  - Are you concerned with thinking or behaviour?
  - Do you want to model humans or work from an ideal standard?
- » In this course, we adopt the view that intelligence is concerned mainly with rational action.
  - Ideally, an intelligent agent takes the best possible action in a situation.
  - We study the problem of building agents that are intelligent in this sense.

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## *Questions & Comments*



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