June 29, 2021

Ronald Laurids Boring, PhD, FHFES

Introduction to Artificial Intelligence (AI) and Some of Its Basic Terminology

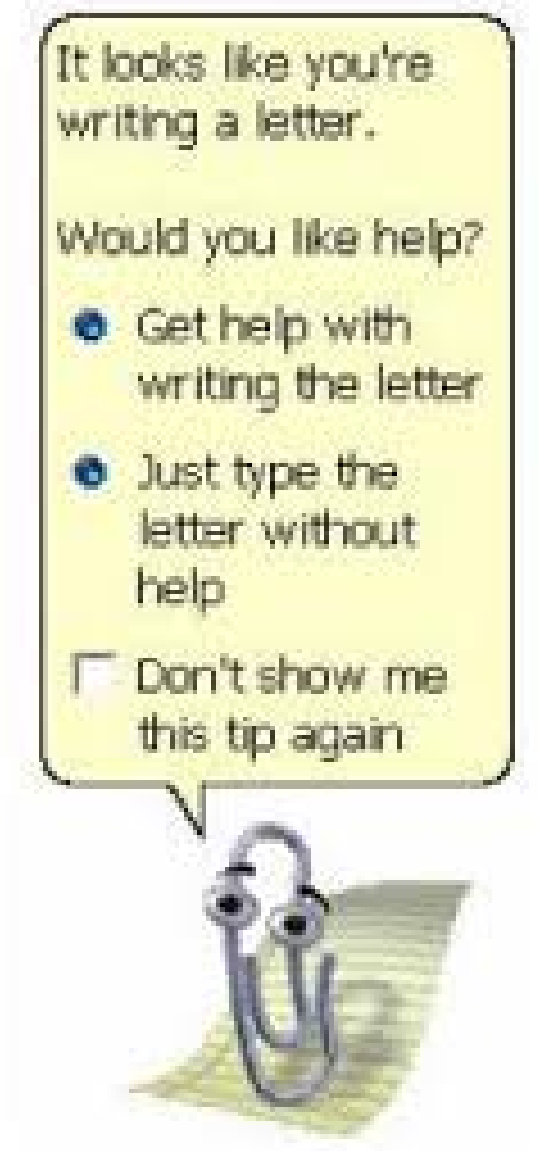
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

INL Idaho National Laboratory

Is this AI?

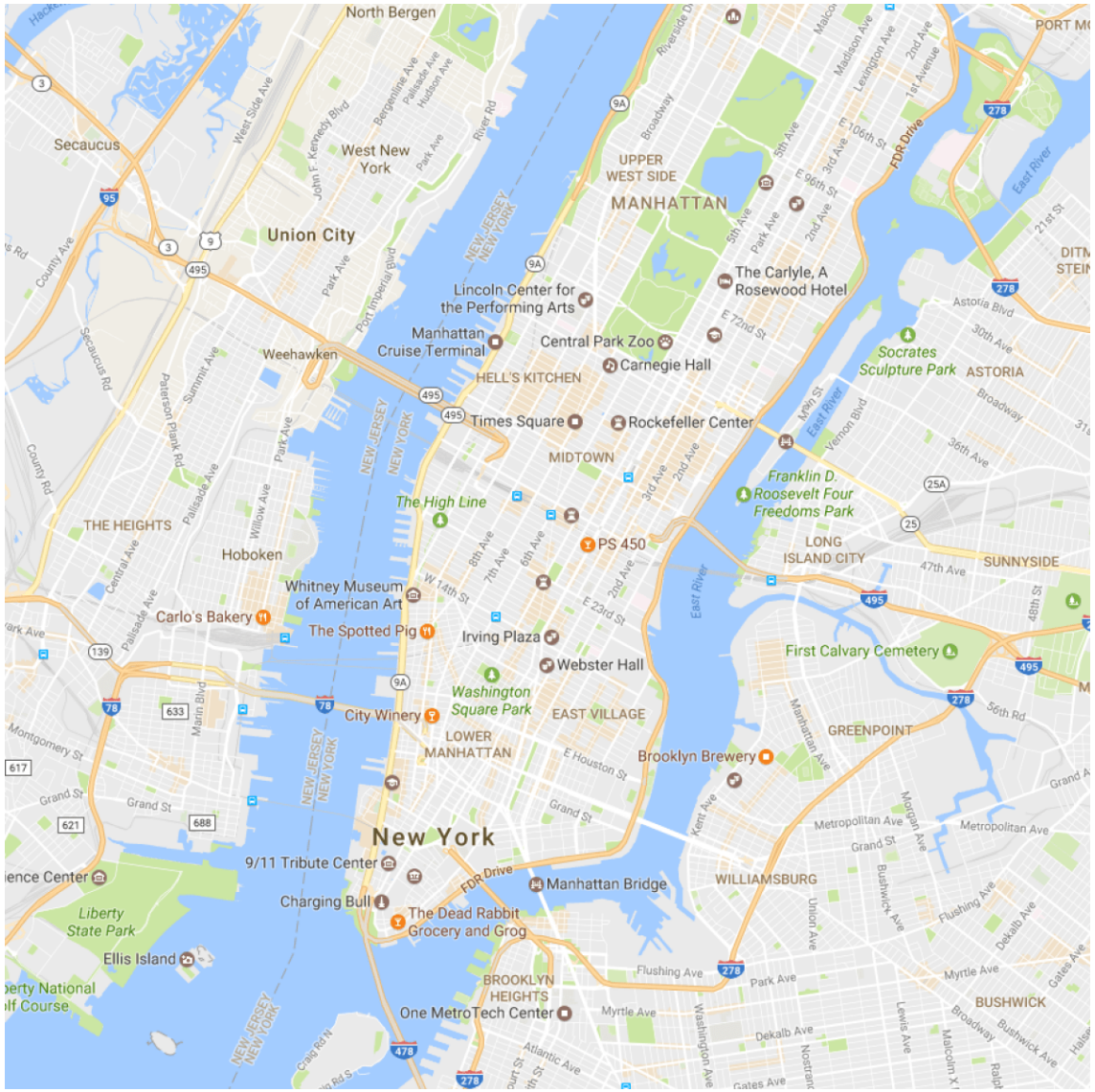
Decoder Ring

Is this AI?



Microsoft Clippy

Is this AI?

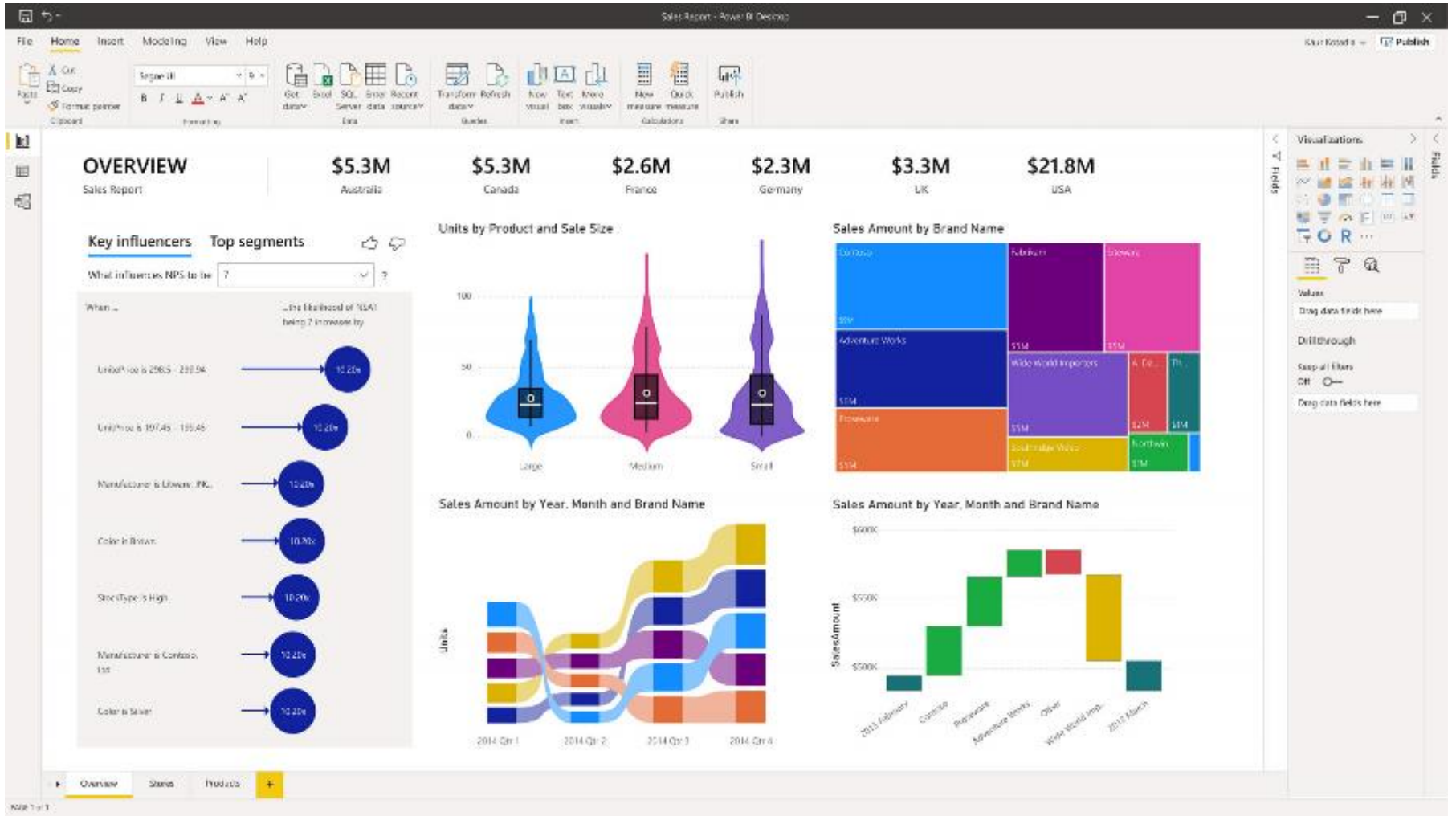


Google Maps

Is this AI?

Apple Watch Heartrate Monitor

Is this AI?


OVERVIEW
Sales Report
$5.3M
Australia
$5.3M
Canada
$2.6M
France
$2.3M
Germany
$3.3M
UK
$21.8M
USA
Key influencers
Top segments
Units by Product and Sale Size
Sales Amount by Brand Name
Sales Amount by Year, Month and Brand Name
Sales Amount by Year, Month and Brand Name
Visualizations
Fields
Drillthrough
Overview
Stores
Products

Is this AI?

They All Feature Applications of AI

Let’s Look at Some of the History and Technology Underlying AI

It all began in

1956

1956 Was a Watershed Year

- **Two Congressional Hearings on Automation**
- **Dartmouth Summer Workshop on Artificial Intelligence**
  - "We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."
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- **Symposium on Information Theory at MIT on September 11, 1956**
  - Birthplace of information processing theory and study of cognition
  - Featured George Miller, Noam Chomsky, Allen Newell, and Herb Simon, and others
- **Birth of AI and cognitive psychology occurred at the same time, because they were interested in the same problems**
  - Deconstructing human thinking into information allowed us to make computer models of it

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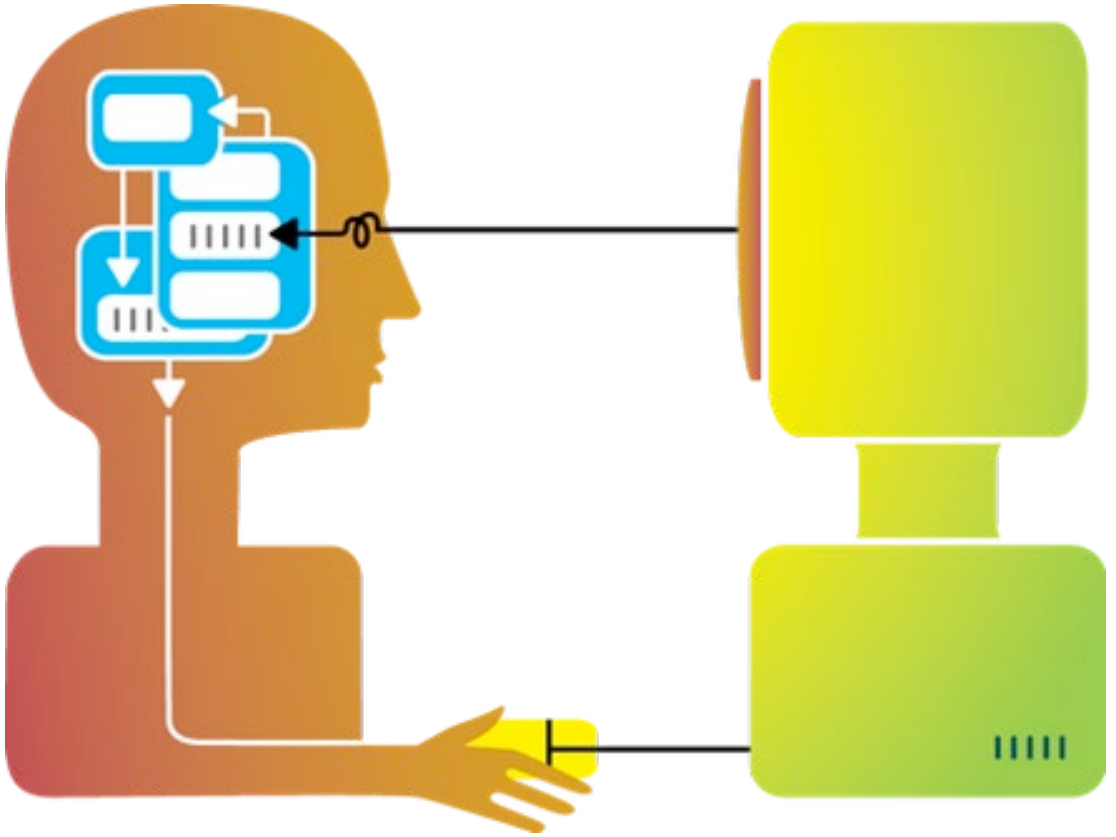
Big Picture in Information Processing

Human-System Interface (HSI)

- Computer output = human sensation and perception
- Human action = computer input
- It's a feedback loop

Each step also represents a form of intelligence that may be modelled artificially

- Perception: Pattern recognition, computer vision, natural language processing
- Knowledge: Expert systems
- Actions and behaviors: Automated controllers



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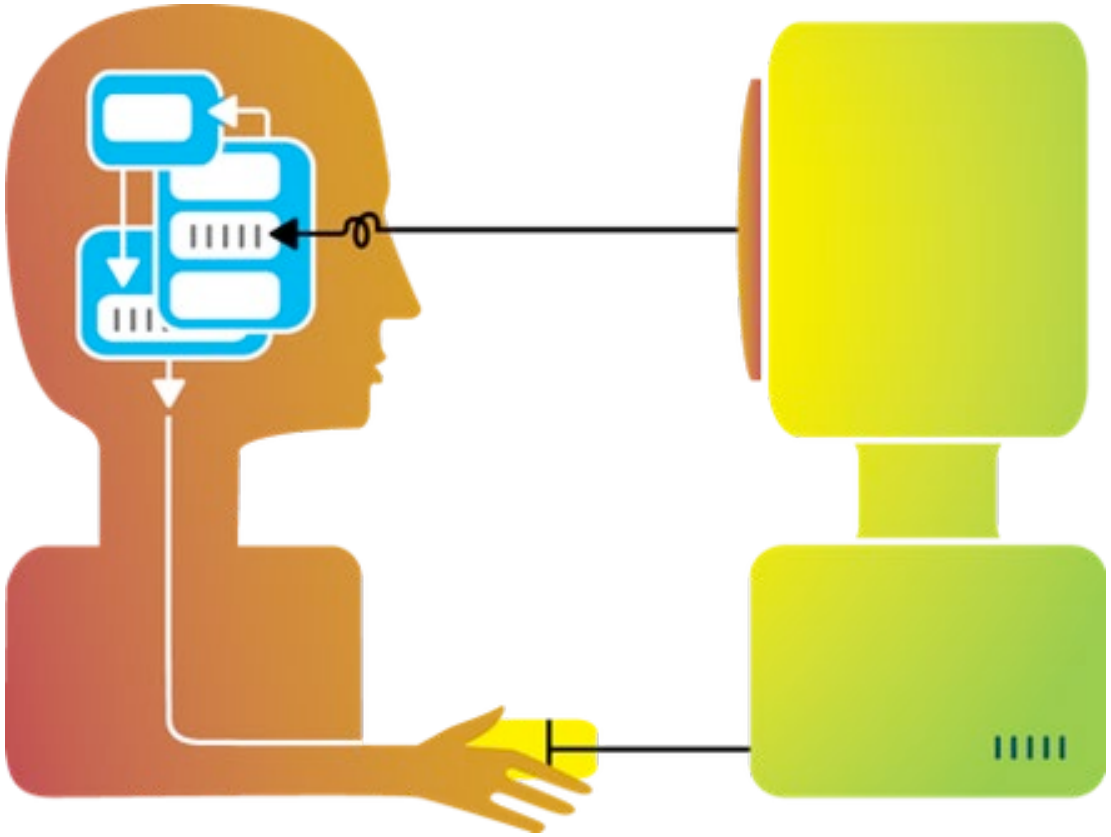
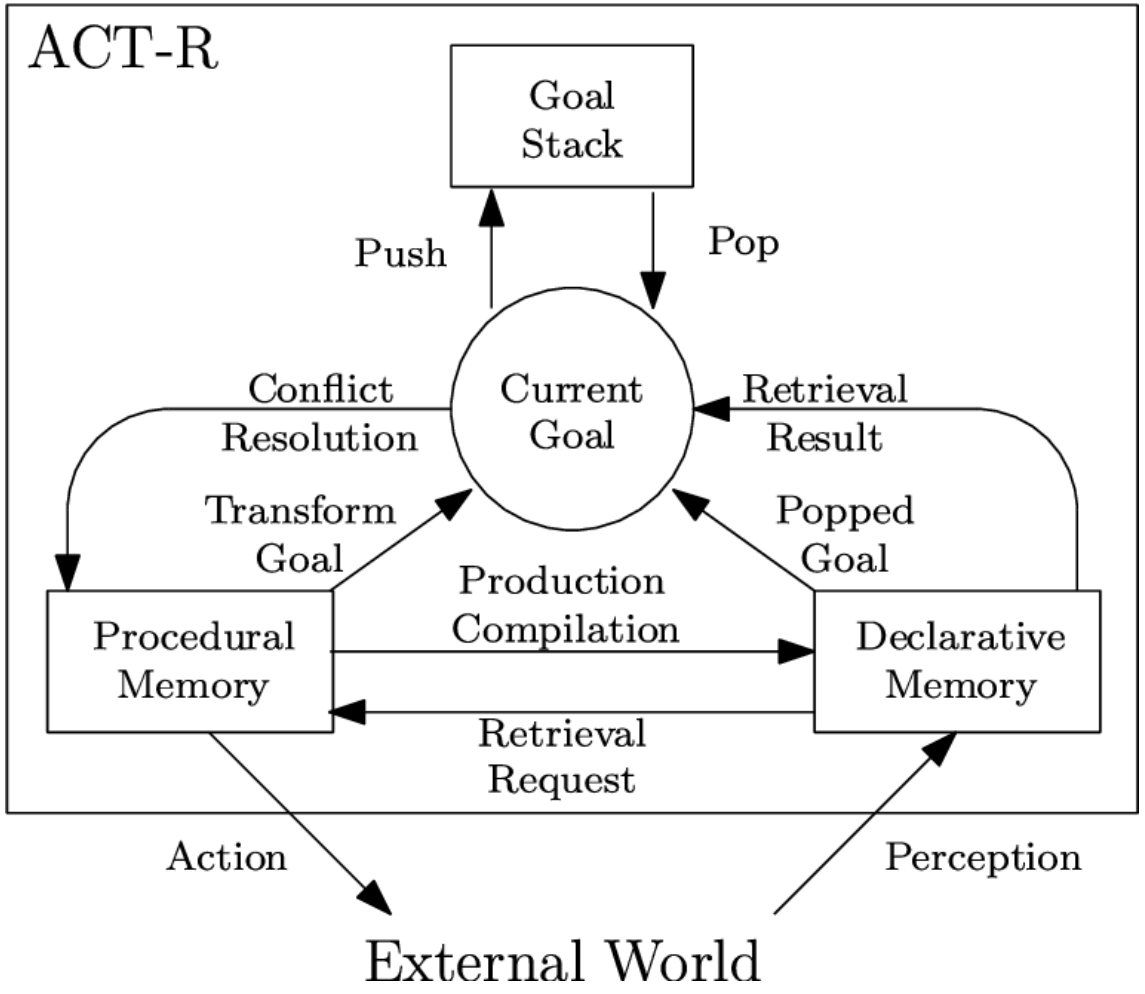


How Does AI Work?

Two Types of AI

- **Good Old-Fashioned AI (GOFAI)**
  - Symbolic logic systems to represent basic elements of human thought like language, numbers, or goals
  - **Production systems** featuring if-then logic
    - General Problem Solver created by Newell and Simon in 1959
  - **Cognitive modeling architectures**
    - Systems like Soar and ACT-R with a heavy emphasis on how humans accomplish goals
  - Much of focus is not to create learning but to capture human-like intelligence related to how humans carry out decisions and actions



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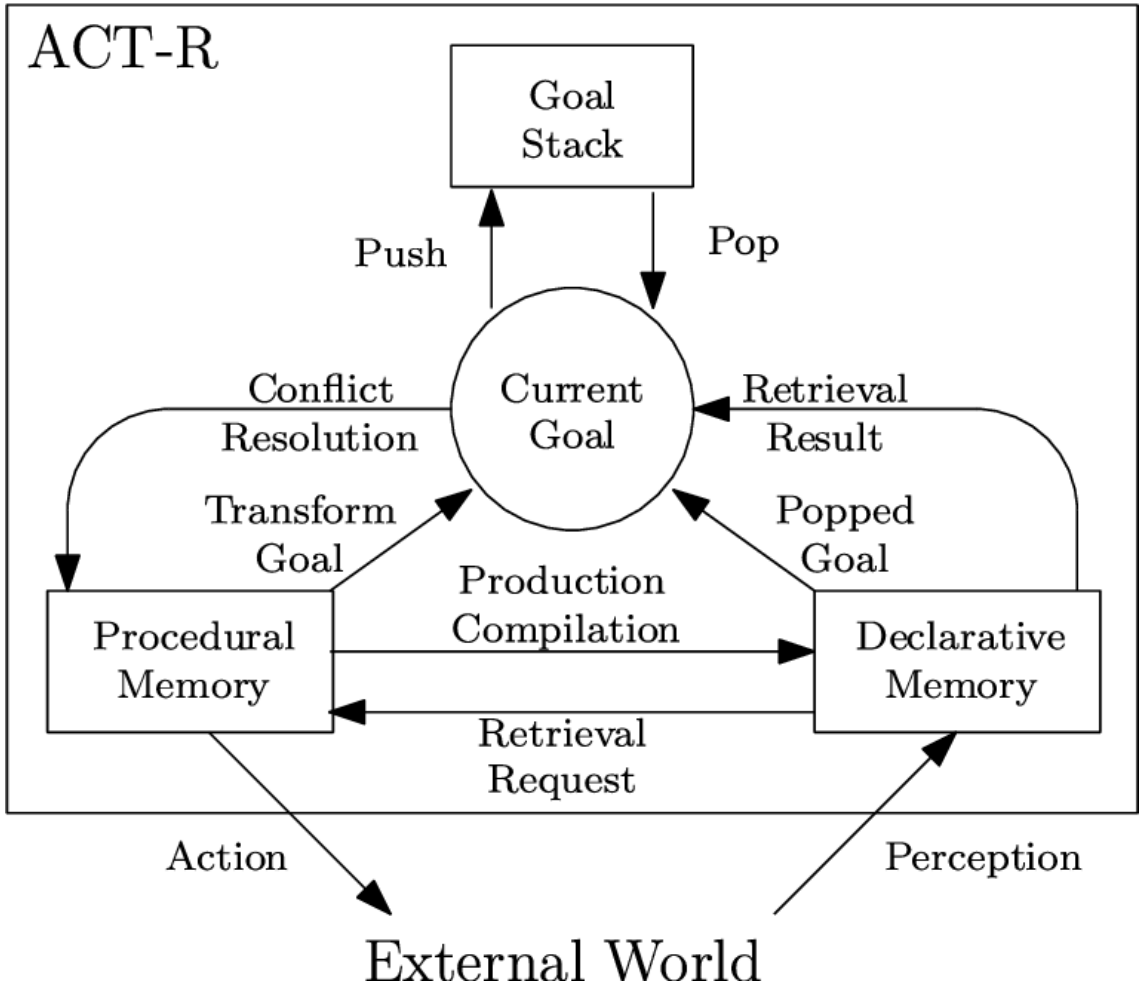

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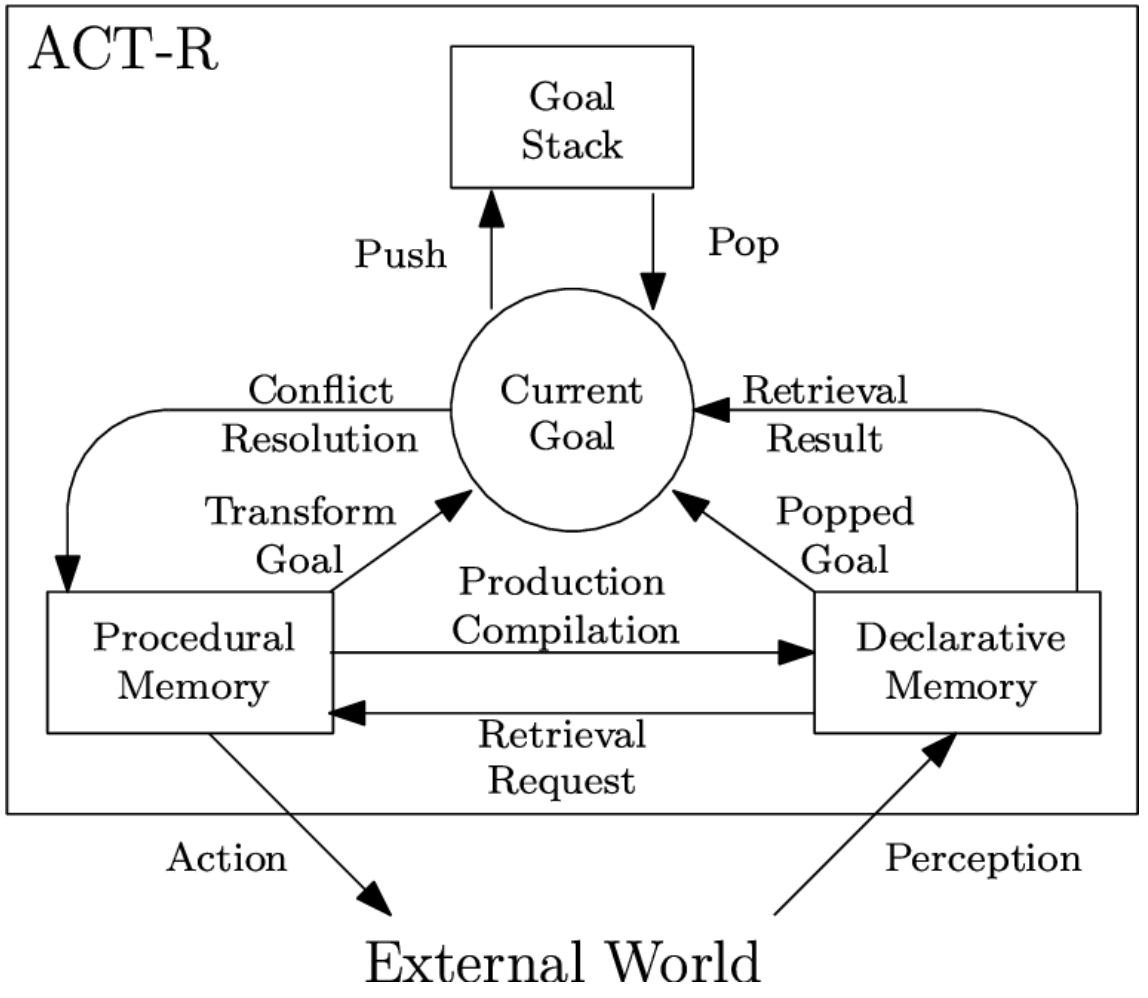

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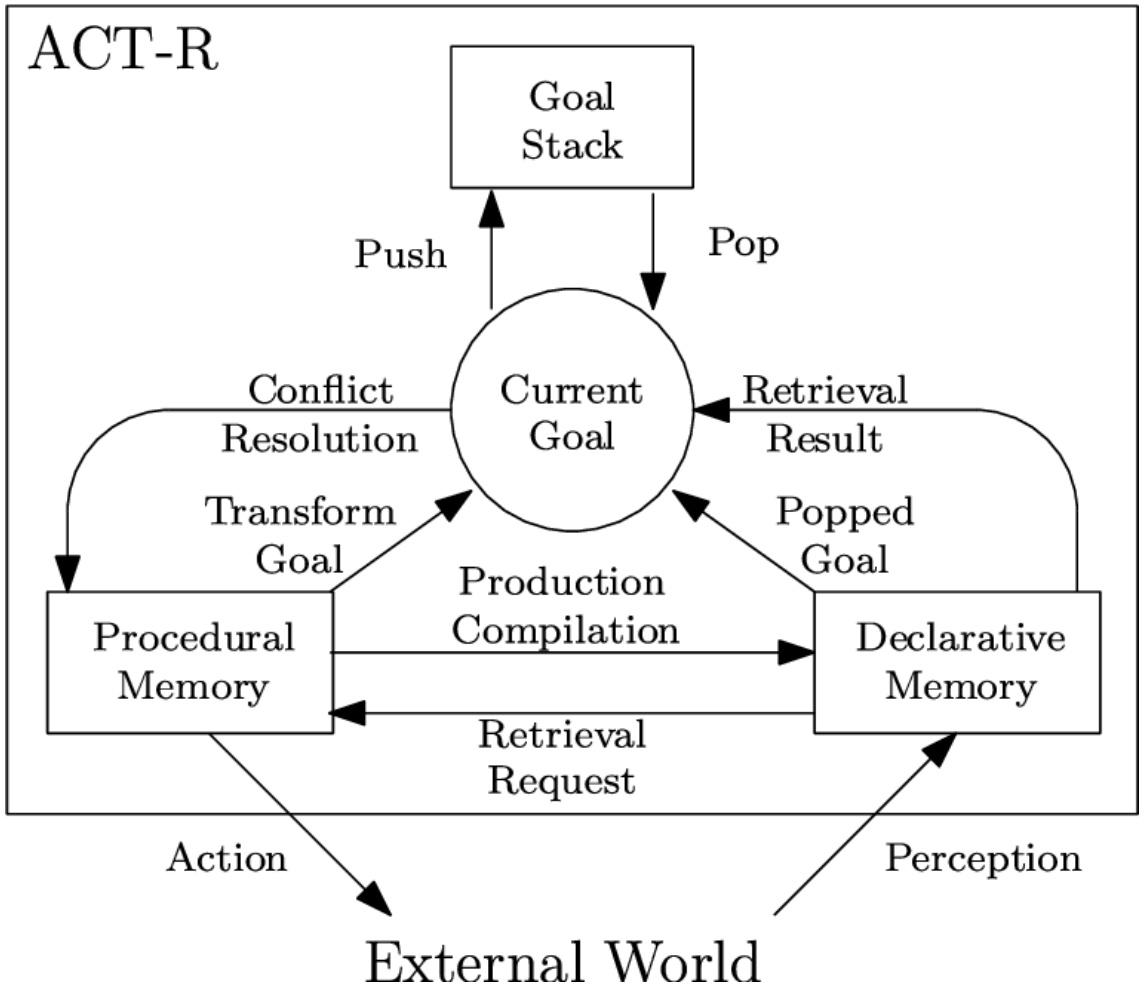
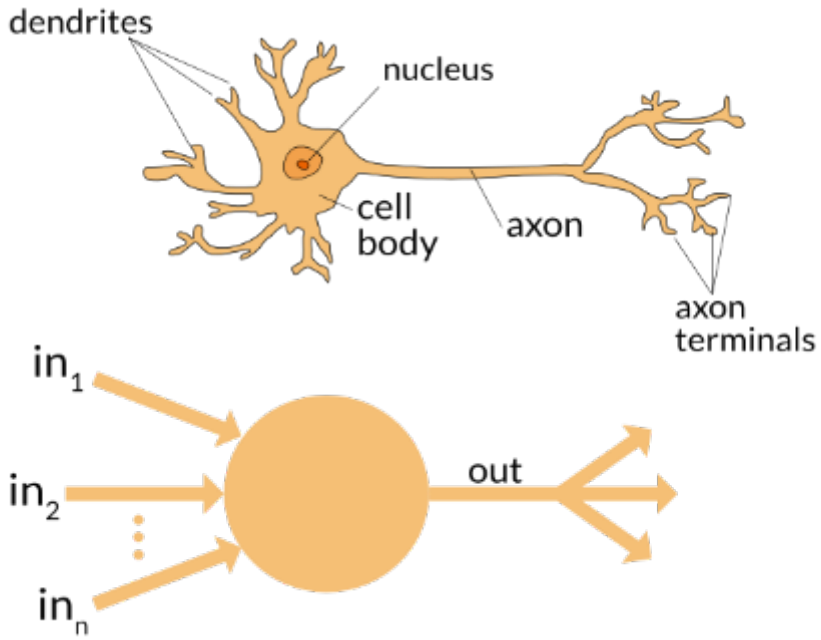


Two Types of AI

- **Neural Networks**
  - **Perceptron** developed in 1958 as approximation of single-cell neuron
  - By 1960s, mathematical algorithms like backpropagation developed to allow perceptrons to learn through training
    - **Machine learning**
  - Multiple perceptrons chained together to create neural networks
    - More layers of neural networks chained to together to create **deep learning**
    - Facilitated by greater availability of parallel computing (e.g., graphical processing units)



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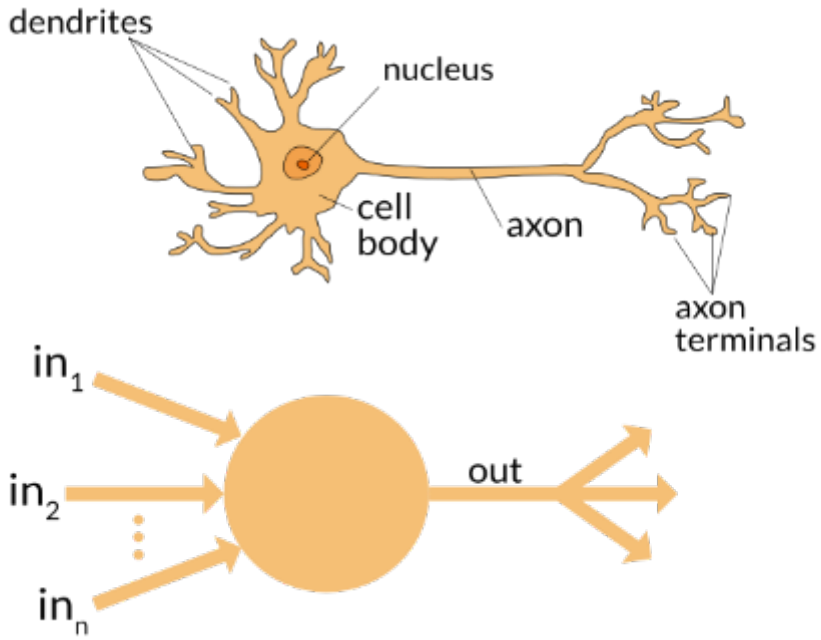

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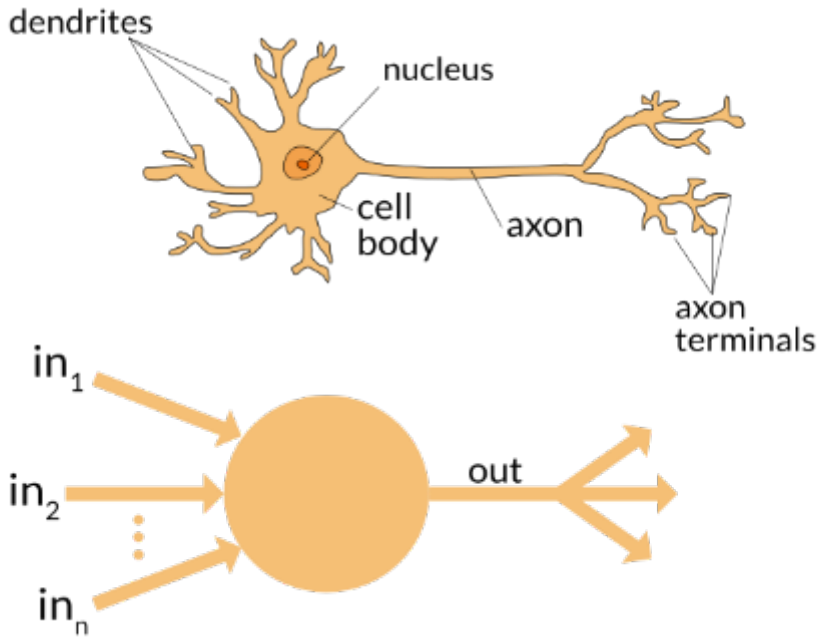

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- **Different Uses**
  - GOFAI is good at following rules and making decisions
  - Neural networks are good at pattern recognition when trained

- **Self-Driving Vehicle Example**
  - Use GOFAI for the rules of the road
    - Procedural knowledge
    - Control automation
  - Neural networks used to recognize the world
    - The eyes on the road
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Very Briefly Noted

Some Key Applications of AI in Nuclear Industry

Key Applications of AI in Nuclear Industry

Automation

- Control automation: Using AI to control a system (or a plant, such as might be the case in a microreactor)
- Information automation: Using AI to intelligently gather information that operator needs
  - Detection of problems such as early warning systems and condition monitoring

Prediction

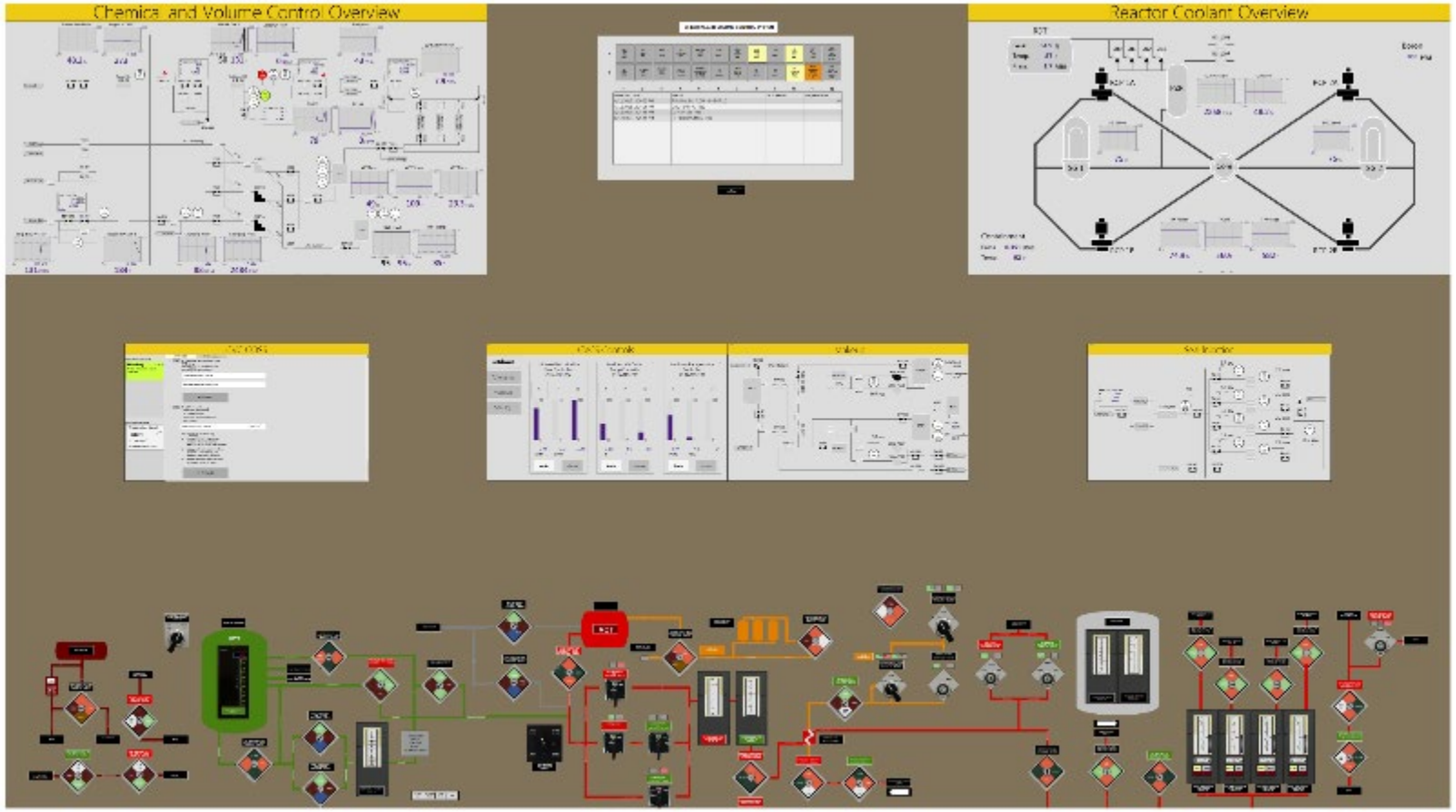
- Predictive—instead of *prescriptive*—maintenance systems

Human-System Interface

- Smart notification systems like alarm filtering
- Natural language processing for hands-free interactivity

Example Possible Automation in Nuclear Power

Information Automation *(Top)*, Control Automation *(Middle)*, and Analog Control *(Bottom)*



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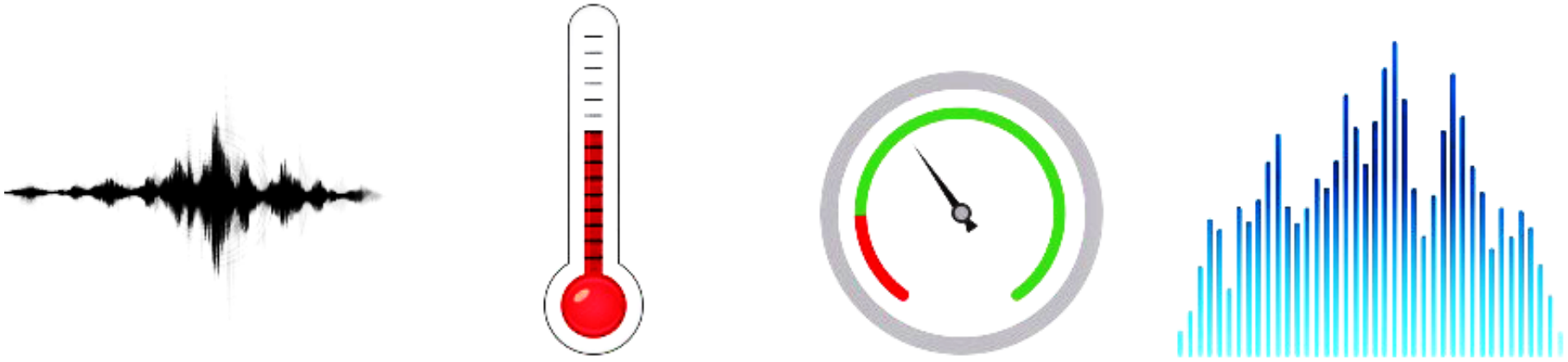
Predictive Maintenance

- Look for signs of performance degradation through sensor data
  - Catch parts that are failing sooner than anticipated
  - Leave perfectly good parts in operation
- Anomaly detection using machine learning
- Convey information to human



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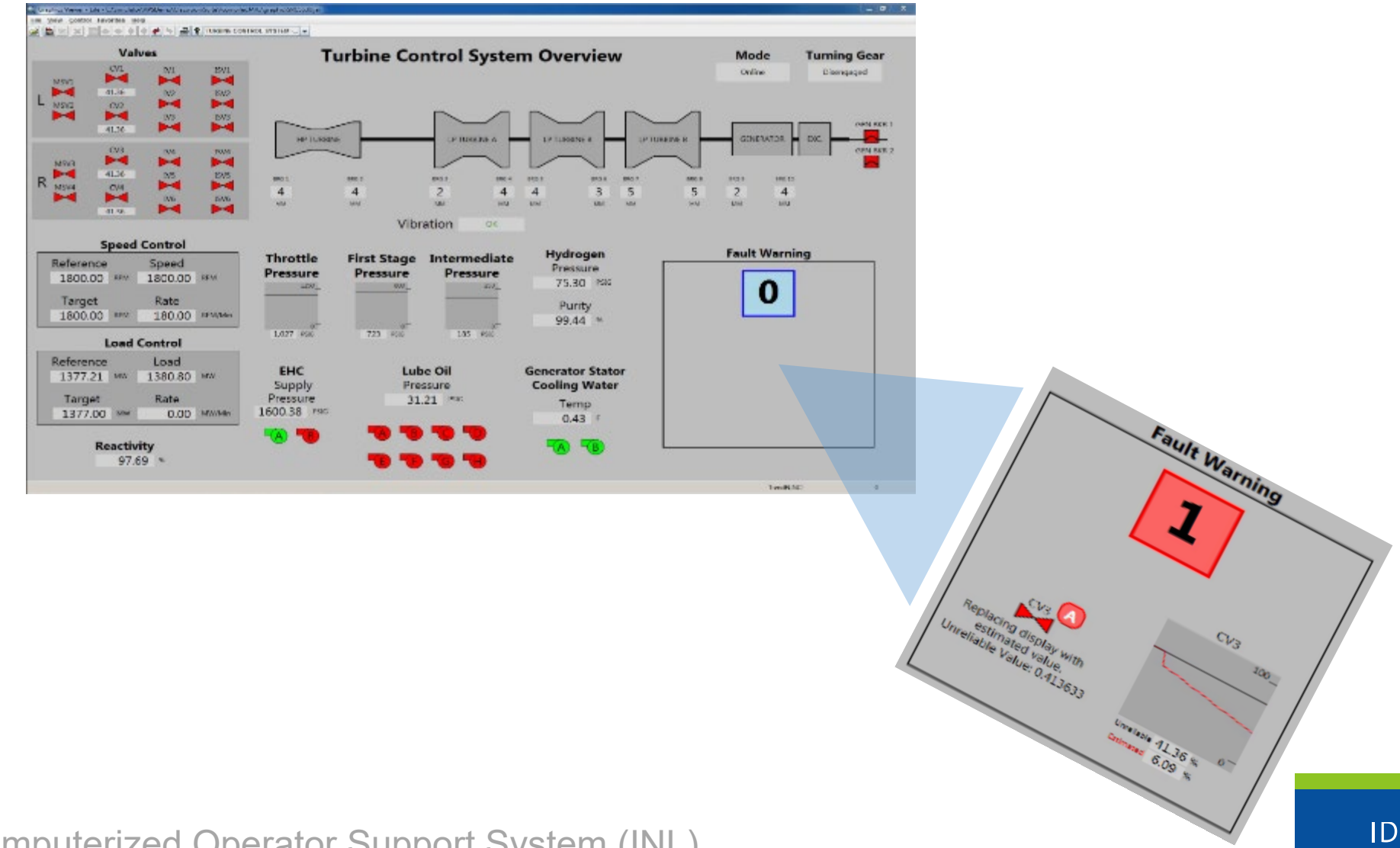
Example Smart Notification System



Who Knows What the Future Will Bring, But AI Will Be Part of It!

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