

# AI Education for Systems Engineers

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# Outline

- **AI Systems Working Tutorials**
- **AI and Systems Engineering Course at GMU**
- **Responsible AI Certificate Program at GMU**

# AI Systems Working Group Tutorial

- **Multiple Tutorials & Teach-Through sessions (IS and IW)**
  - ❑ IS 2021, IW 2022, IS 2023, IW 2023
  - ❑ IW 2025: A mini-tutorial on AI and SE
  - ❑ Primary audience: AI Education for Systems Engineering Community
- **Learning Objectives:**
  - ❑ Develop a sufficient appreciation of artificial intelligence and machine learning technologies
  - ❑ Recognize systems engineering lifecycle implications of AI/ML
  - ❑ Classify different types of AI/ML techniques and identify appropriate applications of each
  - ❑ Discuss the strengths and weaknesses of AI/ML models and processes
  - ❑ Develop intuition of deep neural networks and how they work (without prior knowledge of software code or specialized mathematics)
  - ❑ Differentiate between training, test, and development data
  - ❑ Recognize how deep neural network perform applications like image recognition, classification, regression and natural language processing
  - ❑ Articulate AI implications and importance as applied to system design and capability acquisition lifecycles
  - ❑ Recognize emerging role of Explainable AI for System level Test and Evaluation

# BRIEF INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)

- Which of the following do you consider “artificially intelligent”?

(a)



(b)



(c)



Hey Siri

(d)



- What is AI\*?
  - The term “Artificial Intelligence” was first introduced around 1950’s
    - Mimic human-level intelligence capabilities in hardware and software systems
  - An ability of a system to exhibit behavior, which if exhibited by a human being, would be considered intelligent
    - *But what is considered intelligent: Acting Humanly, Thinking Humanly, Thinking Rationally, and Acting Rationally\*\**
  - An ability of a system/machine to process and learn from data, to recognize and understand patterns, to solve problems, and make decisions autonomously
    - Two primary types of AI
      - Decision making is explicitly pre-programed
      - Decision making is learned from data

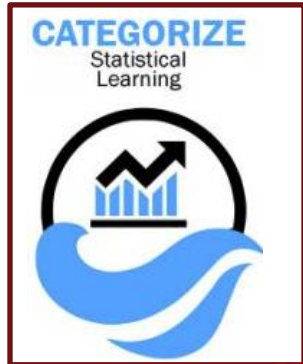
\*[https://sebokwiki.org/wiki/Artificial\\_Intelligence](https://sebokwiki.org/wiki/Artificial_Intelligence)

\*\* Stuart Russel and Peter Norvig, Artificial Intelligence: A Modern Approach, 4<sup>th</sup> Ed.

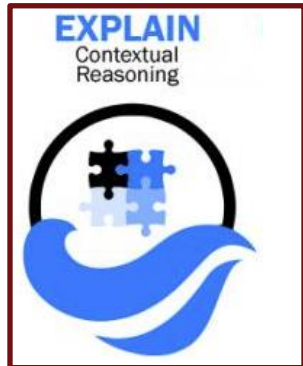
# DARPA's Three Waves of AI\*



- Rule/Logic based Systems, Expert Systems
- Well defined requirements for knowledge representation in well defined domains
- Well established systems engineering methodologies



- Statistical models trained on big data
- Prediction and classification in well defined domains, limited reasoning
- Pertinent need of systems engineering methodologies



- AI systems learn and reason in real-world environments
- Decision-making and contextual reasoning
- Pertinent need of systems engineering methodologies



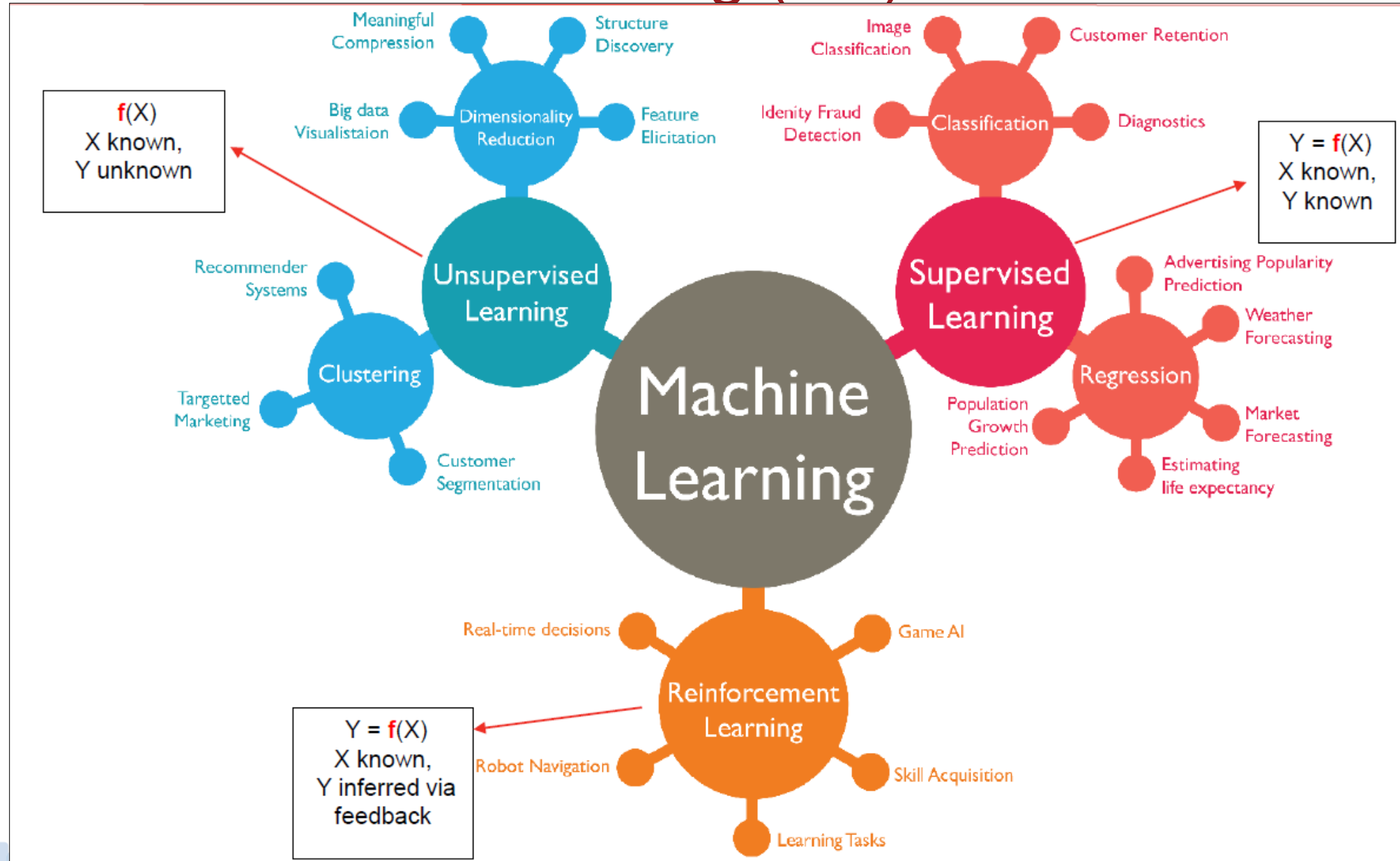
Machine Learning, along with advances in knowledge representation and automated reasoning, is a key-enabler of these waves.

\* Presentation by Arati Prabhakar, DARPA - National Academies

\* Blasch et. al.: Command Guided Swarms

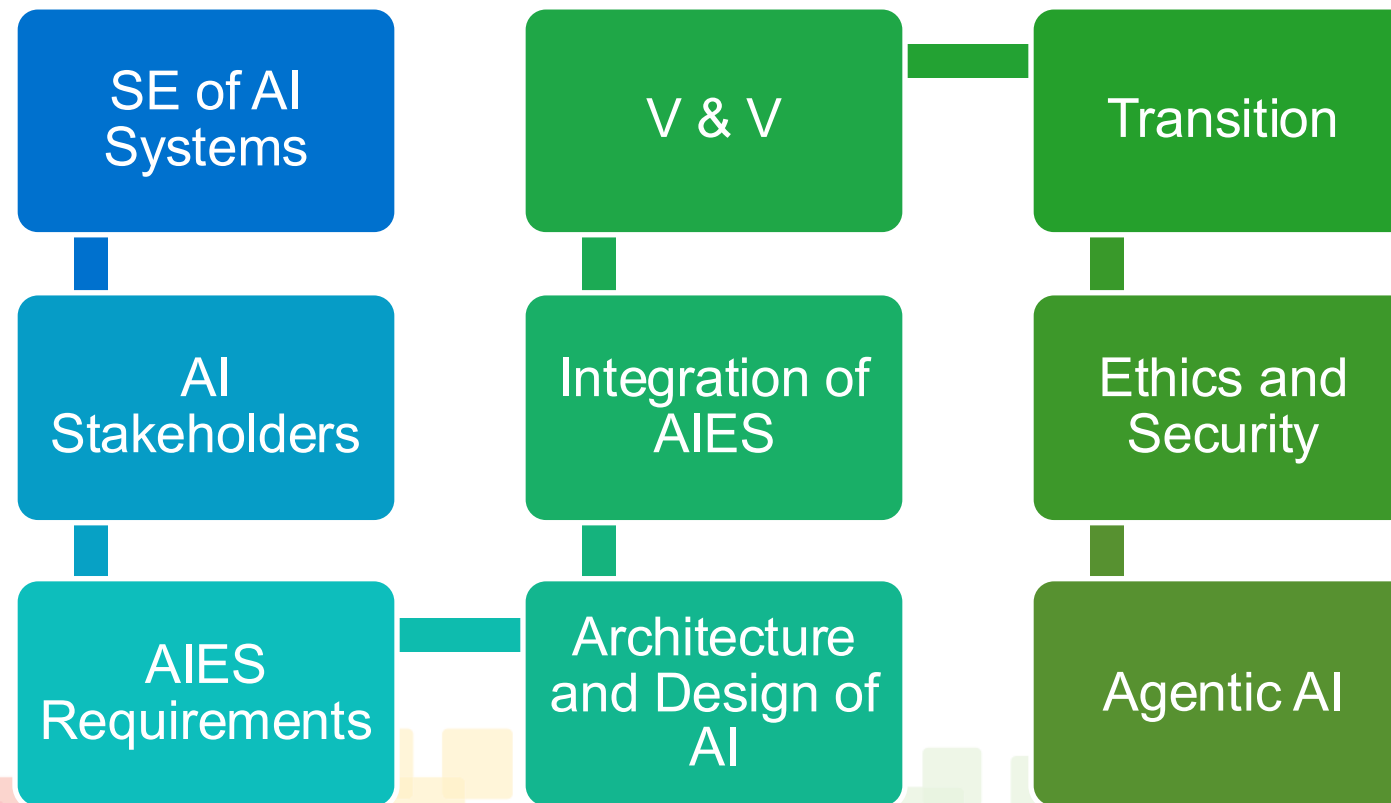


# What about Machine Learning (ML)?



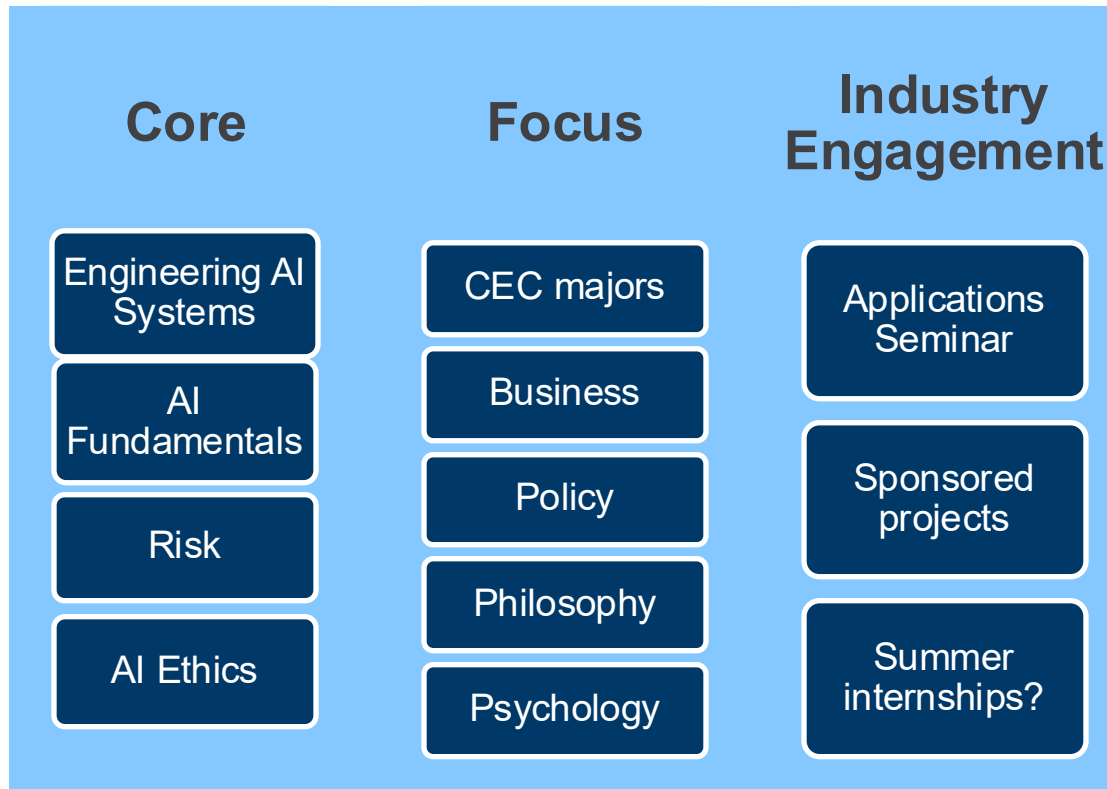
# GMU Course: Systems Engineering of AI Enabled Systems

- A 12-week summer course delves into the **\*\*Systems Engineering\*\*** of AI-intensive solutions, guiding participants through each phase of the life cycle. Drawing on a holistic perspective, it emphasizes how well-defined requirements, rigorous architecture, and integrated security mechanisms must coalesce for robust AI applications.



# GMU Responsible AI Graduate Certificate (1)

- Master's level certificate program in Responsible AI (RAI)
  - Only formalized RAI program in the country
  - New online offering
  - Led by Dr. Missy Cummings
  - Options for executive education



## Learning Outcomes

- the fundamentals of AI,
- how AI systems are architected,
- the principles of systems engineering as they relate to AI systems,
- theories of AI safety and risk,
- how to test and evaluate such systems to meet risk thresholds, and
- how to identify ethical, legal and regulatory issues that arise in such systems.



# GMU Responsible AI Graduate Certificate (2)

<u>ECE 527</u>	Learning From Data	3
or <u>CS 580</u>	Introduction to Artificial Intelligence	
or <u>SYST 568</u>	Applied Predictive Analytics	
or <u>SYST 664</u>	Bayesian Artificial Intelligence	

<u>ME 575</u>	AI Design and Deployment Risks	3
or <u>ECE 575</u>	AI Design and Deployment Risks	

<u>ME 576</u>	AI: Ethics, Policy, and Society	3
or <u>ECE 576</u>	AI: Ethics, Policy, and Society	

<u>ME 577</u>	Emerging AI Robotics Tech Seminar <sup>1</sup>	2
or <u>ECE 577</u>	Emerging AI Robotics Tech Seminar	

<u>SYST 578</u>	Systems Engineering and Artificial Intelligence	3
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- **Cross listed courses across different engineering disciplines**
- **Selected multi-disciplinary seminars**