ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN CONSUMER PRODUCTS

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WPI Interactive Qualifying Project

- 7-week project giving students experience working in interdisciplinary teams to solve a problem or need
- Tackles issues relating science, engineering, and technology to society

WPI IQP Team

Ben Guerriero
Major: Electrical and Computer Engineering
Focus: Analog Microelectronics

Austin Master
Major: Mechanical Engineering
Focus: Design and Manufacturing

Tyson Wiseman
Major: Mechanical Engineering
Focus: Design and Manufacturing

Logan Young
Major: Electrical and Computer Engineering
Focus: Power Systems

Problem Description

Artificial Intelligence (AI) and Machine Learning (ML) are emerging fields and the CPSC needs a way to identify if consumer products are AI and ML capable

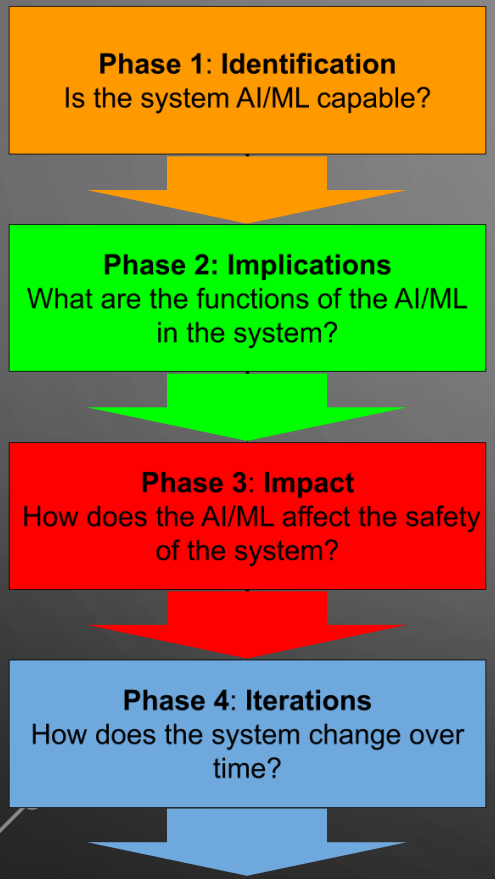
Overview

- Project Goal
- Four Steps Approach
- Artificial Intelligence
- Machine Learning
- Way Forward

Project Goal

Identify if a consumer product has AI or ML capability

Overall CPSC Project



1 - **IDENTIFICATION:** *of the components*

2 - **IMPLICATIONS:** *feature/function of the capability*

3 - **IMPACT:** *influence/effect to safety criteria*

4 - **ITERATIONS:** *transition and transformation*

Phase 1: Identification of the Components

Project Objectives

1. Establish working definitions of AI and ML
2. Identified components of an AI and ML system
3. Create a screening process to identify AI and ML components in consumer products

Project Working Definitions

Safety:

Safety is the state of being protected from physical harm.

Physical Harm:

A source of bodily pain, injury, or cause of an illness suffered by an individual.

Hazard:

A hazard is a potential source or a situation that increases the likelihood of a physical harm to an individual or group of individuals beyond some accepted threshold. Examples could include mechanical contact, hazardous energy release, exposure to hazardous chemicals, or other means of physical harm from a product. *Note: an accepted threshold varies across products, industries, regulators, and consumers; determining this threshold is beyond the scope of this project.*

Artificial Intelligence

Artificial Intelligence

NIST Definition:

AI technologies and systems are considered to comprise software and/or hardware that can learn to solve complex problems, make predictions or undertake tasks that require human-like sensing (such as vision, speech, and touch), perception, cognition, planning, learning, communication, or physical action

Artificial Intelligence

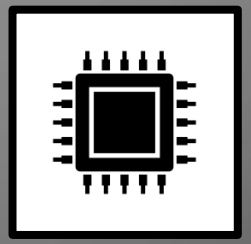
Applied Artificial Intelligence is …

- *Field of computer science*
- *System resembles human decision – making*
- *Processes information to provide outputs*
- *Systems role and support role*

Components for AI Capability

Data Source

Algorithm



Computation

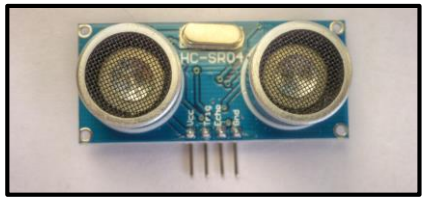
Connection

Data Source

A way to collect information

- *Sensor or human input used to gather data*

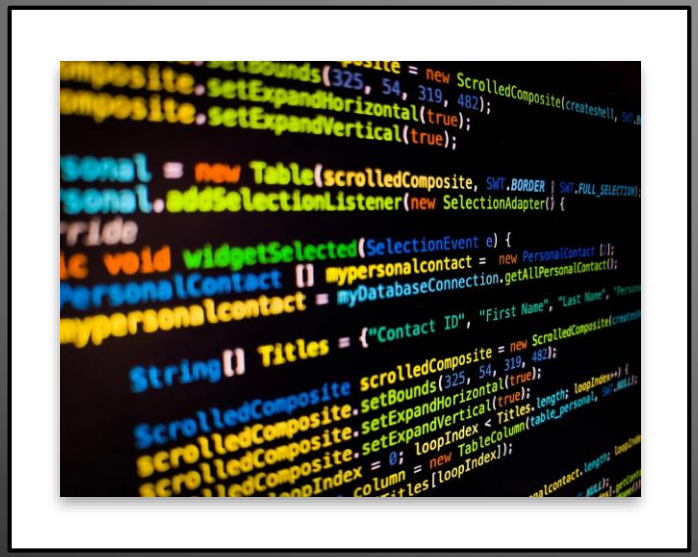
Photocell



Ultrasonic Sensor

Keyboard

Algorithm



Formulas that generate outputs

- *Software in the system*

Computational Capability

System processes the given data

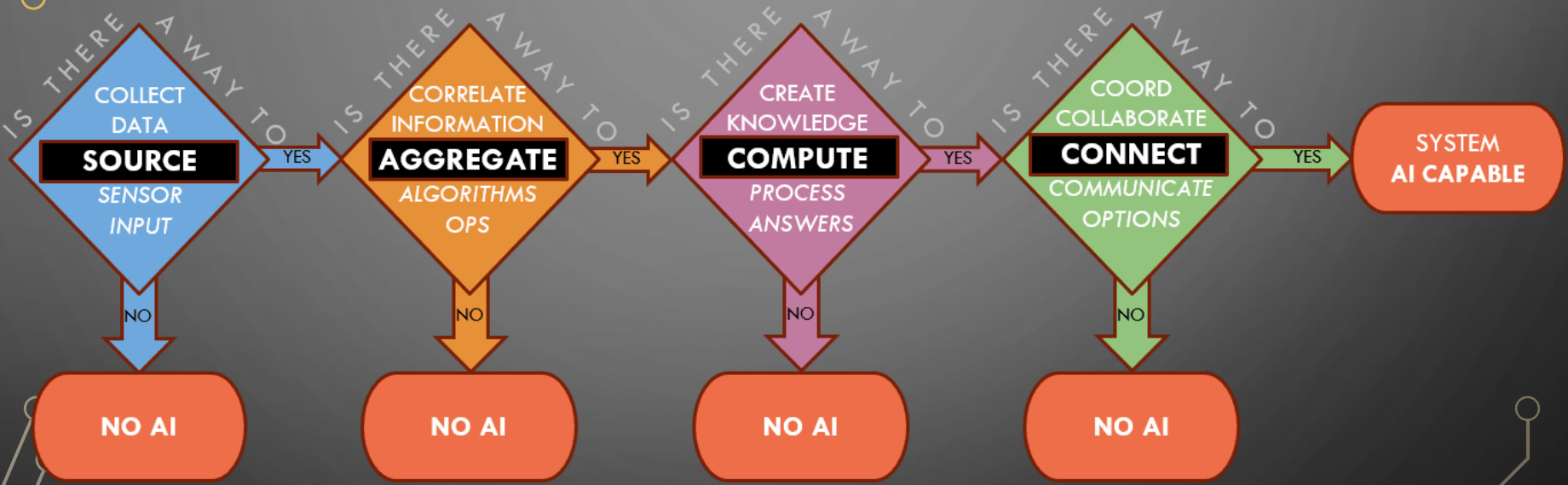
- *Aggregates data collected to allow the system to provide informed answers*
- *CPU*

Connection

Allows for the flow of information

- *Busing*
- *Internet of Things (IoT)*

AI Screening Process

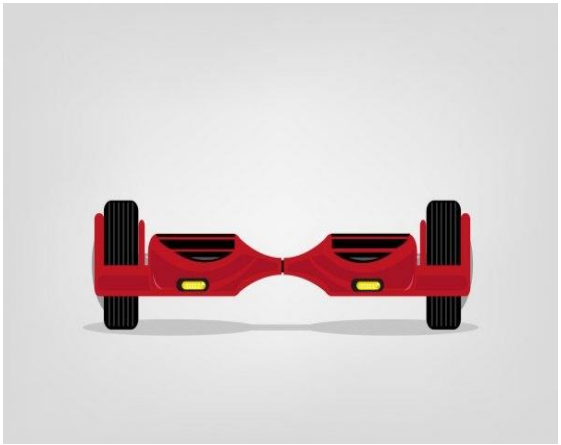


AI Capable Examples

Home Security System

- Data Source ✓
- Algorithm ✓
- Computation ✓
- Connection ✓

AI Capable Examples



Hoverboard

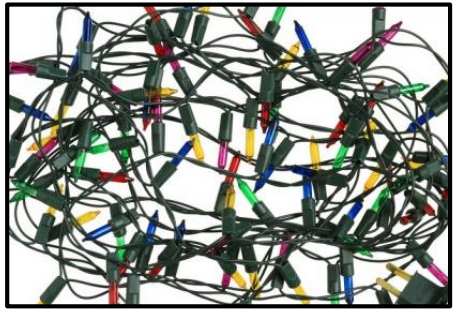
Data Source ✓

Algorithm ✓

Computation ✓

Connection ✓

Non-AI Capable Examples



Christmas Lights Timer

Data Source X

Algorithm X

Computation X

Connection X

Non-AI Capable Examples

Headphones with Microphone

Data Source ✓

Algorithm X

Computation X

Connection ✓

Non-AI Capable Examples

Power Tool

Data Source ✓

Algorithm X

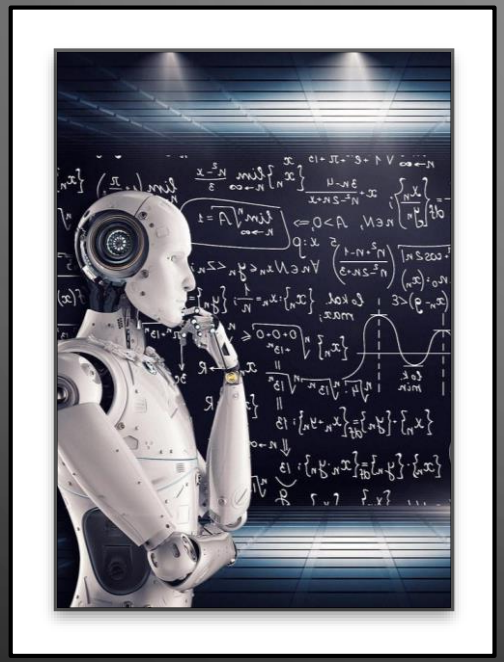
Computation X

Connection X

Machine Learning

Machine Learning

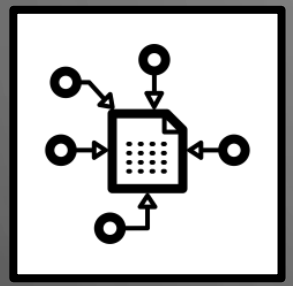
Working Definition



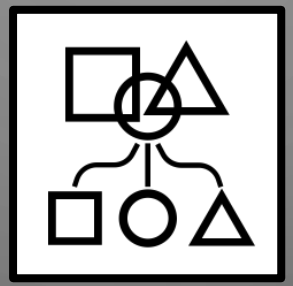
Machine Learning is …

- *Process of gaining knowledge or experience though given data*
- *Assesses outputs*
- *Finds differences*
- *Characterizes outcomes*
- *3D's – Distinctions, Differences, Differentials*

Components for ML Capability



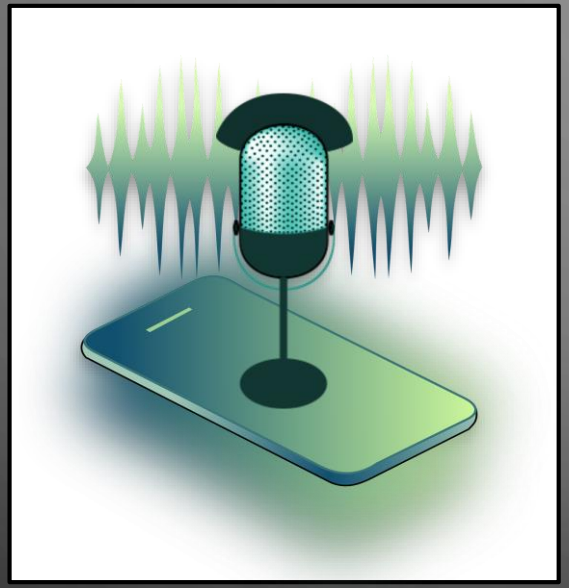
Monitoring



Measuring

Modeling

Monitoring



Assess outputs to observe information

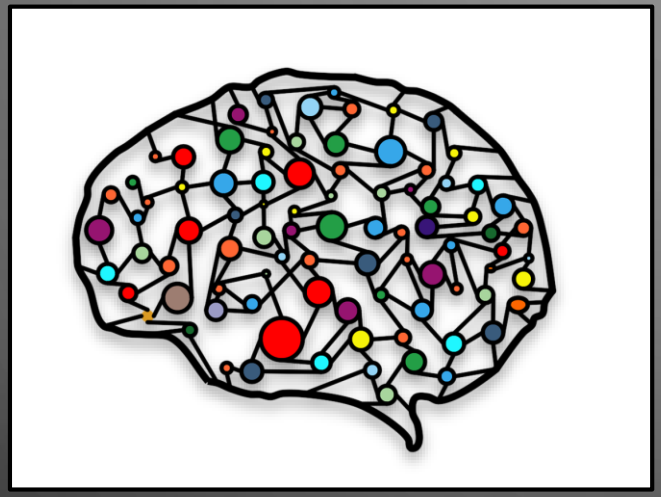
- *Distinctions*

Measuring

Analyze adaptations

- *Differences*

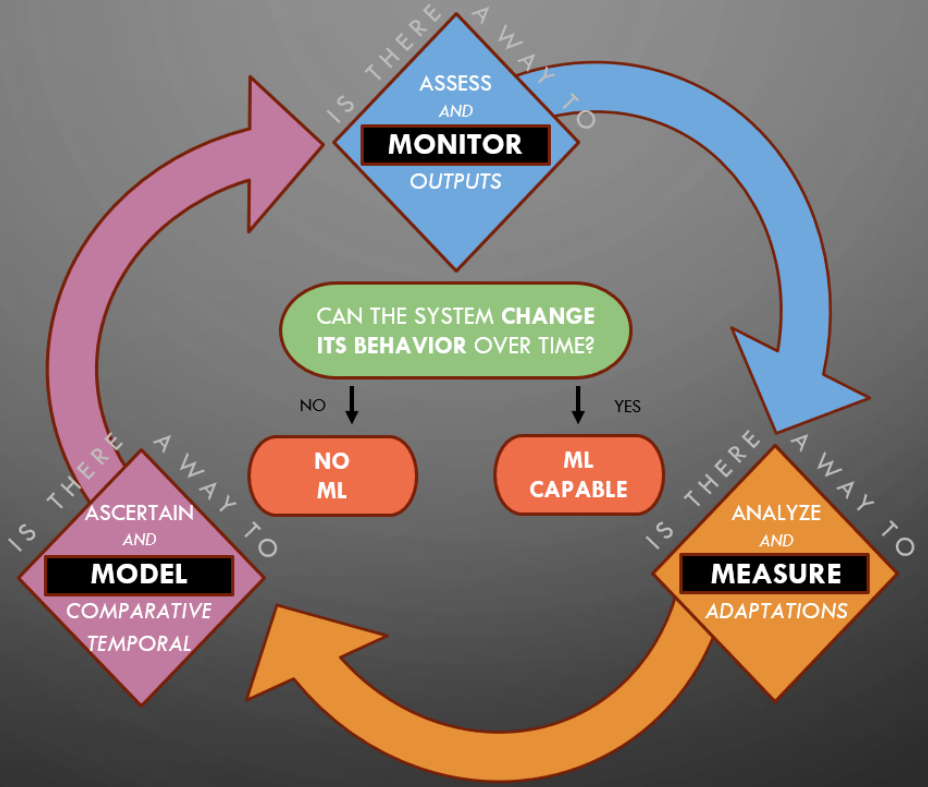
Modeling



3E's – Enlighten, Empower, Evolve

- *Differentials*

ML Screening Process



ML Capable Examples

Smart Fridge

Automatic Vacuum

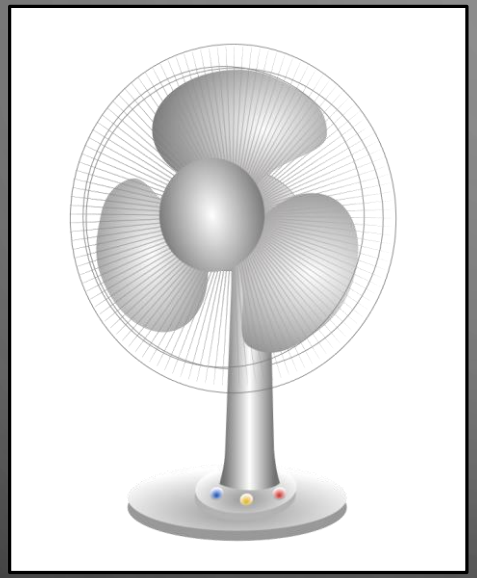
Change Behavior? ✓

Monitoring ✓

Measuring ✓

Modeling ✓

Non-ML Capable Examples



Electric Fan

Change Behavior? X

Monitoring X

Measuring X

Modeling X

Non-ML Capable Examples

Monitor

Change Behavior? X

Monitoring X

Measuring X

Modeling X

Non-ML Capable Examples

Keyboard

Change Behavior? X

Monitoring X

Measuring X

Modeling X

Summary

WPI Project Summary

- Working Definitions
- AI Components and screening process
  - *Data source*
  - *Algorithm*
  - *Computation*
  - *Connection*
- ML Components and screening process
  - *Monitoring*
  - *Measuring*
  - *Modeling*

Next Steps

- Phase 2: Implications
  - *Study the functions of AI and ML in a product*
  - *List of functions*
  - *Functions decision tree*
- Phase 3: Impact
  - *Study of Hazards*
  - *Potential risks in products*
- Phase 4: Iterations
  - *Products Analysis*

Conclusions

Developed working definitions of AI and ML

Identified the components of AI and ML capable systems

Created a methodology to determine AI and ML capability

What We Learned

Understanding of AI and ML

- *What makes up an AI and ML system (components)*

Consumer product safety

- *How they are addressed*
- *Development of Voluntary standards*

Professionalism and Project management

We Would like to Thank

CPSC

- Nevin Taylor
  - Chief Technologist
- Scott Ayers
  - Volunatary Standards
- Survey Respondents
- Interviewees (CPSC/Industry)

WPI

- Professor Holly Ault
  - Department of Robotics Engineering
- Professor James Hanlan
  - Department of Humanities
- Professor Robert Traver
  - International and Global Studies

Questions

Thoughts

Ideas

Ben Guerriero

- Electrical and Computer Engineering
- Focus on analog and microelectronics
- Likes to go camping and rock climbing
- Plays electrical guitar

Austin Master

- Mechanical Engineering Major
- Focus on design and manufacturing
- Enjoys playing and watching basketball
- Participates in the Christian Bible Fellowship club on campus

Tyson Wiseman

- Mechanical Engineering Major
- Focus on mechanical design
- Likes personal CAD design, 3D printing, and digital art
- Parliamentarian for WPI's chapter of the National Society of Black Engineers

Logan Young

- Electrical and Computer Engineering Major
- Focus on Power Systems
- Likes to listen to music
- Member of the Varsity Esports Team

Works Cited

WPI Campus: 2048 × 1365 (advancelocal-adapter-image-uploads.s3.amazonaws.com)

Data source icon: 1374315-200.png (200×200) (thenounproject.com)

Algorithm icon: 2034652-200.png (200×200) (thenounproject.com)

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Hoverboard: https://depositphotos.com/vector-images/hoverboard.html

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Power Tool: https://creazilla.com/nodes/27533-makita-battery-powered-cordless-screwdriver-and-drill-clipart

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Monitor: 56f48523710e2beb6eb8325706b8e20ff8.2x.rsquare.w600.jpg (1200×1200) (nymag.com)

Keyboard 2: https://images.all-free-download.com/images/graphiclarge/keyboard_clip_art_10181.jpg