DEVELOPMENT OF A SIMULATED ENVIRONMENT FOR DECISION MAKING WITH AN AUTONOMOUS SYSTEM UNDER UNCERTAINTY

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OVERVIEW

- Introduction
  - ✓ Background
  - ✓ Statement of the Problem
  - ✓ Aims
  - ✓ Framework (Decision Making/Judgment)
- Lens Model
  - ✓ Lens Model Equation
  - ✓ Hybrid Lens Model

OVERVIEW (CONTINUED)

- Methodology
  - ✓ Computer-based Simulation Testbed
    - Structure of the Figure
    - Mechanism
- Future Work
- Questions & Answers

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INTRODUCTION
BACKGROUND

- Problem
  - ✓ Explosive detection has been an issue for military and law enforcement personnel
    - Lack of automation interaction
    - Human deciding independently
    - Leads to disastrous outcomes
- Purpose of the project
  - ✓ Develop a simulated environment
    - Assist humans with interacting with autonomous systems in making decisions
    - Train humans to make decisions while in situations that contains pressure

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INTRODUCTION
BACKGROUND

- Computer-based simulations
  - ✓ Huge number of skilled individuals needed
  - ✓ Cost efficient due to ambiguity (personnel and computer time)
  - ✓ Simulations are conducted in real time with the use of:
    - Modeling
    - Executing
    - Animating
  - ✓ Quality, safety, and productivity of a task

(UH, 2000)

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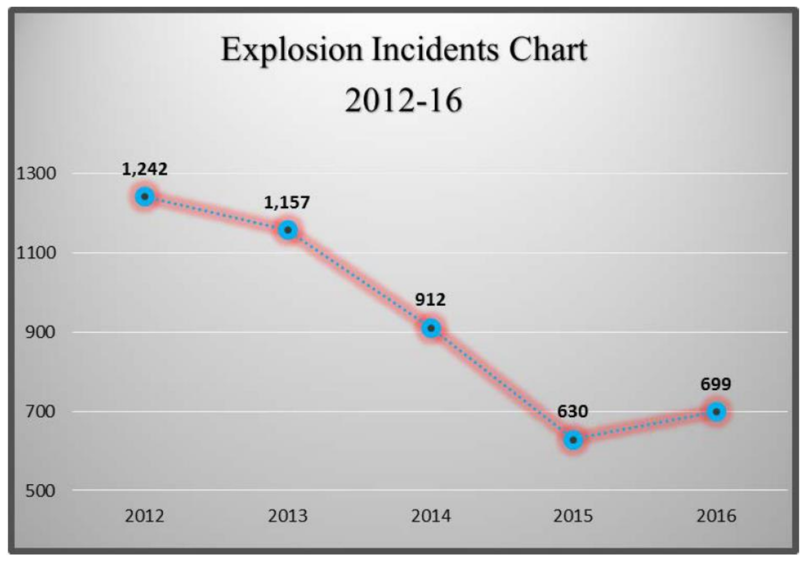
INTRODUCTION
BACKGROUND

- Real Life Stories
  - ✓ United States Bomb Data Center (USBDC)



(ATF, 2016)

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INTRODUCTION
BACKGROUND

- ✓ World Trade Center (New York City, September 11, 2001)
  - Most highly ranked event within the United States history
  - Report of 2,666 deaths
  - Possibly involved explosives on planes or buildings
- ✓ Virtual Interactive Combat Environment (VICE)
  - Train cognitive skills needed by:
    - ➢ Military
    - ➢ Homeland security
    - ➢ Law enforcement
  - Confronts and resolves issues within environments

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INTRODUCTION
BACKGROUND

- Why are simulated environments needed by military, homeland security, and law enforcement?
  - ✓ Prevent hazardous situations (i.e. detecting explosives)
  - ✓ Practice for both experienced and non-experienced individuals
  - ✓ Train the cognitive skills of personnel by:
    - Conducting and resolving potential as well as actual conflict
      - Urban
      - Suburban
      - Rural

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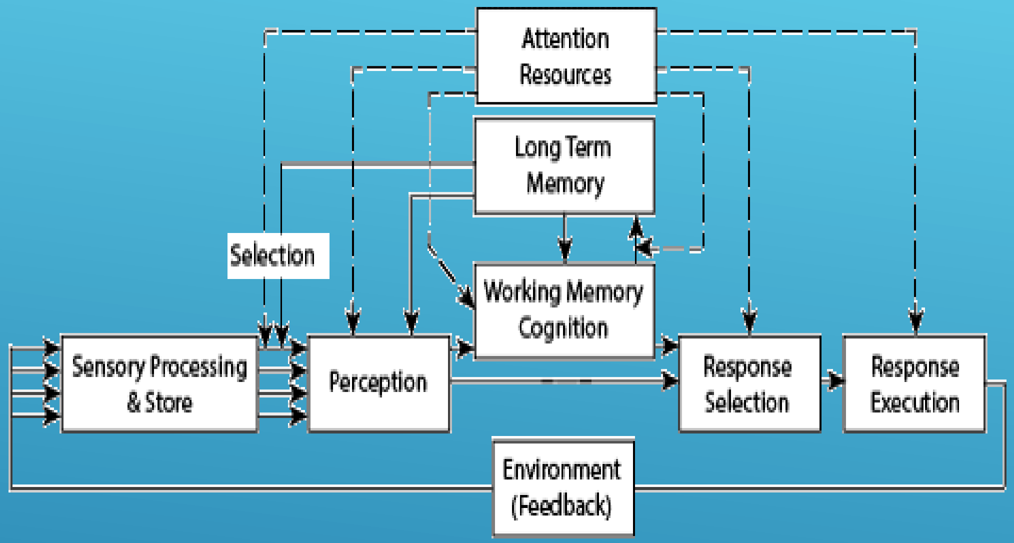
INTRODUCTION
BACKGROUND

- Complexity of a Human
  - ✓ Performance of an individual
  - ✓ Four major areas of human information processing:
    - Mental Workload
    - Situation Awareness (Perception/ Working Memory)
    - Complacency (Decision Making)
    - Skill Degradation (Response Selection) (Parasuraman et al., 2000)



Human information processing (Wickens, 1992)

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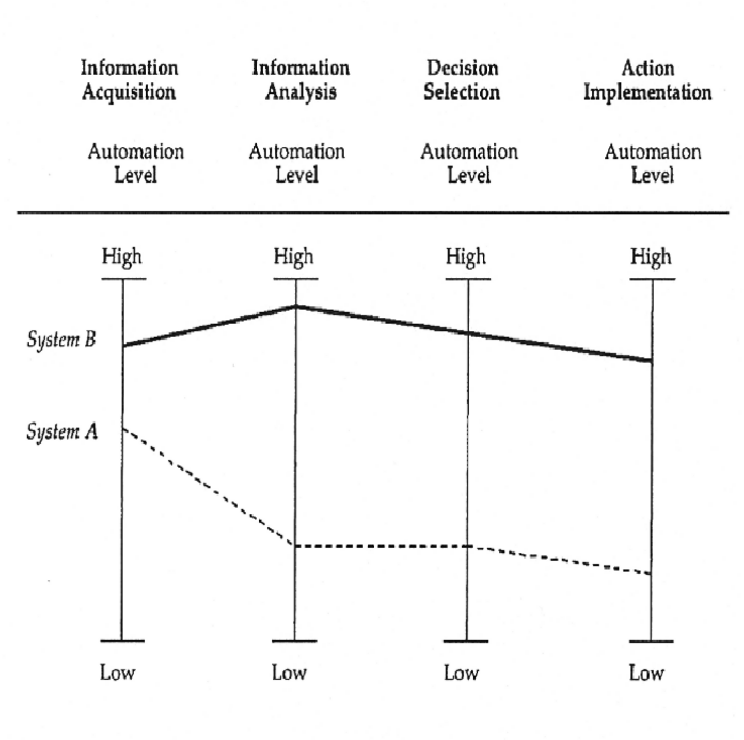
INTRODUCTION
BACKGROUND

- Automation
  - ✓ Automatically operate an apparatus, a process, or a system
  - ✓ Takes the place of human labor
  - ✓ Ability to act alone or work with a human

  (Merriam-Webster Dictionary, 2017)
  - ✓ Four Levels and Stages (Parasuraman et al., 2000)



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INTRODUCTION
STATEMENT OF THE PROBLEM

- Creation of a system (simulated environment)
- Benefits of the simulated environment
  - ✓ Enhancing users utilization
  - ✓ Enabling decisions to be made by a user
- Tools
  - ✓ Software
    - Visual Basic
    - Microsoft Excel

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INTRODUCTION
PROJECT AIMS

- Develop a guideline that will be effective in implementing decision making for an autonomous system into an environment that is simulated.
- Develop a tool that will enhance, integrate, and innovate a systematic process that will enable users to make decisions that sufficient to safety.
- Establish an understanding of how the collaboration between the HO and ADA can lead to effective decision making in an environment that is uncertain.

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INTRODUCTION
FRAMEWORK(DECISION MAKING/JUDGMENT)

- Become more introduced with the use of automation
- Process of making choices
  - ✓ Identification of decisions
  - ✓ Gathering information
  - ✓ Assessment of alternative resolutions
- Judgment focuses on the assessment of an environment

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INTRODUCTION
FRAMEWORK(DECISION MAKING/JUDGMENT)

- Suitable decision making approach – Lens Model
  - ✓ Describes relationships between the environment and behavior of organisms within the environment
  - ✓ Use of ANOVA design
    - Correlation of components such as decisions made by users
    - Use Excel spreadsheet to keep track of data from simulation
    - Create scatterplots by showing the following:
      - Strength
      - Direction
      - Shape

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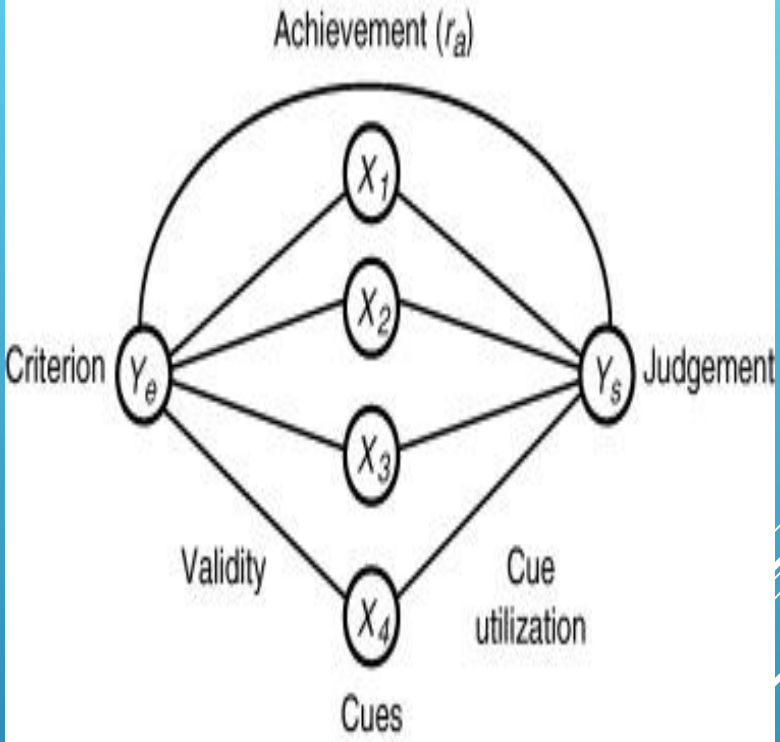
LENS MODEL

- Egon Brunswik's (1952)
  - ✓ Book – The Conceptual Framework of Psychology
  - ✓ Probabilistic Functionalism Theory (Perception)
  - ✓ Selection of environmental cues (Responding)
  - ✓ Validity of perceptions
  - ✓ Probabilistic beliefs versus certainty
- Kenneth Hammond (1955)
  - ✓ Social Judgments



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LENS MODEL
LENS MODEL EQUATION

- Mathematical Approach
- Five Parameters
  - ✓ r_a – Achievement
  - ✓ R_s – Control
  - ✓ R_e – Predictability
  - ✓ G – Linear Knowledge
  - ✓ C – Unmodeled Knowledge

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LENS MODEL
LENS MODEL EQUATION

- Descriptions of the five parameters

Table 1

Description of LME Parameters

Variables	Names	Meanings
r_a	Achievement	Correspondence between the human's judgment and the actual environmental state
Re	Predictability	Reflects how well the prediction of the environment based on the state of the linear model
Rs	Control	Reflects how well the prediction of human's judgment in correspondence with the linear model
G	Linear Knowledge	Reflects how well the actual environment is captured based on model of the human
C	Unmodeled Knowledge	Reflects the differences that are similar between both the predicted and the actual of the human judgments and the values of the environment

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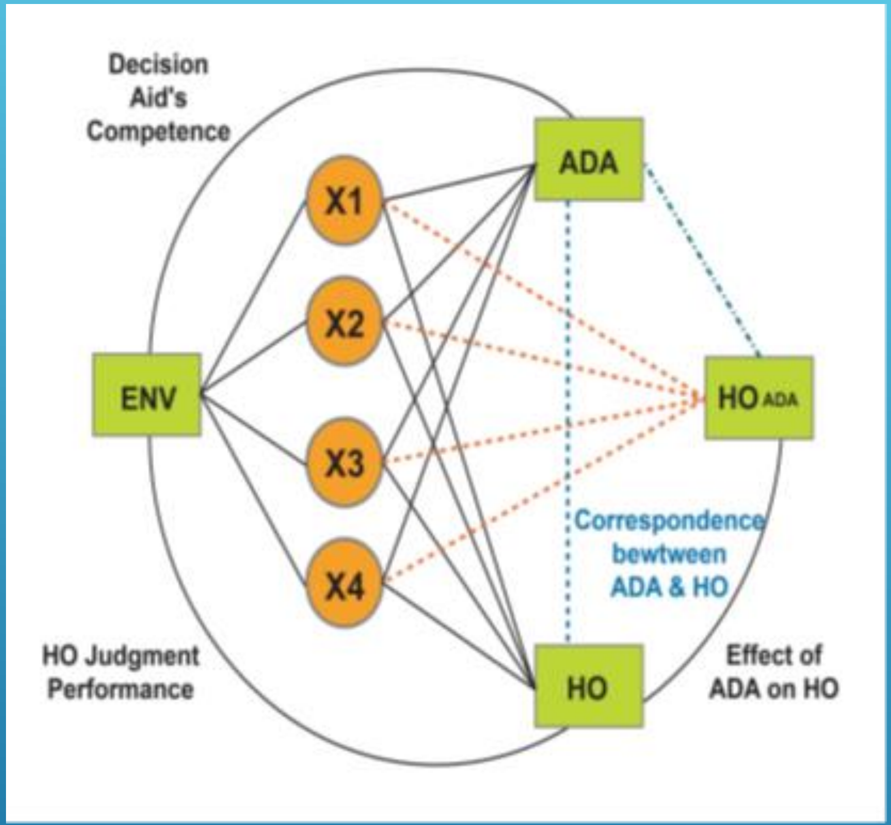
LENS MODEL
HYBRID LENS MODEL (HLM)



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LENS MODEL
HYBRID LENS MODEL (HLM)

Two categorical data sets (decision) and coding (E—1 and N—0)

Y_1	Y_2	Y_1 (coded)	Y_2 (coded)	
E	N	1	0	Not a Match
N	E	0	1	Not a Match
E	E	1	1	Match
E	E	1	1	Match
N	N	0	0	Match

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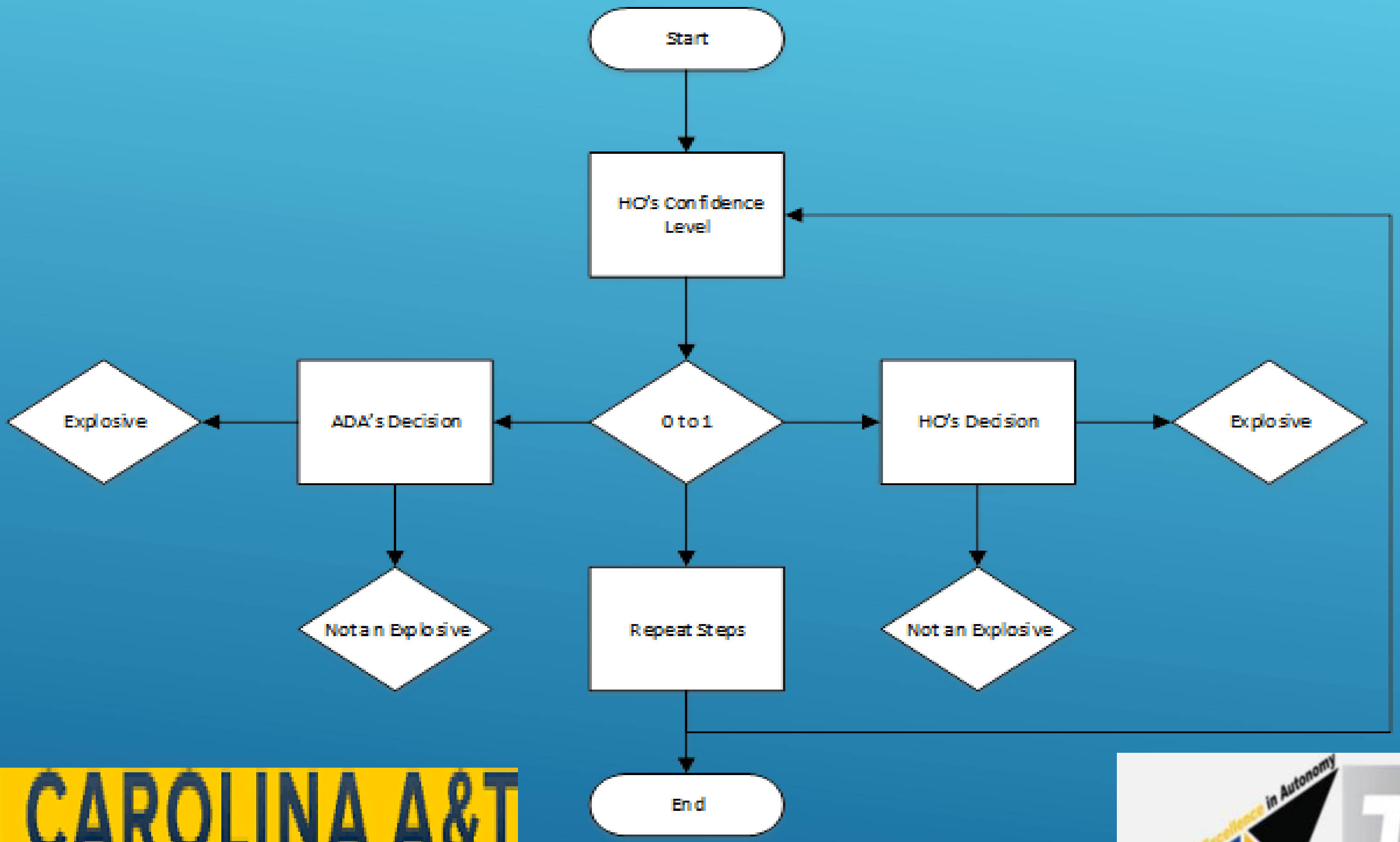
METHODOLOGY
STRUCTURE OF THE FIGURE



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METHODOLOGY
STRUCTURE OF THE FIGURE

- Four tabs
  - ✓ Start – Begins the simulation
    - Autonomous system moves to one of the top numbers randomly
    - User selects the random number
    - Four cues are displayed to the user
    - User inputs level of confidence from 0 to 1 (Twice)
    - ADA's decision is displayed to the user
    - User inputs decision (E or N)

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METHODOLOGY
STRUCTURE OF THE FIGURE

- ✓ Open – Allows the user to open the data file (Excel)
- ✓ Reset – Gives the user the option to start the simulation over
- ✓ Exit – Saves and closes the simulation

- Grid has 100 squares (10 rows and 10 columns)
- Robot (Autonomous System)
- Level of Probability (Compares the decisions between the users)
- Shows a goal that should be accomplished by the user

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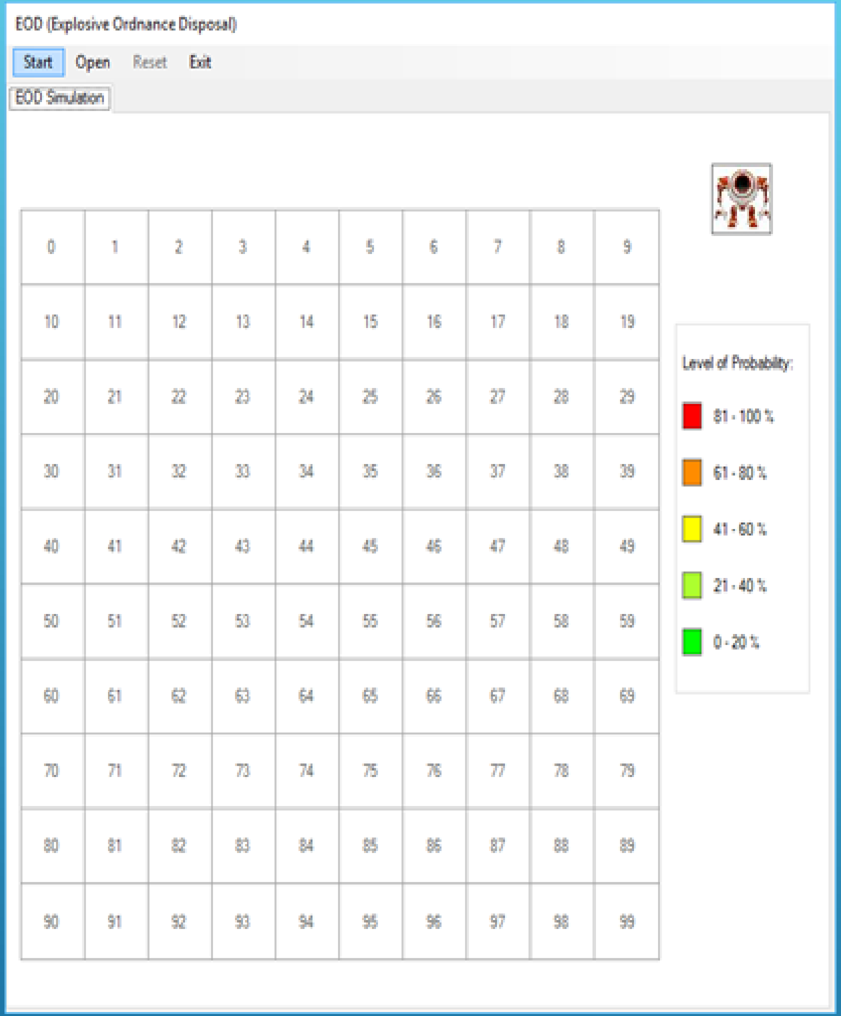
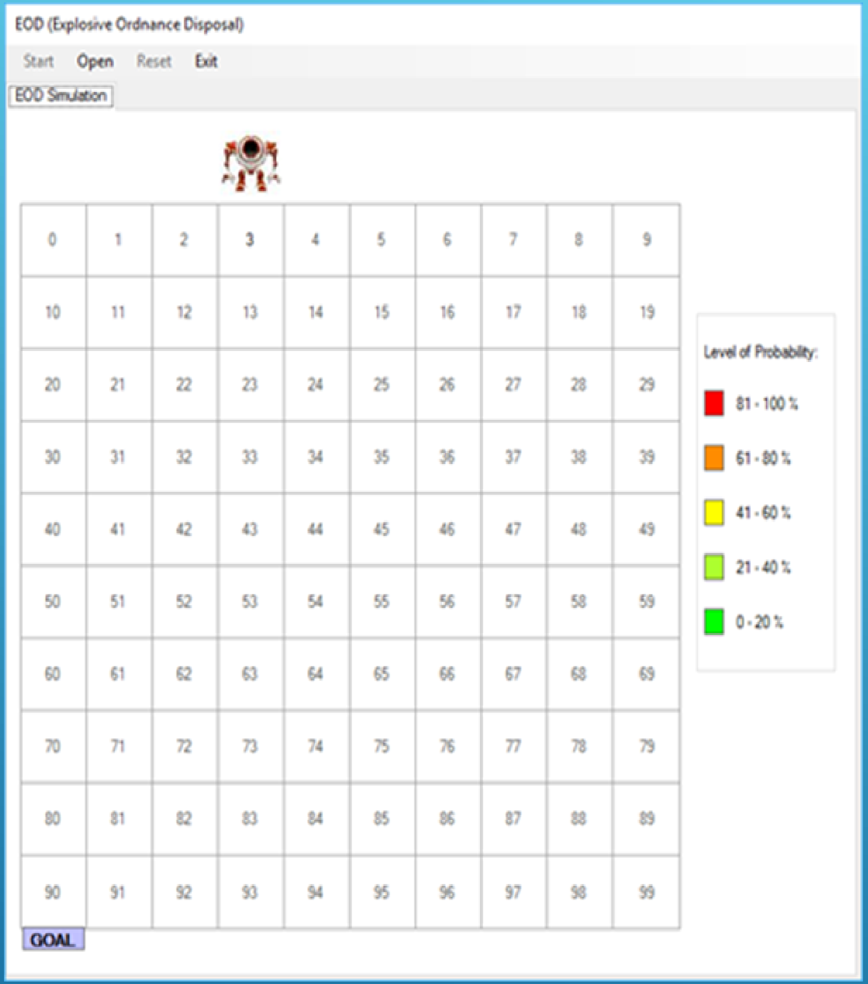


SIMULATION (TEST-RUN 1)

- User clicks the start button



SIMULATION (TEST-RUN 1)

- Robot moves to a randomly generated number
- A goal is set based on a portion of the code within the Visual Studio program
- User is expected to choose the random number that the robot is located above

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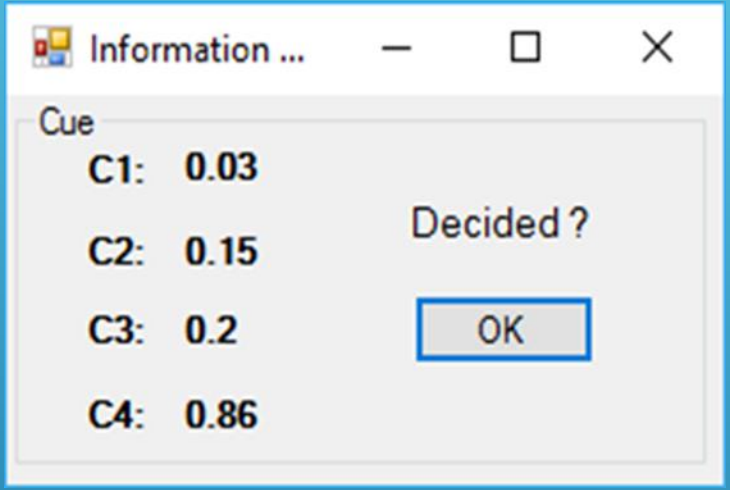

SIMULATION (TEST-RUN 1)

- Four cues are displayed to the user
- User takes as much time as needed to come to a decision
- Once a decision has been made, the user is expected to click the OK button

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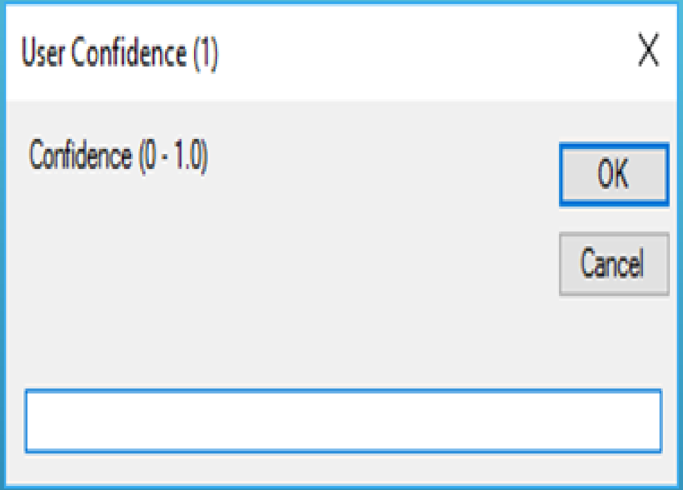

SIMULATION (TEST-RUN 1)

- User decision should be based on a confidence level between 0 to 1
- User chooses a level of confidence
- First confidence level input into the blank box below
- OK button should be clicked

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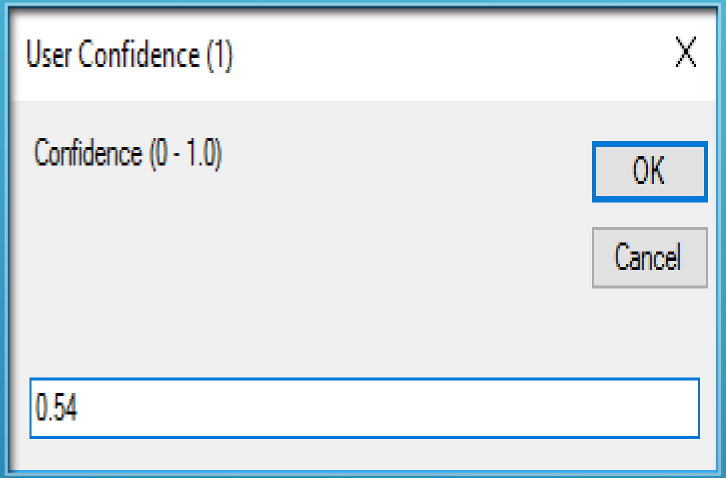

SIMULATION (TEST-RUN 1)

- Example of the user inputting his/her first confidence level
- User chose a confidence level of 0.54
- The user clicks the OK button to continue the simulation

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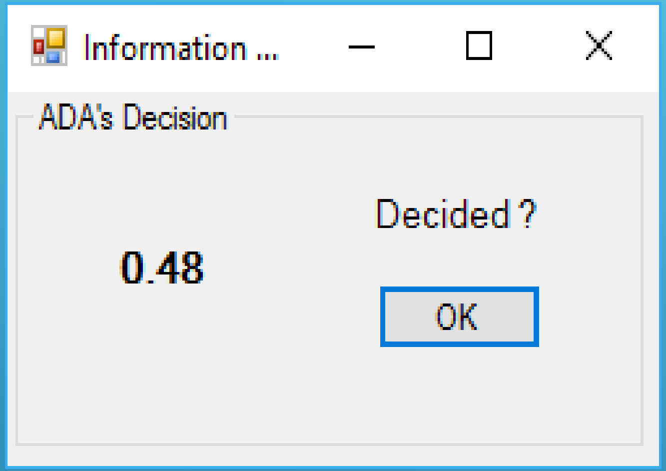

SIMULATION (TEST-RUN 1)

- Decision of an autonomous system is revealed to the user
- User compares his/her confidence level with the autonomous decision aid's decision
- User makes a second decision

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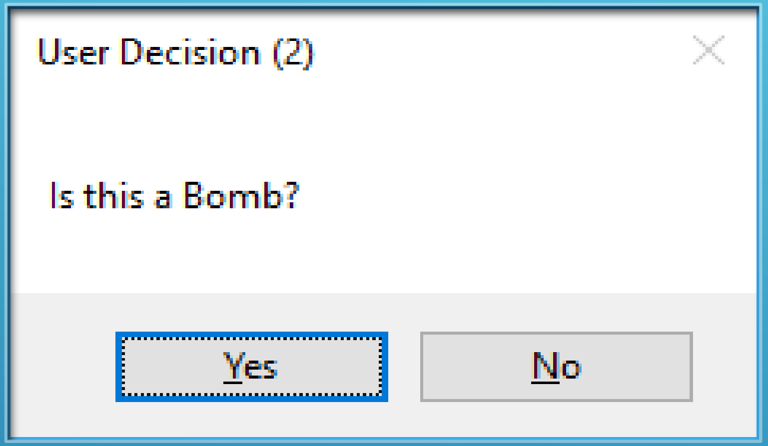
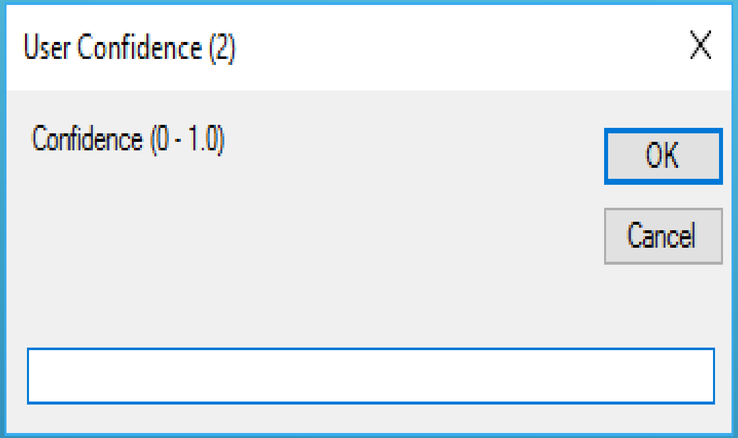


SIMULATION (TEST-RUN 1)

- User contemplates whether or not there is an explosive based on the ADA's decision
- One of two choices are provided to the user:
  - ✓ Yes
  - ✓ No



SIMULATION (TEST-RUN 1)

- Same confidence level scale used from 0 to 1
- User chooses a second level of confidence
- Second confidence level inserted in to
- User clicks the OK button

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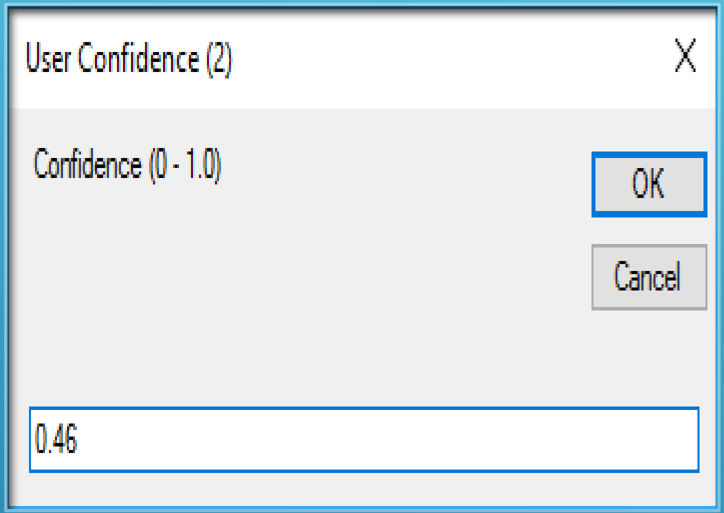
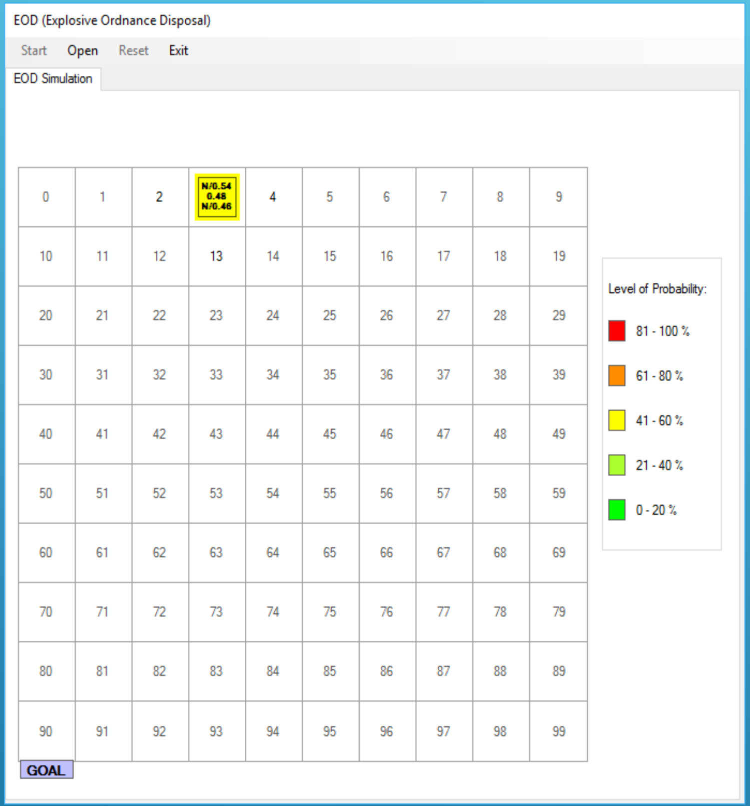


SIMULATION (TEST-RUN 1)

- Example of the user inserting his/her second confidence level
- A confidence level of 0.46 was chosen by the user
- The OK button is to be clicked so that the simulation continues



SIMULATION (TEST-RUN 1)

- After clicking the OK button, the first random number will display:
  - ✓ First decision
  - ✓ First confidence
  - ✓ ADA's decision
  - ✓ Second decision
  - ✓ Second confidence
- Also, a color will be shown in regards of the level of probability based on the decisions made by both users

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SIMULATION (TEST-RUN 1)

- User can move below or either the left or right of the initial randomly generated number
- Robot moves above the done button once all of the grids have been filled
- User can either click done or exit to save the data as shown in the picture

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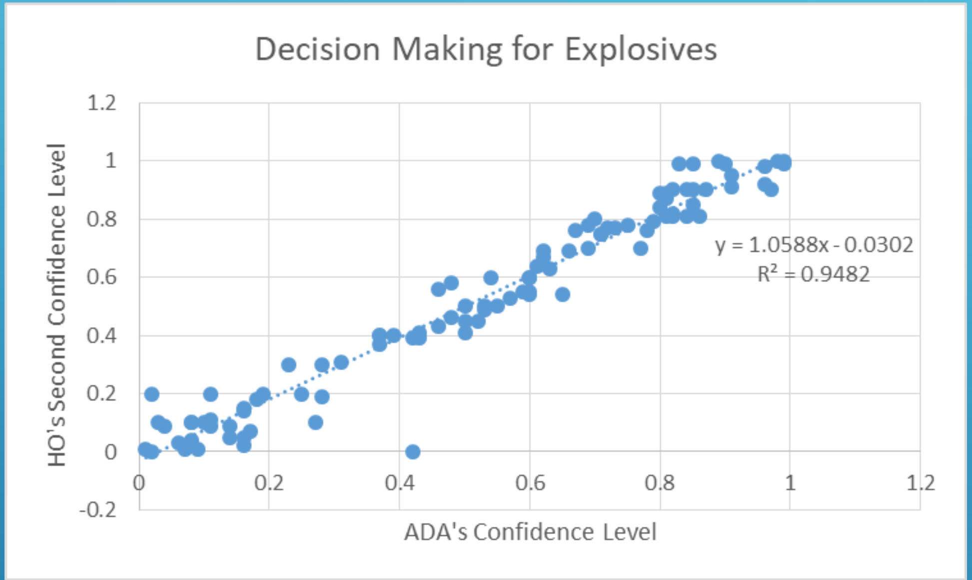
SIMULATION (TEST-RUN 1)

- 100 points plotted
- Weak correlation
- No specific direction
- A few of the plotted points lie on the linear line



SIMULATION (TEST-RUN 1)

- Positive correlation
- Starts at a decreased state and increases
- Shows a strong positive correlation between both the HO and ADA

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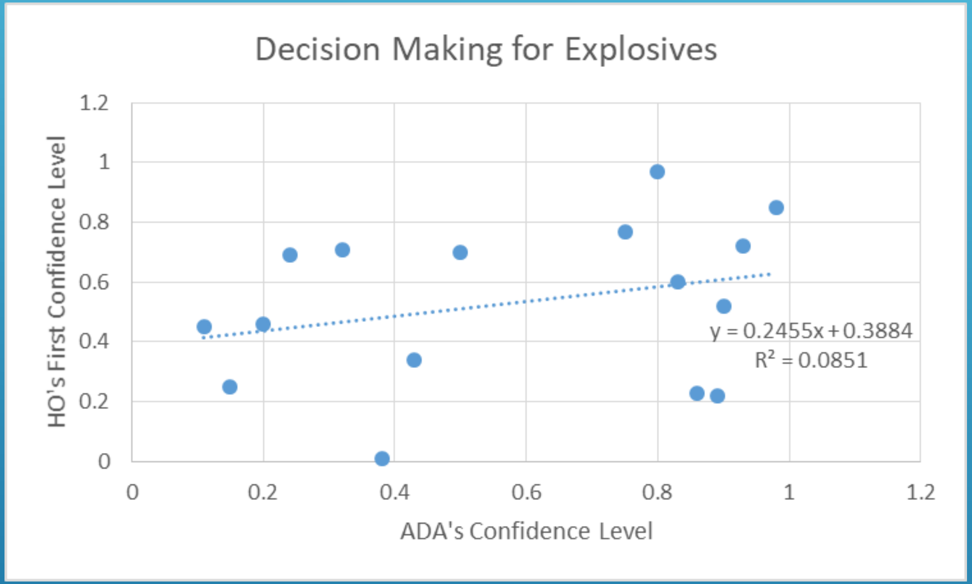
SIMULATION (TEST-RUN 2)



- Weak correlation
- No specific direction
- 2 to 3 of the 16 points are semi-correlated

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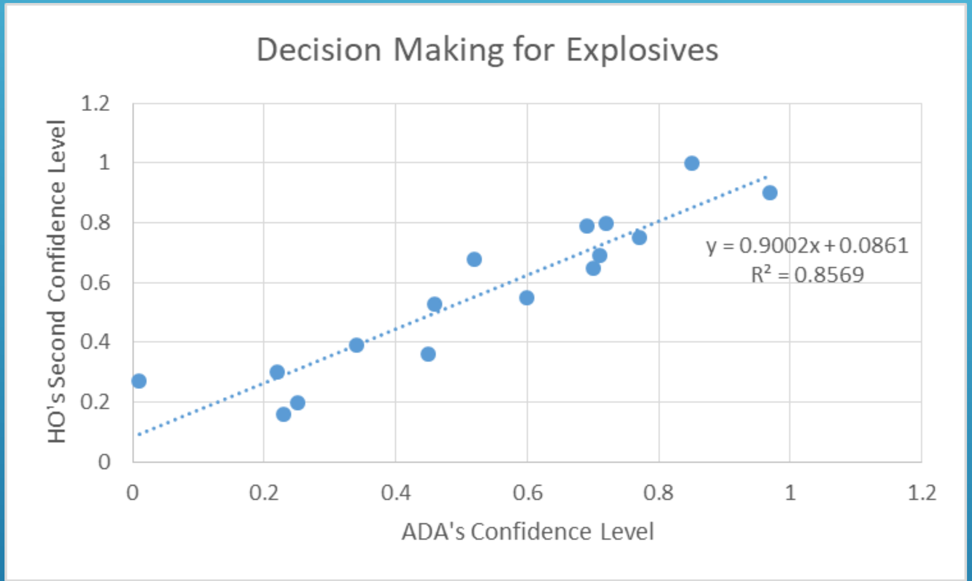

SIMULATION (TEST-RUN 2)

- Positive correlation
- Starts at a decreased state and increases
- Shows a strong correlation between the HO and ADA

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FUTURE WORK

- Research information to create a useful and beneficial guideline to implement users
- Enhancing tools to effectively apply to the simulated environment
- Data from the simulated environment is expected to be run in the statistical analysis system (SAS) program
- Provide results to show whether or not there is a definite match between the environment and users

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QUESTIONS, COMMENTS, AND/OR CONCERNS

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