**Project Title:** *AI-Powered Sustainability Project*

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**Course / Term:** *CISC 440* *Spring 2025*  
**Date:** *May 12, 2025*

**1. Project Summary**

Sustainability is a growing global priority, and AI offers powerful tools to tackle environmental challenges. Search algorithms, game strategies like Minimax, and constraint satisfaction problems help simulate complex systems and model sustainable decision-making. Supervised machine learning can predict environmental trends, guiding proactive actions. Generative AI tools like ChatGPT and DALL·E further support sustainability by creating educational and engaging content. This project combines these AI methods to build interactive tools that promote awareness and action toward a sustainable future.

**2. Game 1 Details**

**Overview**

**Implementation Observations**

**Technical Insights**

**Conclusion & Future Work:**

**3. Plant The Tree First!!!**

**Overview:**

"Plant The Tree First" is an educational game designed to promote sustainability awareness through a competitive tree-planting simulation. The game features two players navigating a grid-based environment to plant trees in designated drop zones while avoiding obstacles.

**Implementation Observations:**

Human vs Human Mode

* Functioned perfectly with balanced gameplay
* Winning probability depends entirely on player strategy

Human vs AI Mode

* Difficulty
  + Easy (Depth 3): Able to find nearby drop zones, Slower response time, less optimal pathfinding
  + Medium (Depth 6): Well-balanced performance, responded efficiently, consistently outperformed human players, Optimal difficulty level
  + A screenshot of a video game

    AI-generated content may be incorrect.A screenshot of a video game

    AI-generated content may be incorrect.A screenshot of a video game

    AI-generated content may be incorrect.Hard (Depth 9): Surprisingly less efficient than Medium, obstacles (houses) interfered with decision-making, occasionally made random moves due to complexity

A screenshot of a video game

AI-generated content may be incorrect.AI vs AI Mode

* Minimax AI (Player 2) consistently outperformed random-move AI (Player 1) across all difficulty levels
* Demonstrated the effectiveness of the Minimax algorithm over random movement
* Validated the AI implementation's correctness

**Technical Insights:**

Algorithm Performance

Minimax with Alpha-Beta Pruning proved effective but showed limitations:

* Performance peaked at medium difficulty (depth 6)
* Higher depths didn't necessarily translate to better performance due to: Increased computational complexity, Obstacle interference in path evaluation, and Time constraints affecting quality

**Conclusion & Future Work:**

Key Findings:

* Medium difficulty (depth 6) provides optimal challenge
* Hard mode requires algorithmic refinement
* AI vs AI mode validates Minimax superiority

Future Development: Implementing Iterative deep learning and integrate more educational content on sustainability

**4. ML Models**

During the machine learning portion of our project, we explored three distinct modeling tasks.

**Logistic Regression: Predicting Recycling Rates**

We began by using logistic regression to predict whether a country recycled 25% or more of its total waste. Our input features were:

* Year
* Total weight of trash collected

We gathered data from 38 OECD countries. One striking observation was the outlier status of the United States, which produced more than three times the trash of the next highest country. This skewed the dataset significantly.

Despite multiple attempts at tuning the model, it consistently predicted that nearly all countries recycled more than 25% of their waste — an optimistic but inaccurate conclusion. This result likely stemmed from poor feature separability and the overwhelming influence of outliers.

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A screenshot of a computer screen

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**Multiclass Logistic Regression: Predicting Air Quality**

Next, we shifted our focus to predicting air quality levels in cities using the following environmental features:

* Dew point
* Humidity
* Pressure
* Temperature
* Wind speed

Using multiclass logistic regression, we found that:

* Humidity was the most influential predictor of air quality.
* Dew point and temperature also had moderate predictive power.
* Pressure and wind speed had little to no impact, likely due to their minimal variability or lack of direct relevance.

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**K-Means Clustering: Land Use and Political Rights**

Lastly, we applied k-means clustering (k = 7) to group countries based on:

* Arable land (% of total land)
* Urban land area (km²)
* Political rights (Freedom House Index)

The clustering results were modest. Most countries fell into a single large cluster, likely due to the global scarcity of large urban areas. However, outliers like China, the U.S., and India stood far apart from the rest.

These outliers significantly influenced the model, suggesting that an alternative method such as DBSCAN may have been more appropriate. DBSCAN could better handle the noise and density variation, mitigating the impact of extreme values.

A graph with purple dots

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**5. GenAI Trivia / Visuals + Reflection**

**Trivia / Visuals**

Include examples of trivia questions or generated visuals from your GenAI integration. (e.g., GPT-generated sustainability quiz, AI-generated images)

**Reflection**

Reflect on what worked well and what was challenging when using generative AI. Did it enhance the experience? Were there limitations?

**6. Conclusion**

**Major accomplishments: of your project.**

**Key learnings: from working on games, AI, and ML together.**

**Potential improvements: or ideas for future versions.**