



GENIUS Research Paper Template

GENIUS AI projects should identify a clearly defined environmental or sustainability-related problem and demonstrate how artificial intelligence, machine learning, intelligent systems, data analysis, or related computational approaches can contribute to understanding or solving that problem.

The research paper should demonstrate not only **what the AI system does**, but also **what the students designed, developed, adapted, trained, tested, evaluated, or validated themselves**.

Simply using an existing chatbot, AI application, pre-built model, or API without meaningful student development, integration, experimentation, or evaluation is not sufficient for a GENIUS AI project.

General:

- All science projects **must submit** a Research Paper
- **Page Limit:** 20 pages (includes all pages and sections).
- **Main Text Font Type:** Calibri, Arial, or Helvetica
- **Main Text Font Size:** 10 or 11 (Larger font size can be used for section headings and Reference section can be 9)
- **Line spacing:** Single or 1.15 spacing
- **Margins:** Minimum 0.8 inch or 2 cm.
- **Every figure, graph, image, or diagram must include a caption that identifies** how it was created and what tool or source was used Example: Figure 1. Model architecture diagram created by the students using Canva.; Figure 2. Training and validation accuracy graph generated by the students using Python and Matplotlib.
- **All required sections must be included**
- Make sure to use following sections with suggested headings in your research paper.

1. TITLE PAGE (required)

- Provide each as separate line and centered:
 - Project Title (in Bold and 14 Font Size)
 - Student (s) Name
 - School Name(s)
 - City, State, Country

2. ABSTRACT (required)

- Limited to 250 words
- It is a concise summary of the entire research project.
- Should focus on completed results and the work done by students.
- Should contain these information:
 - 1 broad sentence about the environmental or sustainability problem is being addressed
 - 2 or 3 sentences summarizing your introduction.
 - 1 or 2 sentences describing type of AI or computational approach was developed
 - 3 or 4 sentences describing the major methodology used.
 - 3 or 4 sentences describing the most important results.
 - 3 or 4 sentences summarizing your major conclusions or significant findings

3. INTRODUCTION (required)

- The Introduction establishes the context and importance of the project.
- Students should explain:
 - The environmental or sustainability issue being investigated
 - The scale or importance of the problem
 - Who or what is affected
 - Existing approaches to addressing the problem
 - Limitations of current approaches
 - What is different about the student's proposed project
 - Why AI may provide a useful solution
 - How the proposed project addresses the problem

4. Goal/Research Question (required)

- This section should clearly state what the project is designed to accomplish.
- This section should be short and concise and should be limited to few sentences
- It can be structured with bullet points
- Depending on the type of project, students may include:
 - Research question, objective, or AI development goal,

Example: The goal of this project was to develop a machine-learning model capable of predicting harmful algal bloom risk using water temperature, nutrient concentration, rainfall, and historical bloom data.

5. AI MODEL/SYSTEM (required)

- This is one of the most important sections of a GENIUS AI research paper.
- Students must clearly explain how their AI system works and demonstrate their understanding of the underlying technology. Include the following sections:
- **AI Approach** (Include information appropriate to the project), Examples include:
 - Machine learning
 - Deep learning
 - Computer vision
 - Natural language processing
 - Predictive modeling
 - Classification
 - Regression
 - Neural networks
 - Decision trees
 - Random forests
 - Reinforcement learning
 - Optimization
 - Recommendation systems
 - AI agents
 - Large language model applications
 - Hybrid AI systems
- **Development and Testing** (Include information appropriate to the project), Examples include:
 - Data collection
 - Data cleaning
 - Data preprocessing

- Feature selection
 - Data labeling
 - Model selection
 - Model training
 - Model validation
 - Parameter selection
 - Model tuning
 - Programming
 - System integration
 - Interface development
 - Hardware integration
 - Testing
 - Comparison experiments
- **Inputs** (Explain what information goes into the system and how), Examples include:
 - Images
 - Sensor measurements
 - Weather data
 - Satellite data
 - Text
 - Geographic data
 - User inputs
 - Historical datasets
 - Environmental measurements
 - Variable or features included
 - Data cleaning process
 - **Outputs** (Explain what the system produces and how), Examples include:
 - Prediction
 - Classification
 - Environmental risk score
 - Recommendation
 - Alert
 - Generated response
 - Optimized solution
 - Detection result
 - Forecast
 - **Model Architecture**
 - Explain the structure of the system.
 - Students may include a diagram showing:
 - Input → Data Processing → AI Model → Analysis → Output
 - For more complex systems, identify individual components and explain how they interact.

6. RESULTS and EVALUATION (required)

- Students should objectively report how well the AI system performed.
- The appropriate evaluation method depends on the type of project.
- **Performance of the system**

- Students must include data and quantify the performance of the system (The final model achieved 91.4% classification accuracy on the independent test dataset, compared with 78.2% for the baseline model)
- Students should discuss both successful and unsuccessful results. Possible measurements include:
 - Accuracy
 - Precision
 - Recall
 - F1 score
 - Mean absolute error
 - Mean squared error
 - Prediction error
 - Detection rate
 - False-positive rate
 - False-negative rate
 - Processing speed
 - Response time
 - Success rate
 - Energy consumption
 - User testing results
 - Comparative performance
- **Comparison and Baseline Testing**
 - When possible, compare the AI system against the following, Comparison helps demonstrate whether the AI approach actually provides an improvement, Comparison helps demonstrate whether the AI approach actually provides an improvement.:
 - A simpler method
 - A previous model
 - An existing solution
 - A model without a particular feature
 - Human performance
 - A baseline algorithm
- **Errors and Limitations**
 - Students should investigate where the system fails. Discuss:
 - Incorrect predictions
 - False positives
 - False negatives
 - Biases in the dataset
 - Insufficient data
 - Limitations of the model
 - Environmental conditions that affect performance
 - Computational limitations
 - Situations where the model should not be used

7. COST AND SCALABILITY ANALYSIS (required)

Students should consider whether their solution could realistically be implemented beyond the research project.



- Discuss the following for Cost analysis and provide estimated cost (this will also show whether students have true understanding of AI use):
 - AI Model
 - Sensors
 - Computing (include training the model and usage)
 - Cloud services
 - Data collection
 - Software
- Discuss the following for the Scalability analysis:
 - Can the system be used by more people?
 - Can it operate in other locations?
 - Can larger datasets be processed?
 - Can the solution work at a larger scale, like city, state, national, or international level?
 - What additional infrastructure would be required?
 - What limitations could prevent large-scale deployment?

8. CONCLUSIONS (required)

- Students should discuss:
 - The key results
 - What the results demonstrate
 - How effectively the AI system addresses the environmental problem
 - Most important technical findings
 - Limitations
 - Improvements that could be made
 - Potential directions for future research
- The conclusion should be based on the actual results of the project and should avoid claims that are not supported by the research.

9. ACKNOWLEDGMENTS (Optional)

- Students may acknowledge individuals or organizations that provided assistance but were not student researchers on the project.
- Acknowledgements should describe the nature of significant assistance when appropriate.
- Examples include:
 - Teachers
 - Research mentors
 - Professors
 - Laboratory personnel
 - Universities or companies providing labs, equipment
 - Funding sources
 - Individuals providing technical advice, access to equipment, or facilities

10. STUDENT ROLES (required)

- This section is required for **both individual and team projects**.
- The purpose of this section is to clearly identify what work was completed by each student and what assistance, information, data, equipment, or expertise came from outside the student team.



- For projects involving two or more students, describe the specific contributions of each student.
- Students should avoid statements such as "both students worked equally" without explaining the actual responsibilities of each student.
- Students completing an individual project should briefly describe the portions of the research they personally completed.
- Students must include "external resources and contribution" section whether it is an individual project or team project, describing any help they received. In the case there are none, they should state that.
- Multiple Student Examples:

Student 1 – Alex Smith: Developed the machine-learning model, wrote the Python data-processing code, trained the model, and performed accuracy testing.

Student 2 – Taylor Brown: Collected and labeled the environmental dataset, developed the web interface, performed model validation, and conducted the cost and environmental-impact analysis.

Both Students: Developed the research question, reviewed the literature, interpreted the results, prepared the research paper, and prepared the final presentation.

External Assistance and Resources: A university researcher explained how convolutional neural networks operate and provided general guidance on selecting an appropriate architecture. The students independently prepared the dataset, implemented the model, selected training parameters, conducted testing, and analyzed the results.

11. REFERENCES (required)

- List the references/documentation used which were not of your own creation (i.e., books, journal articles).
- You may use a font size of 9 in this section
- References section should list all sources used in developing the research project and preparing the research paper.
- Every source listed in the References section should be cited where appropriate within the paper, and sources cited in the paper should appear in the References section.
- Students should use a consistent citation style throughout the paper.
- Students are responsible for ensuring that references are accurate and that cited sources can be located and verified.
- Students must check that references are real and do exist (note that AI generated references can be misleading and fake)