DIGITAL ETHICS CANVAS

CONTEXT

In a tokamak, plasma exists in different confinement modes: Low (L) mode and High (H) mode. Transitioning back from H mode to L mode can lead to plasma instability and reduced energy retention.

SOLUTION

ML model itrained on experimental plasma data to predict HL transitions, enabling better understanding and control of tokamak operations.

BENEFITS

- Improved Stability: Enhanced ability to control plasma stability.
- Risk Mitigation: Helps prevent catastrophic events and plasma degradation.
- Fusion Research: Supports advancements in clean energy solutions.

WELFARE

RISK

- Can the solution be used in harmful ways, in particular with regards to vulnerable populations?
- What kind of impacts can errors from the solution have?
- What type of protection does the solution have against attacks or misuse?

- Model Errors: False predictions could cause operational failures, damaging equipment or delaying experiments.
- Vulnerability to Attacks: Model could be vulnerable to cyberattacks or data poisoning.

MITIGATION

- Conduct adversarial testing to ensure robustness.
- Use explainable AI techniques to understand predictions.
- Implement strict access controls and audit trails for data and model usage.

FAIRNESS

RISK

- How accessible is the solution?
- What kinds of biases may affect the results ?
- Can the outcomes of the solution be different for different users or groups?
- Could the solution contribute to discrimination against people or groups?

- Bias: Training data could inadvertently favor specific plasma states or conditions, leading to uneven predictive accuracy.
- Discrimination: If data reflects historical biases, it may limit generalization across different tokamaks or setups.

MITIGATION

- Use diverse datasets that include various experimental setups and plasma conditions.
- Regularly audit and test for potential biases in the ML model.

AUTONOMY

RISK

- Can users understand how the solution works and what its limits are?
- Are users able to make choices (e.g. consent, settings) in their use of the solution and how?
- How does the solution affect user autonomy and agency?

- User Understanding: Researchers may not fully understand how the ML model makes predictions or its limitations.
- User Choice: Limited options for customization or interpretability may reduce user agency.
- Impact on Autonomy: Over-reliance on predictions may reduce critical human oversight.

MITIGATION

- Provide comprehensive training and user guides for researchers.
- Incorporate interpretable AI to make model predictions explainable.
- Encourage active human oversight in decision-making processes.

PRIVACY

RISK

- What data does the solution collect
- Is it collecting personal or sensitive data
- Who has access to the data?
- How is the data protected?
- Could the solution disclose / be used to disclose private information?

- Data Collection: Primarily involves experimental plasma data; however, metadata (e.g., lab details) could be sensitive.
- Access Control: Potential risks if experimental data is leaked or accessed by unauthorized parties.
- Disclosure: Inappropriate sharing of data or model outputs could reveal proprietary research insights.

MITIGATION

- Store data securely using encryption and access controls.
- Implement clear policies on data sharing and anonymization.
- Regularly review and update data protection protocols.

SUSTAINABILITY

RISK

- What is the carbon footprint of the solution?
- What types of resources does it consume (e.g. water) -and produce (e.g. waste)?
- What type of human labor is involved?

- Carbon Footprint: Training the ML model on large datasets could consume significant energy.
- Resource Usage: Computing infrastructure and data storage contribute to energy and hardware costs.
- Labor: Requires specialized expertise, potentially increasing human resource constraints.

MITIGATION

- Optimize ML model efficiency to reduce energy consumption.
- Use green data centers or renewable energy sources where possible.
- Encourage skill-sharing and cross-institution collaboration to ease labor demands.