UNIVERSITÄT BAYREUTH

– P&E Master's Programme –
Chair of Philosophy, Computer Science & Artificial Intelligence

Automating the Modelling of Transformative Artificial Intelligence Risks

—

"*An Epistemic Framework for Leveraging Frontier AI Systems to Upscale Conditional Policy Assessments in Bayesian Networks on a Narrow Path towards Existencial Safety*"

—

A thesis submitted at the Department of Philosophy

for the degree of *Master of Arts in Philosophy & Economics*

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Word Count:
30.000

Source / Identifier:
Document URL

26th of May 2025

Contents

Preface

This is a Quarto book.

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Abstract

Outline(s): Table of Contents

Chapter 1

Introduction

1.1 Introduction

```
10% of Grade:

-   introduces and motivates the core question or problem
-   provides context for discussion (places issue within a larger debate or sphere of
-   states precise thesis or position the author will argue for
-   provides roadmap indicating structure and key content points of the essay

\~ 14% of text \~ 4200 words
```

- introduces and motivates the core question or problem

  Testing crossreferencing grapics Figure 1.1.

1.2 Motivation: Problem Statement

1.3 Motivation: Research Question

- provides context for discussion (places issue within a larger debate or sphere of relevance)

1.4 Scope: Aim & Context of the Research

1.5 Significance of the Research: Theory of Change

- states precise thesis or position the author will argue for

Figure 1.1: Caption/Title 2

1.6 Thesis Statement & Position: (Aim of the Paper)

- provides roadmap indicating structure and key content points of the essay

1.7 Overview: Structure & Approach of the Paper (Roadmap — Theory of Change)

1.8 Table of Contents

1.9 Problem Statement — Motivation

Continued AI Progress:

- Rapid advancements in AI technology increase both potential benefits and risks.

Existential Risks (AI X-Risk):

- Advanced AI systems could pose significant threats if misaligned with human values.

Complexity Challenges:

- The intricate nature of AI systems complicates policy formulation and understanding.

Limitations of Current Approaches:

- MTAIR's Reliance on Human Labor:
  - Modeling Transformative AI Risks (MTAIR) is constrained by manual cognitive efforts.

- Need for Automation:
  - Scaling and automating risk modeling is essential to keep pace with AI developments.

Opportunity:

- Leveraging new technologies to enhance our ability to model and mitigate AI risks.

1.10 Aim of the Paper

1.10.1 Research Question & Scope

Can frontier AI technologies be utilized to automate the modeling of transformative AI risks, so as to allow for the prediction of policy impacts?

Frontier AI Technology: Today's most capable AI systems (e.g. GPT4 level LLMs)
Scaling Up: Automating the previously "manual" cognitive labor

Modeling: Formalizing the world views underlying arguments
Transformative AI: Level of AI capabilities defined by severe impact on the world
Safety & Governance Literature: Publications, reports etc. concerned with risks from AI

Automated Estimation: Non-manual (AI systems + scaffolding), quantified evaluations
Probability Distributions: Formal expressions of the expectations over future worlds
Conditional Trees of Possible Worlds: "If … then…" reasoning over ways things may play out
Forecasting Policy Impacts: Qualitative & quantitative evaluation of expected outcomes

1.10.2 Significance of the Research

1.11 Theory of Change — Approach & Structure of the Paper

Multiplicative Benefits:

- Automation × Live Prediction Market Integrations × Policy Impact Evaluations

Explanation:
Automation:

- Increases efficiency and scalability of risk modeling.

  Live Prediction Markets:

- Provides up-to-date, collective intelligence to inform models.

  Policy Impact Evaluations:

- Improves the accuracy and relevance of policy assessments.

Outcome:

- Enhanced ability to develop effective policies that mitigate AI risks.

Visual Aid:

- A diagram illustrating how each component amplifies the others, leading to greater overall impact.

1.12

1.13 Overview / Table of Contents

Chapter 2

Context

```
### 20% of Grade: {.unnumbered .unlisted}

- demonstrates understanding of all relevant core concepts

- explains why the question/thesis/problem is relevant in student's own words (suppor

- situates it within the debate/course material

- reconstructs selected arguments and identifies relevant assumptions

- describes additional relevant material that has been consulted and integrates it wi

~ 29% of text ~ 8700 words
```

1. successively (chunk my chunk) introduce concepts/ideas — and 2. ground each with existing literature

2.1 Theoretical Background Considerations

2.2 Literature, Concepts & Terminology

2.2.1 DAG / BayesNets

2.2.2 State of the art (MTAIR) — Explanation

Carlsmith Model (Analytica)

2.2.3 (Intro) Example — Rain/Sprinkler/Lawn

/ Rain/Sprinkler/Lawn DAG / BayesNet — Extended Example

…

Own Position/Argument: AMTAIR … Own Rain/Sprinkler/Lawn DAG / BayesNet Implementation

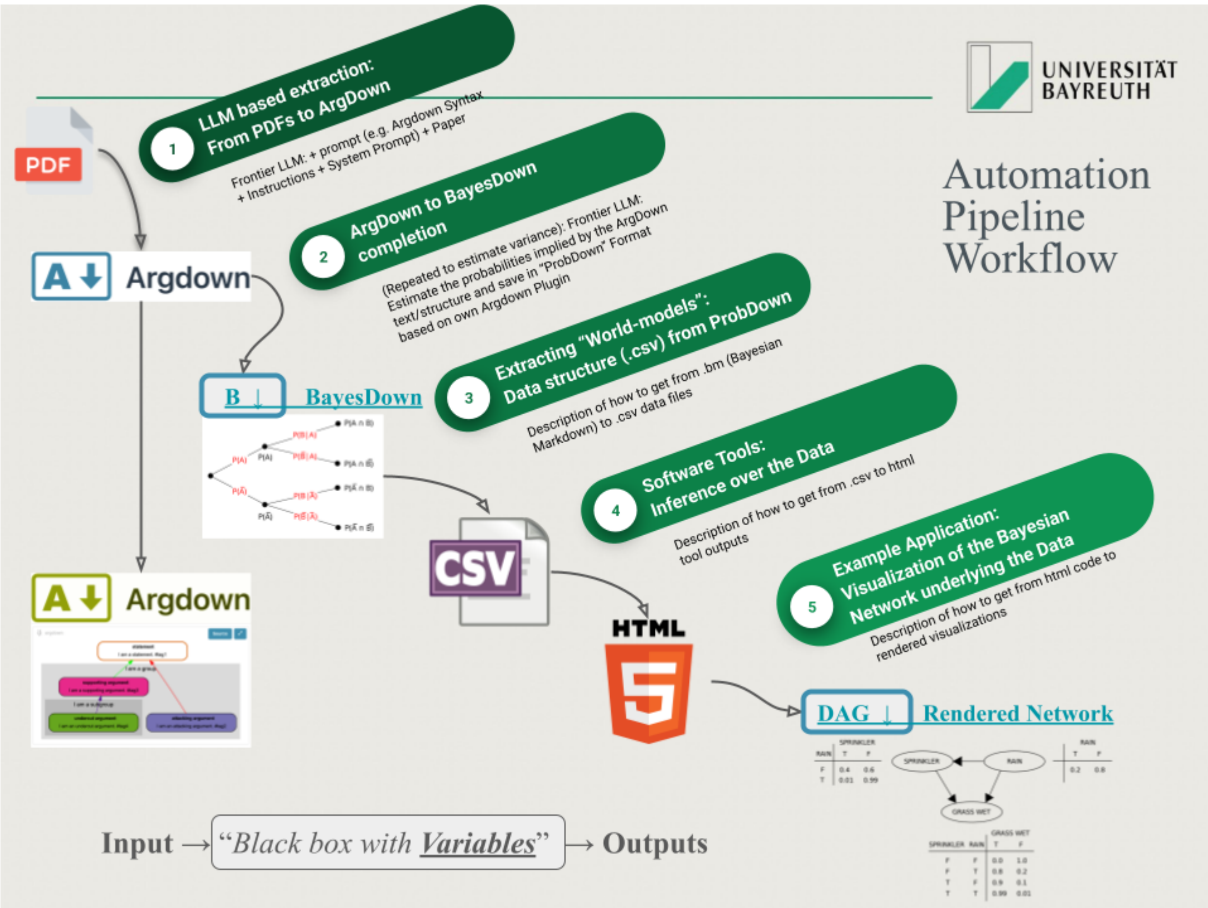


Figure 2.1: AMTAIR Automation Pipeline

2.3 Methodology

MTAIR / Carlsmith Model (Analytica) — Explanation (— is motivation: should come first)

2.3.1 Kialo

2.3.2 Rain/Sprinkler/Lawn DAG

2.3.3 BayeServer

2.3.4 BayesNet — Extended Example

2.3.5 Code + documentation

Testing crossreferencing grapics Figure 2.1.

Chapter 3

AMTAIR

```
### 20% of Grade: ~ 29% of text ~ 8700 words

- provides critical or constructive evaluation of positions introduced
- develops strong (plausible) argument in support of author's own position/thesis
- argument draws on relevant course material claim/argument
- demonstrate understanding of the course materials incl. key arguments and core conc
- claim/argument is original or insightful, possibly even presents an original contri
```

3.1 Own Carlsmith Model Implementation — Explanation

3.2 Own Implementation: Good example from a published paper

3.3 Implementation

TestText

3.4 Results

TestText

Chapter 4

Insights & Findings

4.1 Automated Modeling Pipeline — From Academic Papers to Political Strategy

`Success of Automation:`

- Demonstrated feasibility of automated model extraction.
  Improved Forecasting:
- Enhanced accuracy with real-time data integration.
  Policy Analysis:
- Identified impactful policies through conditional forecasting.
  Scalability Achieved:
- Efficient processing of extensive data sets.
  Addressed Challenges:
- Overcame limitations of manual modeling.

4.2 Project Scaling — Workflow Pipeline & Automation

Scaling Opportunities:

- Horizontal: Incorporate more data sources.
- Vertical: Add detailed variables.

New Capabilities:

- Advanced analytics.
- Real-time data integration.

Requirements:

- Software Setup: Robust infrastructure.
- Financial: Funding for APIs and compute resources.

Impact:

- Broader, more comprehensive models.
- Enhanced policy analysis.

4.3 Computational Complexity — Computational Tractability

Challenges:

- High computational demands of complex models.

Solutions:

- Clustering Worldviews:
- Group similar perspectives to simplify models.
- Correlation Management:
- Adjust for variable interdependencies.
- Efficient Algorithms:
  Use optimized sampling methods like Monte Carlo.

Outcome:

- Achieved efficiency without sacrificing accuracy.

Link to Theory of Change:

- Scalability amplifies policy impact.

4.4 External Validation — Manual Extraction & Processing

`Purpose:`

- Assess accuracy of automated methods.
  Comparison:
- Automation Strengths:

- Speed, consistency.

- Human Strengths:

- Nuanced understanding.
  Findings:

- Automation excels in data handling.

- Human oversight enhances quality.
  Conclusion:

- Optimal results from combining AI with expert input.

Chapter 5

Discussion

5.1 Discussion

```
10% of Grade: ~ 14% of text ~ 4200 words

- discusses a specific objection to student’s own argument
- provides a convincing reply that bolsters or refines the main argument
- relates to or extends beyond materials/arguments covered in class
```

Chapter 6

Discussion — Exchange, Controversy & Influence

6.1 Challenges & Problems — Red Teaming Problems, Failures & Downsides

`Potential Failures:`

- Data Issues: Inaccurate or biased inputs.
- Model Limitations: Oversimplifications.
- Tech Risks: AI misinterpretations.
  Red Teaming:
- Stress-testing models to find weaknesses.
  Impact on Theory of Change:
- Identifying points of failure strengthens the approach.

6.2 Implications & Impact — Uptake, Feedback Loops, Uptake & Success – Green Teaming –

`Potential Outcomes:`

- First-Order: Reduced AI risks through better policies.
- Second-Order: Enhanced collaboration.
- Third-Order: Framework applied to other global risks.
  Feedback Loops:

- Continuous model improvement.

- Adaptive policy-making.
  Green Teaming:

- Strategies to maximize positive impacts.

6.3 Known Unknowns & Unknown Unknowns — Input Data Example: Modeling Author Worldviews from Bibliographies Instead of Individual Papers

`Potential Outcomes:`

- First-Order: Reduced AI risks through better policies.

- Second-Order: Enhanced collaboration.

- Third-Order: Framework applied to other global risks.
  Feedback Loops:

- Continuous model improvement.

- Adaptive policy-making.
  Green Teaming:

- Strategies to maximize positive impacts.

Chapter 7

Conclusion

7.1 The Current State of Things & How to Continue

```
10% of Grade: ~ 14% of text ~ 4200 words

- summarizes thesis and line of argument
- outlines possible implications
- notes outstanding issues / limitations of discussion
- points to avenues for further research
- overall conclusion is in line with introduction
```

7.2 Summary — Key Takeaways & Findings

7.2.1 Assessing Policy Effects:

Evaluating how different policies alter P(Doom).

7.2.2 Conditional Probability:

Calculating P(Doom | Policy Alpha).

7.2.3 Methodology:

Update model parameters based on policy implementation.
Recompute probabilities accordingly.

7.2.4 Purpose:

Inform policymakers of potential policy effectiveness.
Prioritize interventions that significantly reduce risks.

7.3 Outlook — Outlook & Next Steps / Further Research

7.3.1 Scaling Up:

- Include more variables and data sources.

7.3.2 Collaboration:

- Partner with policymakers and researchers.

7.3.3 Technological Enhancements:

- Employ advanced AI techniques.

7.3.4 Potential Impact:

- Influence global AI governance.

7.3.5 Limitations of the Analysis

7.3.6 Policy Implications & Recommendations

7.3.7 Areas for Future Research

7.3.8 Open Questions — Central/Remaining Questions & Feedback

Questions:

- How can we improve automation accuracy?
- What challenges exist in policy implementation?
- How do we mitigate AI model biases?
- How can interdisciplinary efforts enhance outcomes?

Feedback:

- Invite thoughts, critiques, and suggestions.

7.3.9 Outlook — Outlook & Next Steps / Further Research

Frontmatter

Prefatory Apparatus: Illustrations and Terminology — Quick References

List of Tables

List of Graphics & Figures

List of Abbreviations

esp. especially
f., ff. following
incl. including
p., pp. page(s)
MAD Mutually Assured Destruction

- AI - Artificial Intelligence
- AGI - Artificial General Intelligence
- ARPA - AI Risk Pathway Analyzer
- DAG - Directed Acyclic Graph
- LLM - Large Language Model
- MTAIR - Modeling Transformative AI Risks
- P(Doom) - Probability of existential catastrophe from misaligned AI
- CPT - Conditional Probability Table

Glossary

- **Argument mapping**: A method for visually representing the structure of arguments
- **BayesDown**: An extension of ArgDown that incorporates probabilistic information
- **Bayesian network**: A probabilistic graphical model representing variables and their dependencies
- **Conditional probability**: The probability of an event given that another event has occurred
- **Directed Acyclic Graph (DAG)**: A graph with directed edges and no cycles
- **Existential risk**: Risk of permanent curtailment of humanity's potential
- **Power-seeking AI**: AI systems with instrumental incentives to acquire resources and power

- **Prediction market**: A market where participants trade contracts that resolve based on future events
- **d-separation**: A criterion for identifying conditional independence relationships in Bayesian networks
- **Monte Carlo sampling**: A computational technique using random sampling to obtain numerical results

Quarto Features Incompatible with LaTeX (Below)

Bibliography (References)

Headings & Potential Headings

`verbatim code formatting for notes and ideas to be included (here)`

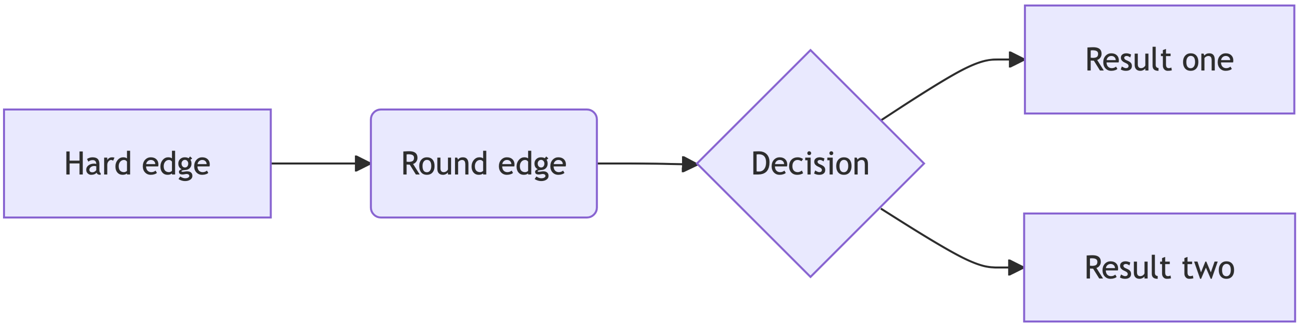
```
Also code blocks for more extensive notes and ideas to be included (here)
- test 1.
- test 2.
- test 3.
2. second
3. third
```

> Blockquote formatting for "Citations / Things to reference"

Here is an inline note.[1]
Here is a footnote reference,[2]
Here's some raw inline HTML:
page 1

[1]Inlines notes are easier to write, since you don't have to pick an identifier and move down to type the note.
[2]Here is the footnote.

page 2



Testing crossreferencing grapics Figure 2.1.

Citations

Adams [1]
[1] and [3]
Blah Blah [see 3, pp. 33–35, also 2, chap. 1]
Blah Blah [3, 33–35, 38-39 and passim]
Blah Blah [2, 3].
Wickham says blah [2]

[1] Ernest W Adams. “Four Probability-Preserving Properties of Inferences”. In: *Journal of Philosophical Logic* 25 (1996), pp. 1–24. ISSN: 0022-3611.

[2] Jakub Growiec. “Existential Risk from Transformative AI: An Economic Perspective”. In: *Technological and Economic Development of Economy* 30.6 (July 10, 2024), pp. 1682–1708. ISSN: 2029-4921, 2029-4913. DOI: `10.3846/tede.2024.21525`. URL: `https://journals.vilniustech.lt/index.php/TEDE/article/view/21525` (visited on 11/13/2024).

[3] Donald E. Knuth. “Literate Programming”. In: *Computer Journal* 27.2 (May 1984), pp. 97–111. ISSN: 0010-4620. DOI: `10.1093/comjnl/27.2.97`. URL: `https://doi.org/10.1093/comjnl/27.2.97`.

Appendix A

Appendices

A.1 Appendices

A.2 Appendix A

A.3 Appendix B

A.4 Appendix C

A.5 Appendix D

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Appendix B

appendixA

testtext

List of Figures

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Affidavit

Declaration of Academic Honesty

Hereby, I attest that I have composed and written the presented thesis

Automating the Modelling of Transformative Artificial Intelligence Risks

independently on my own, without the use of other than the stated aids and without any other resources than the ones indicated. All thoughts taken directly or indirectly from external sources are properly denoted as such.

This paper has neither been previously submitted in the same or a similar form to another authority nor has it been published yet.

Bayreuth on the
May 19, 2025

Valentin Meyer