



MONASH University

Formal Explainability for Artificial Intelligence in Dynamic Environments

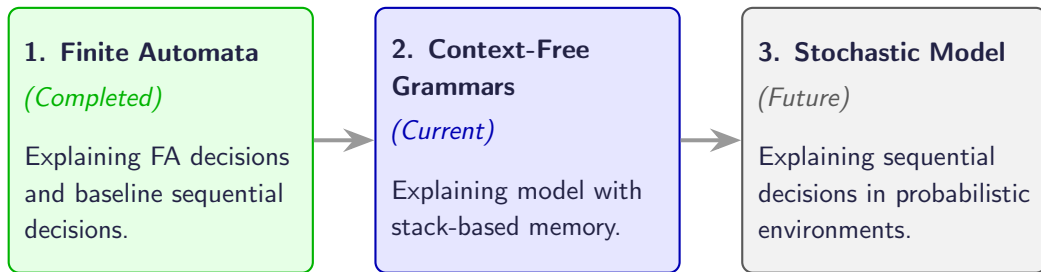
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Project Summary & Refinements

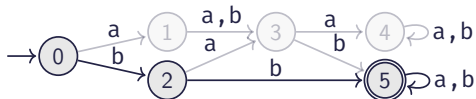
Goal: Deliver explanations for sequential decision-making models.



Completed Work: Finite Automata

Explaining Finite Automata (Completed)

FA is a mapping from an input $w \in \Sigma^*$ to a class $\mathcal{K} = \{\text{Accept}, \text{Reject}\}$.



Input w :

b	b	b	b	b
---	---	---	---	---

 → Accept

AXp 1:

b	b	Σ	Σ	Σ
---	---	----------	----------	----------

 → Guarantees Accept $L(bb\Sigma\Sigma\Sigma) \subseteq L(\mathcal{A})$

AXp 2:

Σ	Σ	b	Σ	Σ
----------	----------	---	----------	----------

 → Guarantees Accept $L(\Sigma\Sigma b\Sigma\Sigma) \subseteq L(\mathcal{A})$

Why Finite Automata Are Not Enough

- $L = \{a^n b^n \mid n \geq 1\}$ cannot be described by a FA.
- For a rejected word like aaaabb, standard parsers identify the error at the end.

Source Code:

```
1 int main(){  
2     for(int i=0; i<10; i++){ // Error  
3         printf("hello");  
4     }  
5 }
```

Parser Output:

```
error: expected '}' at end of input  
5 | }  
  | ^
```

Explaining Context-Free Grammars

- Transition to Context-Free Grammars (CFGs).
- Consider $G = (\{B\}, \{ (,) \}, R, B)$ for balanced parentheses, with rules R :

$$B \rightarrow (B) B \quad (\text{Rule 1})$$

$$B \rightarrow (B) \quad (\text{Rule 2})$$

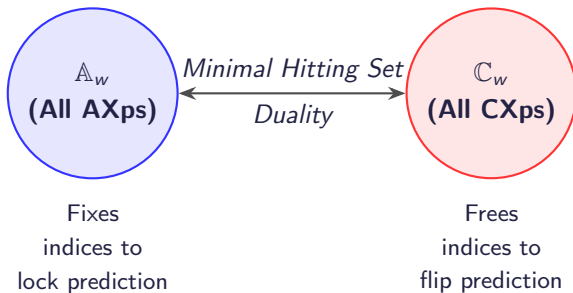
$$B \rightarrow () B \quad (\text{Rule 3})$$

$$B \rightarrow () \quad (\text{Rule 4})$$

(1)

The Minimal Hitting Set Duality

- **The Core Relationship:** Abductive and contrastive explanations share a formal duality [?].
- Every AXp is a minimal hitting set of the complete set of CXps, and vice versa.
- To flip a prediction (CXp), you must free at least one token from every reason that guarantees the current prediction (AXp).



Outcomes: Enumeration & Milestone

- **Algorithmic Contribution:**

- Leveraged this duality to develop algorithms for the formal **enumeration** of explanations in Finite Automata.
- Successfully maps the abstract concepts of XAI onto rigorous formal language properties.

Phase 1 Milestone Achieved

Status: Completed.

Output: The formal definitions, duality proofs, and enumeration algorithms have been compiled and submitted to **ICALP 2026**.

- *Transitioning to Phase 2:* With the baseline for regular languages established, we now scale the complexity to languages requiring memory.

- ADD CONTENT

Separated content, e.g., variable explanations

Frame without a title

- Frames do not need to have a title...

Math Expressions

$$\iint_{\partial\Omega} f(x)dx \in \mathbb{C} \quad (2)$$

$$E = mc^2 \quad (3)$$

$$F = ma \quad (4)$$

m Mass

c Speed of light

Theorem

The following statement is correct

$$\frac{\partial f(\vec{x})}{\partial x_i} = \sum_{l=1}^L \cos \left(l \frac{2\pi}{L} + 0 \right) \quad (5)$$

Elements

The theme provides sensible defaults to
^^I^^I\emph{emphasize} text, \alert{accent} parts
^^I^^Ior show \textbf{bold} results.

becomes

The theme provides sensible defaults to *emphasize* text, **accent** parts or show **bold** results.

Font feature test

- Regular
- *Italic*
- SMALL CAPS
- **Bold**
- ***Bold Italic***
- **Bold Small Caps**
- Monospace
- *Monospace Italic*
- **Monospace Bold**
- ***Monospace Bold Italic***

Items

- Milk
- Eggs
- Potatoes

Enumerations

1. First,
2. Second and
3. Last.

Descriptions

PowerPoint Meeh.
Beamer Yeeeha.

Table 1: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

Blocks

Three different block environments are pre-defined and may be styled with an optional background color.

Default

Block content.

Alert

Block content.

Example

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Default

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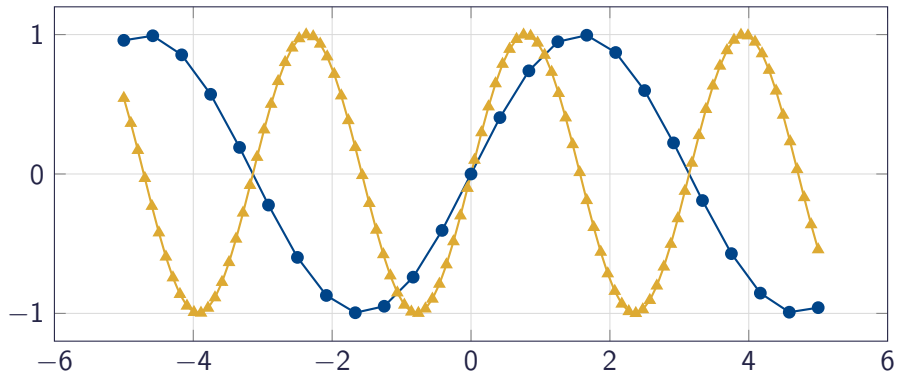
Alert

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Example

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Line plots



Standout Frame!

Backup slides

Sometimes, it is useful to add slides at the end of your presentation to refer to during audience questions.

The best way to do this is to include the `appendixnumberbeamer` package in your preamble and call `\appendix` before your backup slides.

The theme will automatically turn off slide numbering and progress bars for slides in the appendix.