Bounded Skeptical Reasoning

Isabelly Lourêdo Rocha

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Byrne's suppression task

Ruth MJ Byrne. Suppressing valid inferences with conditionals. In: Cognition. (1989)

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Syllogistic reasoning

Ana Oliveira da Costa, Emmanuelle-Anna Dietz Saldanha, Steffen Hölldobler, and Marco Ragni.
A computational logic approach to human syllogistic reasoning. In: Conference of the Cognitive Science Society (2017)

Sceptical Reasoning Framework

Computing Abductive Sceptical Consequences

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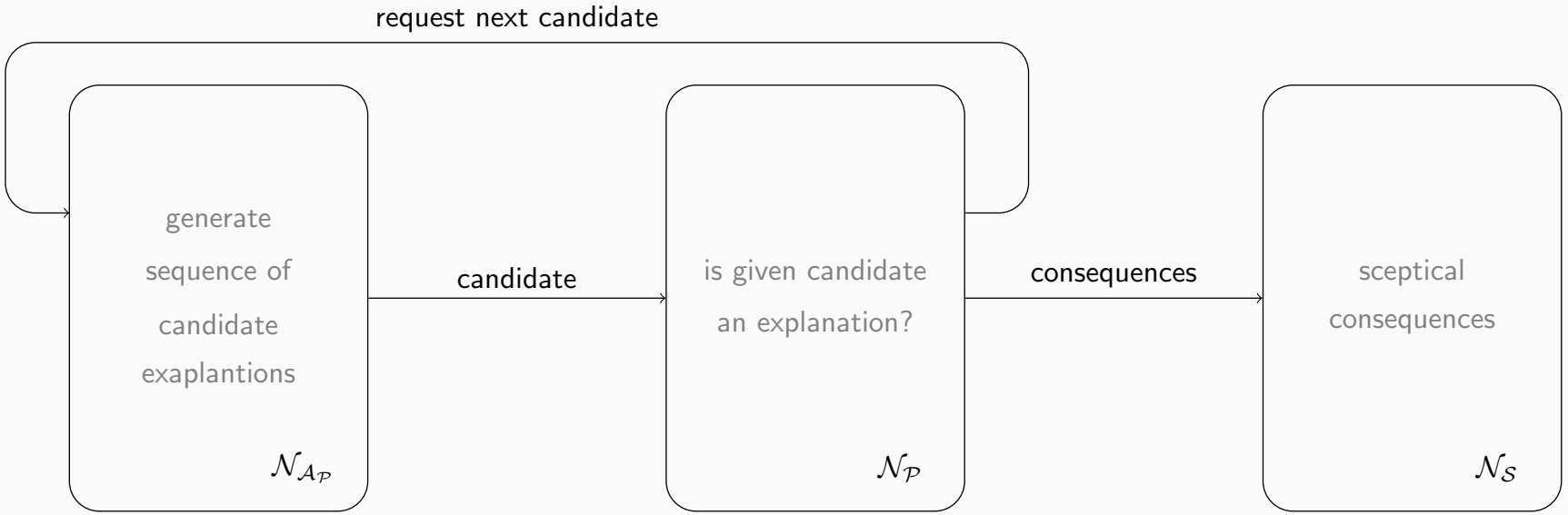

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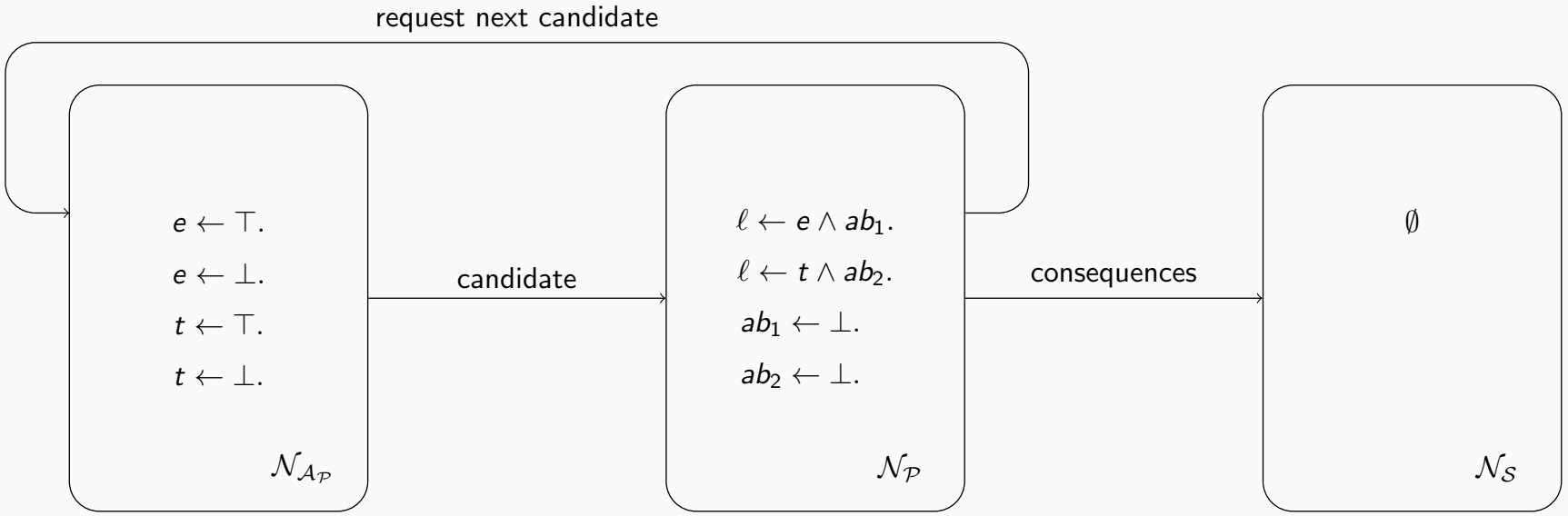

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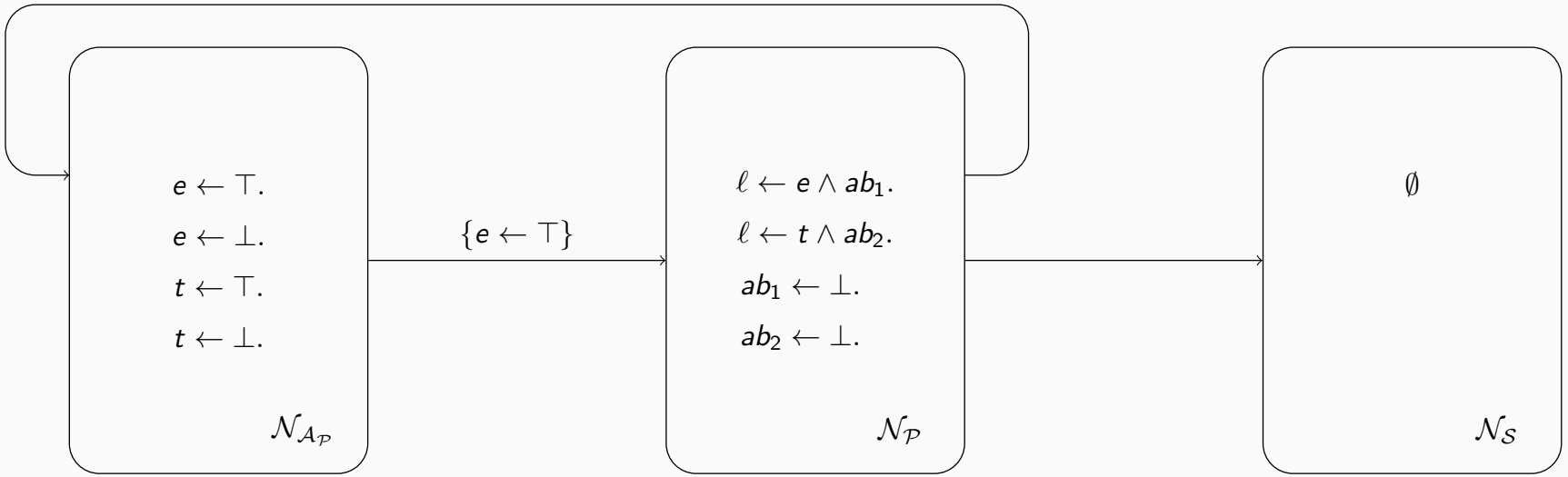

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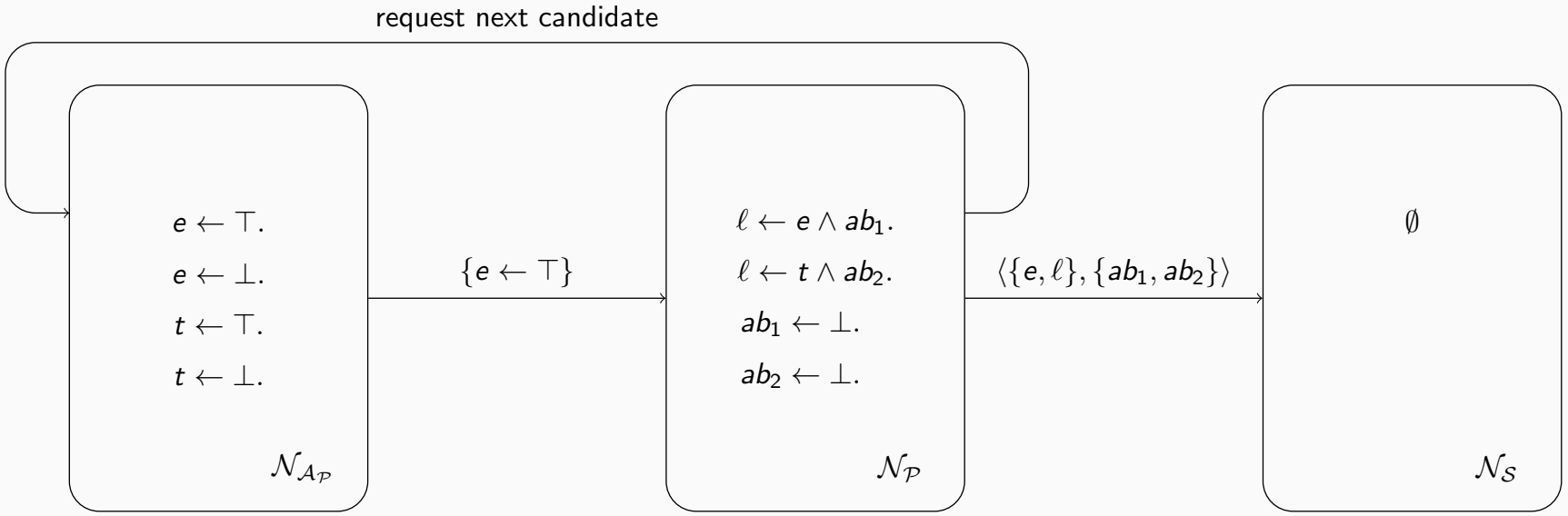

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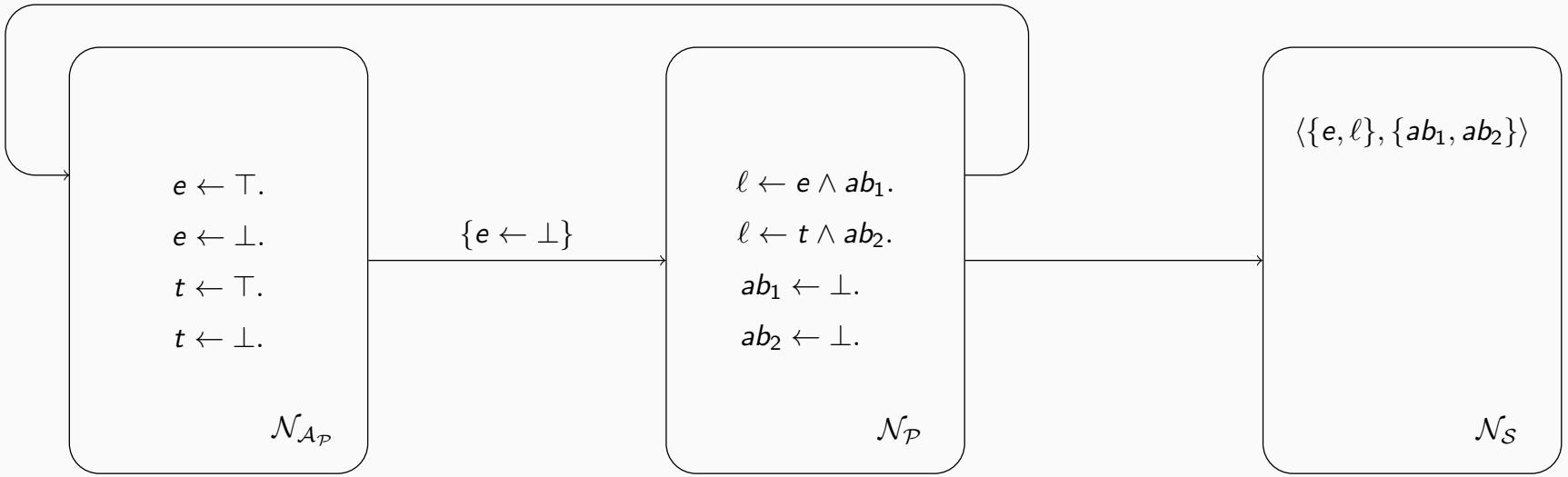

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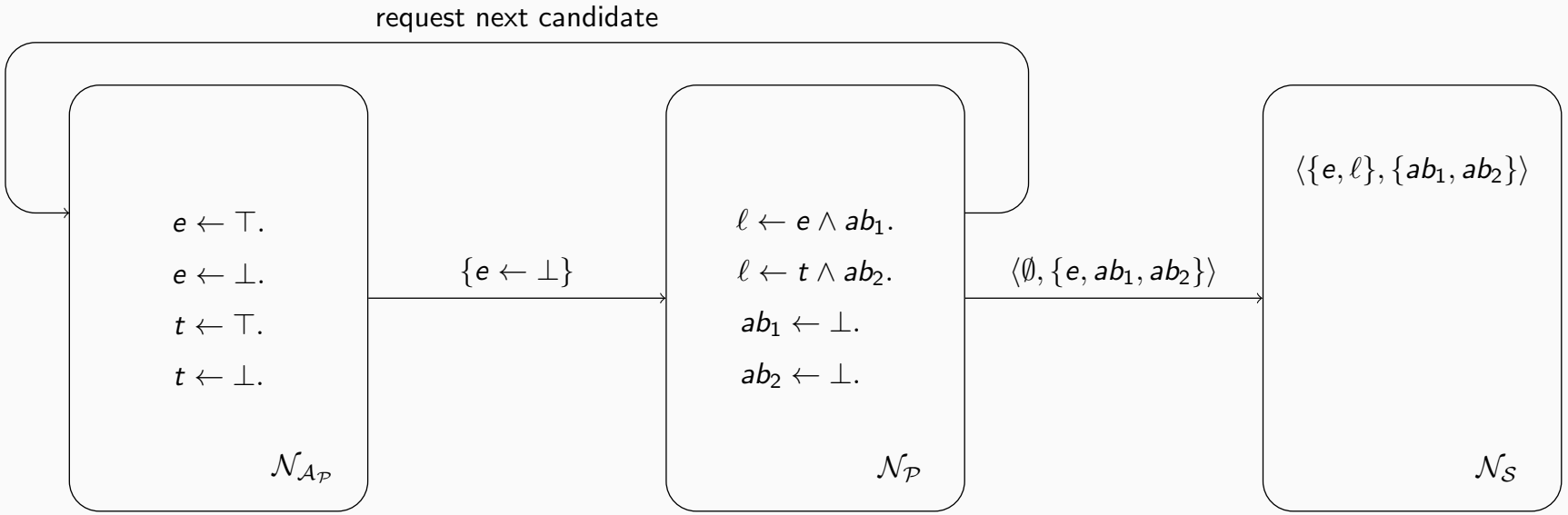

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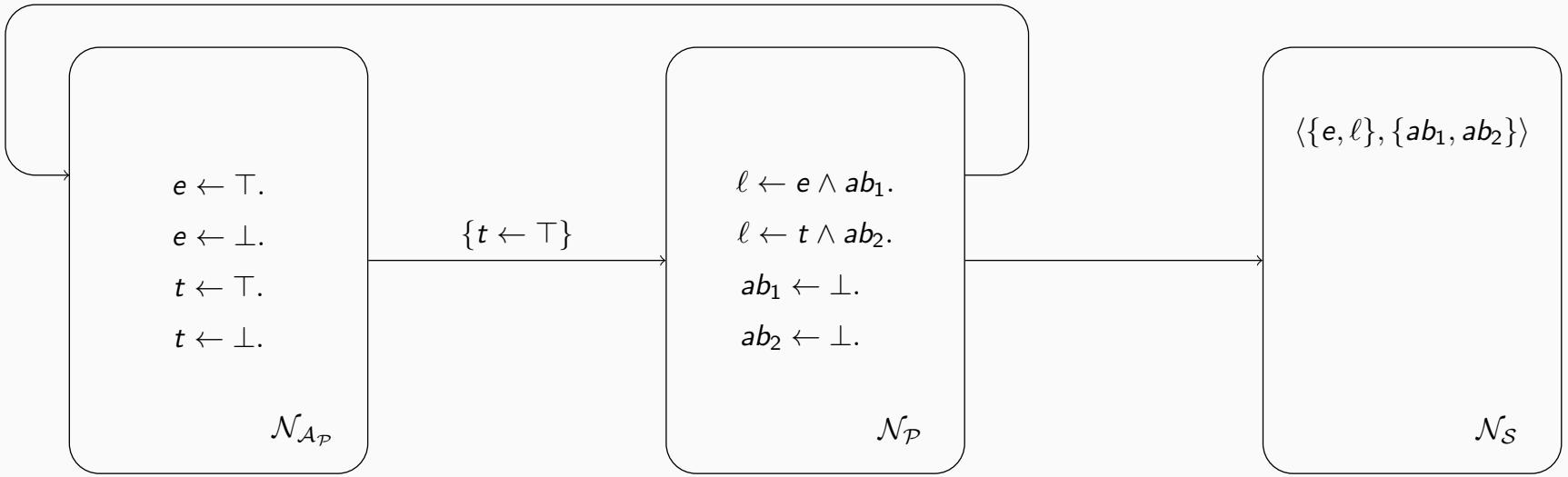

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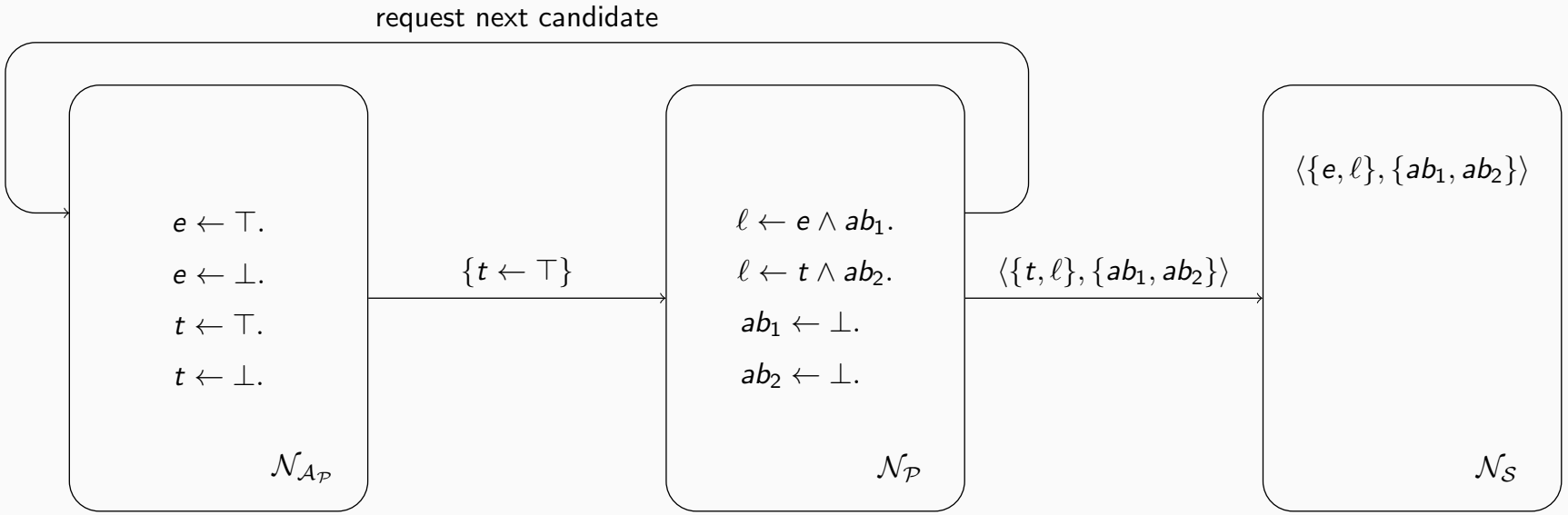

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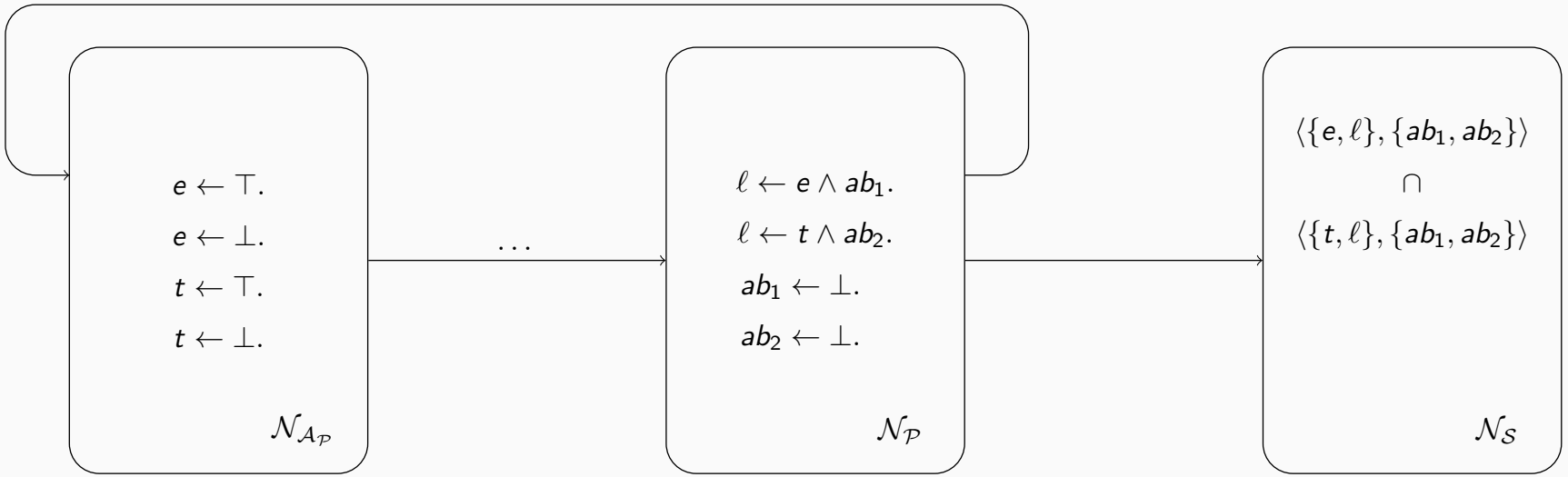

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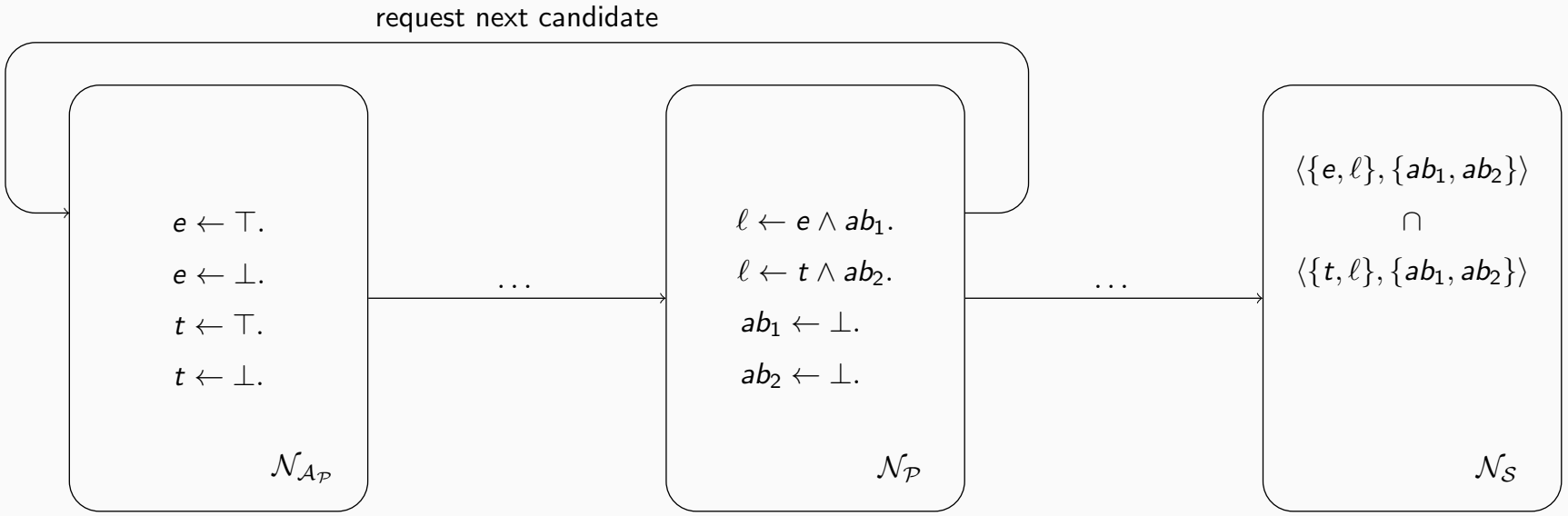

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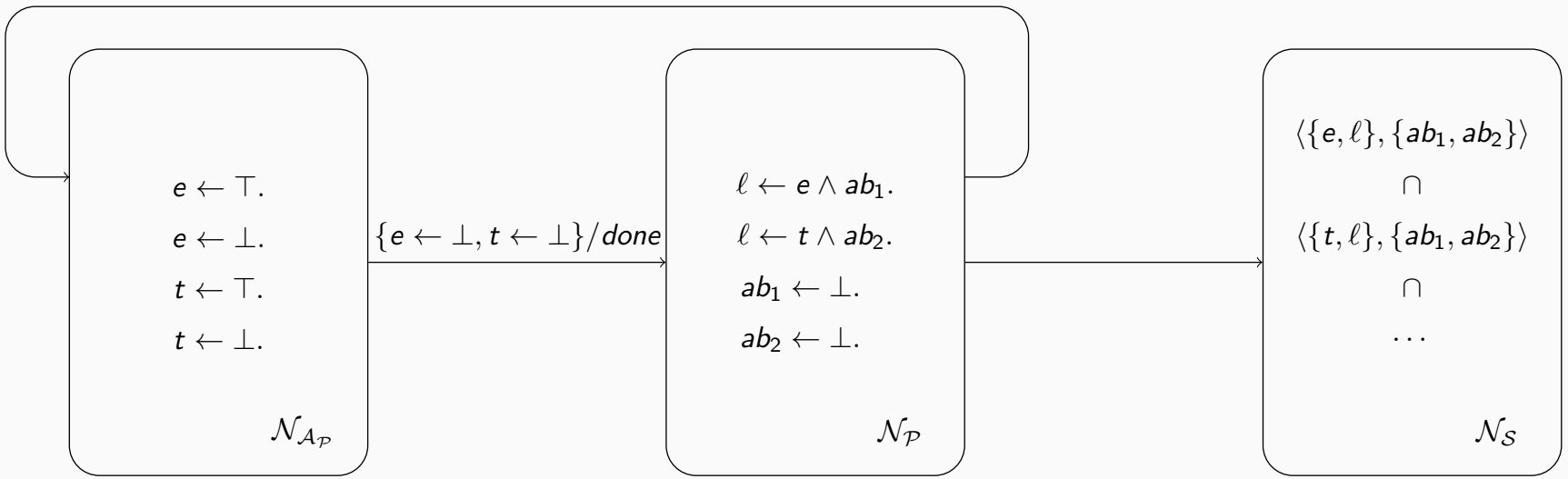

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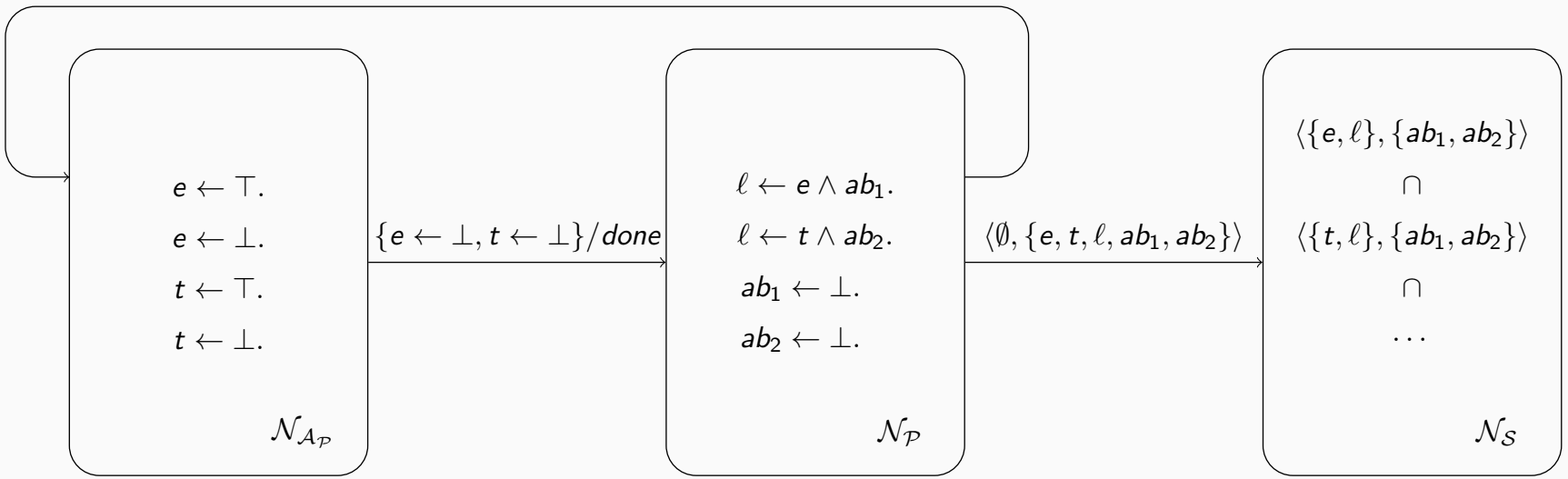

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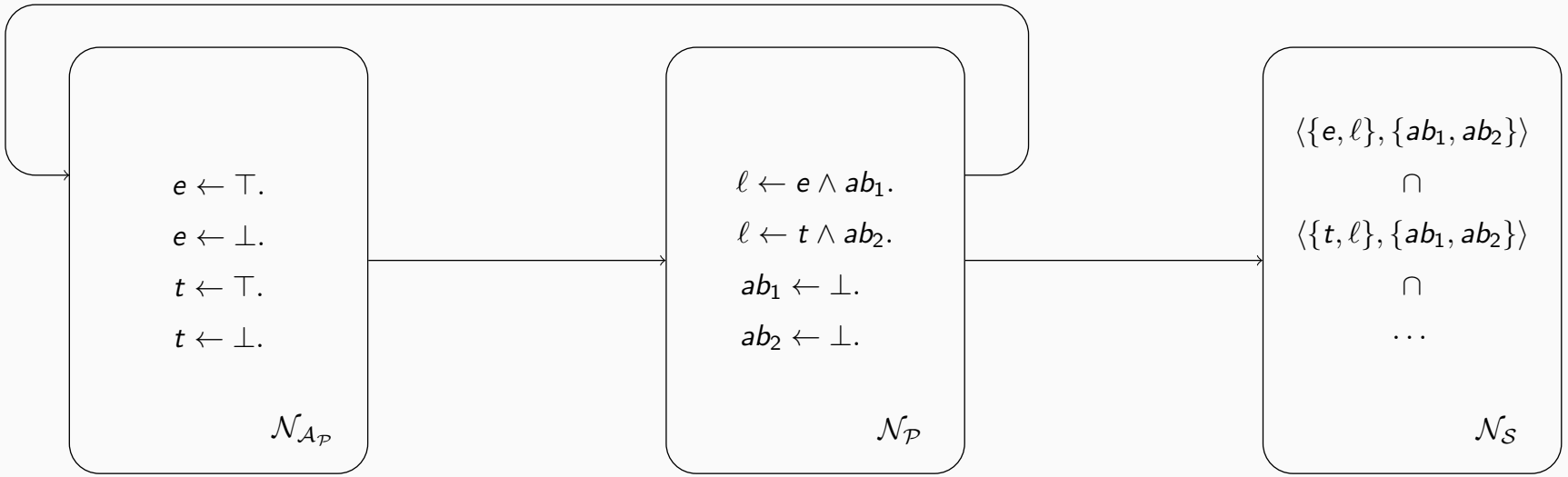

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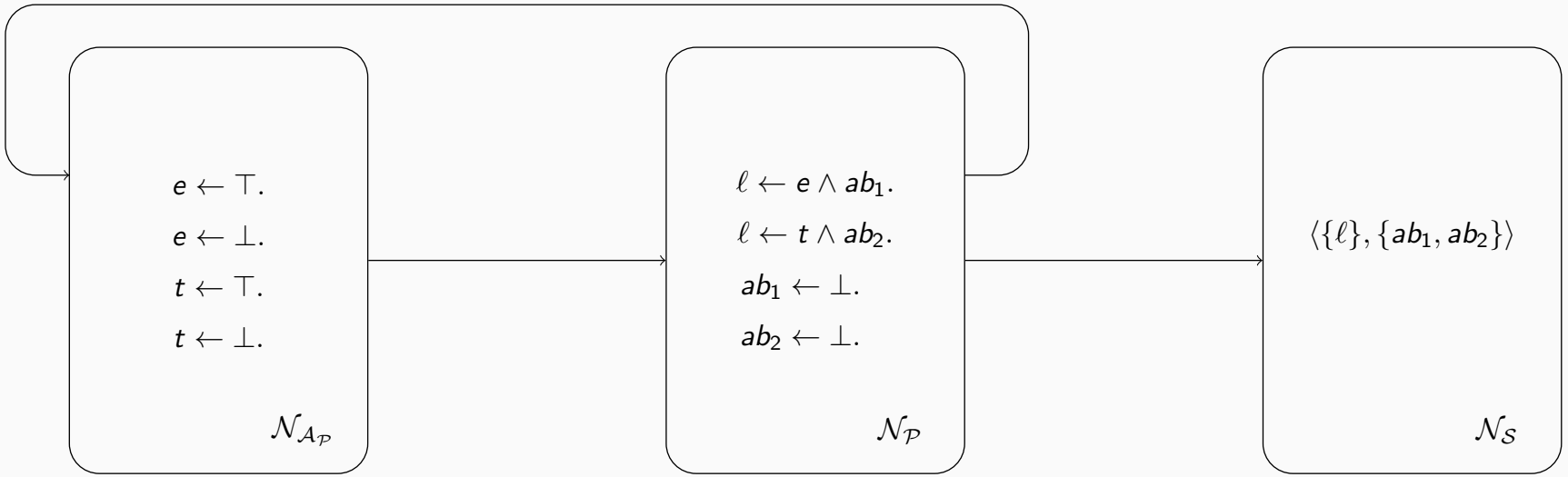
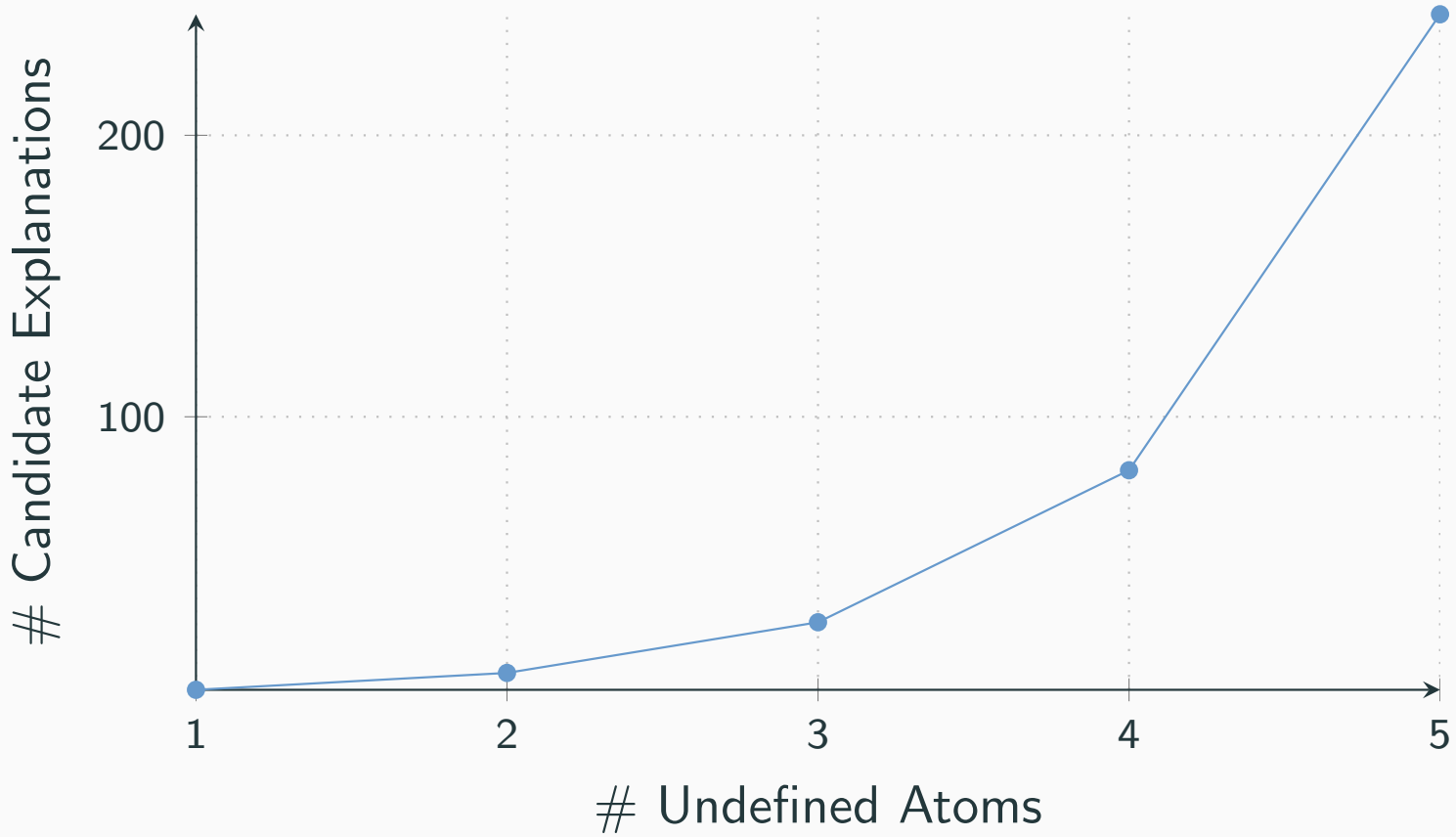


Candidate Explanations' Exponential Growth



Generating Candidate Explanations

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  - Store and use this information to block the generation of candidates which are supersets of known explanations

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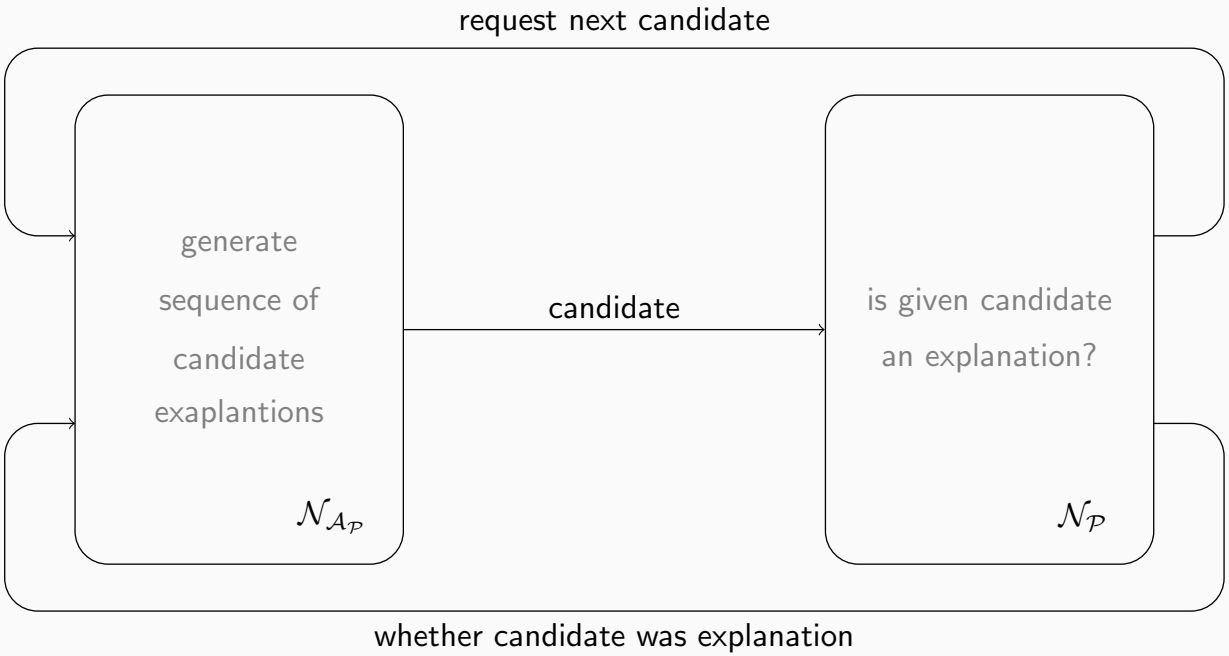

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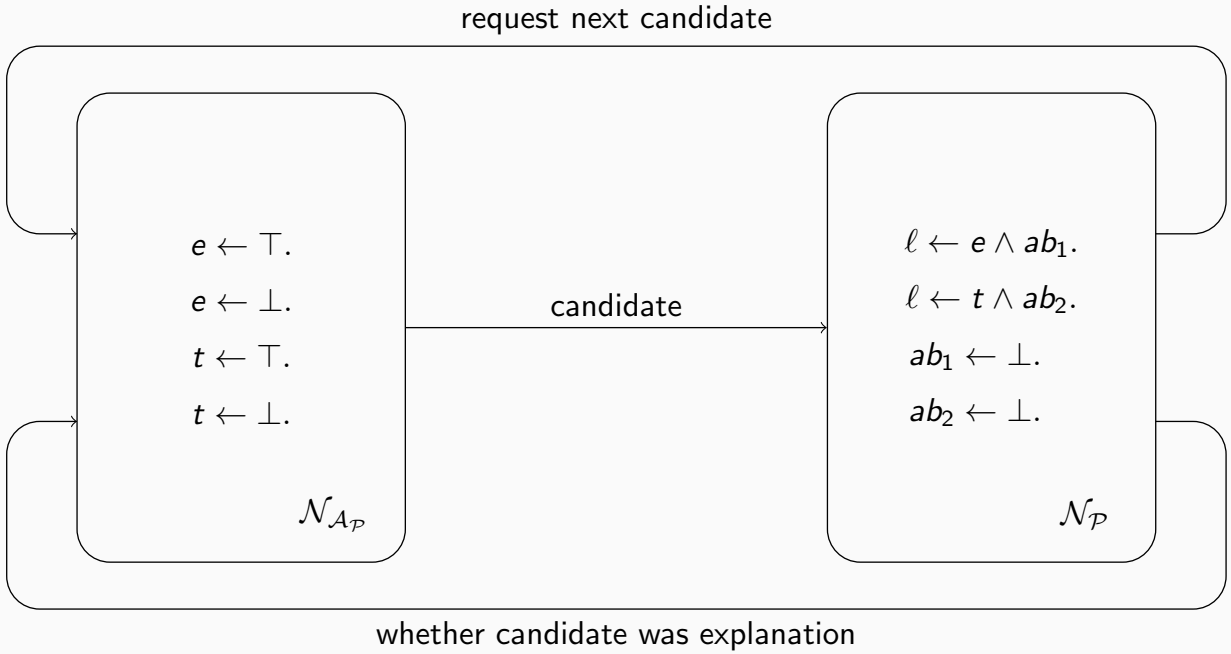

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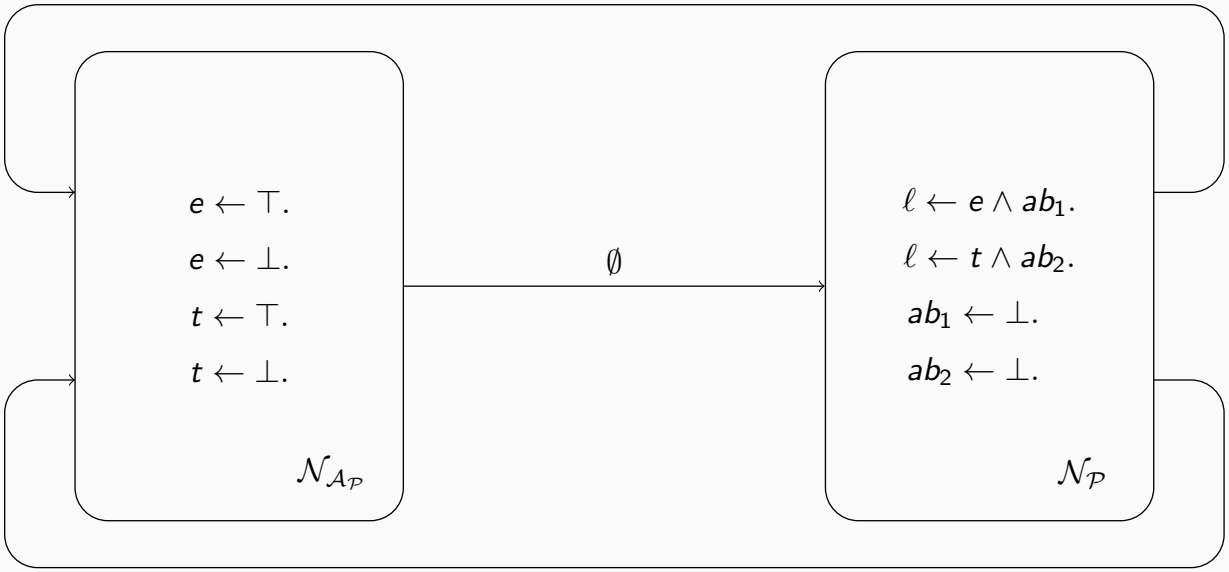

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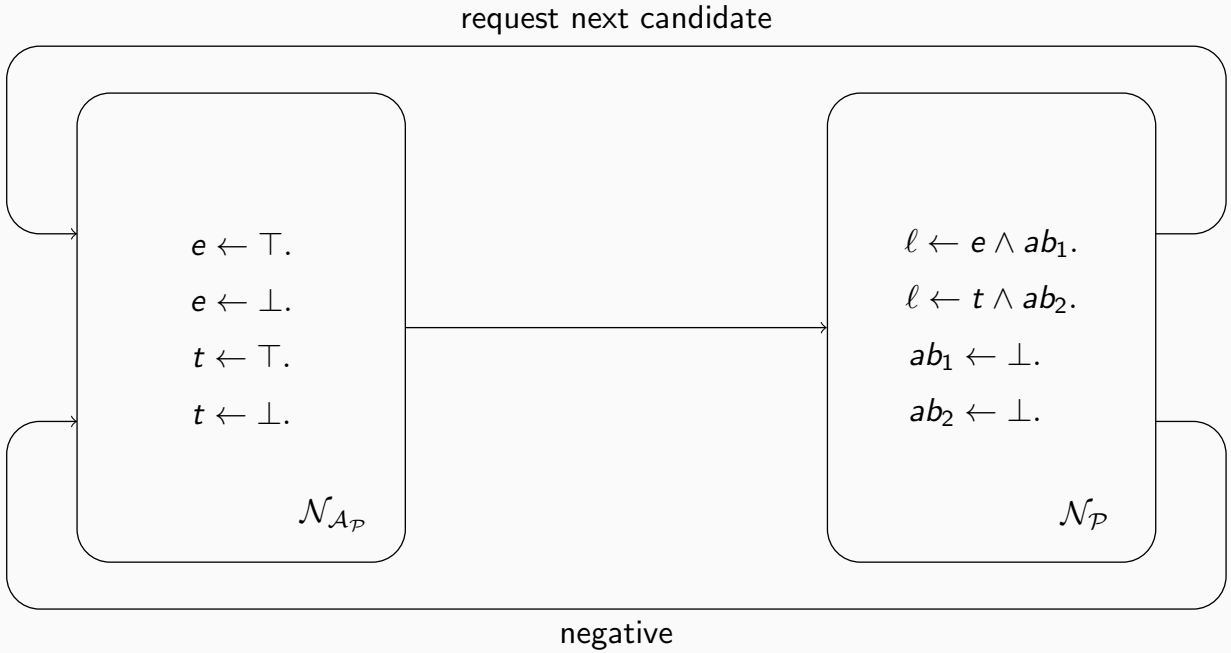

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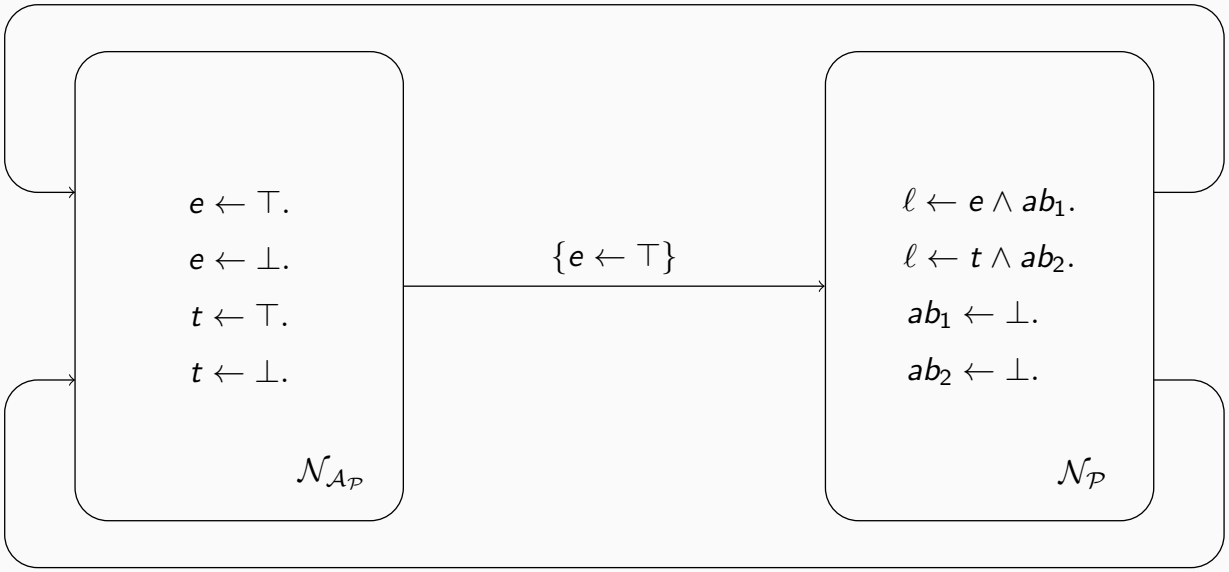

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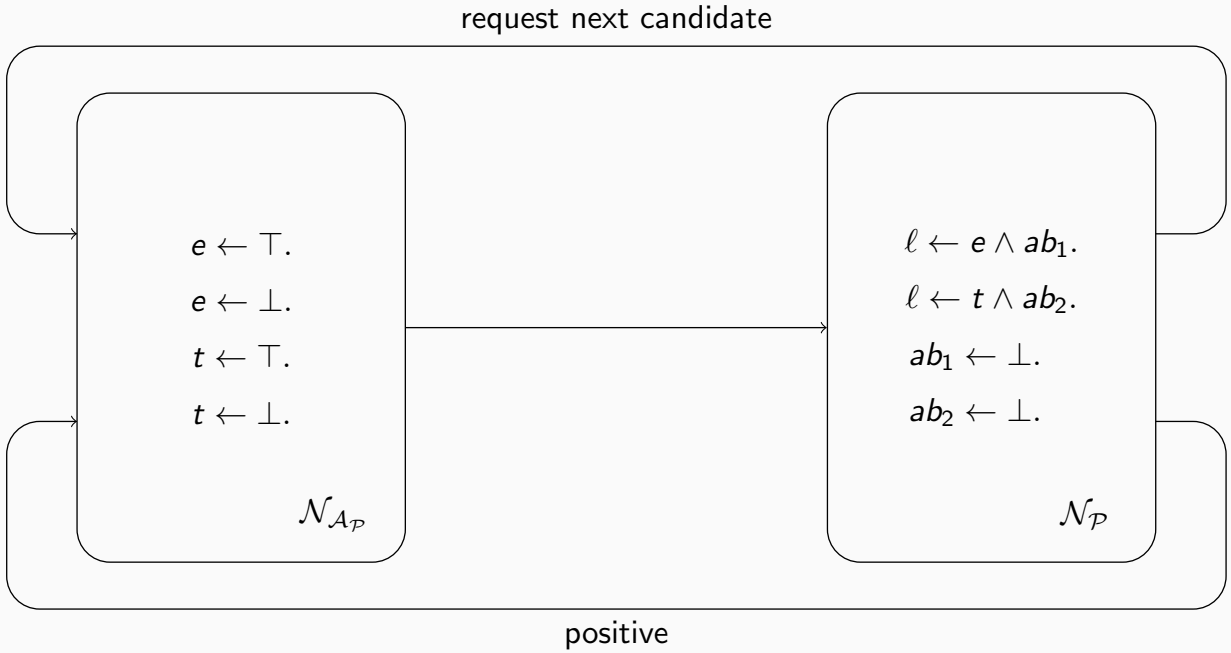

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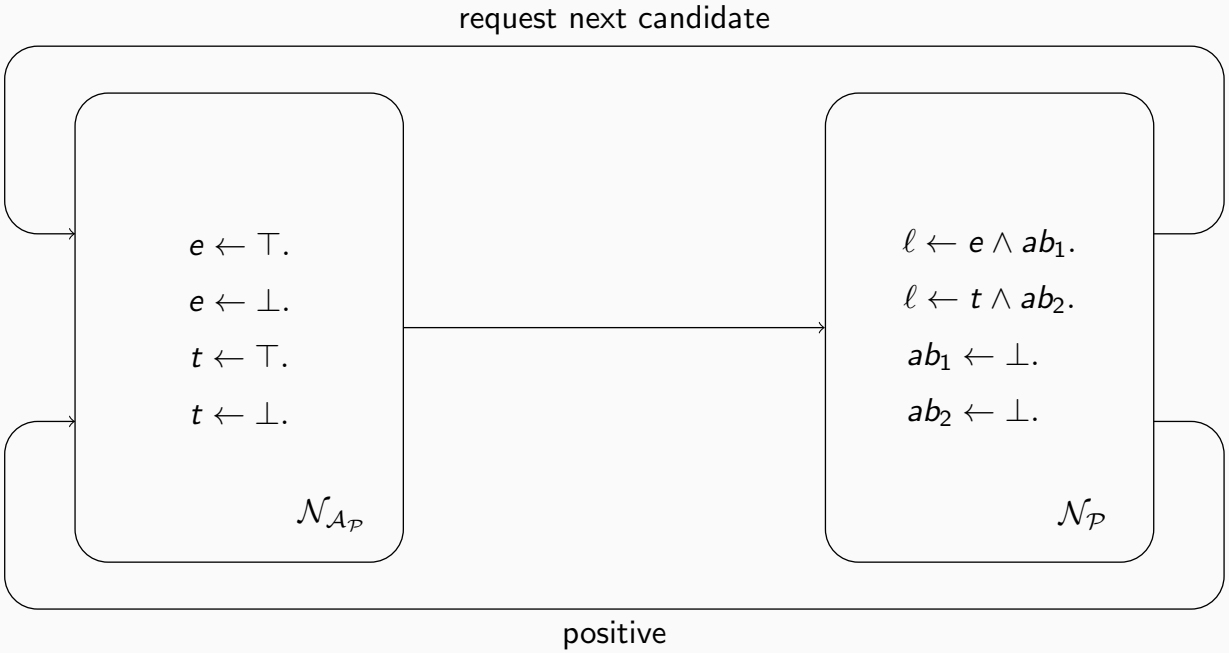

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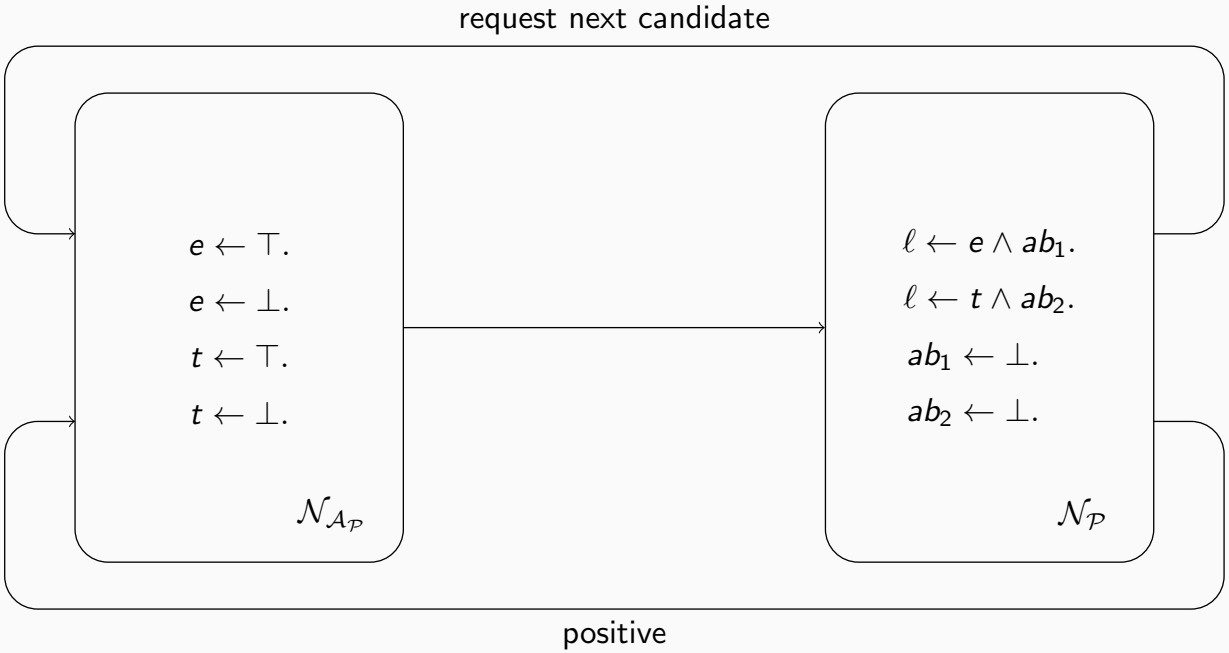

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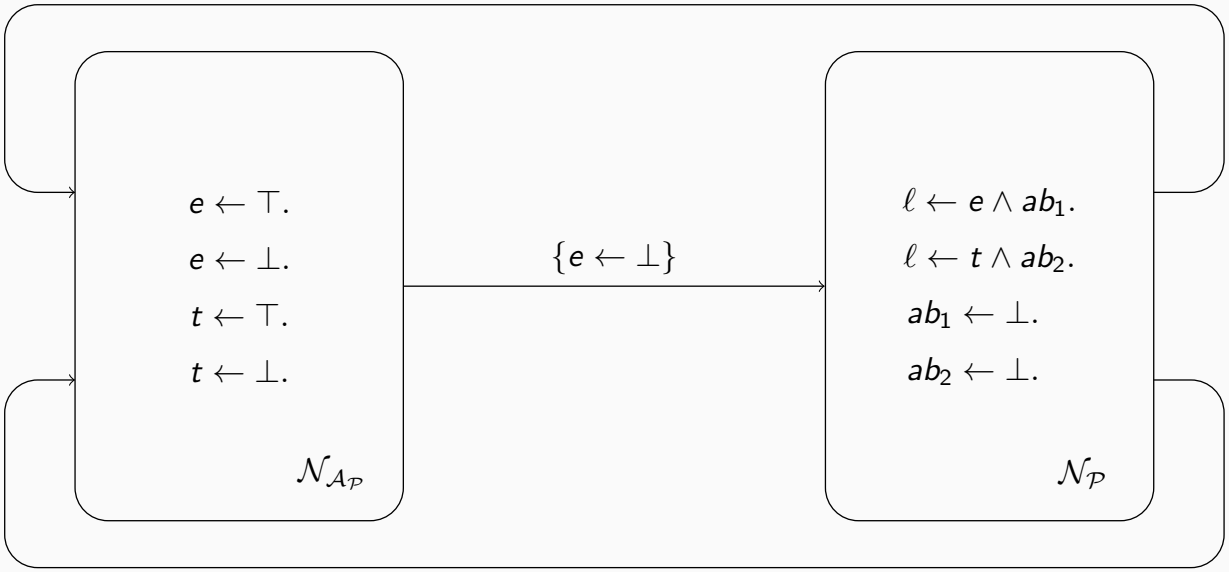

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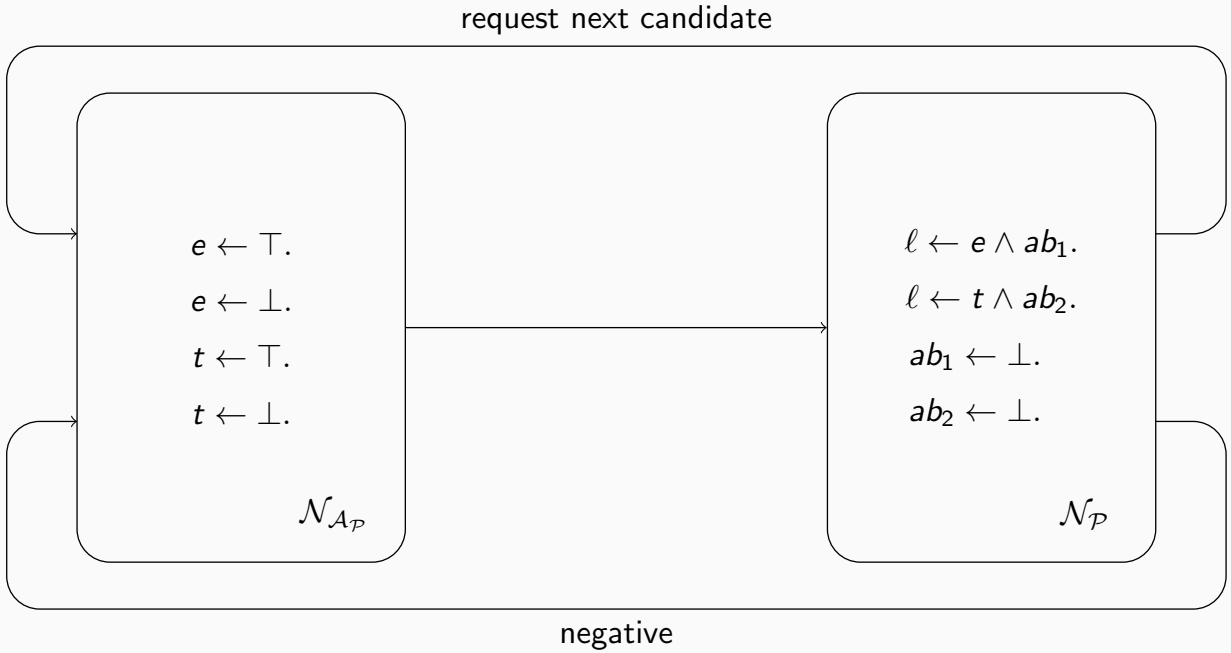

Minimal Candidate Explanations

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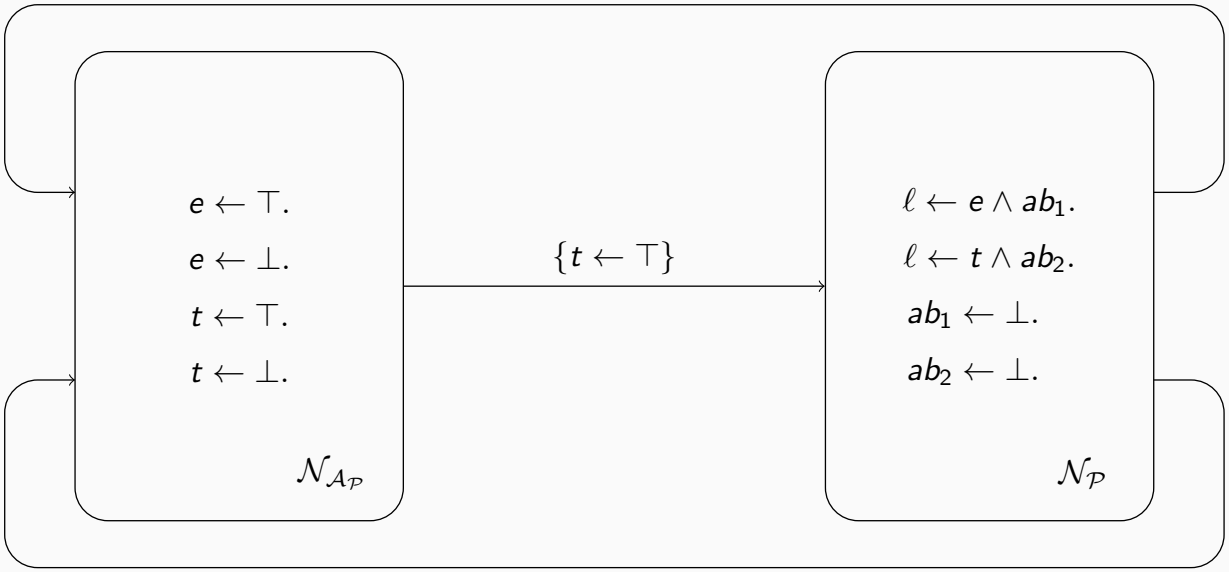

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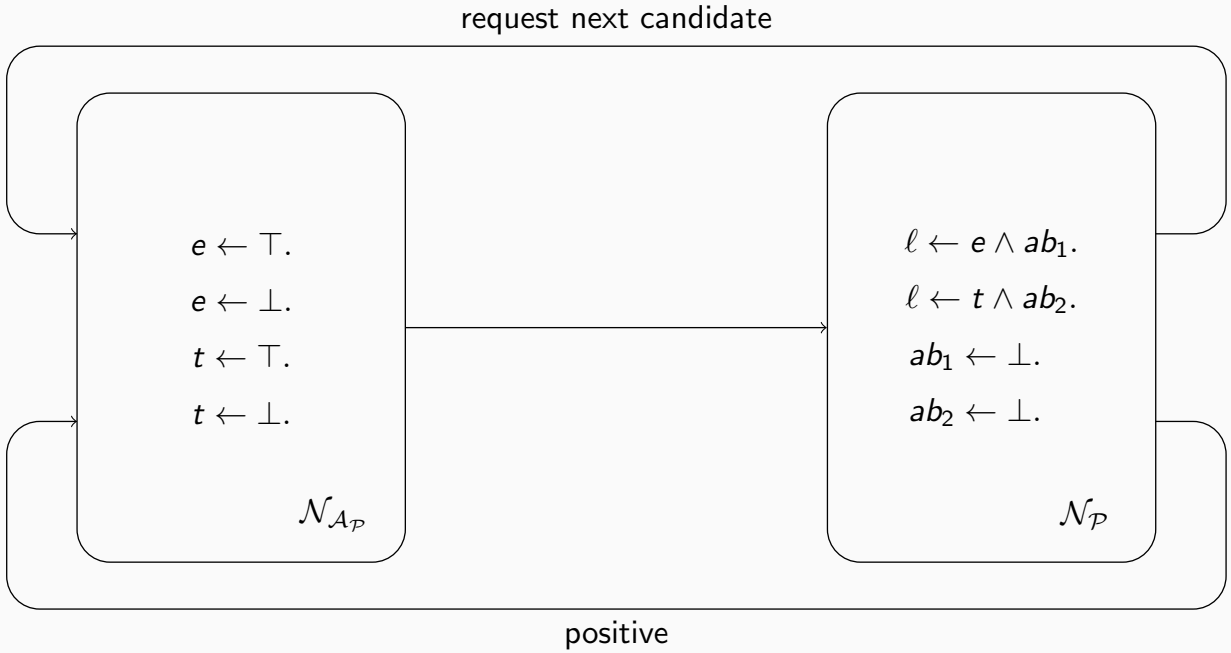

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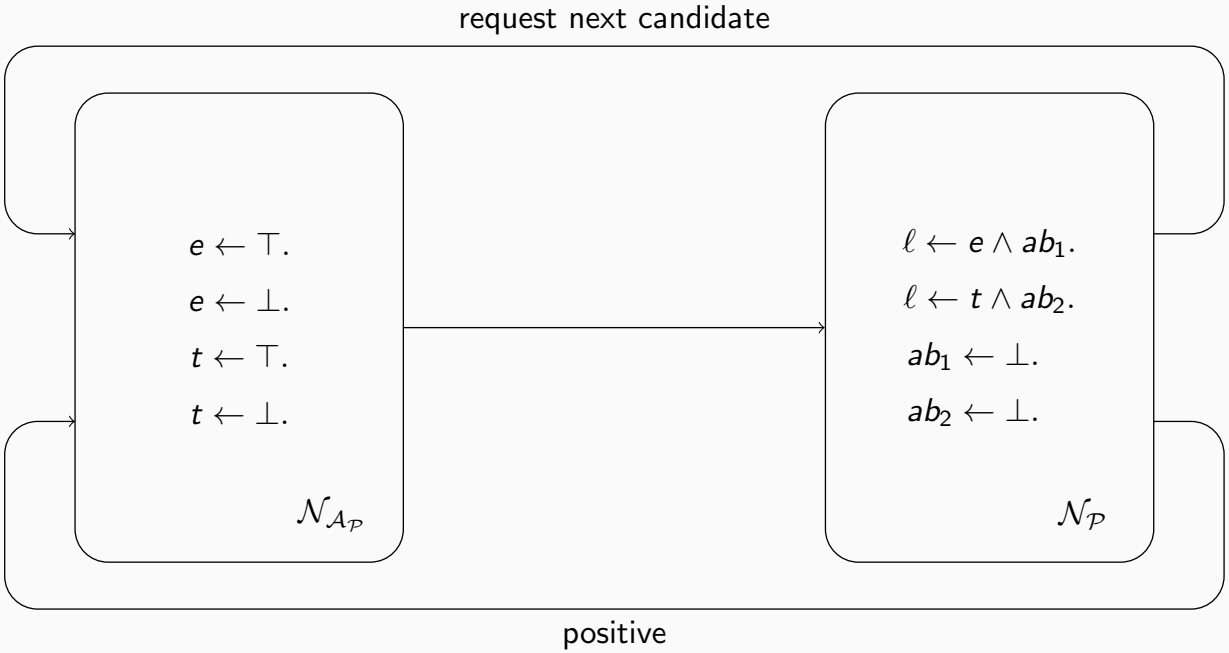

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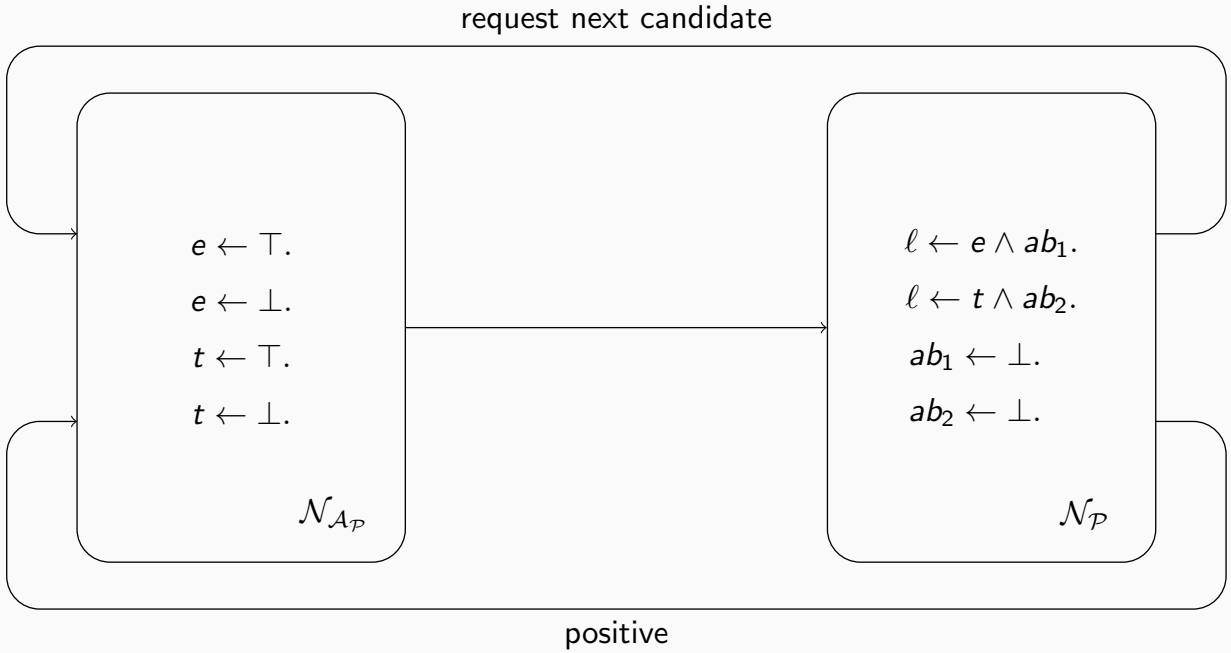

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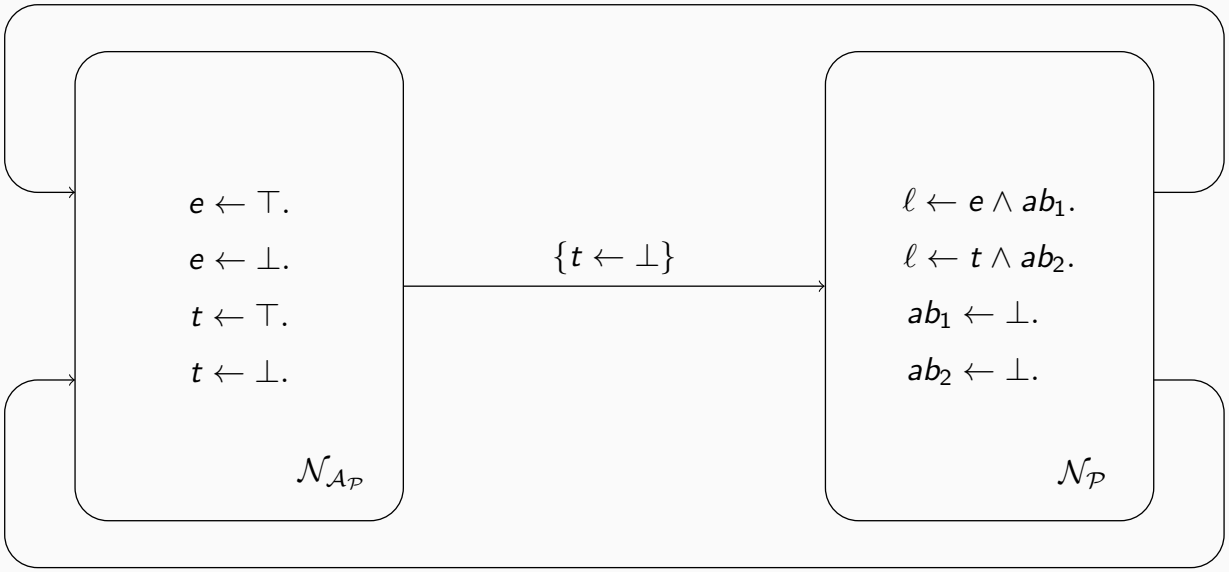

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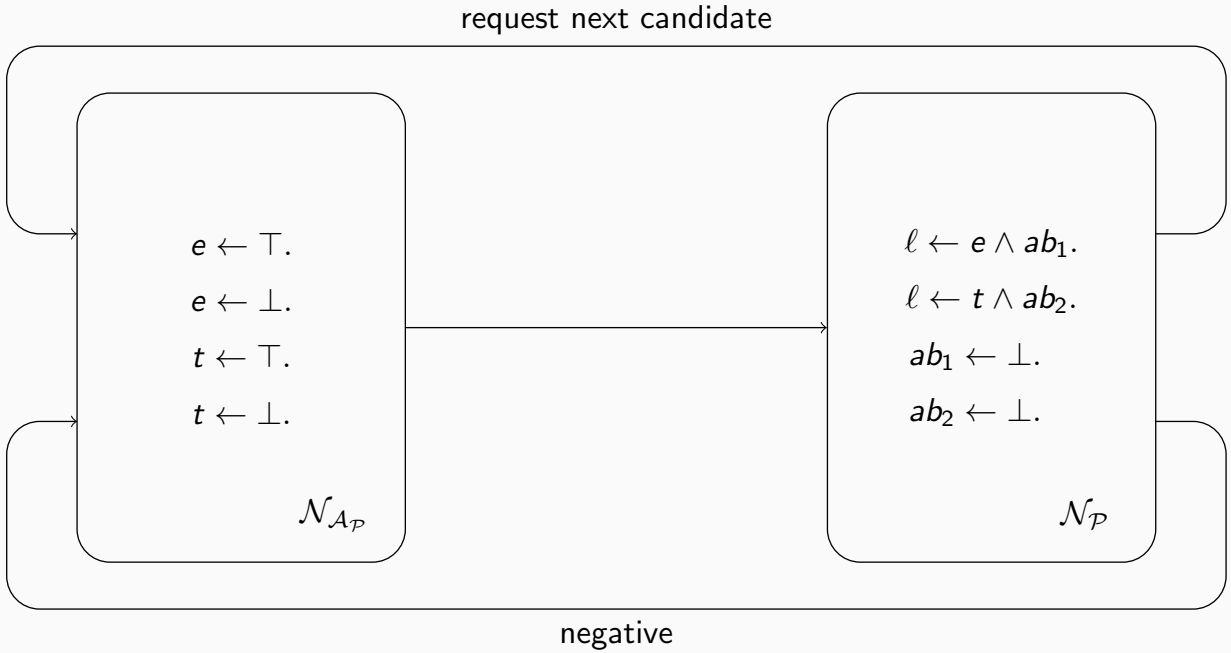

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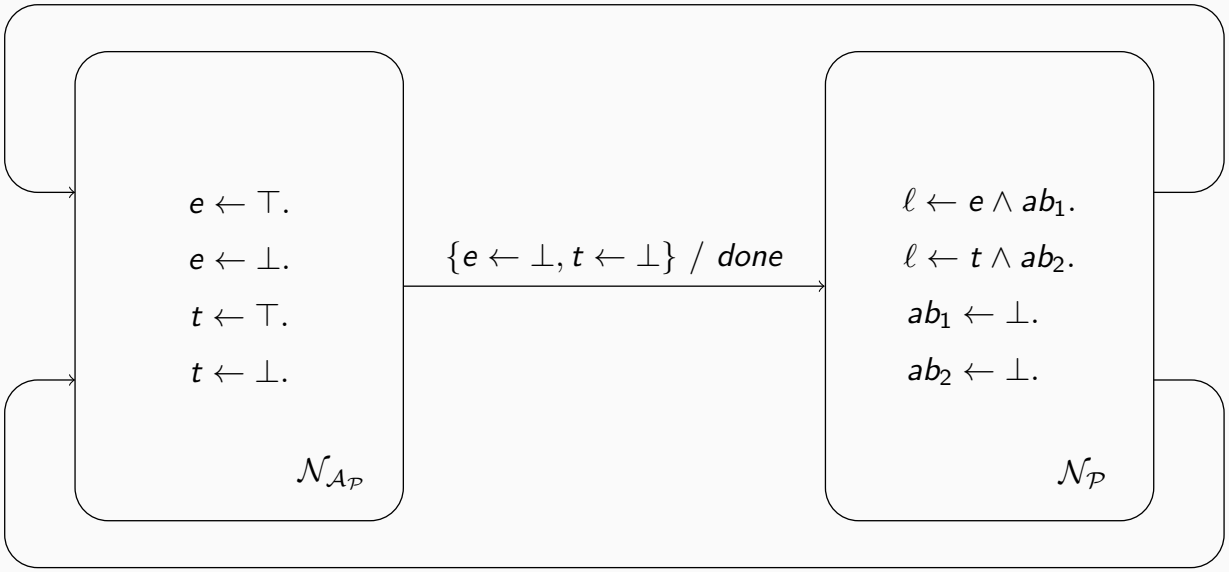

Minimal Candidate Explanations

Cognitive adequacy

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    2 undefined atoms: $1! * 4! * 4! = 576$

Recurrent Networks

Recurrent Network

- Designed to learn sequential or time-varying sequences

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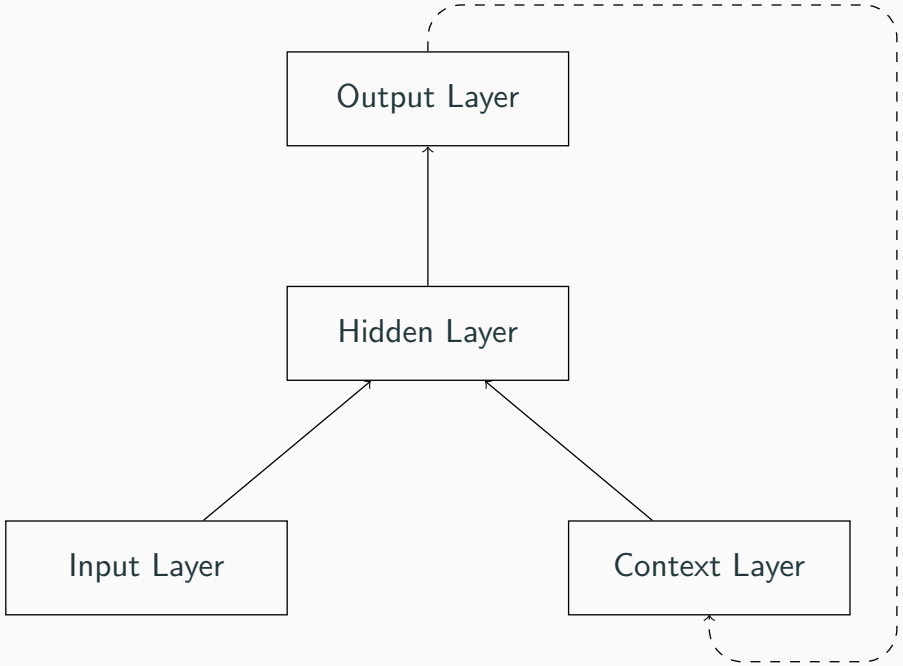
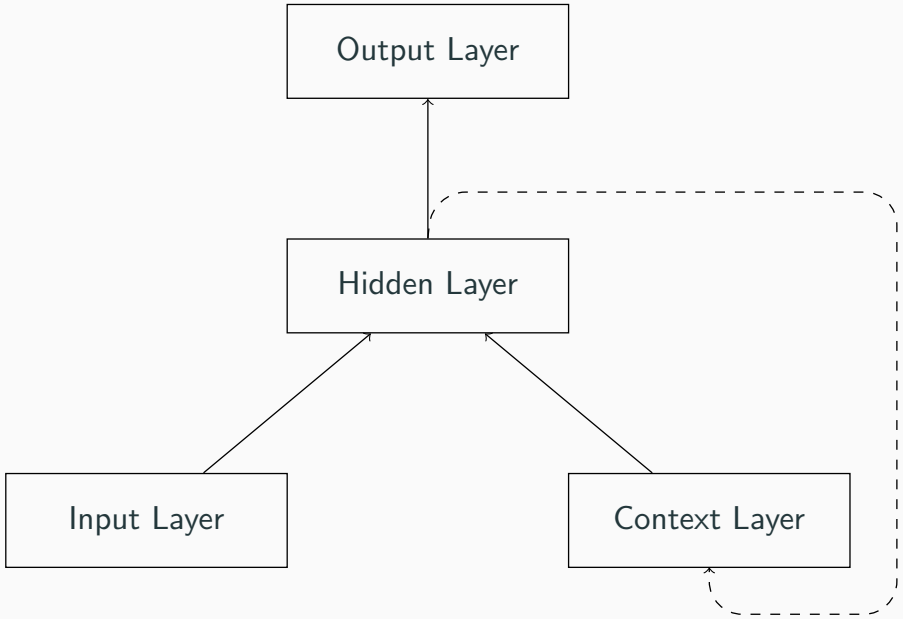
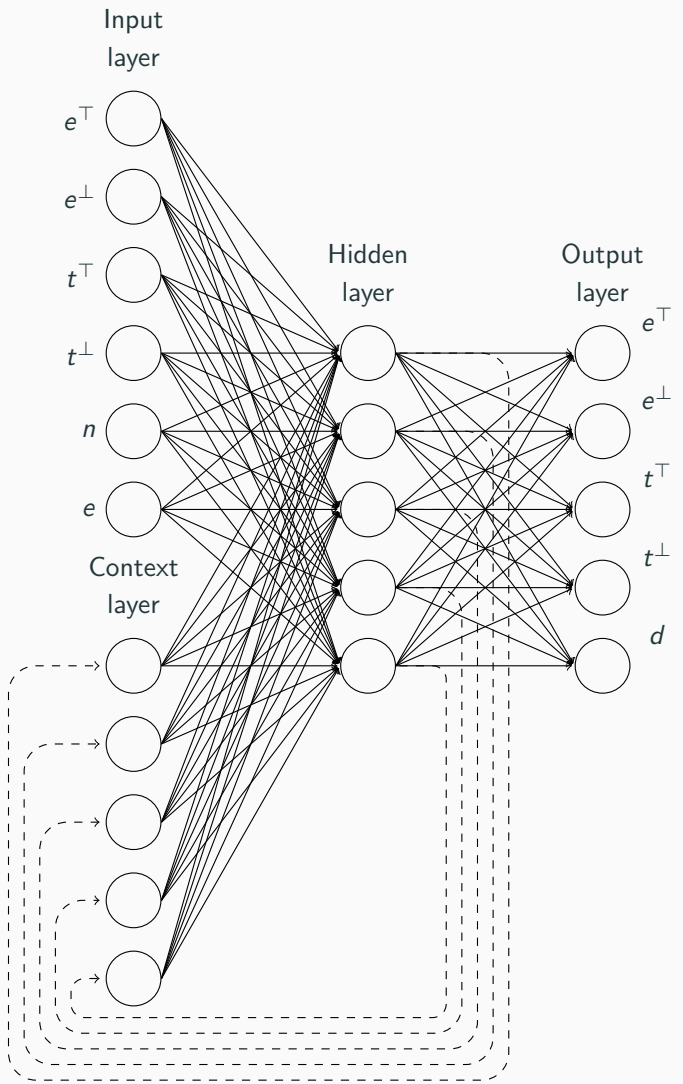


Elman Networks



Generating Arbitrary Sequences



Generating Arbitrary Sequences

- Training and testing data

Generating Arbitrary Sequences

- Training and testing data
  - Random activation of unit *next* (n)

Generating Arbitrary Sequences

- Training and testing data
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Generating Arbitrary Sequences

- Training and testing data
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$$\text{expected output} = \begin{cases} \text{next candidate}, & \text{if unit } \textit{next} \text{ is active} \\ \text{current candidate}, & \text{otherwise} \end{cases}$$

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- **Testing**: Mean absolute error
- 10-fold cross validation

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- What is the ideal number of hidden units?

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  - **Too few**: underfitting

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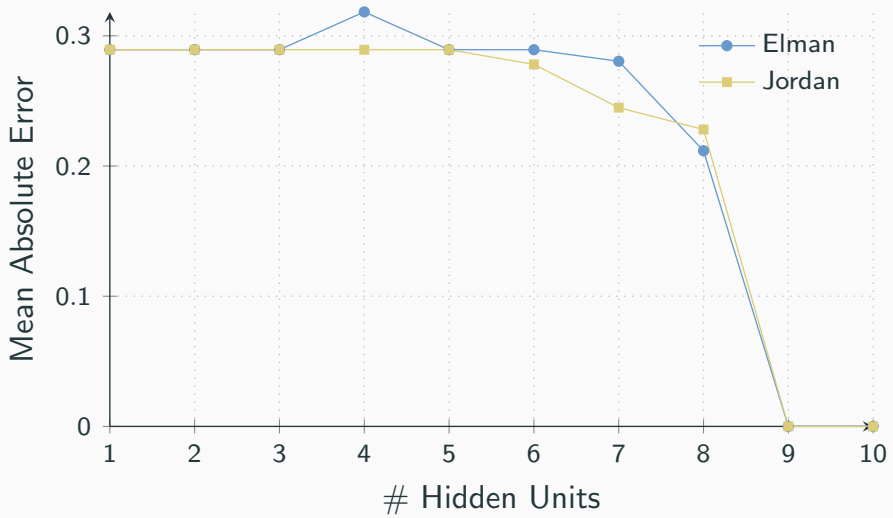

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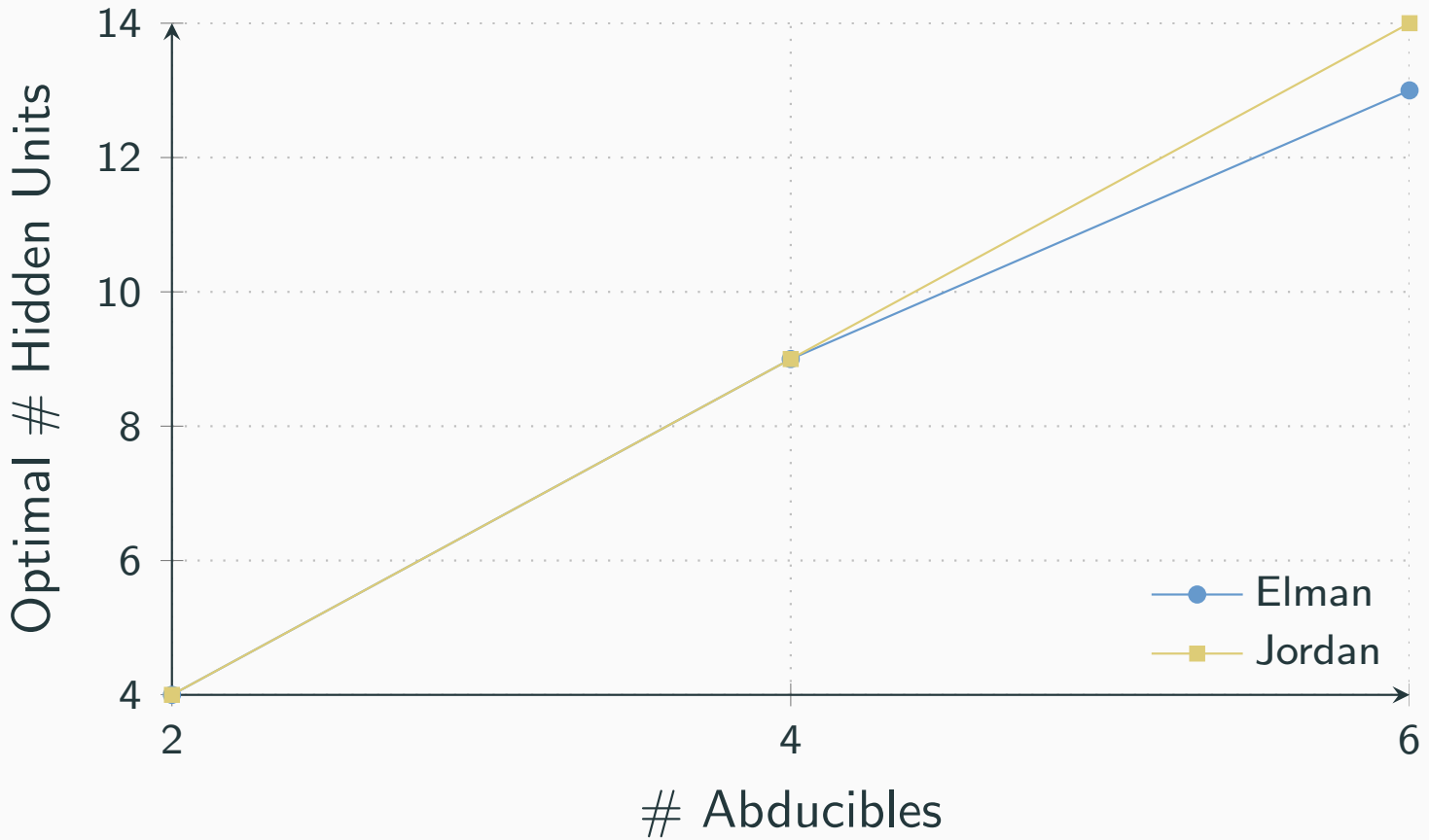

Generating Arbitrary Sequences

- Advantages of new approach

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- Advantages of new approach
  - Results can be generalised

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    - Any set of abducibles

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- Advantages of new approach
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    - Any set of abducibles
    - Different sequence orderings

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  - Anytime behaviour

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  - Automatisation
    - Generation of data

Generating Arbitrary Sequences

- Advantages of new approach
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    - Training and testing via k-fold cross-validation

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    - Plot of the experiment outcome

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    - Plot of the experiment outcome
  - Facility to test variations of the problem

Psychological Experiments

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- **Hypothesis:** Only minimal candidate explanations are considered

Psychological Experiments

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  - **Observation**: She will study late in the library

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    - She has an essay to write

Psychological Experiments

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    - She has an essay to write
    - She has a textbook to read

Psychological Experiments

- **Hypothesis:** Only minimal candidate explanations are considered
  - **Observation**: She will study late in the library
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    - She has an essay to write
    - She has a textbook to read
    - She has an essay to write and a textbook to read

Psychological Experiments

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  - Does it follow that *she has an essay to write*?

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    - No minimality

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  - Does it follow that *she has an essay to write*?
    - No minimality: ≈100% yes
    - Minimality: ≈50% yes

Open Questions

- Do humans consider only basic explanations?

Open Questions

- Do humans consider only basic explanations?
- Are the candidate explanations sequentially generated?

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- Are the candidate explanations sequentially generated?
- Are complementary candidates not considered?
- Do humans generate all the candidates?
- If a bound is applied, how is this bound characterised?

Contributions

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- Optimisation of sceptical abduction

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  - Reducing number of candidate explanations generated

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Thank you!