All You Need is Generalized GLL

Parsing algorithms are not only about string processing

Semyon Grigorev

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Generalized Parsing

- Handles arbitrary context-free grammars
  - Ambiguous
  - (Hidden) Left-recursive (for LL)
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- GSS — Graph Structured Stack, compact representation of stack
- SPPF — Shared Packed Parse Forest, compact representation of parse forest

Generalized LL (GLL)[1]

- Descriptor
  - Grammar slot: $S \rightarrow a \cdot Sb$
  - Input position
  - Top element of stack
  - Root of tree

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- Iguana — GLL-based parser generator

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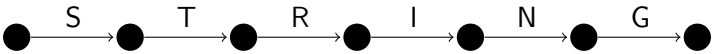
- SPPF becomes more complex

Nonlinear Input Handling

String = linear graph



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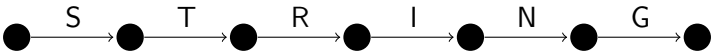

What makes a graph **not** a string?

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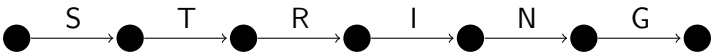

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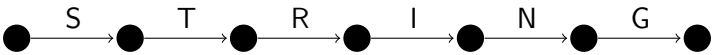

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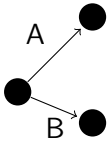
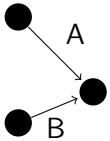
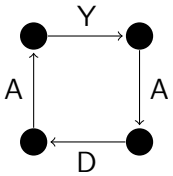




Cycles



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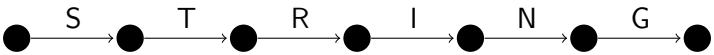

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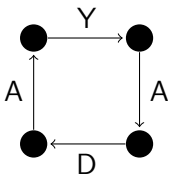

- Multiple different terminals can be the next symbols for the current state
- Each descriptor handle once (cycles and merges not a problem)

Error Recovery

- Language Editing Distance (LED): for the given language $\mathcal{L}$ and the given string w to find string w_1 such that $w_1 \in \mathcal{L}$, $\texttt{dist}(w, w_1)$ is minimal

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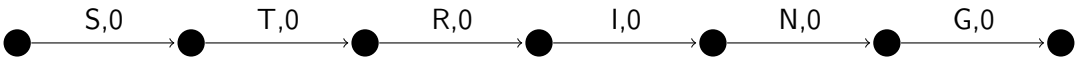

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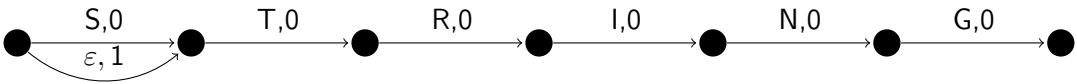

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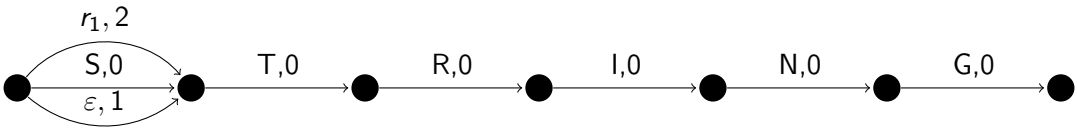

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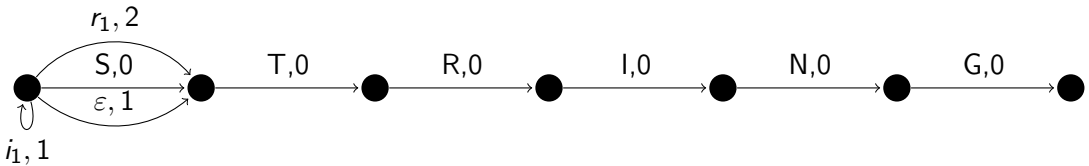

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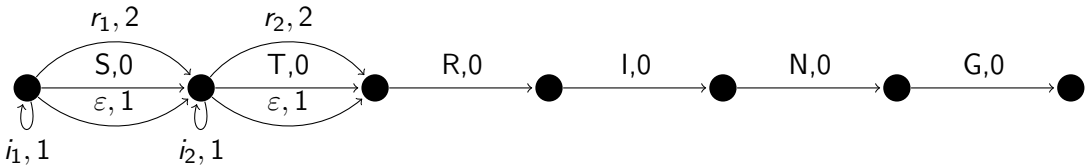

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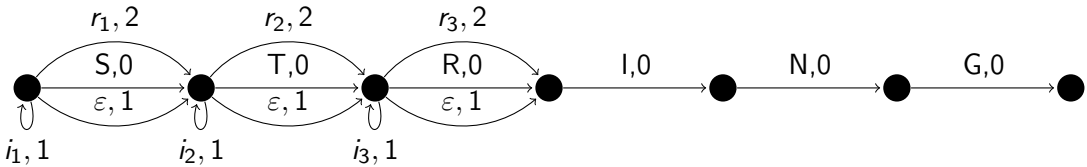

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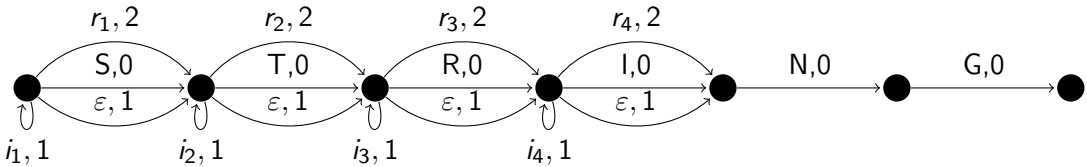

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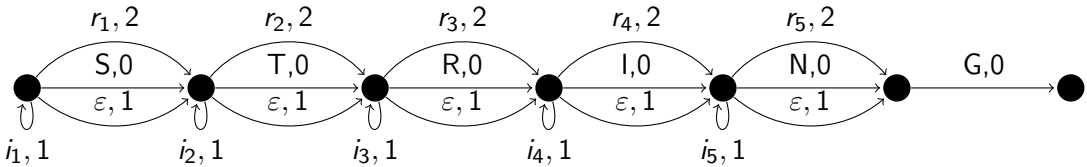

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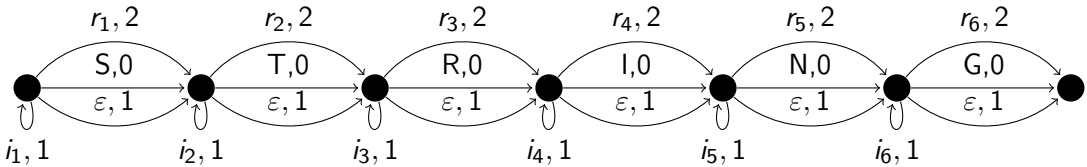

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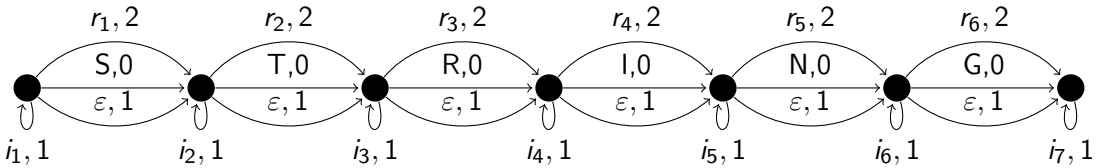

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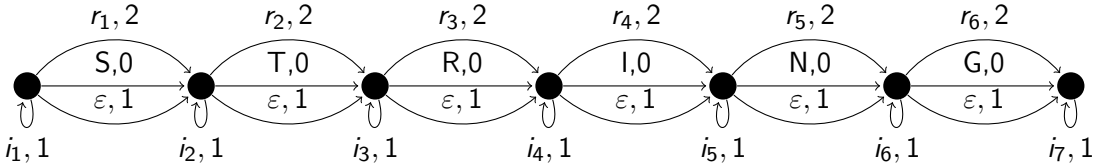
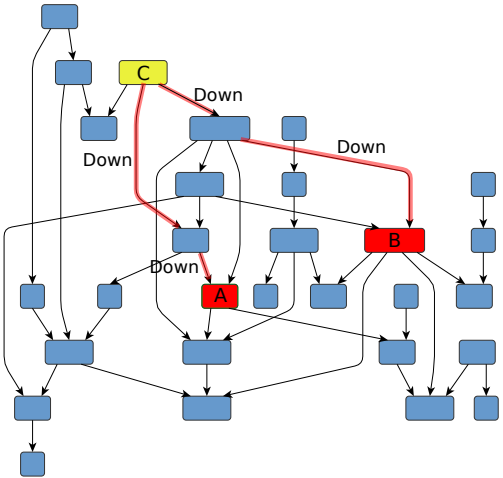


- Error recovery $\rightarrow$ find a minimal weight path from start to final in the given graph which forms a word in the given language
- Set of descriptors to handle $\rightarrow$ priority queue

Path Querying



Context-free languages as constraints (CFPQ, Context-Free Path Querying)

- Are nodes A and B on the same level of hierarchy?
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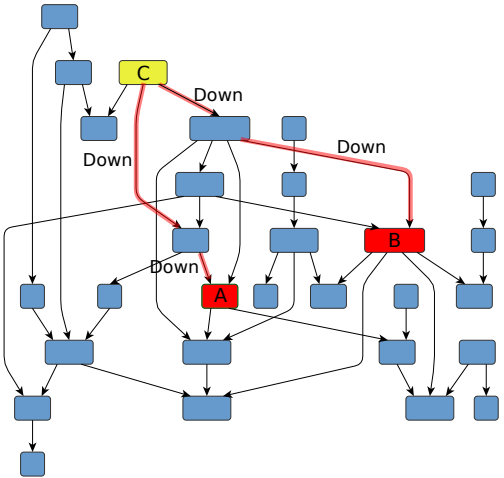

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Applications

- Static code analysis [T. Reps, et al, 1995]
- Graph segmentation [H. Miao, et al, 2019]
- Biological data analysis [P. Sevon, et al, 2008] ...

Conclusion

- Generalized parsing opens the door to
  - Arbitrary context-free grammars handling
  - Natural error recovery
  - Graph navigation
  - ...