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Learning Structural Edits via Incremental Tree Transformations

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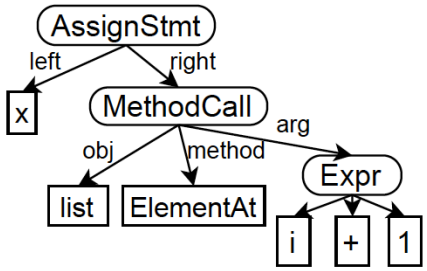
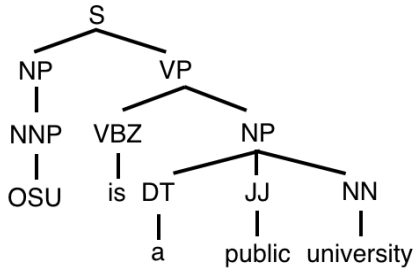
Motivation

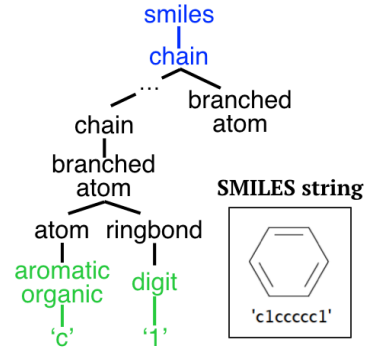
- The prevalence of tree-structured data



Abstract Syntax Trees (AST) of computer programs



Syntactic parse trees of sentences



Parse trees of molecules
(James+ 2015; Kusner+ 2017)

The need for **editing** tree-structured data

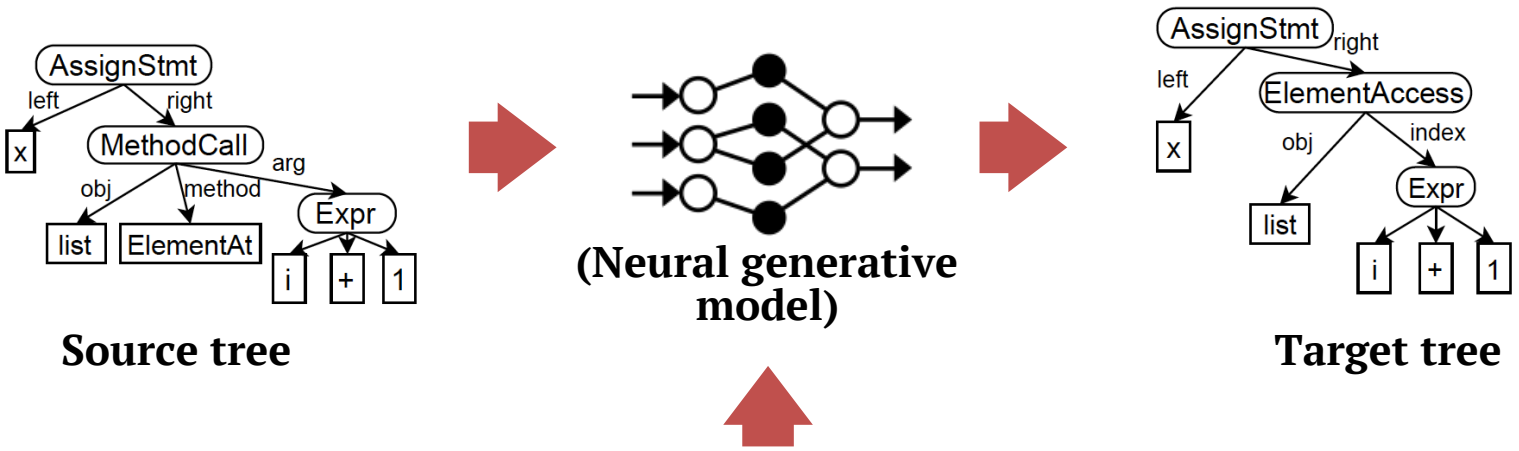
e.g., code refactoring, bug repair, edit-based code generation

e.g., syntax-based sentence simplification

e.g., drug molecule discovery and design

Learning to Edit Tree-Structured Data

- Problem formulation

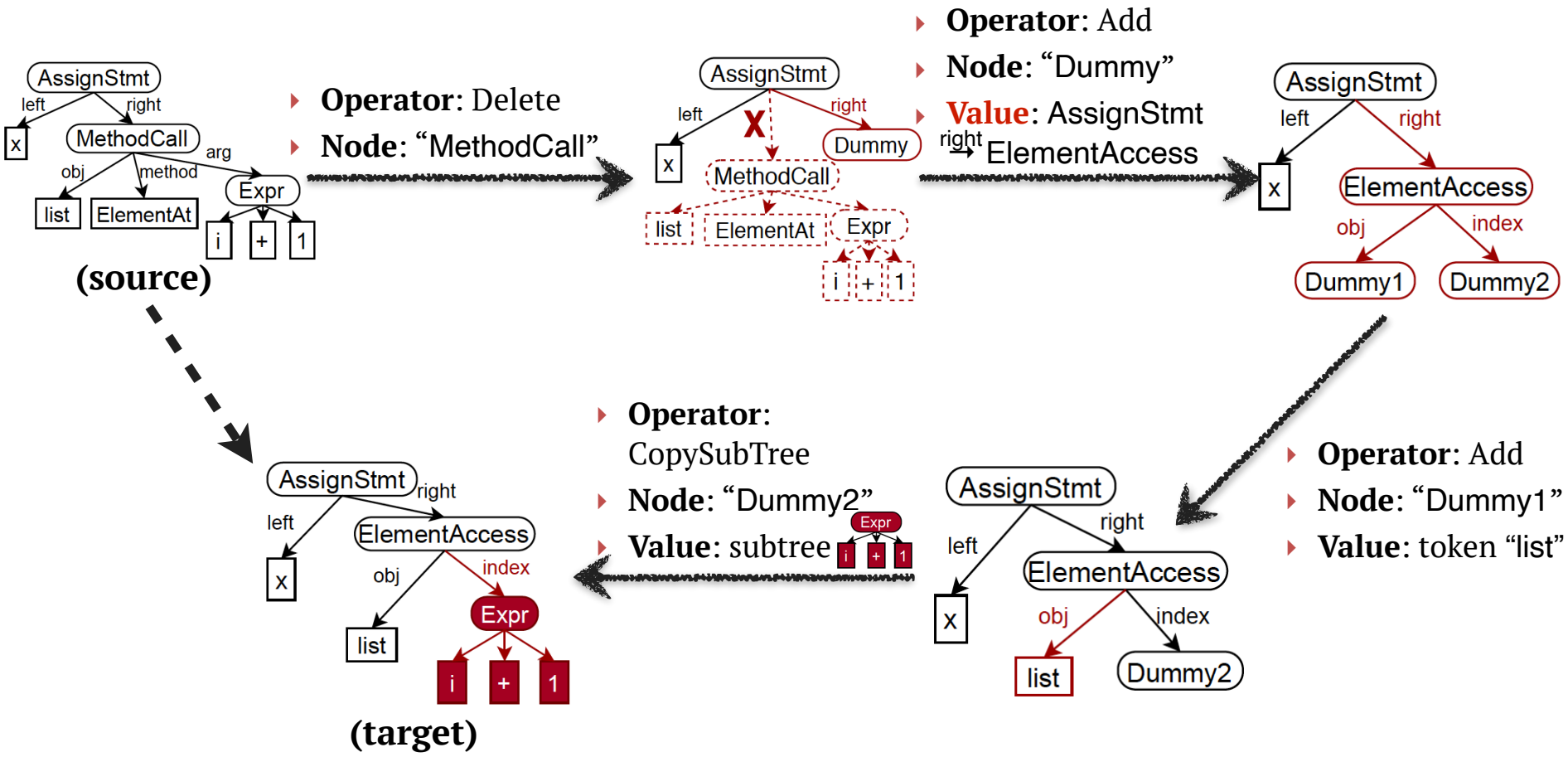


This work: **A general-purpose model for tree editing**

- Generating *incremental tree edit actions* => capable of iterative tree edit
  - vs. generating *the edited tree* (Yin+ 2019; Chakraborty+ 2020)
- Language-agnostic & grammar-valid
  - w/ Abstract Syntax Description Language (ASDL; Wang+ 1997)

Structural Edit via Incremental Tree Transformations

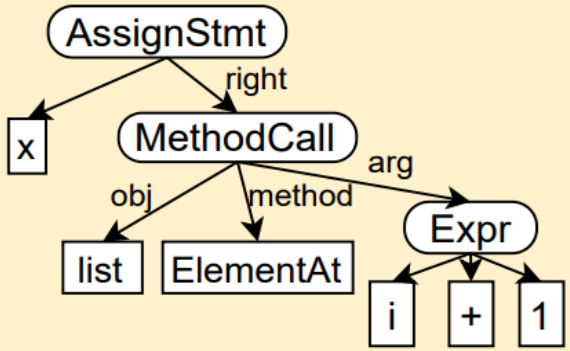
(Using editing the AST of a computer program as a canonical example)



Note: Operator "Stop" is omitted

Structural Edit via Incremental Tree Transformations

Apply edit & transform tree, $t \leftarrow t + 1$



Current tree C_t

+

Edit specification Δ

state s_t → edit action a_t

- **Operator**: [Delete, Add, CopySubTree, Stop]
- **Node**: e.g., "MethodCall" (edit location)
- **Value**: new node to add or subtree from C_1 to copy

$$p(a_{1:T}|\Delta, C_1) = p(a_1|\Delta, C_1)p(a_2|\Delta, C_{1:2}) \cdots p(a_T|\Delta, C_{1:T})$$

Experiment

Evaluation setting: $\langle \Delta = \langle C'_{src}, C'_{tgt} \rangle, C_{src} \rangle \rightarrow C_{tgt}$

(**Δ**: edit specification)

e.g.,

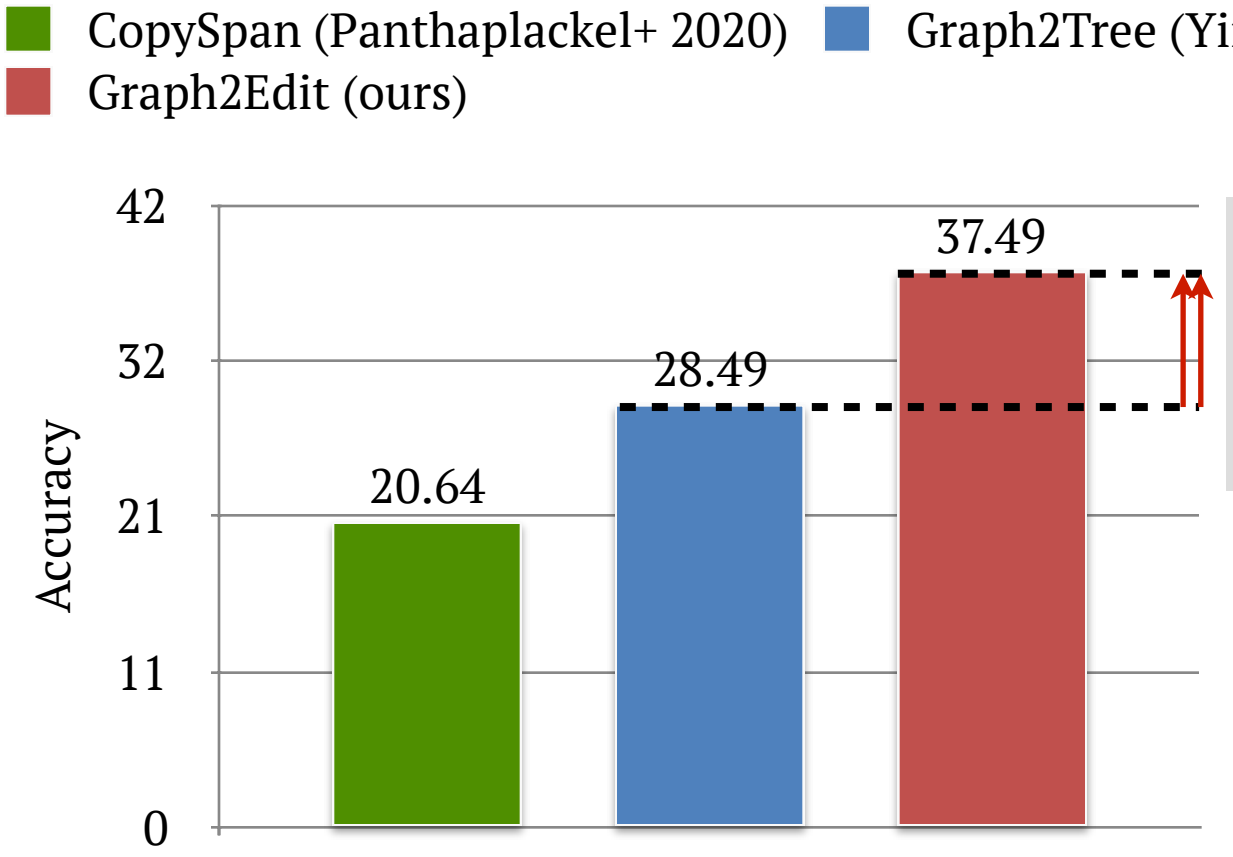
$\langle$ `string VAR0 = VAR1.ElementAt((int)VAR2.id);` , `string VAR0 = VAR1[(int)VAR2.id];` $\rangle$

```
x = list
.ElementAt(i+1)
```

```
x=list[i+1]
```

Experiment

Evaluation setting: $\langle \Delta = \langle C'_{src}, C'_{tgt} \rangle, C_{src} \rangle \rightarrow C_{tgt}$

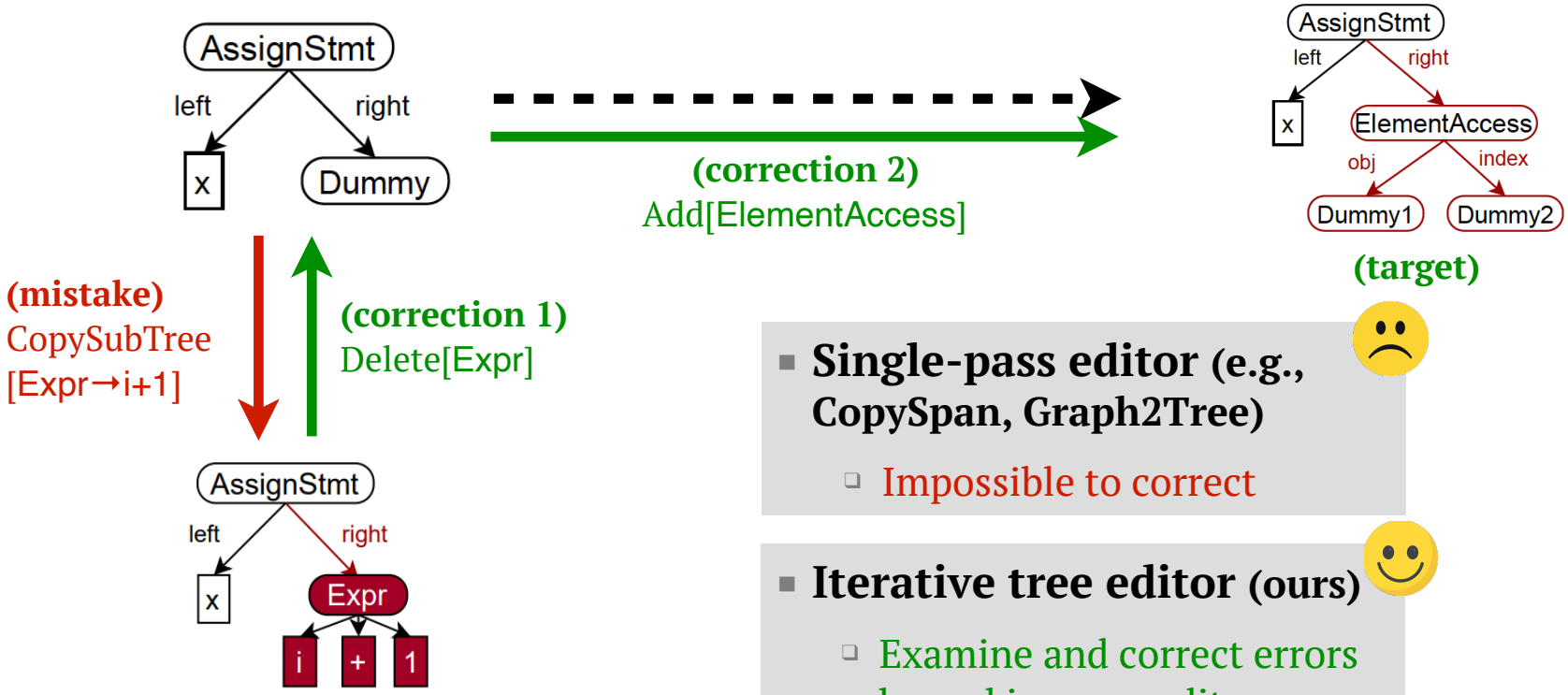


Graph2Edit:
More capable of capturing the generalizable edit intent

w/ Sequential edit encoder; on Fixers dataset (Yin+ 2019)

Robust Tree Edit with Error Correction

- What if the model made a *wrong* edit in *inference time*?



- **Single-pass editor (e.g., CopySpan, Graph2Tree)**
  - Impossible to correct
- **Iterative tree editor (ours)**
  - Examine and correct errors by making new edits

Our contributions

- Training iterative tree editors to correct mistakes by **imitation learning**
- **Take-away**: continuous structural demonstrations are preferable

Summary

- Contributions: How to edit tree-structured data?
  - `Graph2Edit`: A general-purpose neural model for editing tree-structured data iteratively
  - Robust tree editing via imitation learning

  (More in paper:)
  - `TreeDiff`: a novel edit encoder for learning representations of edit specifications

- Code and data available on GitHub: https://github.com/neulab/incremental_tree_edit
- See you at **Poster Session 2 on May 3, 9-11AM PDT**!