Code Clone Detection

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Github Repository -https://github.com/sedflix/code_clone_detection

What's "clone"?

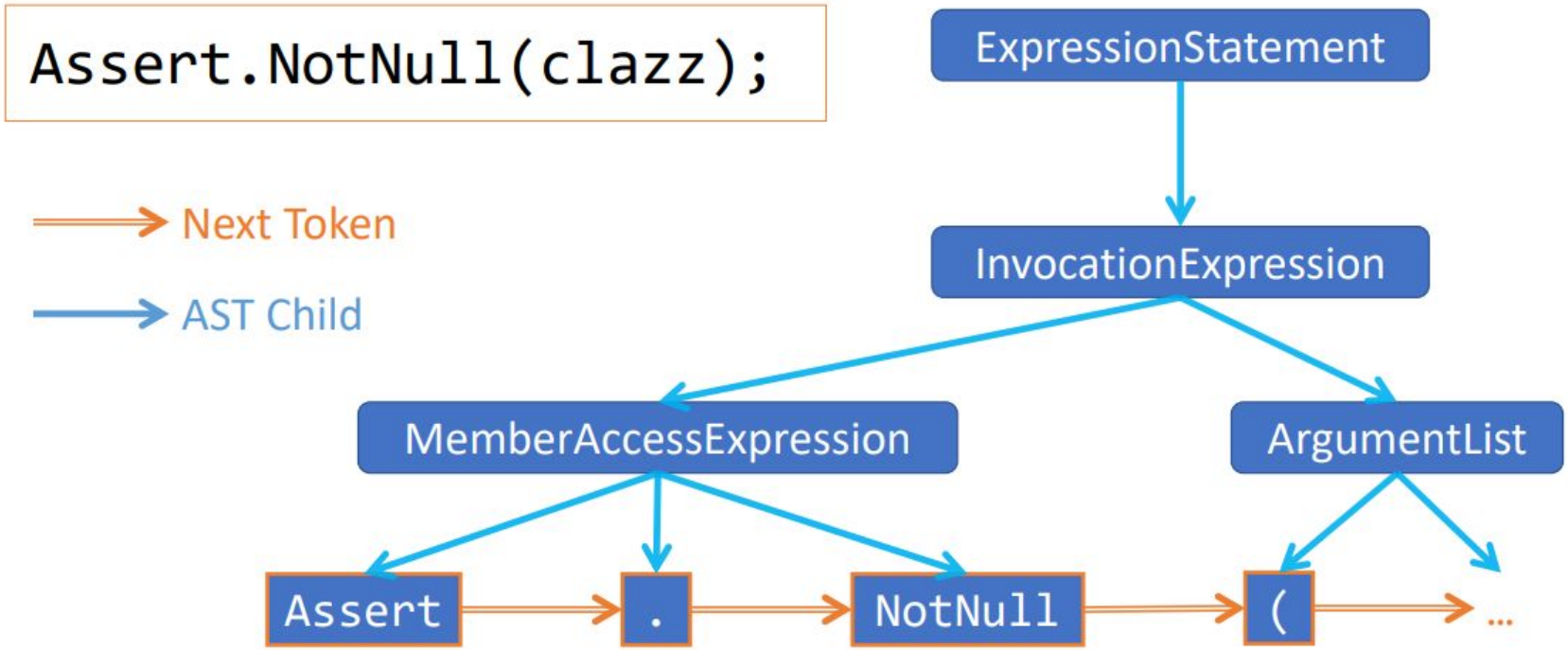
Source code	Type-1 clone	Type-2 clone
int main() { int x = 1; int y = x + 5; return y; }	int main() { int x = 1; int y = x + 5; return y;//output }	int func2() { int p = 1; int q = p + 5; return q; }

Type-3 clone	Type-4 clone
int main() { int s = 1; int t = s + 5; t = t/++s; return t; }	int func4() { int n = 5; return ++n; }

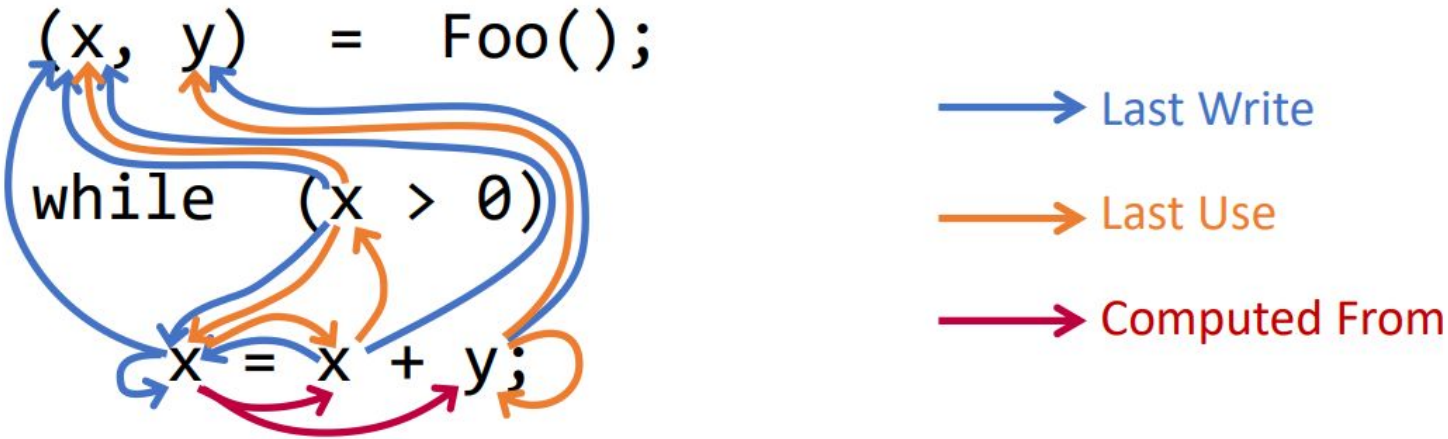
Duplicates in Open Source

Dataset	# Files (x1000)	% duplicates
C# ICLR'19	28.3	10.6
Concode- Java*	229.3	68.7
Java GitHub Corpus	1853.7	24.8
Java-Small	79.8	4.7
Java-Large	1863.4	20.2
JavaScript-150k	112.0	20.7
Python-150k	126.0	6.6
Python docstrings v1*	105.2	9.2
Python docstrings v2*	194.6	31.5

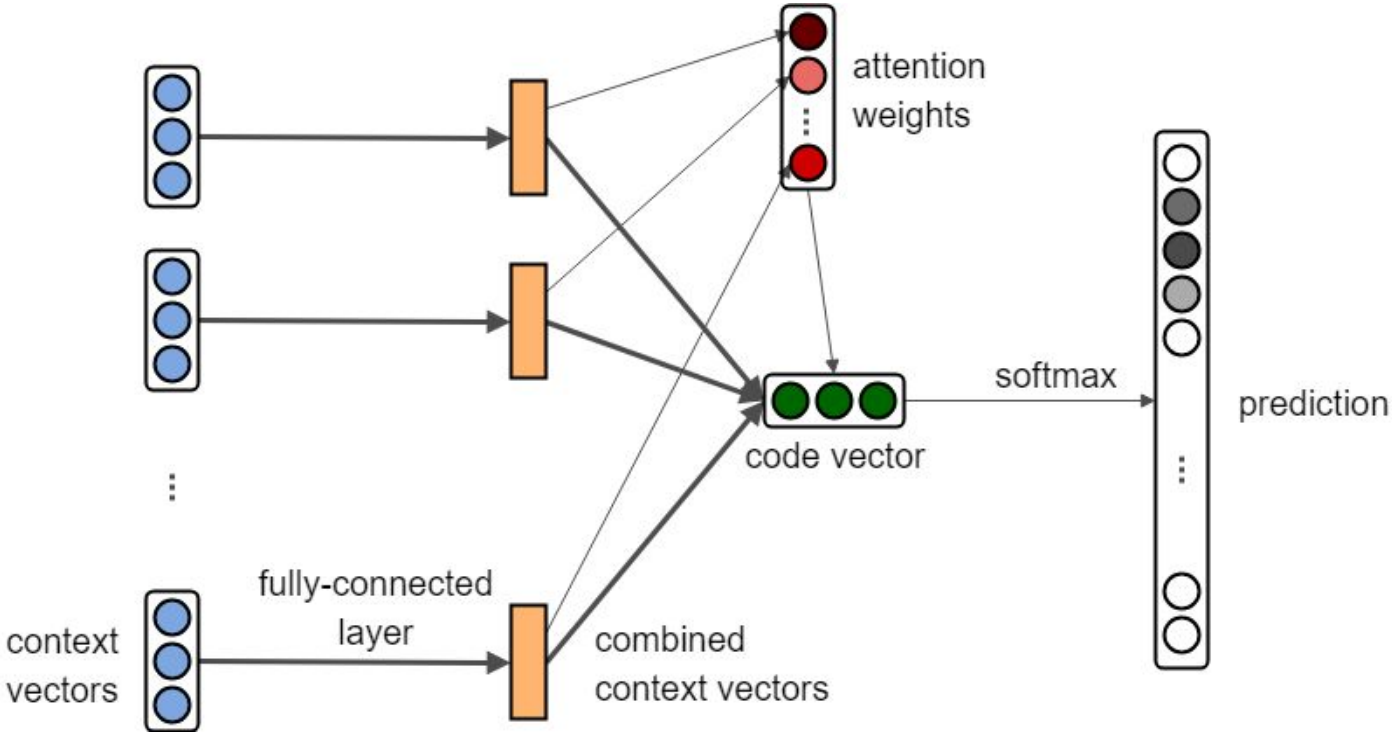
Representing Code as Graph: AST



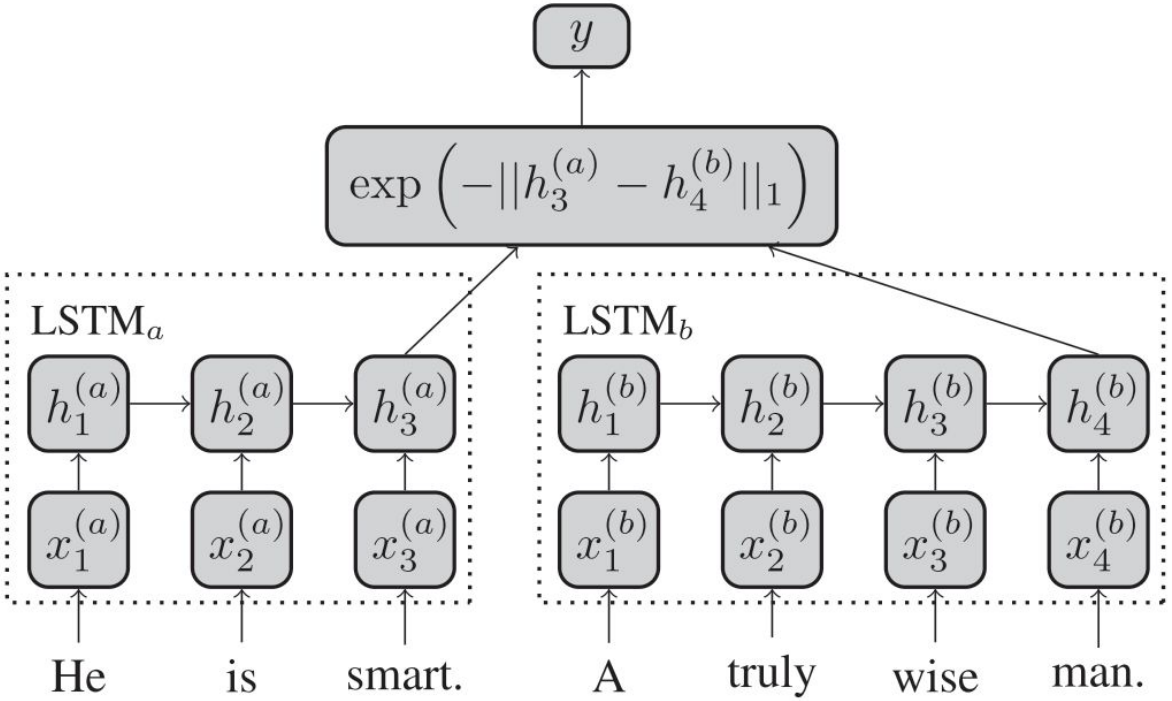
Representing Code as Graph: Dataflow



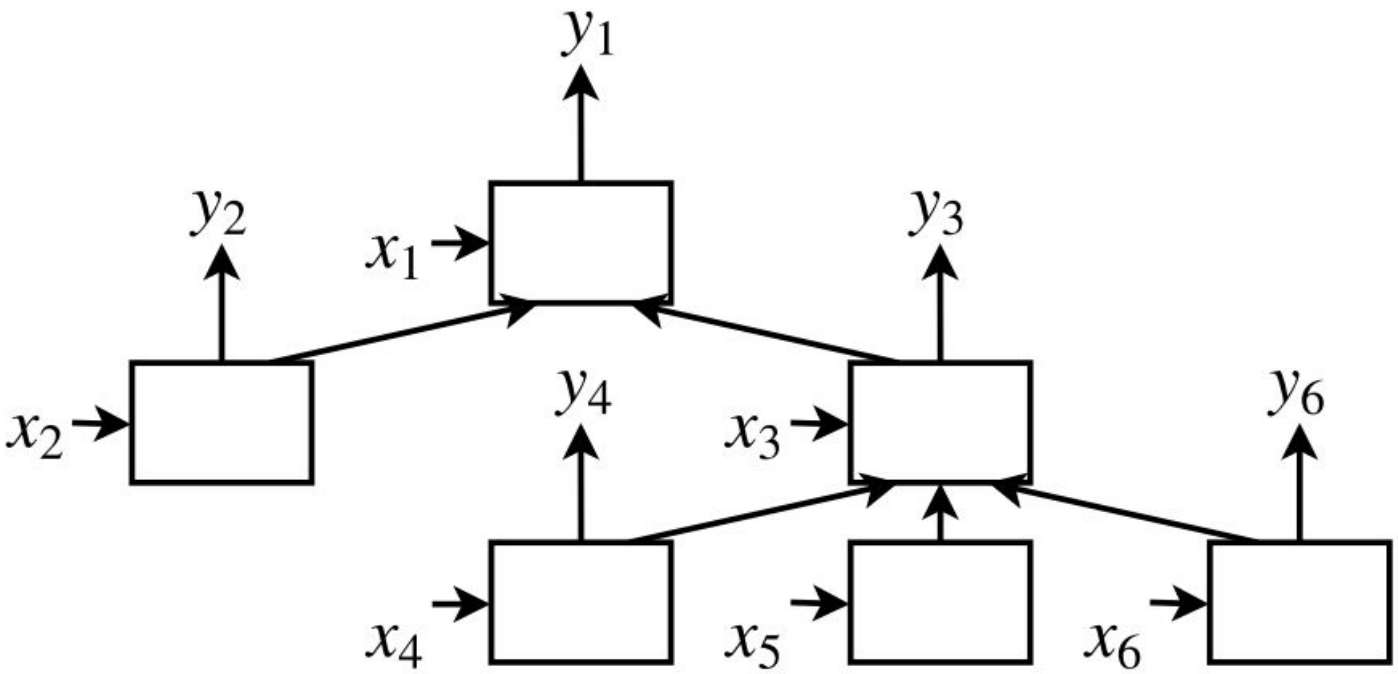
Building Blocks: code2vec



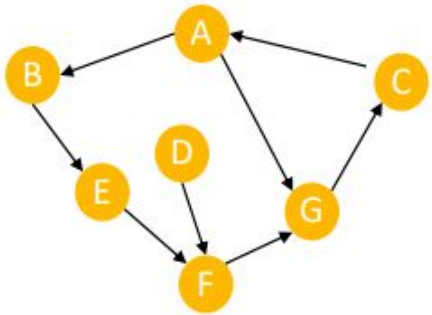
Building Blocks: Siamese RNN



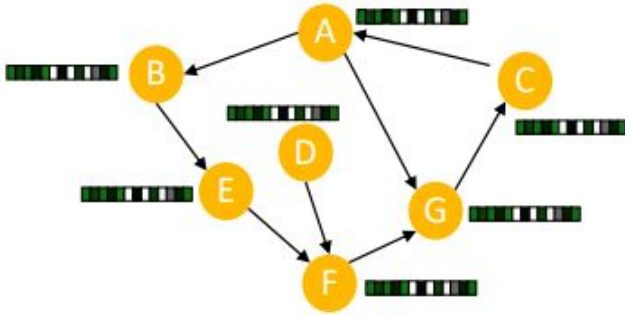
Building Blocks: Tree RNN



Building Blocks: GNN: Setup

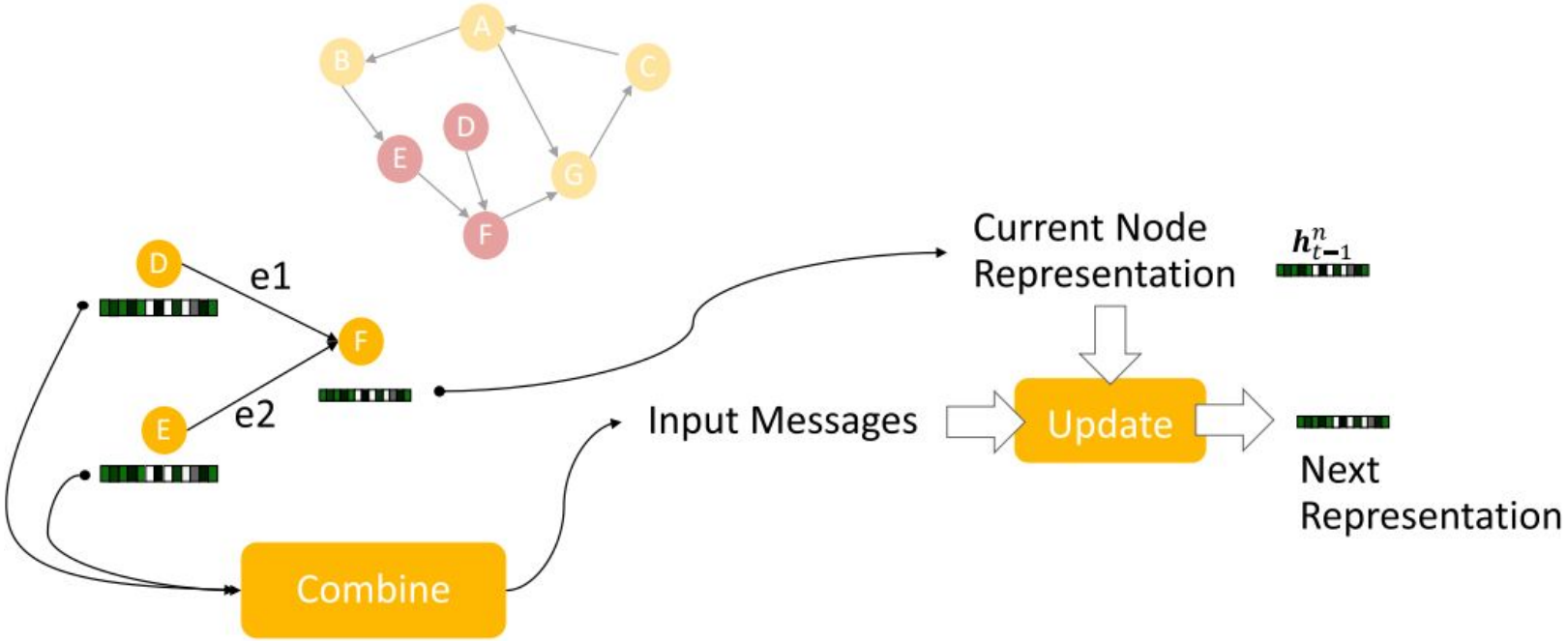


Graph Representation
of Problem

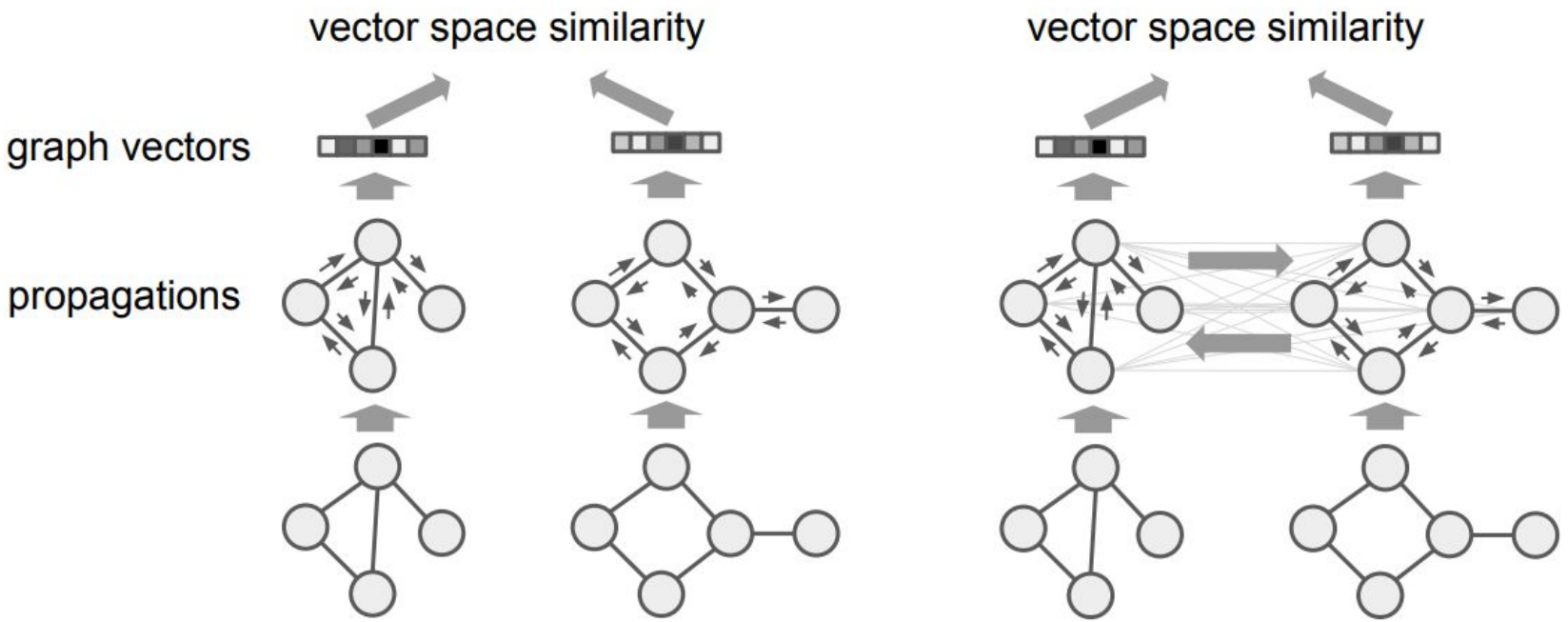


Initial Representation
of each node

Building Blocks: GNN: Message Passing



Building Blocks: Graph Matching



GCN Propagation Rule

$$H^{(l+1)} = \sigma\left(\tilde{D}^{-\frac{1}{2}}\tilde{A}\tilde{D}^{-\frac{1}{2}}H^{(l)}W^{(l)}\right)$$

- $H^{(l+1)}$ - Hidden features at next layer
- D - Degree Matrix of A
- A - Adjacency Matrix with Self loops
- $H^{(l)}$ - Hidden features of current layer
- W - Weight matrix
- σ - Non linear activation function (Relu)
- $*H^{o}$ - X (initial representation of node)

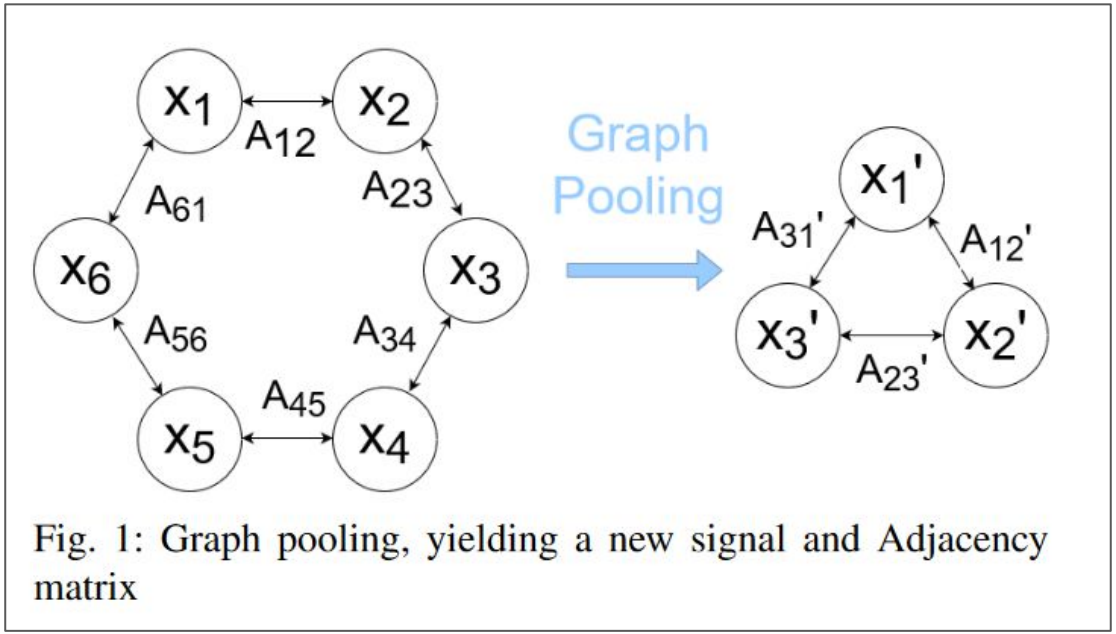


Fig. 1: Graph pooling, yielding a new signal and Adjacency matrix

https://arxiv.org/pdf/2004.03519v1.pdf

Top-k Pooling: Top-k Pool pools using a trainable projection vector $p^{(l)} \in R^f$ and select the top-k indices of the projection $X^{(l)}p^{(l)}$ and the corresponding edges in $A^{(l)}$.

Dataset: Big Clone Bench

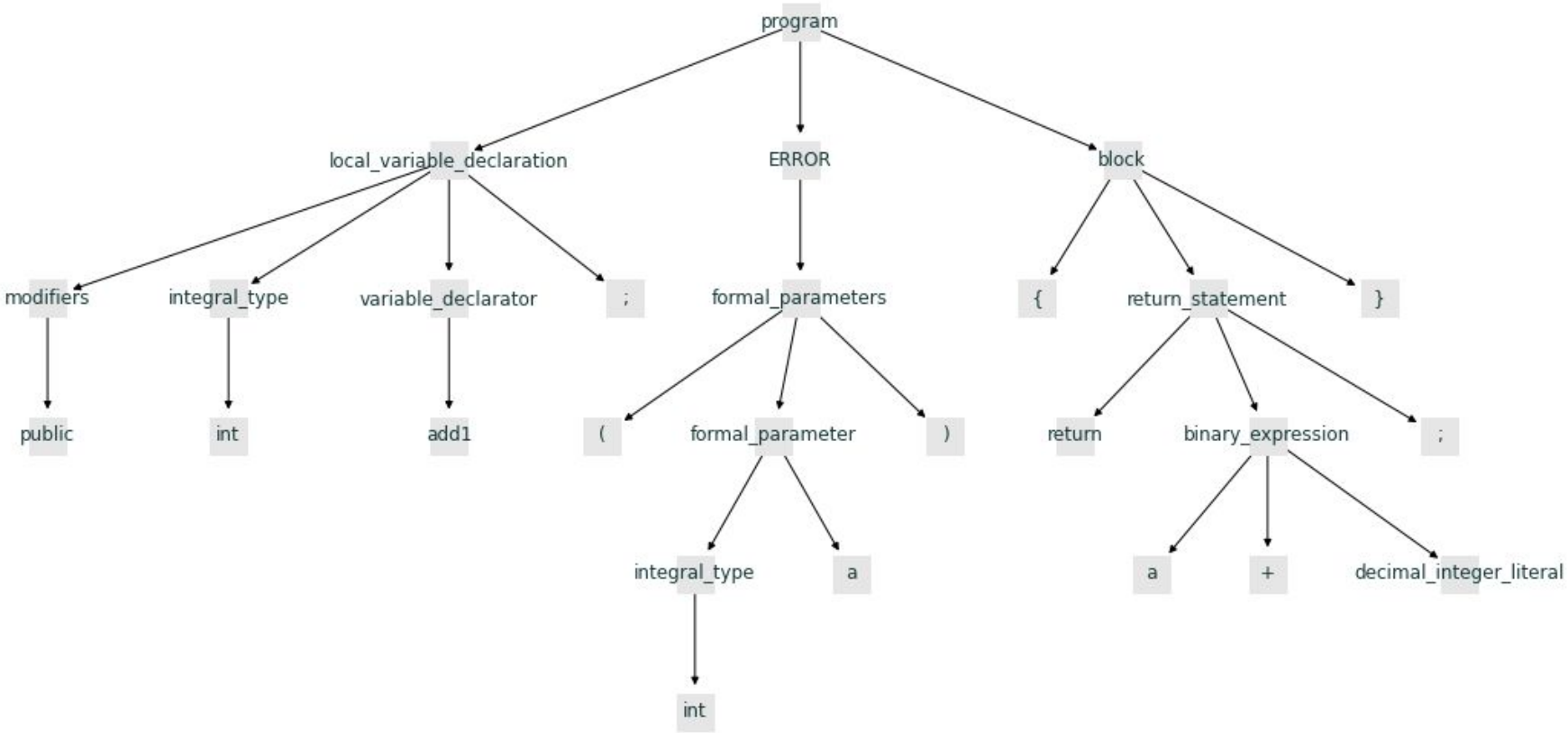
- Code Fragments: 59,688
- True clone pairs: 95.7%
- Max Tokens: 16,253
- Avg tokens: 227
- Max AST depth: 192
- Avg AST depth: 9.9
- Max AST nodes: 15,217
- Avg AST nodes: 206

Data Preprocessing

- Code2Vec embedding for dataset
- TreeSitter -> for getting AST from code at any level
- FastText Embedding for dataset - We have trained fasttext embeddings on the inorder ordering of the AST because around 50% unique tokens were OOV when using code2vec

Example 1 :
Simple add 1 to given number program

Program 1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local_variable_declaration
ERROR
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modifiers
integral_type
variable_declarator
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formal_parameters
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return_statement
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formal_parameter
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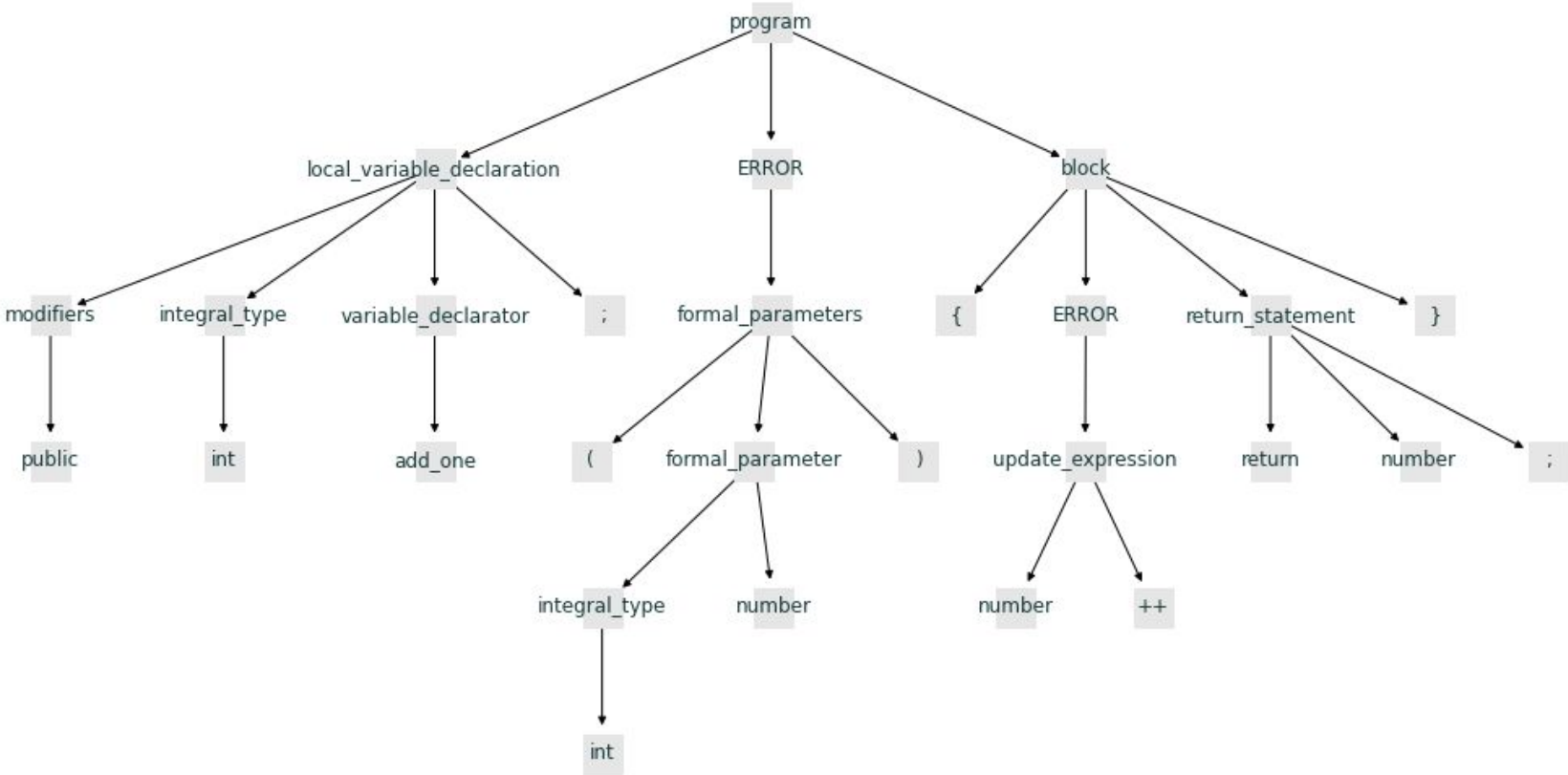
Program 2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;
integral_type
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number
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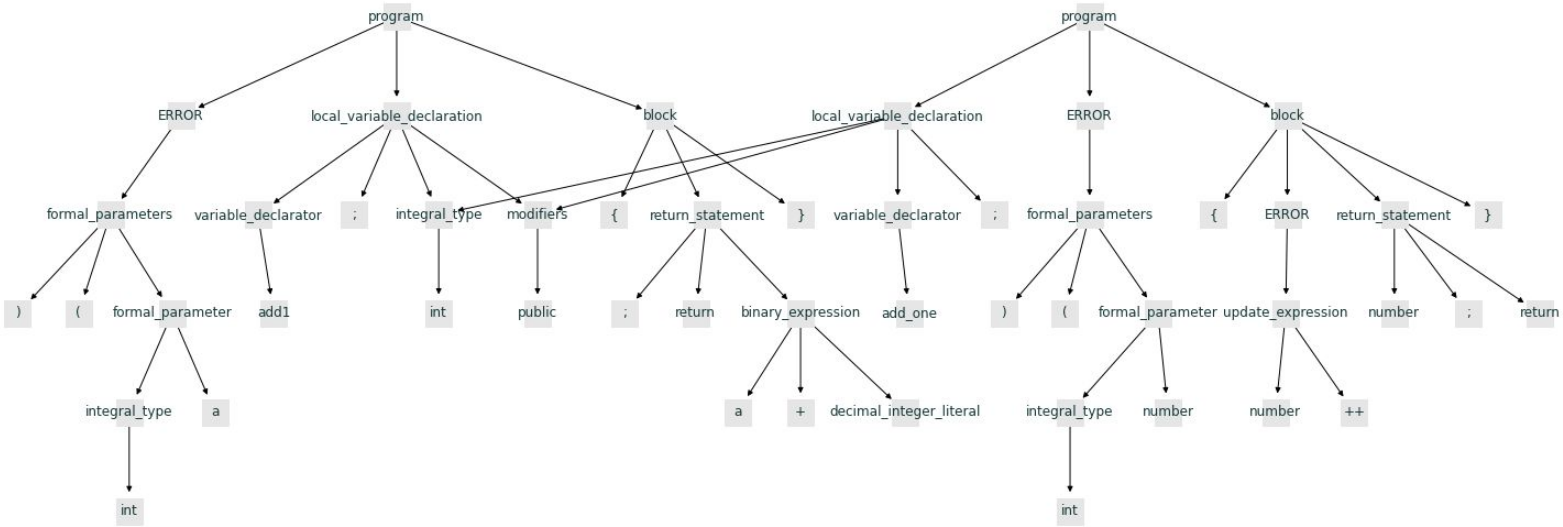
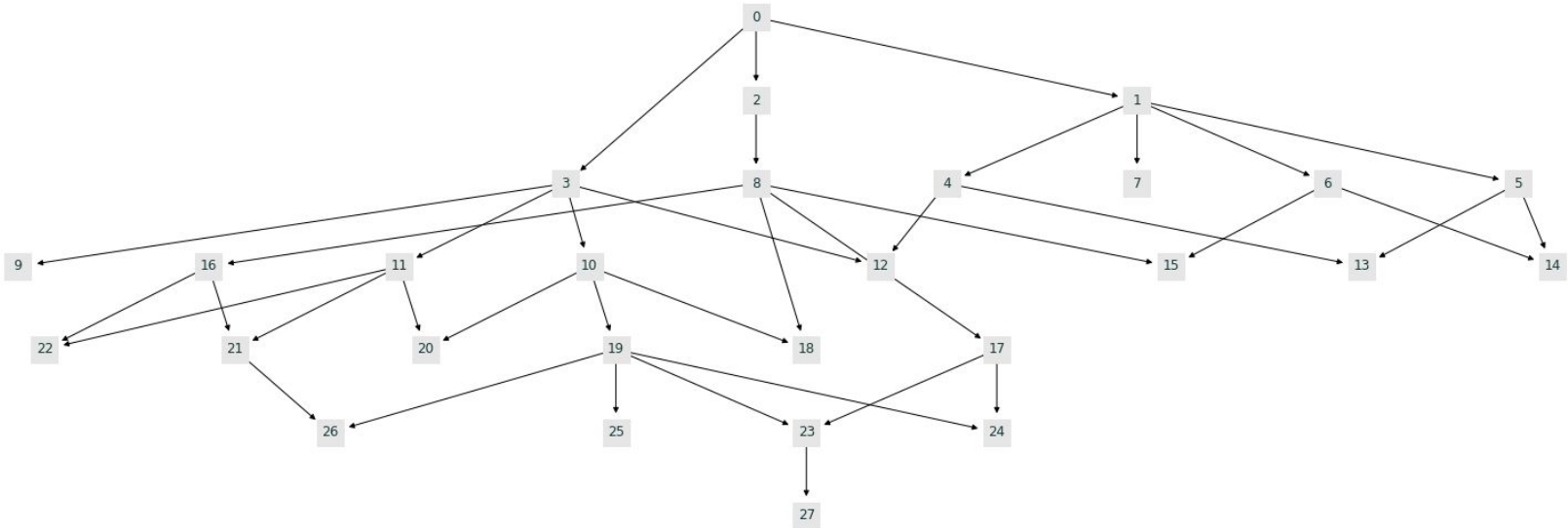
int

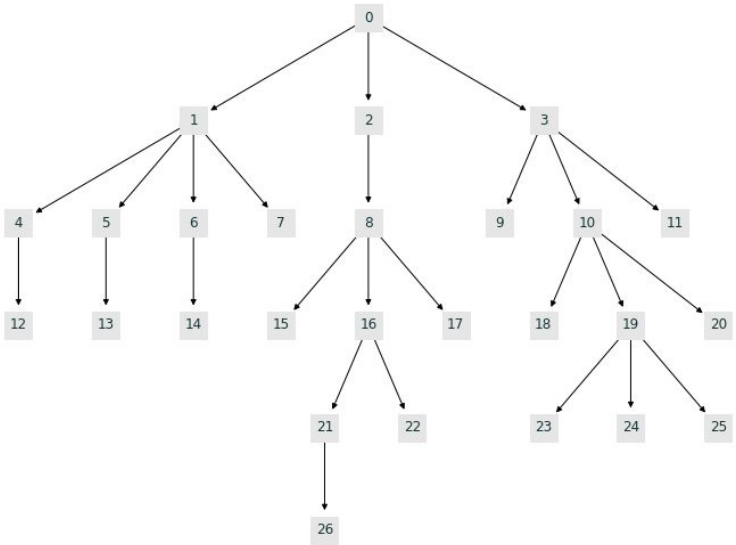
compose: considering location of text too

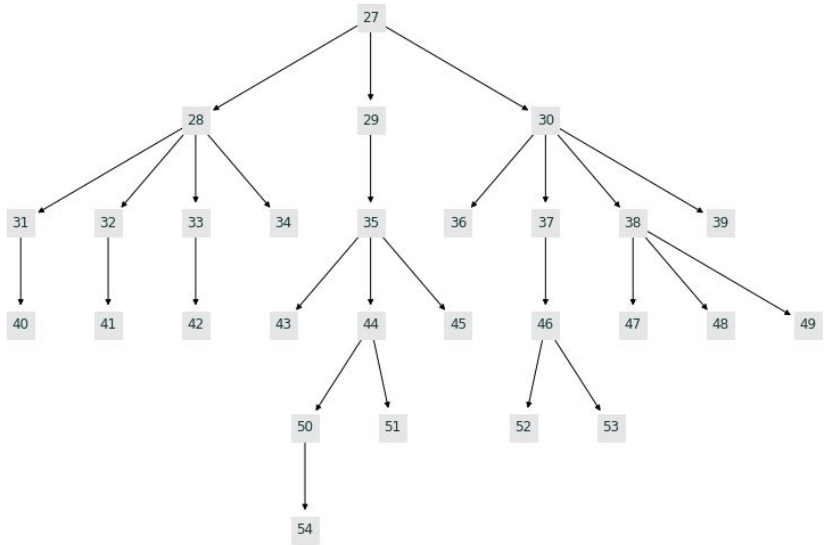


compose: based on ast structure only



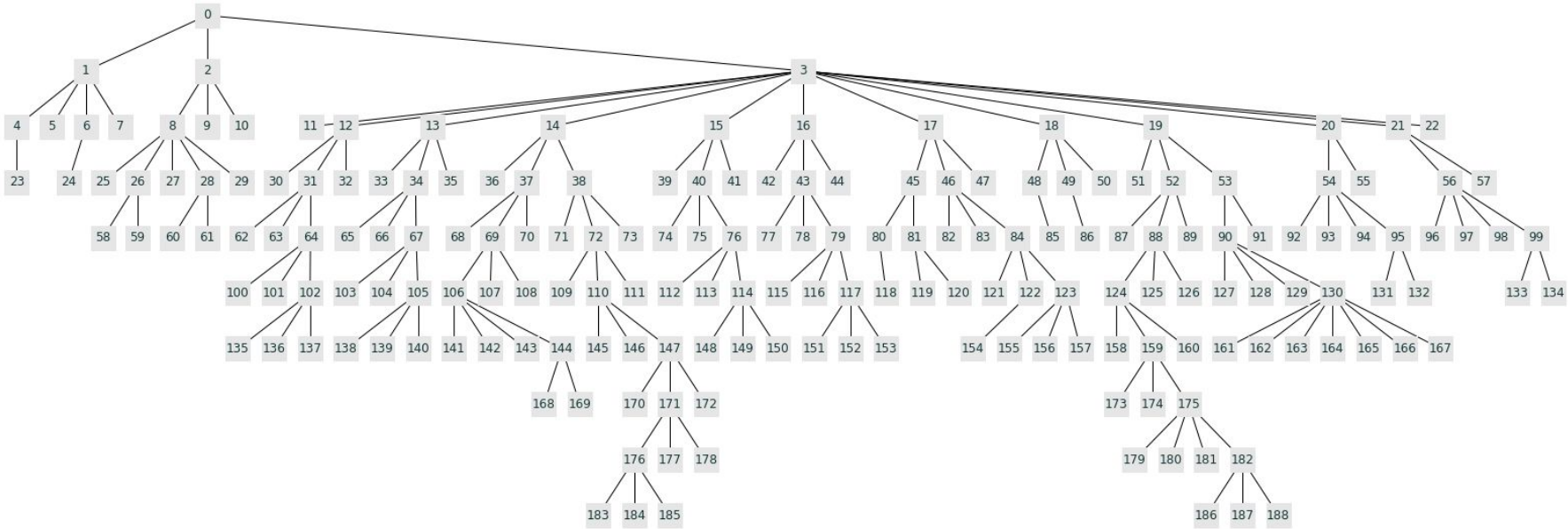
Disjoint Ast





Example 2 :
Real World Programs

Program 1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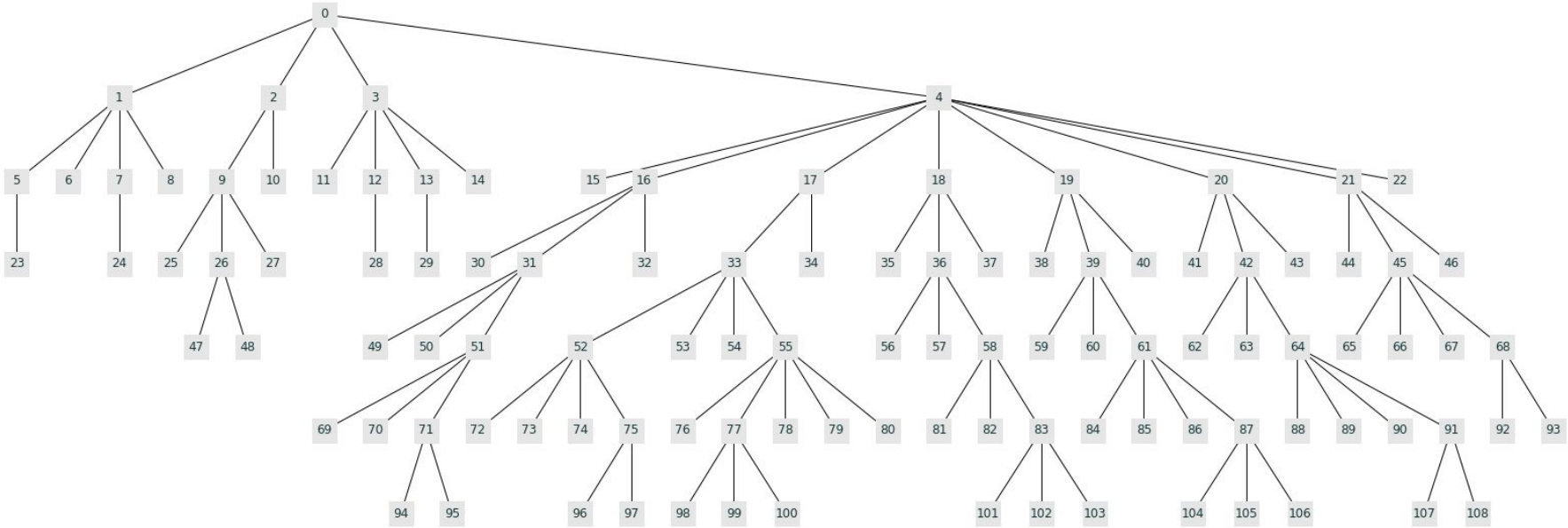
Program 2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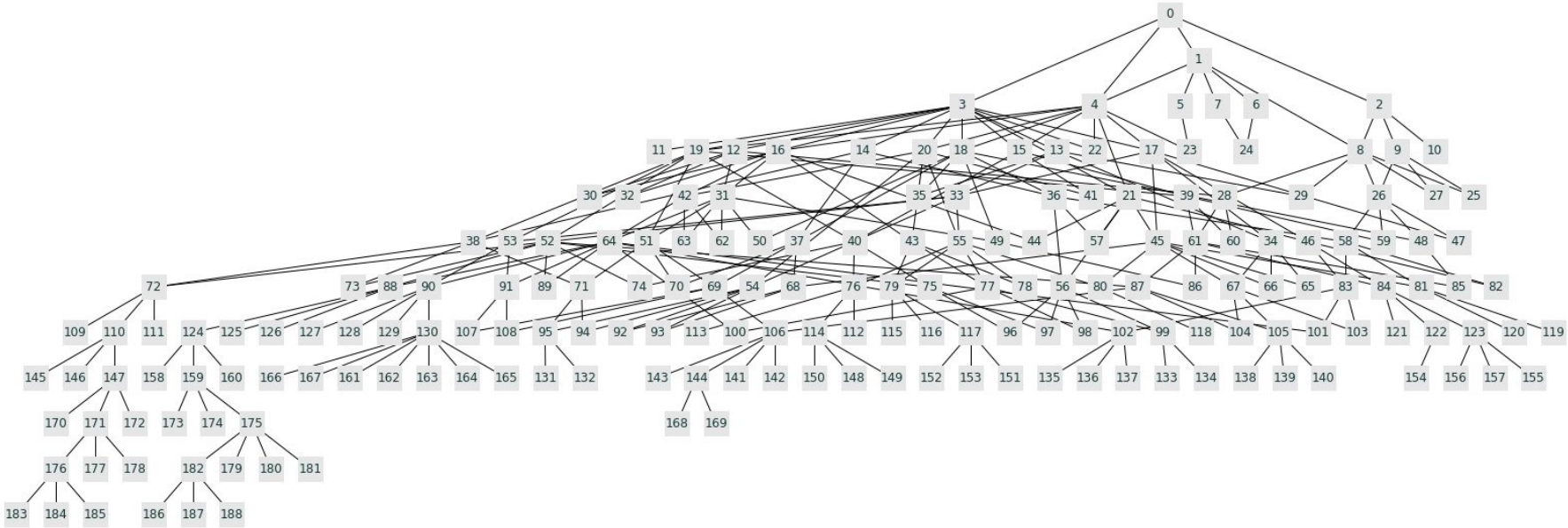
Overlapping structure



Model	Embedding	Accuracy
RNN	Normal	0.83
RNN	Code2Vec	0.86
GraphConv - TopKPooling*	Code2Vec	0.57
GraphConv (AST merged by tokes and their location)	Code2Vec	0.84
GraphConv (AST merged by their structure)	FastText	0.84
GraphConv (Disjoint AST)	FastText	0.87
Siamese of GraphConv	**FastText**	**0.90**

*Only instance where GraphConv without TopKPooling, otherwise TopKPooling is used with GraphConv everywhere else

CodRep'18

Registered participants:

1. JetBrains Research, HSE
2. Microsoft Research
3. The University of Edinburgh
4. Inria
5. Siemens Technology and Services Private Limited
6. source{d}
7. Universidad Central "Marta Abreu" de Las Villas
8. IPT Sao Paulo
9. Singapore Management University
10. Ericsson & Rise
11. Otto-von-Guericke University Magdeburg
12. KAIST, South Korea
13. University of Wisconsin--Madison & Microsoft Research

References

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- https://arxiv.org/pdf/1906.08094.pdf
- https://arxiv.org/pdf/1904.12787.pdf
- https://arxiv.org/pdf/2004.03519v1.pdf
- https://github.com/rusty1s/pytorch_geometric
- https://github.com/zhangj111/astnn
- https://github.com/JetBrains-Research/astminer/
- https://github.com/c2nes/javalang
- https://github.com/tree-sitter/py-tree-sitter/
- https://github.com/rusty1s/pytorch_geometric
- https://github.com/dmlc/dgl
- https://github.com/dmlc/dgl/tree/master/examples/pytorch/tree_lstm
- https://github.com/microsoft/tf2-gnn/
- https://github.com/deepmind/graph_nets
- https://colab.research.google.com/github/deepmind/deepmind_research/blob/master/graph_matching_networks/graph_matching_networks.ipynb1

End

Siamese RNN: Results

- Embedding Dimension: *384*
- LSTM Units: *384*
- One FC Layer of *512*
- Trained for 25 epoches, with ADAM
- With Code2Vec:
  Acc: 0.86 | Recall: 0.83 | Precision: 0.85
- Without Code2Vec:
  Acc: 0.83 | Recall: 0.81 | Precision: 0.83

CodeRep

Input:

```
public class test{

  int a = 1 ;

  int b = 0.1; //error

}
```

Output:

2

Task 2: CodeRep (if time permits)

- CodeRep Challenge: https://github.com/KTH/codrep-2019/ (2020 version will be released soon)

- Description: Given a code file, find the line number in which the bug appear.

- Translated to a graph problem of **Node Selection or Classification.**

Model	Test Accuracy
GraphConv - TopKPooling + Code2vec Embedding	0.56
Siamese + GraphConv + Code2Vec : Correct	0.57
Siamese RNN without Code2Vec	0.83
GraphConv +Code2Vec	0.84
GraphConv + Ast merged by strucute + FastText	0.85
Siamese RNN with Code2Vec	0.86
Siamese + GraphConv + FastText	0.89