Flattening Abstract Syntax Trees for Efficiency [1]

Yijun Yu, The Open University, U.K. http://mcs.open.ac.uk/yy66

Serendipity

Software engineering tools exchange code representations through serialised **abstract syntax trees**.

Surprisingly, hierarchical representation is **NOT** the fastest to exchange tree structures.

Requirements

Speed up the processing of code whilst preserving the ***equivalence*** to hierarchies in an ***efficient*** form.

Design Rationale

1) Save AST as a *flat* 1D array by converting tree pointers into integer offsets;
2) Flattened AST can be more efficient to access by programming tools through APIs.

Features

- ☑ ***fast***
- ☑ ***language-agnostic***
  - ☑ ***ANTLR4 grammar***
- ☑ ***microservice ready***
  - ☑ ***containerised***
- ☑ ***IDE friendly !***
- ☑ ***human readable !***

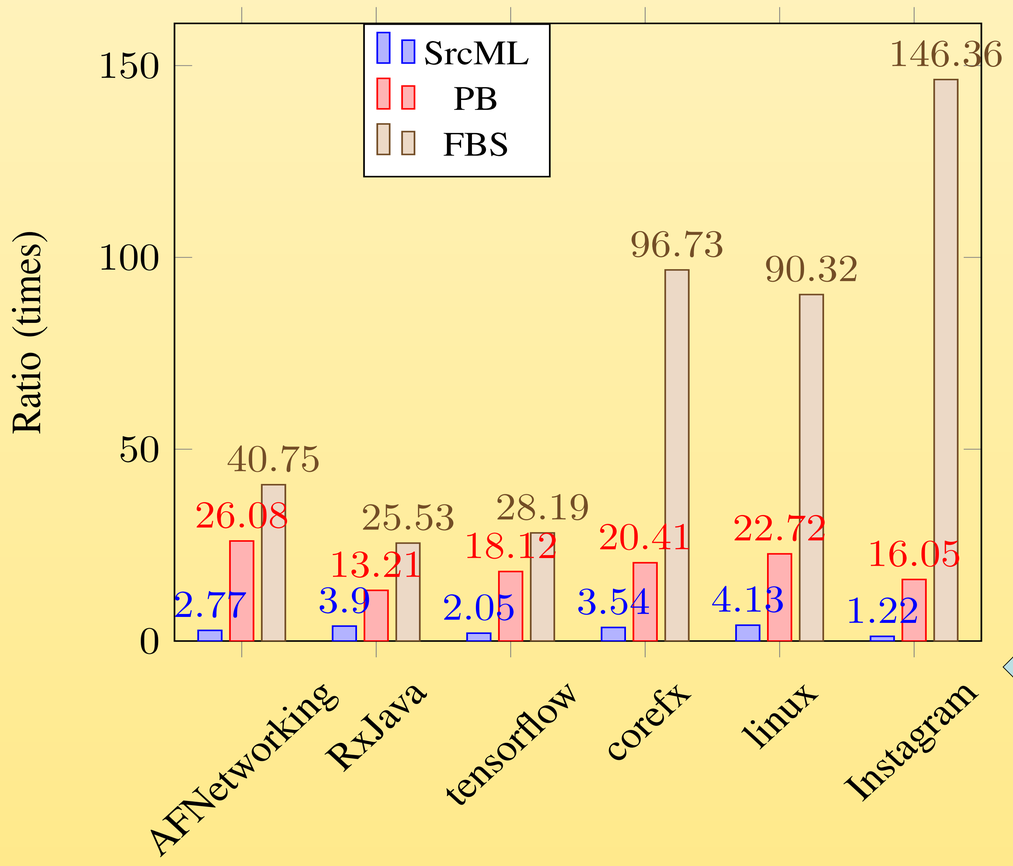
Example Usage

```
# print the command line options and arguments
  alias fast="docker run -v $PWD:/e yijun/fast"
# convert a C++ code into protobuffer representation
                fast foo.cc foo.pb
# convert a Java code into flatbuffers representation
               fast bar.java bar.fbs
# convert a flatbuffers representation back to C#
               fast moo.fbs moo.cs
# slice a program
             fast -S -G foo.java foo.fbs
# diff two programs
              fast -D v1.java v2.java
```

Applications

- ☑ **Parsing: 100x faster for 6 popular projects**
  - ☑ **Cross-Language Deep Learning [2] [3] (see a demo below)**
- ☑ **Slicing**
  - ☑ **2.5x faster than `srcSlicer[4]`**
- ☑ **Diffing*: 20x faster* [5]**
  - ☑ **Bug localisation (`ConCodeSe`) [6]**
- ☑ **Extending *IDE***
  - ☑ ***Visual Studio Code***
  - ☑ ***Browser-based IDE***
- ☐ **Search for gravitational lens**

Evaluation Results



Parsing flattened AST is 100x faster on a benchmark of 29 projects of 6 programming languages: ObjectiveC, Java, C++, C#, C, Smali). A total of 298,312,076 LOC.

Fig. 1 shows the speedup ratios of 6 projects, one for each programming language.

Live Demo

References

1) Yijun Yu. "**fAST: Flattening Abstract Syntax Trees for Efficiency**". In: *41st ACM/IEEE International Conference on Software Engineering*, 25-31 May 2019, Montreal, Canada, ACM and IEEE.
2) Nghi D. Q. Bui, Yijun Yu, Lingxiao Jiang: "**Bilateral Dependency Neural Networks for Cross-Language Algorithm Classification**". In *the 26th IEEE International Conference on Software Analysis, Evolution and Reengineering (SANER)*, Hangzhou, China, February 24-27, 2019: 422-433.
3) Nghi D. Q. Bui, Yijun Yu, Lingxiao Jiang: "**SAR: Learning Cross-Language API Mappings with Little Knowledge**", In the 27th ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC-FSE'19), To appear. (early work see ICSE'19 Student Research Competition).
4) Hakam W. Alomari, Michael L. Collard, Jonathan I. Maletic, Nouh Alhindawi and Omar Meqdadi. "**srcSlice: very efficient and scalable forward static slicing**". Software: Evolution and Process, 26(11):931-961, November 2014.
5) Yijun Yu, Thein Thun Tun, and Bashar Nuseibeh, "**Specifying and detecting meaningful changes in programs**," In: Proc. of the *26th IEEE/ACM Conference on Automated Software Engineering*, pp. 273-282, 2011.
6) Tezcan Dilshener, Michel Wermelinger, Yijun Yu: "**Locating bugs without looking back**". *Automated Software Engineering* 25(3): 383-434 (2018)