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Towards a multi-scale approach for source code approximate match report

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ABSTRACT

Finding exact clones in source code can be efficiently handled using classical exact substring or subtree pattern matching techniques inspired from genomics applications. These methods may be wisely employed as a foundation to sketch new techniques highlighting duplicated code chunks presenting minor edits or more extensive modifications at a higher structural scale. The main goal is to improve recall of small near matches and to aggregate them into larger ones to provide a more global view of similarities with a reasonable complexity. These concerns are essential to be able to address a large database of source code projects.

Categories and Subject Descriptors
D.2.8 [Software Engineering]: Metrics; I.5.3 [Computing Methodologies]: Pattern Recognition

General Terms
Algorithms

Keywords
Source code similarity, clones, software plagiarism

1. CONTEXT

Most popular clone detection tools, either in a code reengineering or in a plagiarism highlighting context, consider sequences of tokens [10, 8] or syntax trees [1] as an abstracted view of the source code. For token sequence representations, groups of occurrences of exact repeated token factors can be found with suffix indexing structures like the suffix arrays [9] or the suffix trees [13] in linear time. Zones of high density of similar n-grams [12] can also be used to spot similarities. Nevertheless, when local edits are introduced between code clones, looking for exact repeated factors is inappropriate: in this case, local alignment algorithms [6] could be used to retrieve approximate substring matches containing small unmatched gaps. However, these techniques require a detrimental quadratic running cost in number of tokens: it is preferable to use them on carefully selected zones containing suspected clones.

2. FUNCTIONAL CALL GRAPHS OF TOKEN SEQUENCES

To cope with multiple occurrences of similarities and to have a global view of them, we proposed in [3] a method allowing similarity report at a kind of function level. Using suffix structures, we split each original function of the source code into different components that are either token substrings shared by other functions or unmatched token sequences. Shared token substrings may themselves be decomposed with the help of smaller nested similarities found among them. Following this approach, we transform individual function call graphs of the compared projects into a global call graph introducing new synthetic functions that represent the granularity of shared chunks of code across the projects. We do not use these call graphs for refactoring purpose, but rather to define several metrics based on the amount of code represented by shared nodes between projects. This method allows similarity retrieval at a synthetic-function level despite extensive edits involving removal, transposition, addition of source code or even inlining or outlining of functions (clones of type 3 according to [2] or types 3-4 for [11]).

Thanks to this factorization approach, comparing elementary unmatched token sequences using an alignment algorithm allows retrieval of similarities that would be missed otherwise thanks to resiliency towards local edits (like removing or adding neutral token sequences, for instance - 0 or * 1 in arithmetic expressions like in figure 1). Identifying tiny local similarities may also help to counter to the development of identifiers into expressions (like the development of identifier diff seen in lines 8-9 of stdDev2) but also to select pairs of token sequences containing high densities of tiny clones that will be tested through alignment methods.

3. CLASSIFYING ABSTRACT SYNTAX SUBTREES

Concerning methods based on syntax tree representations, most accurate approaches [14] involve extensive and very costly dynamic programming comparison of all subtrees comparing to linear token approaches. Preclustering potential similar subtrees, using degraded, hashing strategies or metrics [7], appears essential to reduce the number of subtree
trivial local edits are detected and their distance quantified. Abstraction profiles. Thus, duplicated subtrees involving most of subtrees according to several abstraction profiles (con-
temporary linked to the start and the end of the system for large scale source code. In ICSE '07, pages 100–105, Washington, DC, USA, 2007. IEEE-CS.

5. REFERENCES


