Centre for Digital Trust and Security

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Project Title:

Automated summarisation of FRET requirements

Project Investigators:

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Project overview:

The consistent refactoring of a technical system is a process that's crucial not only for the its lifespan, but for ensuring users and developers of the system can continue utilising and maintaining it, respectively. This project introduces a prototype of a general-purpose tool that can take a pre-defined finite formal language and a set of formulas in that language to identify repeated patterns that can be rewritten with macros, a process known as macrofication [2,3]. The use of macros, also referred to
as fragments, make formulas more concise and readable, often leading to a better structured and understandable formula base.

The proposed method relies on subgraph isomorphisms, parsing the formulas into trees and then finding repeated patters as subtrees. The use case logic utilised in the project is NASA's FRET (Formal Requirements Elicitation Tool), more specifically, the LTL (Linear Temporal Logic) formulas from it, which consist mainly of boolean, arithmetic and temporal operators. FRET was chosen as there are ongoing efforts in its refactoring process [1].

[1] Marie Farrell et al. "Towards refactoring FRETish requirements". In: NASA Formal Methods Symposium. 2022, pp. 272–279.
[2] Christian Kindermann et al. "Minimal Macro-Based Rewritings of Formal Languages: Theory and Applications in Ontology Engineering (and beyond)". In: AAAI 2024: 10581-10588.
[3] Christian Kindermann et al. "Concrete Names for Complex Expressions in Ontologies: A Survey of Biomedical Ontologies". ICBO 2023: 82-93.

Key findings:

The prototype is able to take a FRET formula base, extract its LTL formulas and rank subterms in those formulas by applying heuristics and filters. The system's pipeline can be summarised in four main steps (1) serialisation, (2) extracting subterms and their heuristics, (3) visualising subterm relationship graph, and (4) applying ranking and filtering to determine suitable macrofication candidates.

We presented this work, at the FRET Refactoring and Macrofication day in the University of Manchester, to Anastasia Mavridou (NASA Ames, FRET Team Leader), Rosemary Monahan (Maynooth University), Oisin Sheridan (Maynooth University) and Matt Luckcuck (University of Nottingham). Their feedback was positive and there is interest in using this work in MU-FRET, perhaps even implementing a similar approach in the main FRET branch.

Outputs to date:

1. Prototype tool support that can identify potential opportunities for refactoring at the LTL formula level as well as a ranking for these identified fragments.
2. Draft project report that will be consolidated and written up as a workshop contribution.

Were all planned outcomes achieved?
If not, how did you mitigate non-achievement?
Yes, they have been achieved.

Planned activities post-project:
1. Draft funding proposal with Christian Kindermann (Stanford), Anastasia Mavridou (NASA Ames), Uli Sattler and Marie Farrell (University of Manchester).
2. Transform the project report into a paper for a workshop or a conference.