

# Untangling the Knot

## Enabling Rapid Software Evolution

### Problem

To quickly deliver new capabilities and take advantage of new technologies, government organizations need the ability to efficiently restructure software for common scenarios like:

- migrating a capability to the cloud
- harvesting software for reuse
- containerizing software

One recent anecdote estimates the effort to isolate a capability from the platform at 14,000 staff hours just for development.

### Solution

Create an automated assistant that rapidly refactors software to support software isolation goals that enable software evolution.

- Allows users to specify project-specific goals.
- Uses genetic algorithms to recommend refactorings.
- Navigates multiple, competing objectives.

### Intended Outcomes (FY19-21)

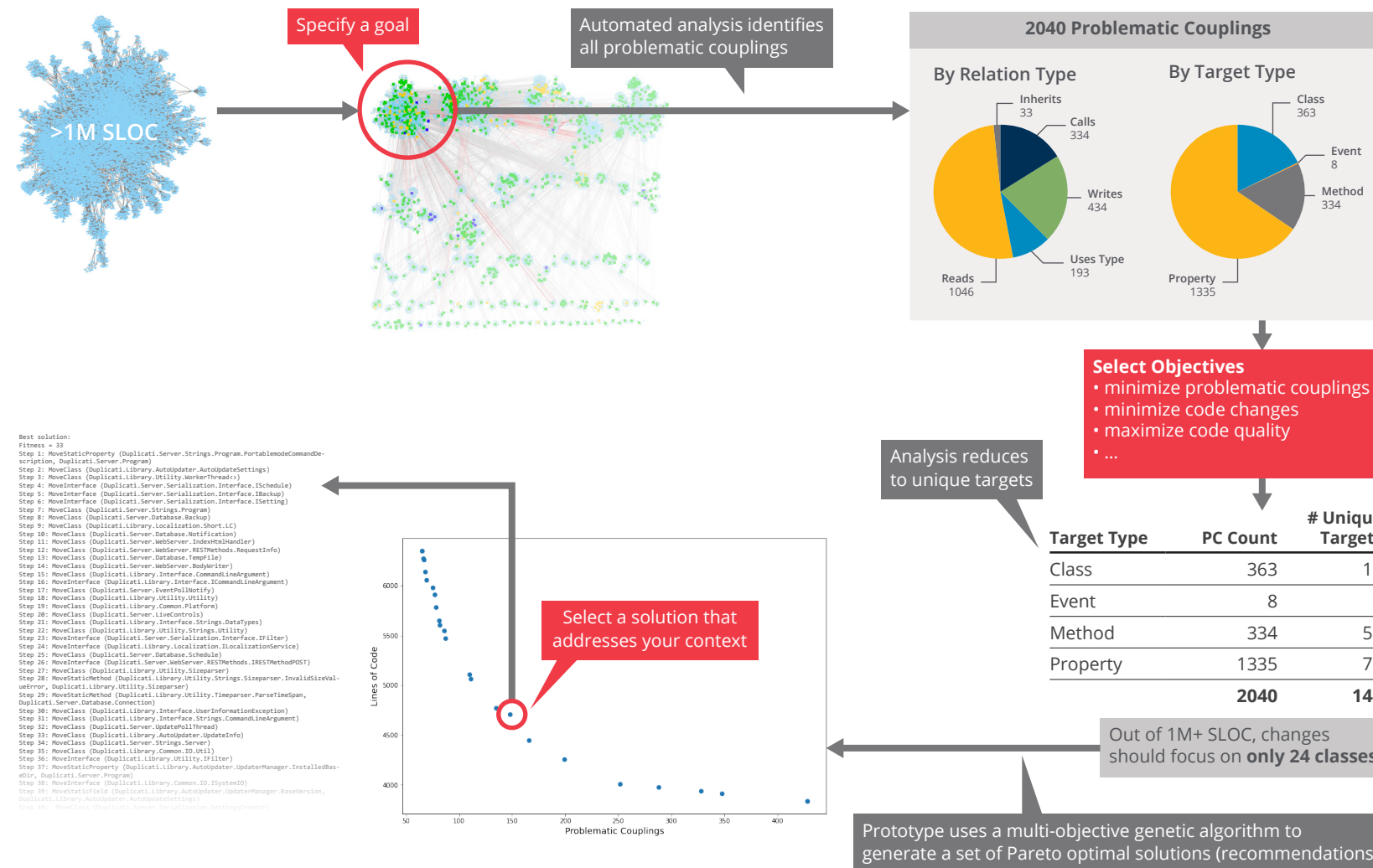
- Refactoring recommendations outperform those based only on quality metrics, reducing problematic couplings by more than 87%.
- Our automation reduces the time to restructure software to 1/3 of the time compared to manual effort.

### Read more about our vision:

J. Ivers, I. Ozkaya, R. L. Nord, C. Seifried. [Next Generation Automated Software Evolution: Refactoring at Scale. ESEC/FSE 2020. ACM.](#)

Watch a talk from Research Review 2020: [Untangling the Knot: Enabling Rapid Software Evolution](#)

# Automated refactoring can improve the structure of existing software in **1/3 of the time** it takes to manually refactor.



**Our prototype can help with common evolution scenarios:**

### Scenario

Gather data to assess the difficulty associated with project-specific goals as input to funding decisions.

### Expected Results

Enumeration of problematic couplings, their locations, and types potentially impacted by proposed change as data to inform cost estimates.

### Scenario

Compare the difficulty of different refactoring approaches.

### Expected Results

Enumeration of problematic couplings, their locations, and types potentially impacted by proposed change as data to inform cost estimates.

### Scenario

Automatically refactor software to isolate software and speed its evolution.

### Expected Results

Recommended refactorings that enable the proposed change address multiple criteria.

### Maturity

Available now for C# (TRL 4)  
Support for Java expected early 2022

Contact [sei-knot@sei.cmu.edu](mailto:sei-knot@sei.cmu.edu) if you are interested in partnering with us.

Copyright 2020 Carnegie Mellon University.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution. Please see Copyright notice for non-US Government use and distribution.

Internal use:\* Permission to reproduce this material and to prepare derivative works from this material for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use:\* This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other external and/or commercial use. Requests for permission should be directed to the Software Engineering Institute at [permission@sei.cmu.edu](mailto:permission@sei.cmu.edu).

\* These restrictions do not apply to U.S. government entities.

DM20-0856