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Bachelor's Thesis
Instrumenting C# LINQ Queries to Collect Execution Traces For Visualization

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Background and Motivation

C#'s Language Integrated Query (LINQ) is a powerful feature that enables developers to process data sequences in a declarative, functional style. It provides a high-level abstraction for complex operations on data collections, such as filtering, mapping, and aggregating. Despite its advantages, the underlying complexity of these pipeline operations can make it challenging for developers and students to fully comprehend how data flows through the system.

To address similar challenges in Java, prior work has successfully developed an automated marble diagram visualizer for the Java Stream API. This tool captures and analyzes the execution traces of stream operations. By tracking the complete journey of every input object through the stream pipeline, the system generates dynamic marble diagrams that visually represent data flow, item transformations, and operation sequencing.

Objective

The primary objective of this Bachelor's thesis is to extend this visualization capability to C# by instrumenting LINQ queries to generate execution traces compatible with the existing visualization system. While the underlying trace format may require slight modifications to account for the architectural differences between Java Streams and C# LINQ, cross-compatibility must be maintained to ensure the visualizer continues to work seamlessly for both languages.

Specific Tasks

To achieve these goals, the student will:

- Investigate and document the conceptual differences between Java Streams and C# LINQ.
- Evaluate various C# instrumentation techniques and frameworks (e.g., Mono.Cecil, Fody, or C# Interceptors) to determine the most suitable approach for trace collection.
- Implement the chosen instrumentation strategy to successfully capture and export LINQ execution traces.
- Ensure the generated traces integrate correctly with the existing marble diagram visualizer.

Modalities:
The progress of the project should be discussed at least every three to four weeks with the advisor(s). A time schedule and a milestone plan must be set up within the first 2 weeks and discussed with the advisor(s). It should be continuously refined and monitored to make sure that the thesis will be completed in time. The final version of the thesis must be submitted not later than 30.04.2026.