

# **Software Systems as Cities: A Controlled Experiment**

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# Software as 3D city

- a city metaphor to depict software systems as three-dimensional cities;
- From Nov 2009 to Apr 2010:
  - the pilot;
  - the experiment;

# Experimental wish list

- Choose a fair baseline for comparison;
- Involve participants from industry;
- Take into account the range of experience level of the participants;
- Provide a tutorial of the experimental tool to the participants;
- Find a set of relevant tasks;
- Include tasks which may not advantage the tool being Evaluated;
- Limit the time allowed for solving each task;
- Choose real-world systems;
- Include more than one subject system in the experimental Design;
- Provide the same data to all participants;
- Report results on individual tasks;
- Provide all the details needed to make the experiment Replicable;

# Questions

- Q1 : Does the use of CodeCity increase the correctness of the solutions to program comprehension tasks, compared to nonvisual exploration tools, regardless of the object system's size?
- Q2 : Does the use of CodeCity reduce the time needed to solve program comprehension tasks, compared to non-visual exploration tools, regardless of the object system's size?
- Q3 : Which are the task types for which using CodeCity over nonvisual exploration tools makes a difference in either correctness or completion time?

# Questions (cont)

- Q4 : Do the potential benefits of using CodeCity in terms of correctness and time depend on the user's background (i.e., academic versus industry practitioner)?
- Q5 : Do the potential benefits of using CodeCity in terms of correctness and time depend on the user's experience level (i.e., novice versus advanced)?

# People

- Pilot runs:
  - Master students of the University of Lugano enrolled in a course on Software Design;
- Experimental runs:
  - Bologna I. 8 professionals with 4–10 years of experience;
  - Bologna II. 9 professionals with 7–20 years of experience;
  - Lugano I. 1 researcher/development leader of a small company;
  - Lugano II & III. 5 practitioners with 10+ years of experience;
  - Antwerp. 3 Ph.D. and 8 MSc students;
  - Bern. 2 consultants, 1 professor, 7 Ph.D. and 1 MSc student;

# Data collection

- Participants answered an online questionnaire about personal information and professional data before the experiment;
- A Timing web application in Smalltalk was used to measure the task execution for each participant.

# Group selection

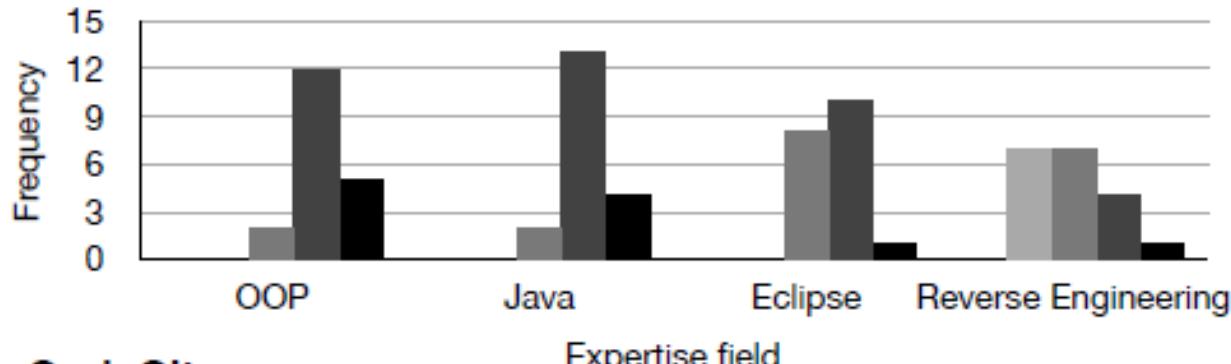
- Randomized block design;
- Each participant was assigned by personal information collected before the experiment (background and experience level);
- Participants were divided in four groups:
  - academy-beginner;
  - academy-advanced;
  - industry-beginner;
  - and industry-advanced;

# Groups

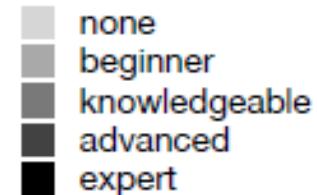
- Two groups used CodeCity;
  - Azureus;
  - FindBugs;
- Two groups used Eclipse IDE + Excel;
  - Azureus;
  - FindBugs;

# Subject's expertise on experimental runs

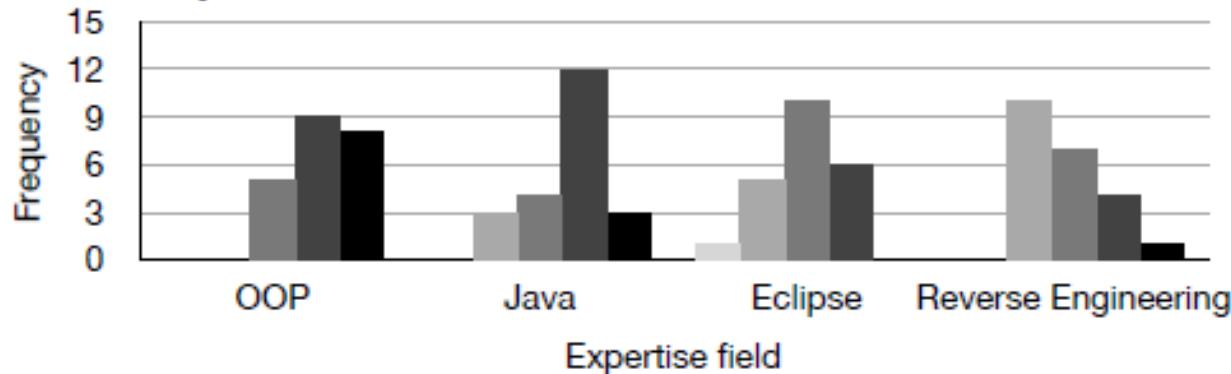
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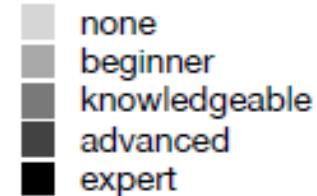
Legend:



CodeCity



Legend:



# Tasks

- Structural understanding;
- Concept location;
- Metricbased analysis;
- Focused design assessment;
- Holistic design assessment.

# Result Summary

- CodeCity enabled an increase in correctness of 24.26% over Ecl+Exl;
- CodeCity enabled a completion time reduction of 12.01% over Ecl+Exl;
- Excel is more efficient than CodeCity to find precise answers at focused tasks;
- At tasks that benefit from an overview, CodeCity constantly outperformed the baseline;
- The overview enabled the experimental group to produce a faster and more confident solutions.

# Referências

- Software Systems as Cities: A Controlled Experiment, Richard Wettel, Michele Lanza, Romain Robbes, In Proceedings of ICSE 2011 (33rd International Conference on Software Engineering), pp. 551 - 560. IEEE CS Press, 2011.