GROWTH LESSONS FROM THE REFACTORING COMMUNITY

AKA – REFACTORING THE REFACTORING

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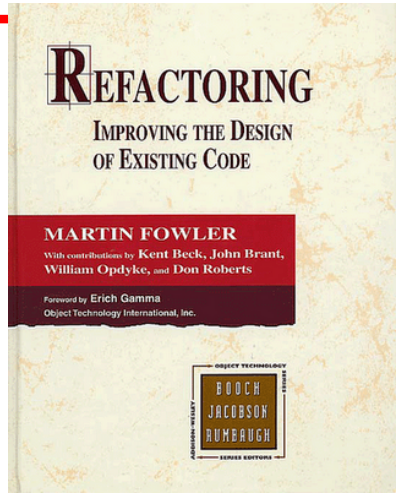
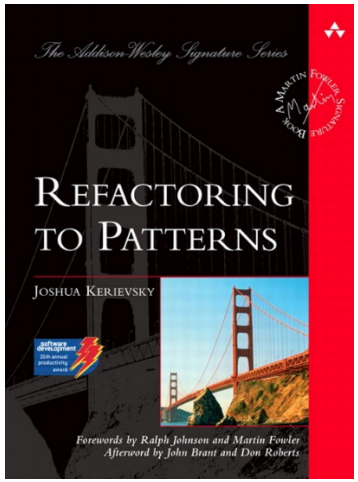
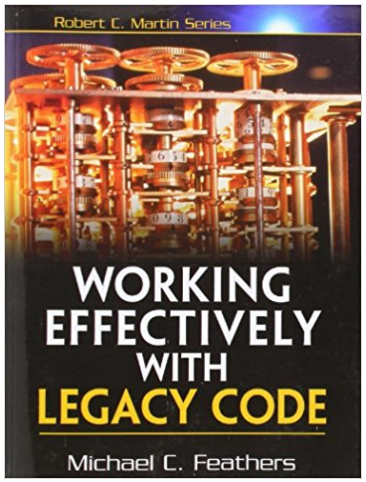
What is Refactoring?

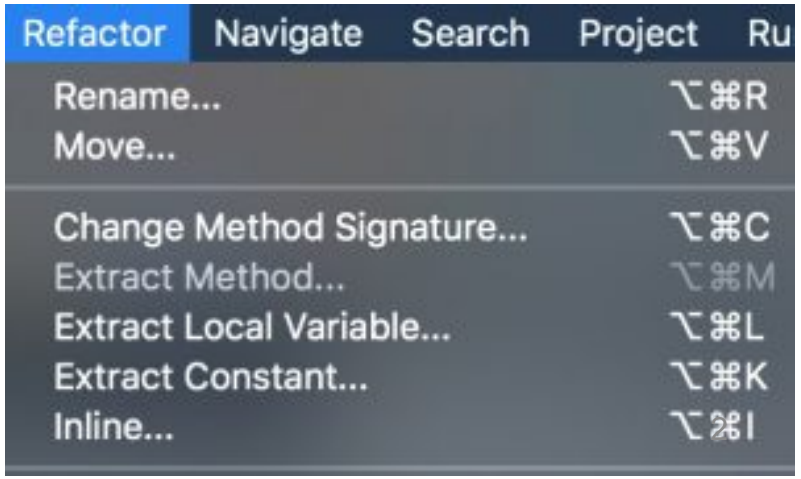
"A change made to the internal structure of software to make it easier to understand and cheaper to modify without changing its observable behaviour" – M. Fowler [1999]







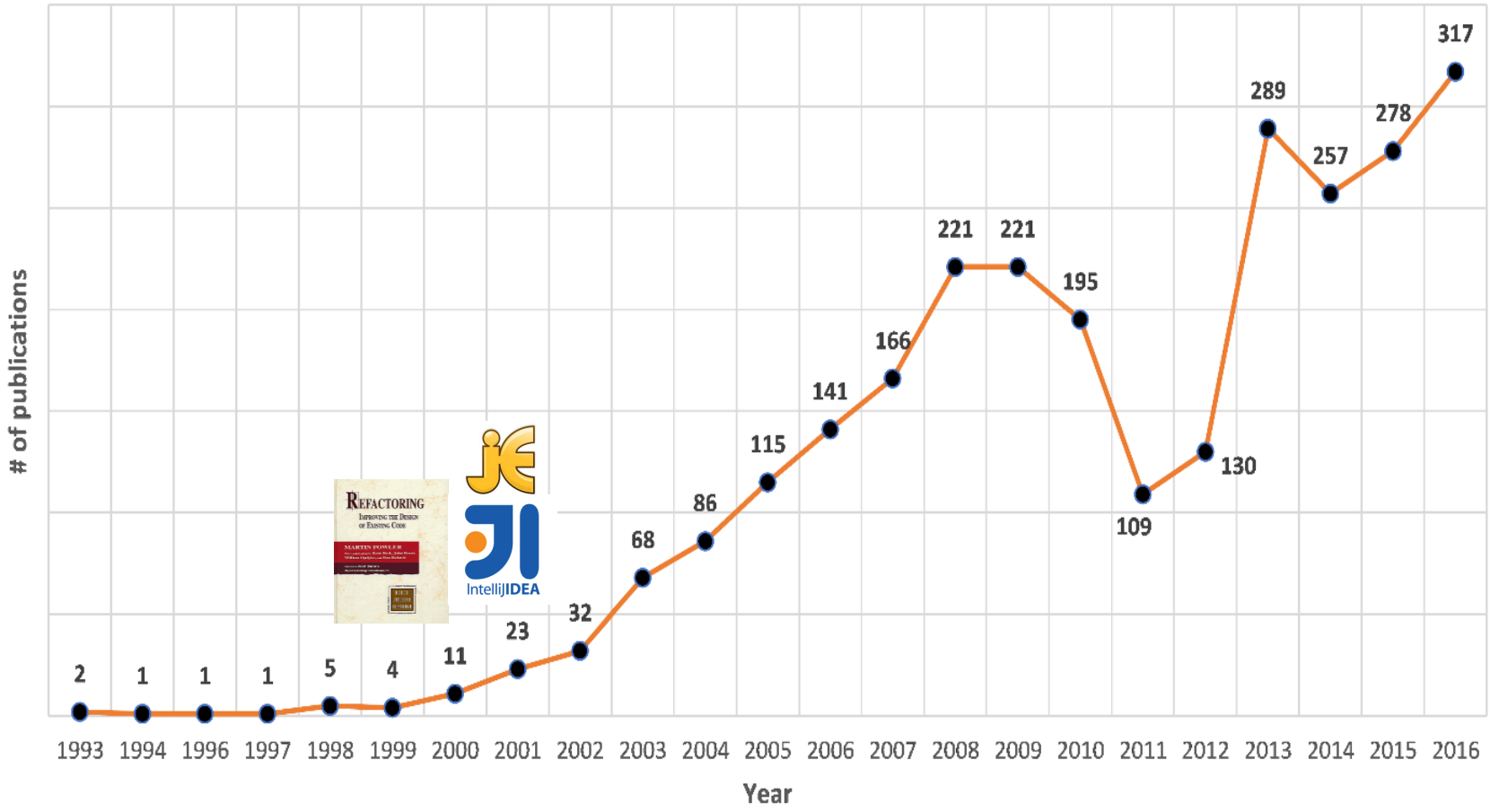
Top-level menu in all modern IDEs



- **In 2000, I created the first open-source refactoring tool**

Refactoring research growth

2,880 refactoring papers (4,944 authors) since 1990



The Humble Beginnings

First refactoring paper:

- Bill Opdyke and Ralph Johnson [SOPPA'90]: ***Refactoring, an Aid in designing application frameworks and evolving OO systems***

First PhD dissertations:

- **Bill Griswold '91 at U of Washington**
- **Bill Opdyke '92 at U of Illinois**
- **Don Roberts '99 at U of Illinois**

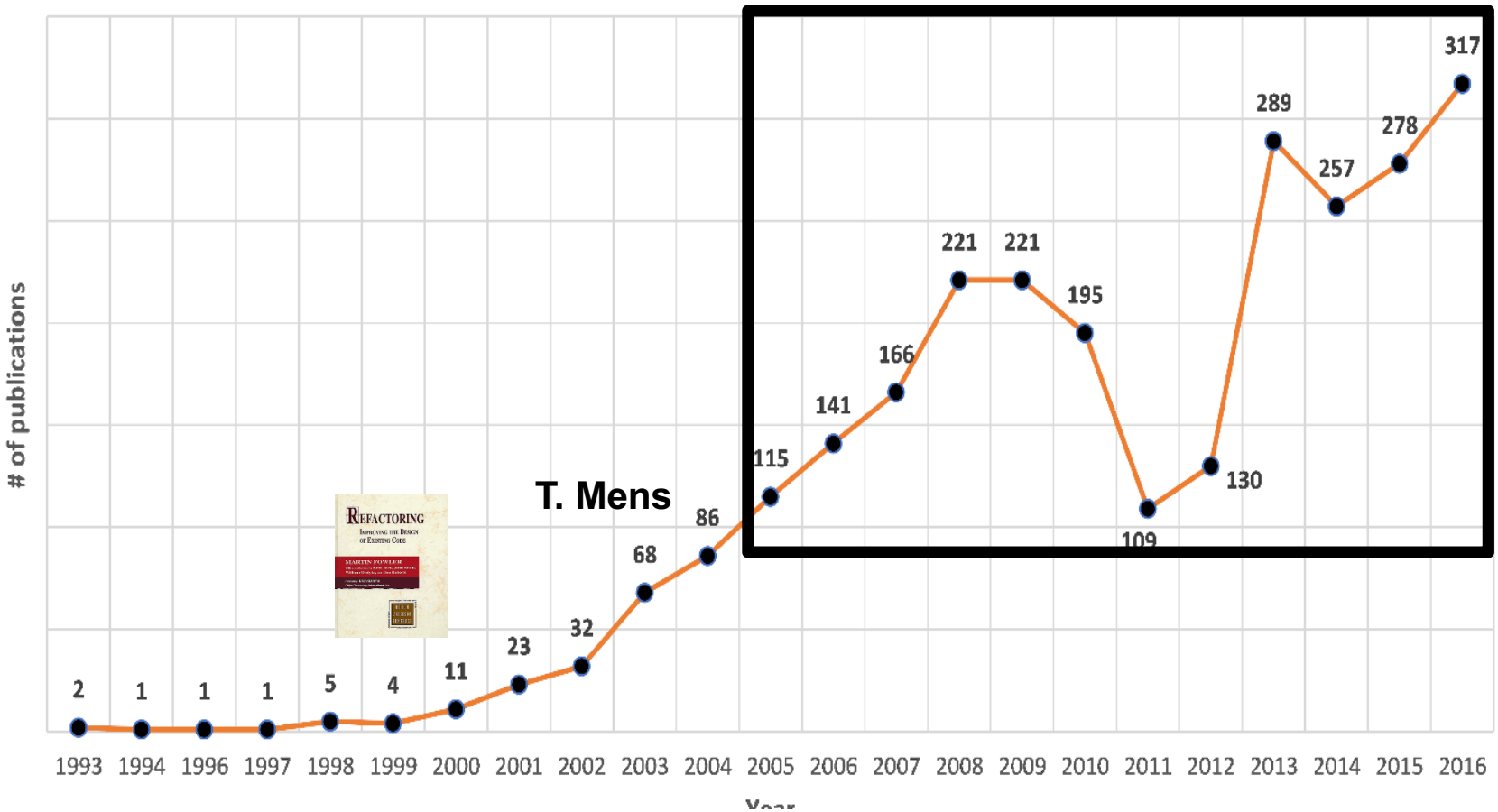
Refactoring research hard to publish in early 90s

- conflated with the compiler community

Most recent Decade of Refactoring Research

2,880 refactoring papers since 1990

2,442 papers between 2005-2016



Corpus of Papers

Work done by Marouane Kessentini and his team at Michigan

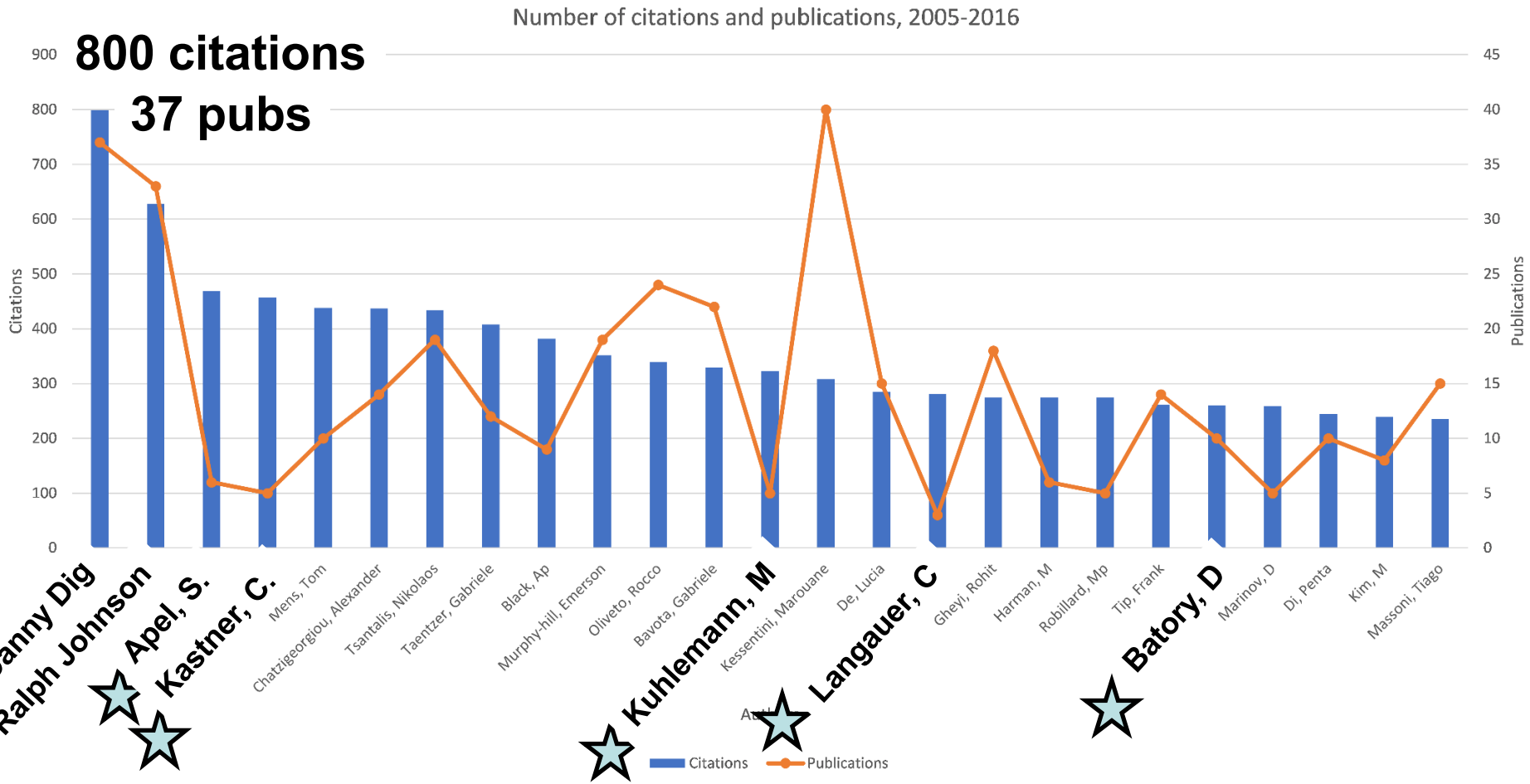
Scopus and Web of Science
- **"Refactoring" in title, abstract, and keywords**
- **yielded 3277 papers**

Refactoring definition:
- **transformation with behavior preservation**

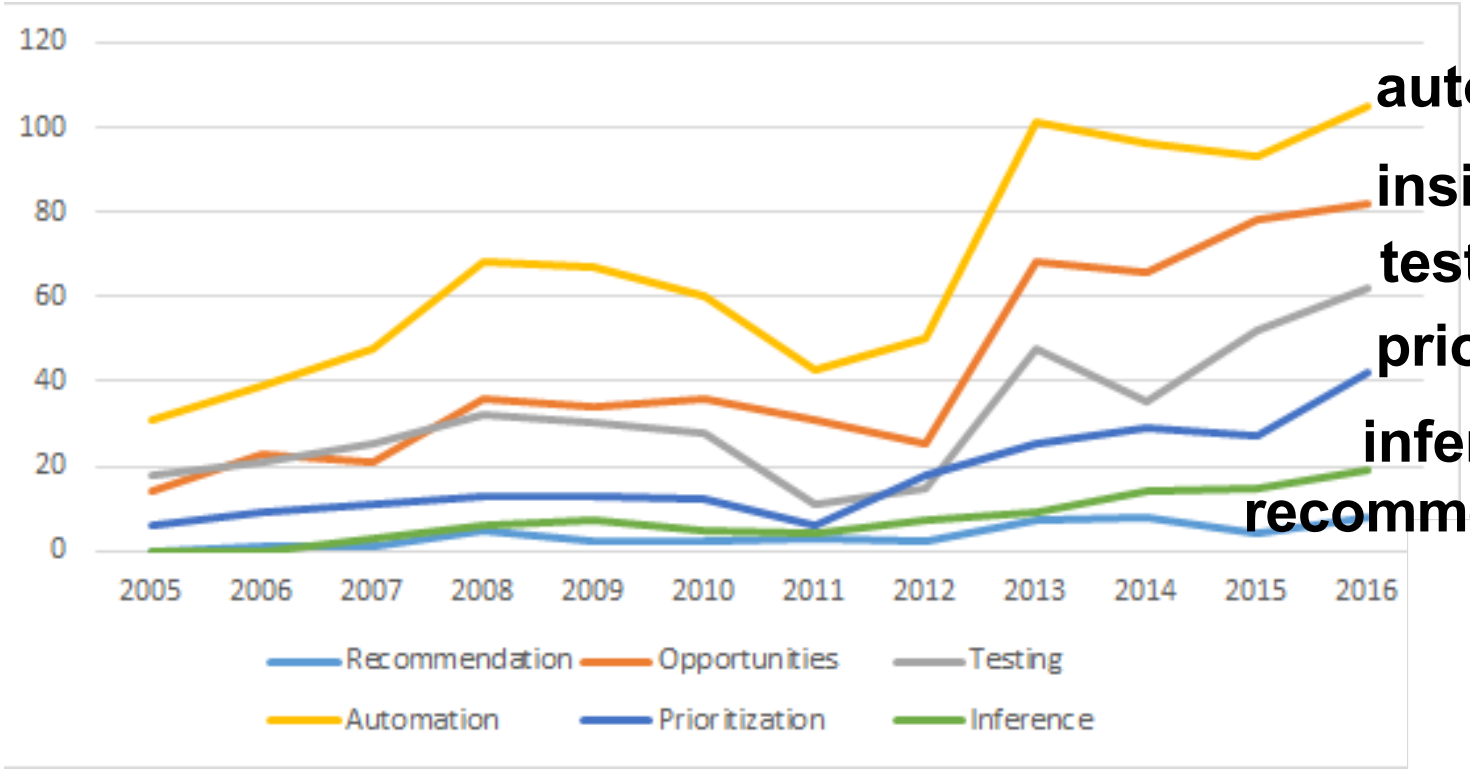
Manual validation of ALL papers:
- **each paper analyzed title, abstract (and sometimes content)**
- **4 grad students who took a graduate class on Softw QA**
- **Kessentini (faculty) looked at the contentious papers**

In the end we removed 397 papers

O1: To Grow, Welcome Outsiders, Champions from Other Communities



O2: To Grow, Expand Focus of Interest (the WHAT)



automating

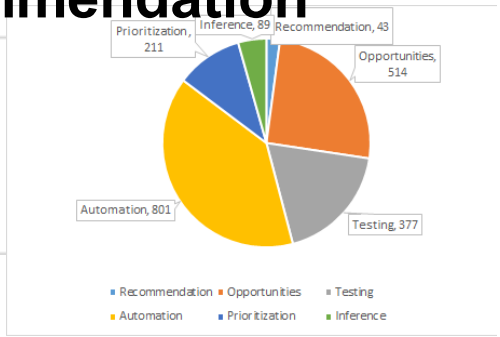
insight

testing

prioritization

inference

recommendation



Expand focus to meet new needs that you can serve

Examples of new Focus on Automation

Refactoring for introducing functional features in OO programs
loop iterators --> functional streams with lambda [Gyori et al. FSE'13]

Scalability 1: Refactoring to Design Patterns contain hundreds of lower-level refactoring steps [Batory et al. – ICSE'16]
- 10x faster than state-of-the-art IDE refactorings

Scalability 2: Ultra-large scale refactoring for codebases of Hundreds of Millions LOC (e.g.,  Google  Microsoft **scale)**
- whole-program analysis is not feasible

Advancing the next generation of global, distributed refactoring
- MapReduce on the cloud: scalable, safe, useful
Attend our ICSE'19 technical-track talk on Friday 4:20pm, Var-Horne

Examples of new Focus on Inferring Refactorings

RefactoringCrawler infers API-level refactorings for API migration
[Dig et al. – ECOOP'06]

RefFinder – infers the most comprehensive list of refactorings
[Kim et al. – ICSM'10]

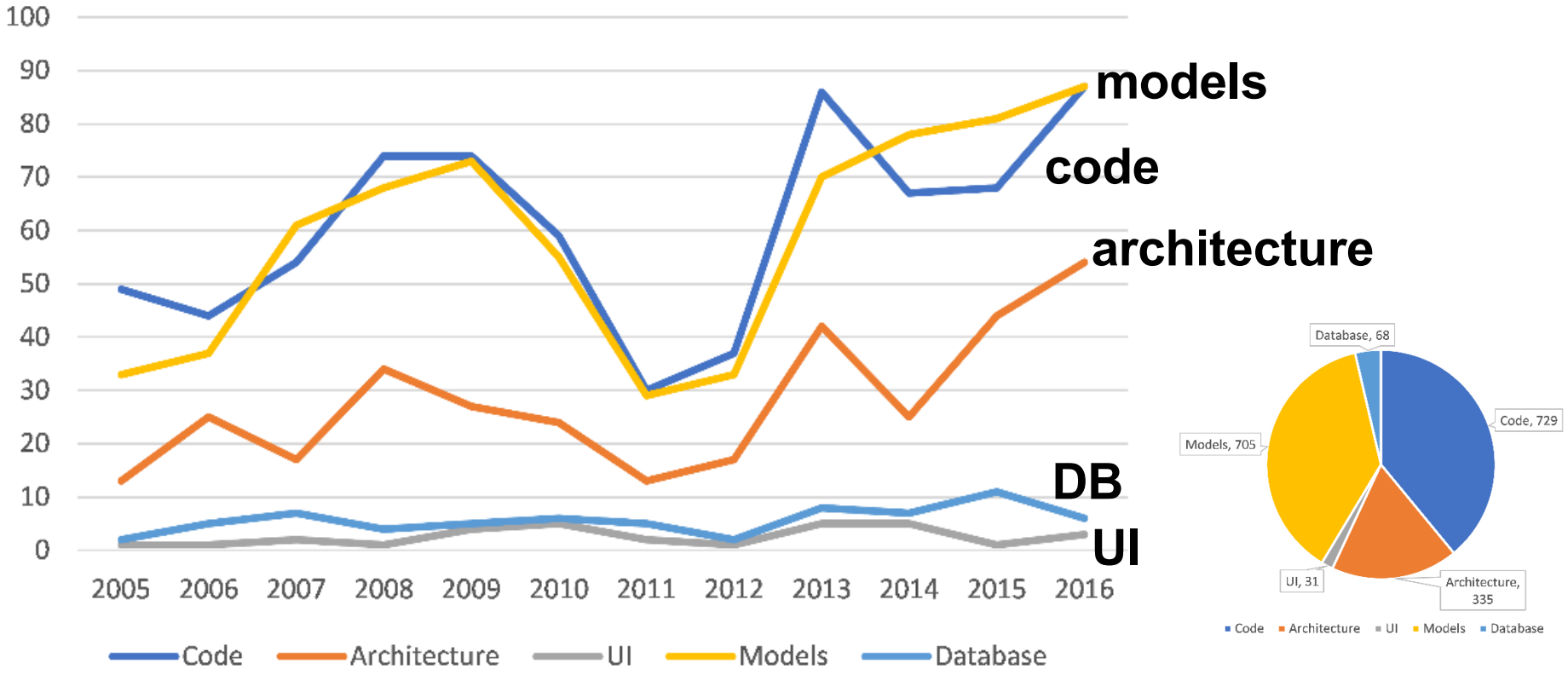
RefactoringMiner: commit-based detection [Tsantalis et al. – ICSE'18]

- **No similarity thresholds**
- **High accuracy**: 98% precision, 87% recall
- **Ultra-fast**: 58ms on median per commit
- **Better than competitive tools (RefDiff)**: +22% precision, 7x faster

Largest and least biased refactoring oracle up to date

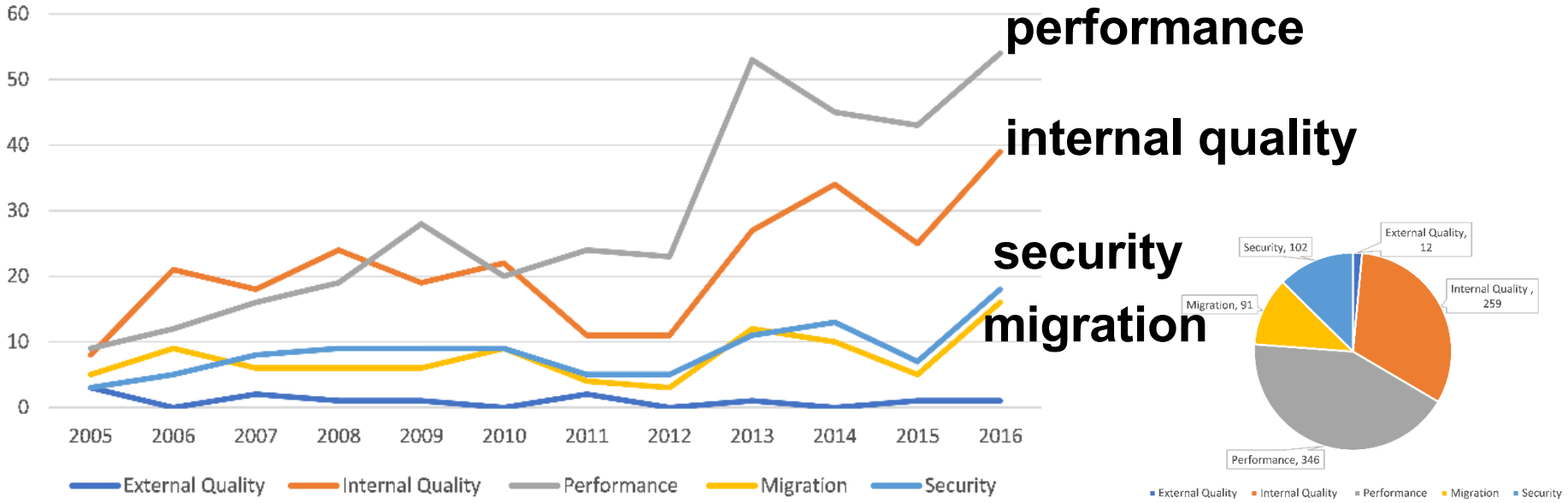
- **3188** true refactoring instances, **538** commits, **185** open-source projects http://refactoring.encs.concordia.ca/oracle/

O3: To Grow, Expand the Target Artefacts



Expand target: new refactoring research is about change to the code, models, architecture, DB, UI

O4: To Grow, Expand Objectives (the WHY)

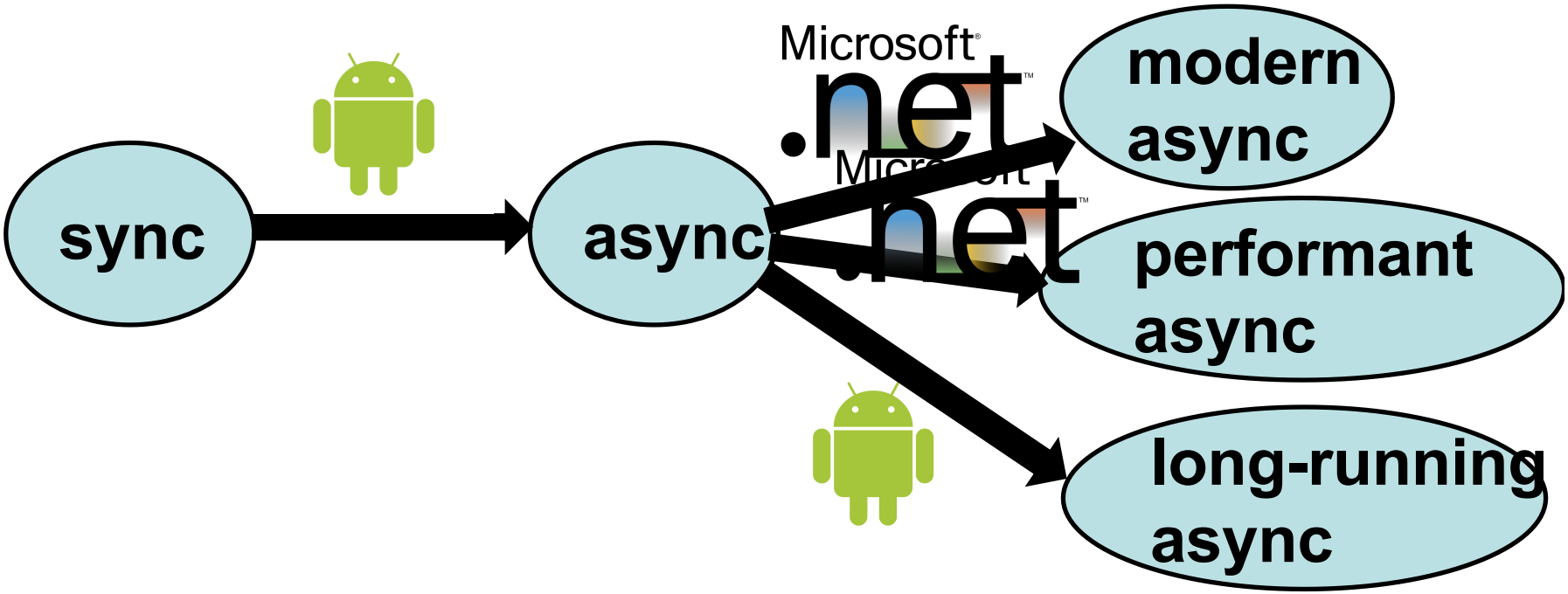


Expand Objectives: new refactoring research is to improve performance, security, migration (beyond internal quality)

Overview of Our Refactorings for Asynchronous Programming for Mobile Apps

Slow operations freeze mobile apps and frustrate users
- 75% of performance bugs in Android [Li et al., ICSE'14]

Culprit: long running operations running in the main UI thread
Solution: refactoring for asynchronous execution



Overview of Our Refactorings for Parallelism

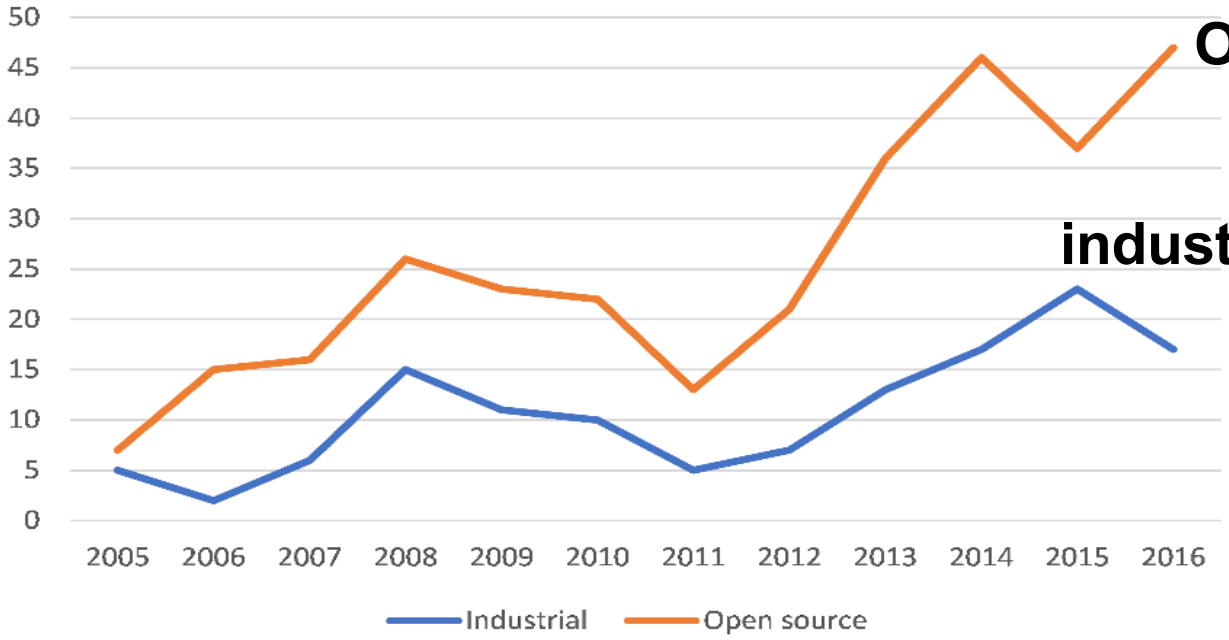
Refactorings for thread-safety
- make class immutable [ICSE'11]
- convert to Atomic* classes [ICSE'09]
- use concurrent collections [ICSE'09]
- infer region annotations [ASE'09]
- atomic check-then-act operations [ICST'13]

Interprocedural analyses:
- control, data-flow
- points-to
- constraint-based

Refactorings for throughput
- parallel recursive divide-and-conquer [ICSE'09]
- loop parallelism via ParallelArray [OOPSLA'10]
- loop parallelism via lambda functional operators [FSE'13]

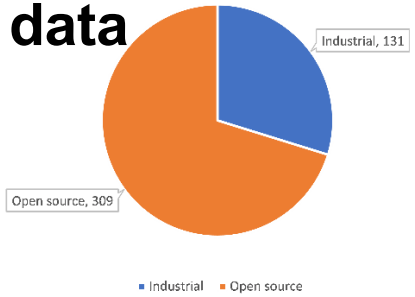
Refactorings for scalability
- Atomic*, concurrent collections [ICSE'09]

O5: To Increase Practical Impact, Work with Industry



Open-source data

industrial data

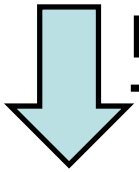


Industrial collaboration levels:

- **surveys with practitioners**
- **tool validated on industrial codebase**
- **tool licensed to industry, adopted in products**

Big Growth of the Field: Expanding Definition

"A change made to the internal structure of software to make it easier to understand and cheaper to modify without changing its observable behaviour" – M. Fowler '99



Expanded Focus, Objectives, Techniques

"Automation/insight/testing/prioritization of changes to the artifacts of software to improve non-functional requirements and without changing its proper, intended behaviour" – D. Dig '18

Communities that thrive are going to be more accepting of new ideas

Big Growth Enabled by Community Engineering

Industry champions: Martin Fowler, Kent Beck, Ward Cunningham, Joshua Kerievsky, Michael Feathers, Uncle Bob

Complementary skills: tool builders, paper writers, curators

Mindset for industrial collaboration and adoption

Shared platform:
- **Eclipse (Erich Gamma + Frank Tip), analysis frameworks**

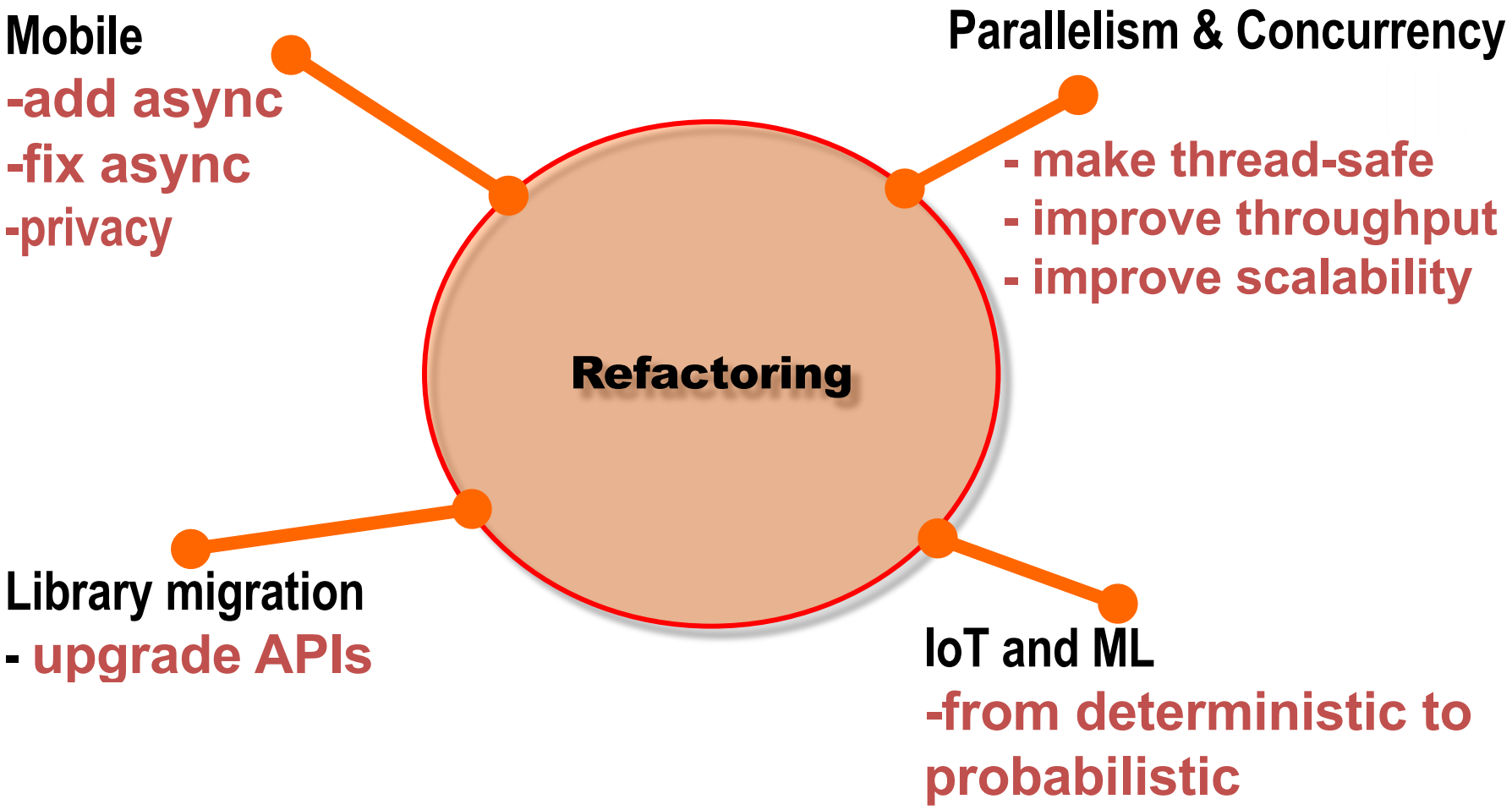
Community infrastructure: 7 Refactoring Workshops, Dagstuhl
- **first workshop in 2007, 50+ participants, 32 posters**
- **invited all major IDE providers**
- **growing new leaders**

Reflections and Lessons I am Learning

On Aug 5, 2015 …

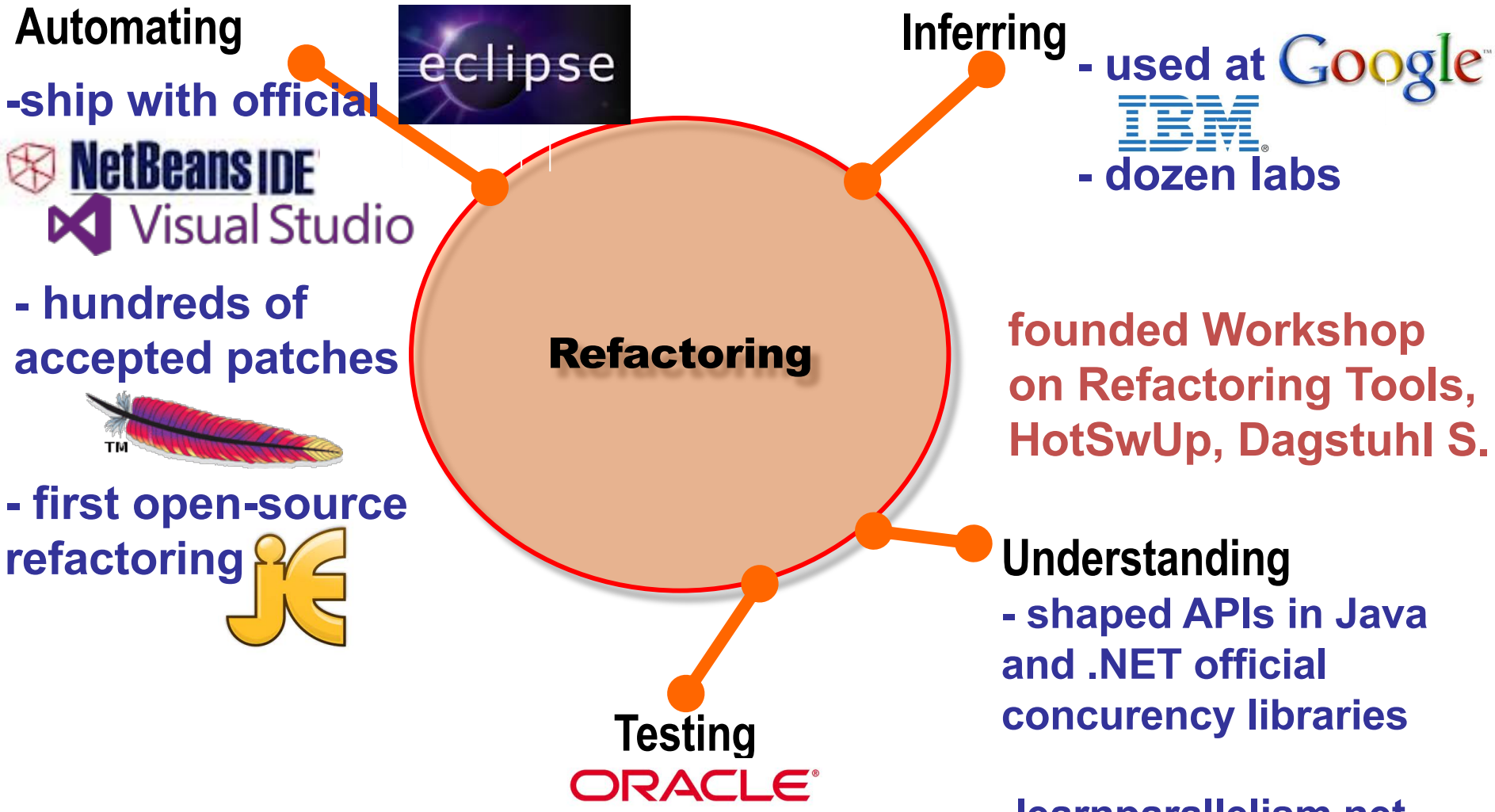
A life of significance: intentionally serve others

L1: Work in Your Strength Zone but Reinvent Yourself



Principles for changing between different programming models

L2: Find Your Dream and then Live It



L3: Proactively Look for Opportunities, but Be Flexible

Expected Company	Actual Company	Expected Target	Actual Target
IBM	ORACLE	Lambda Expressions	Lambda Expressions
Google	Google	Async Programming	Type migration at scale

L4: To Grow Others, First Grow Yourself

Do you have a plan for your personal growth?
How do you get better at what you do?
How do you improve your relationships?
How do you hire great students?
How do you mentor and grow them into tomorrow's tech leaders?
How do you prioritize the important over the urgent?

My Most Important Investment

Michael Hilton (PhD'17, now at CMU)
Semih Okur (PhD'16, now at Microsoft)
Yu Lin (PhD'15, now at Google)
Stas Negara (PhD '13, now at Google)
Ameya Ketkar (PhD)
Malinda Dilhara (PhD)
Tom Dickens (PhD)
Sruti Srinivasa (PhD)
Shane McKane (MS'17, now at Intel)
Mihai Codoban (MS '15, now at Microsoft)
Kendall Bailey (MS '15, now at Intel)
Cosmin Radoi (MS '13, now PhD student UIUC)
Sandro Badame (MS '12, now at Google)
Fredrik Kjolstad (MS 2011, now PhD student MIT)
Binh Le (MS 2009, SW developer)
Can Comertoglu (MS 2009, now at Microsoft)

Jacob Lewis (Summer'16 – '17)
Jonathan Harijanto (Summer'16 –'17)
Lily Mast (Summer'15)
Elias Rademacher (Summer'15 - current)
Nicholas Nelson (Summer 2014-15)
Sean McDonald (Summer'14 –Fall'15)
Hugh McDonald (Summer'14 – Fall'15)
Alexandria Shearer (Summer'12)
Kyle Doren (Summer'12)
Lyle Franklin (UIUC, Summer'12)
Alex Gyori (UIUC, Summer'12)
Yuwei Chen (UIUC, Spring 2012)
Anda Bereckzy (UIUC, Fall'11-Spring'12)
Alex Sikora (UIUC, Fall'11)
Jack Ma (UIUC, Summer'11)
Lorand Szacaks (UIUC, Summer'11)
Caius Brindescu (UIUC, Summer'11)
Mihai Codoban (UIUC, Summer '11)
Mihai Tarce (UIUC, Summer'09)
Cosmin Radoi (UIUC, Summer'09)
John Marrero (MIT, Spring'08 – Summer'08)

Call to Action

Big growth enabled by "refactoring" the refactoring

L1: work in your strength zone, but reinvent yourself
L2: find your dream and then live it
L3: proactively look for opportunities, be flexible
L4: to grow others, first grow yourself

If you want to go fast in life, go alone. If you want to go far, go with others.

Contact me at digd@eecs.oregonstate.edu
- you have codebases where you retrofit ML computations
- finding your own peer-best-practices, like-minded group

Attend Ultra-large Scale Refactoring: Friday at 4:20pm, Prog. Transf.

Join Faculty Mentorship Roundtables (Wed-Fri), limited seats, sign today
https://2019.icse-conferences.org/track/icse-2019-Faculty-Mentorship-Lunch