Mining Software Repositories

John Businge

References

The Road Ahead for Mining Software Repositories

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Software Intelligence:
The Future of Mining Software Engineering Data

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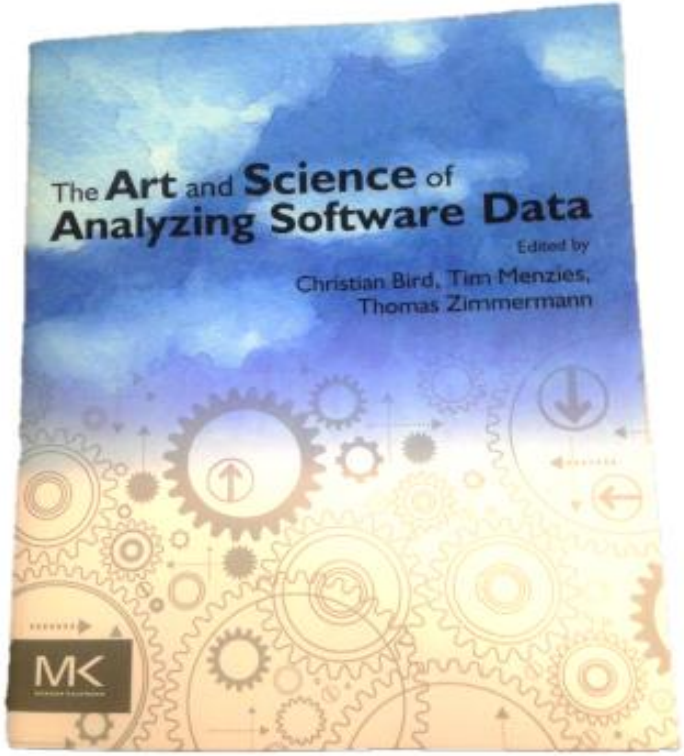
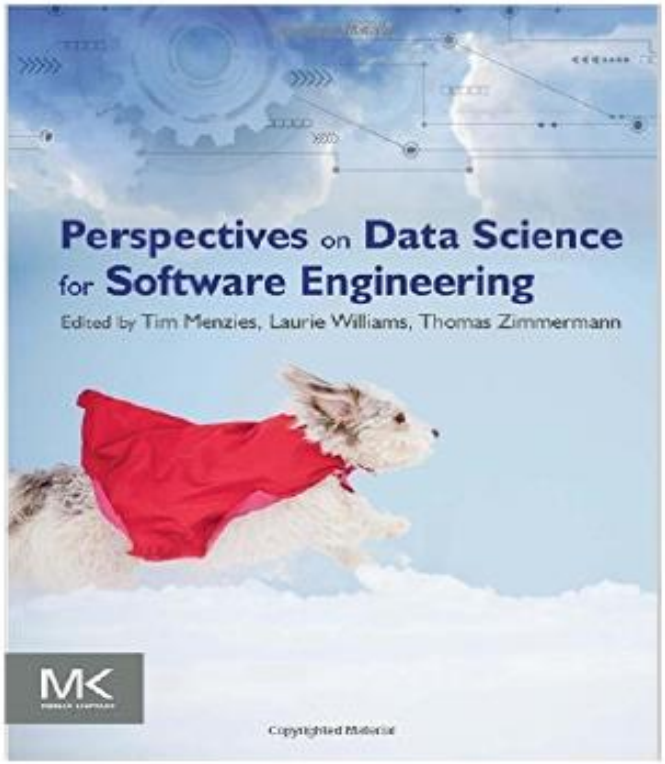
More References





Acknowledgement

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With updates by **John Businge** from the University of Nevada Las Vegas

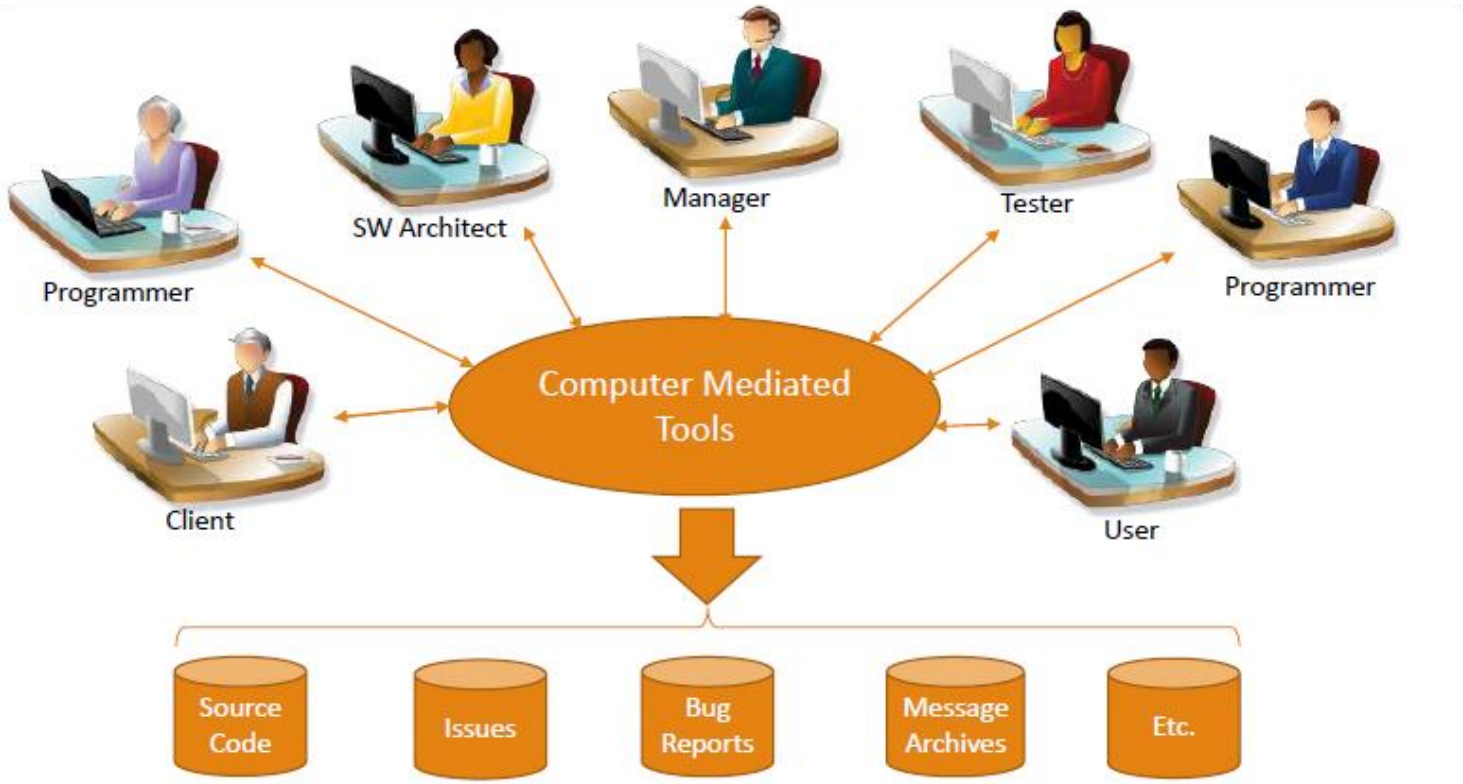
Lecture Goals

- **Learn about:**
  - Classic and notable research and researchers in mining SE data
  - Data mining and data processing techniques and how to apply them to SE data
  - Risks in using SE data due to e.g., noise
- **After the lecture, you should be able to:**
  - Retrieve SE data
  - Prepare SE data for mining
  - Mine interesting information from SE data

Why mine SE data?

- **SE data can be used to:**
  - Gain empirically-based understanding of software development
  - Predict, plan, and understand various aspects of a project
  - Support future development and project management activities

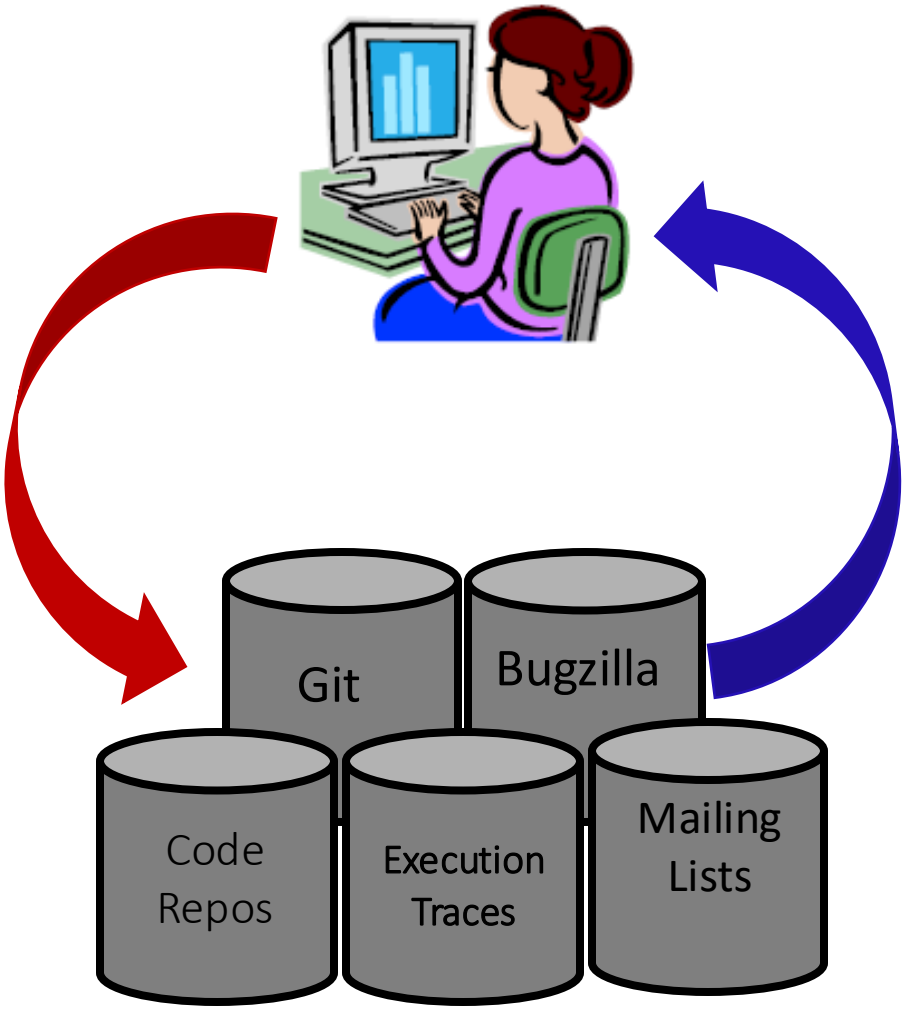
How is SE Data generated?



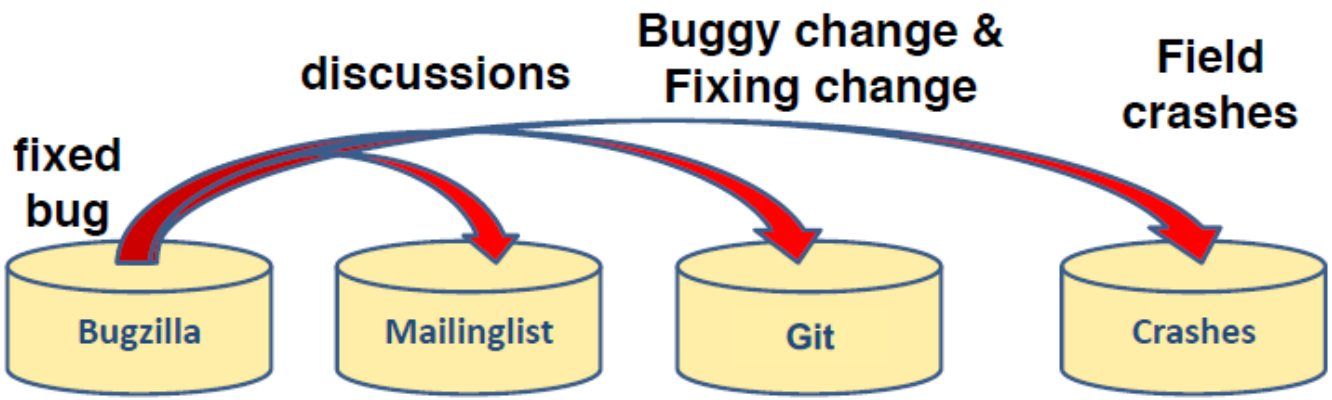
Current and historical artifacts and interactions are registered in software repositories

What is MSR?

- Transforming static record keeping SE into active data
- Making SE data actionable by uncovering patterns and trends



MSR researchers analyze and cross-link repositories



New bug report
Estimate fix effort
Suggest experts and fix!

Study Outline

- **Part I**: What can we learn from SE data?
  - A sample of notable findings for different SE data types
- **Part II**: How can we mine SE data?
  - Understand the structure of SE data

MSR studies – Bugs – Part I

Using imports to predict Bugs

71% of files that import compiler packages, had to be fixed later on.

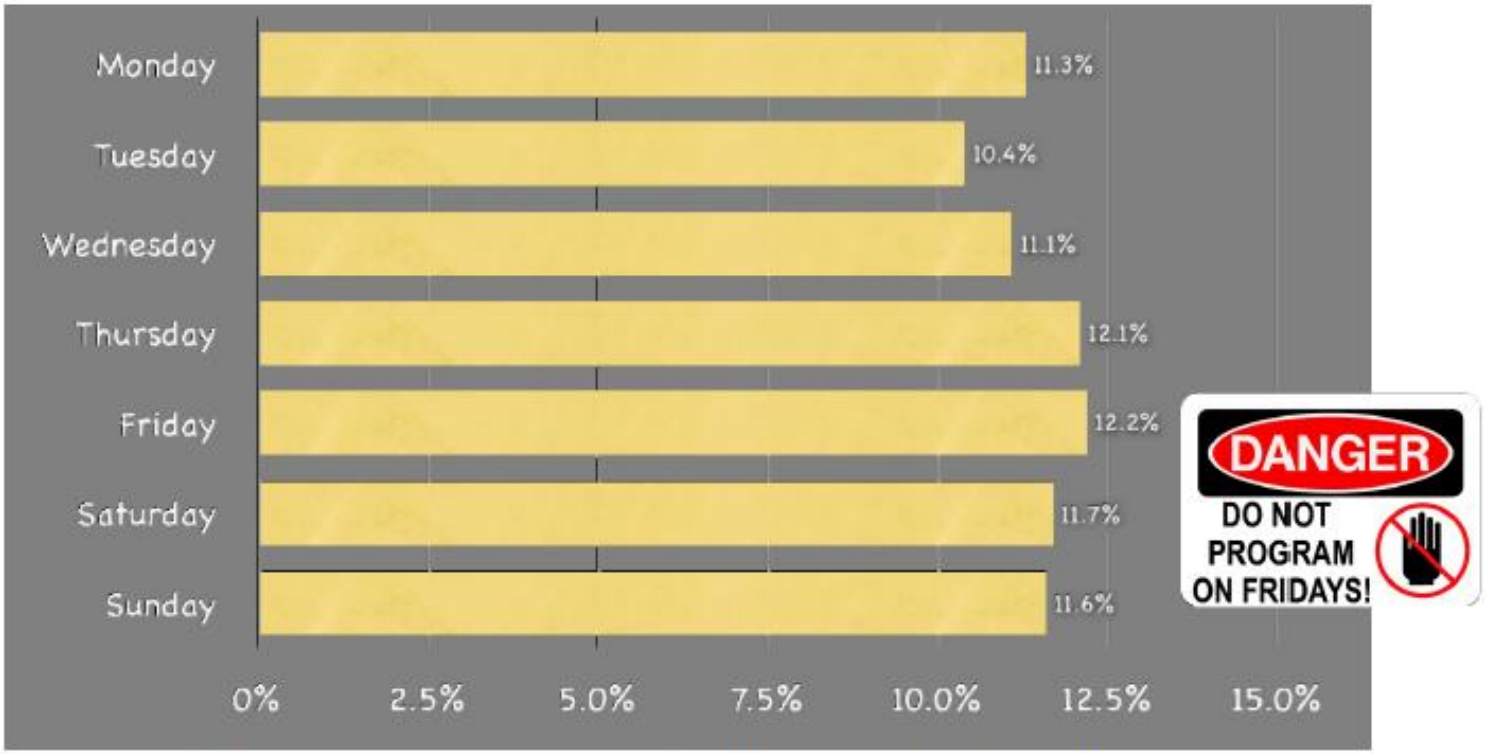
```
import org.eclipse.jdt.internal.compiler.lookup.*;
import org.eclipse.jdt.internal.compiler.*;
import org.eclipse.jdt.internal.compiler.ast.*;
import org.eclipse.jdt.internal.compiler.util.*;
...
import org.eclipse.pde.core.*;
import org.eclipse.jface.wizard.*;
import org.eclipse.ui.*;
```

[Schröter et al. 06]

14% of all files that import ui packages, had to be fixed later on.

MSR studies - Bugs

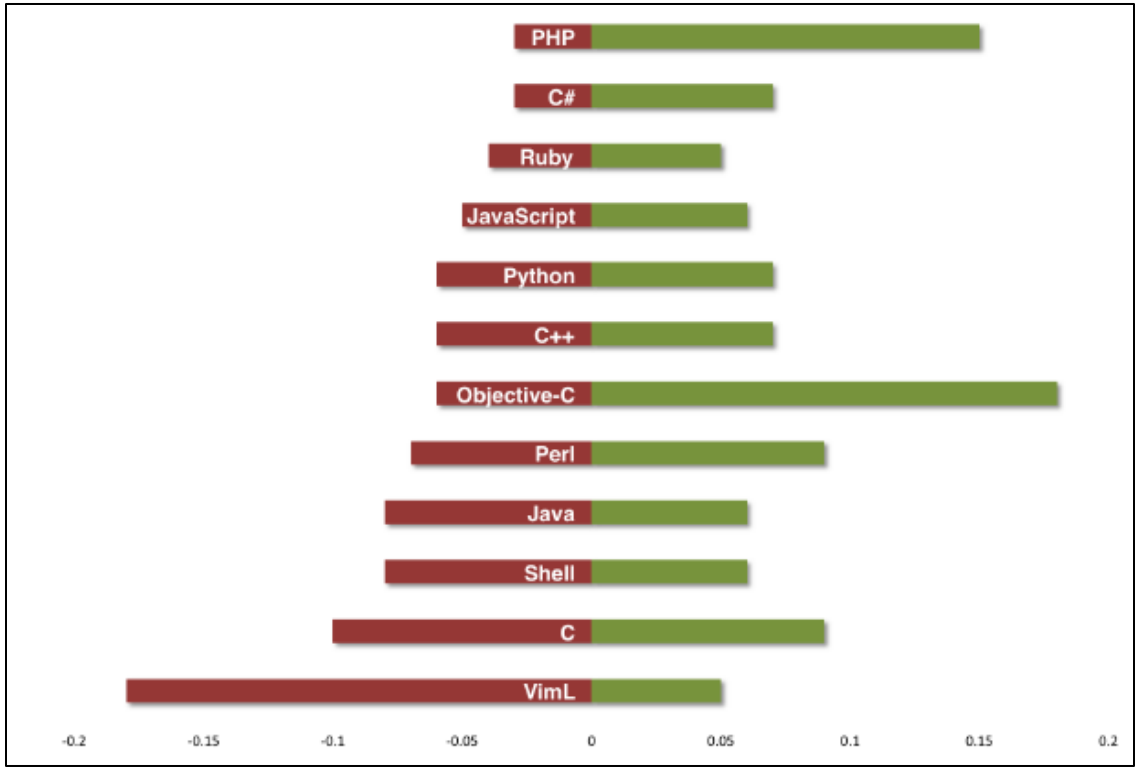
Do not program on Friday ;-)



Percentage of bug-introducing changes for eclipse [Zimmermann et al. 05]

MSR studies – Sentiment Analysis

Anger vs. Joy



How they stack up?

- **PHP**, **Object-C**, and **C#** are net positive
- **Java**, **Shell**, and **C** are fairly even while **VimL** is just bad news.

[Doll and Grigorik, 2012]

MSR studies – Sentiment Analysis

10/23/12 3:56 AM

Disable 'showmatch' option Matching parens are highlighted even without this option; what it does is jump the cursor to the matching paren which is [redacted] insane.

10/23/12 3:28 AM

styles everywhere, tutorial for first user login, fixing some css [redacted]

10/23/12 2:57 AM

[redacted] again

10/23/12 2:30 AM

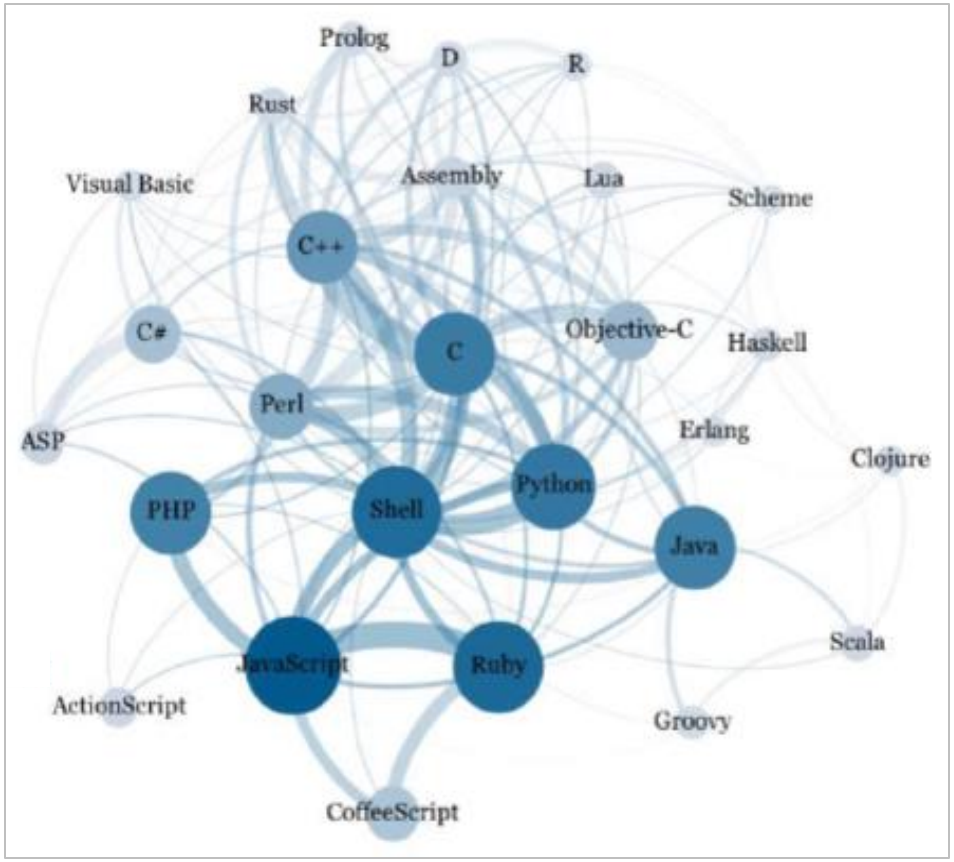
more [redacted]

10/23/12 2:29 AM

Security [redacted] worked out

MSR studies – Programming languages

Programming language relations



A **Ruby** programmers **is very likely to know Javascript**, while a **Perl** programmer is not

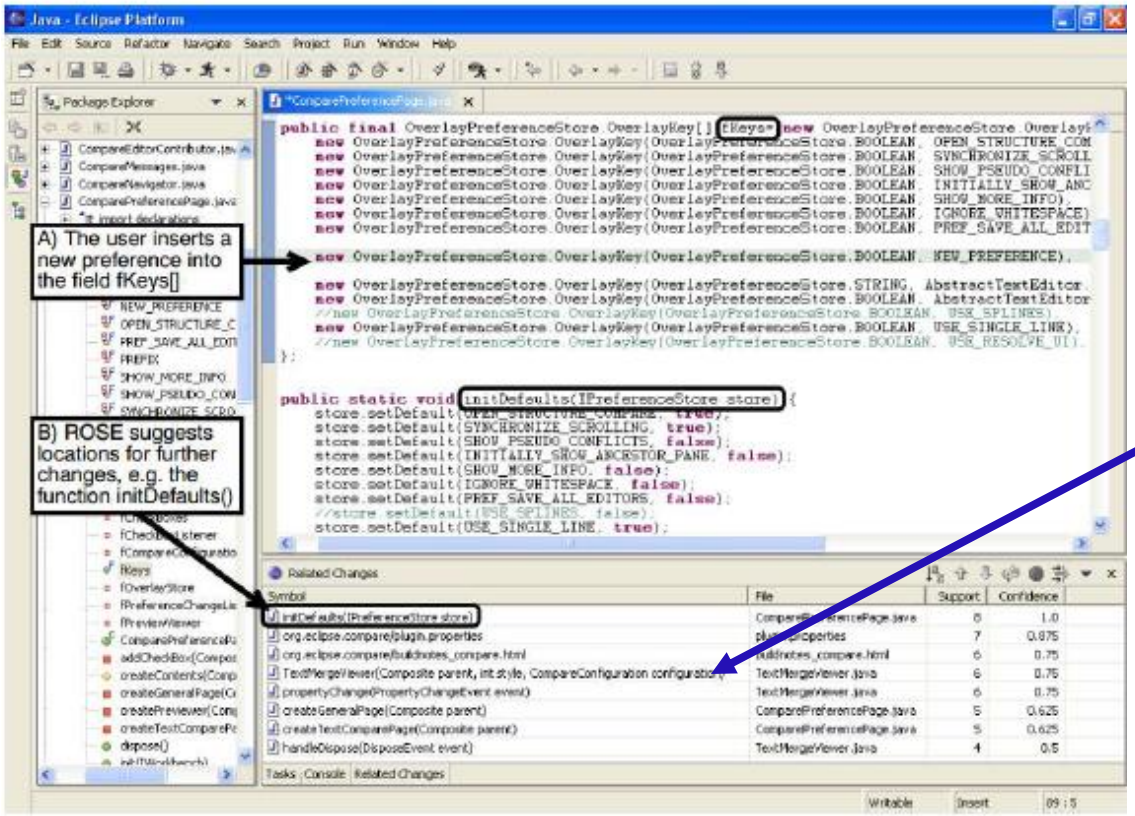
Java is a popular programming language but stands primarily alone

https://github.com/mjwillson/ProgLangVisualise

MSR studies – Changes by programmers

Programming language relations

[Zimmermann et al., 2005]
Mining Version Histories to Guide Software Changes



After the programmer has made some changes to the source (above), **ROSE** suggests locations (below) where, in similar transactions in the past, further changes were made

- Suggests and predicts likely changes
- Prevents errors due to imcoplete changes

How can we mine SE Data – Part II

Repositories of Repositories

July 2025:
150 million developers
518 repositories

April 2019
28 Millinon repositories
10 Million Users

April 2019
28K projects

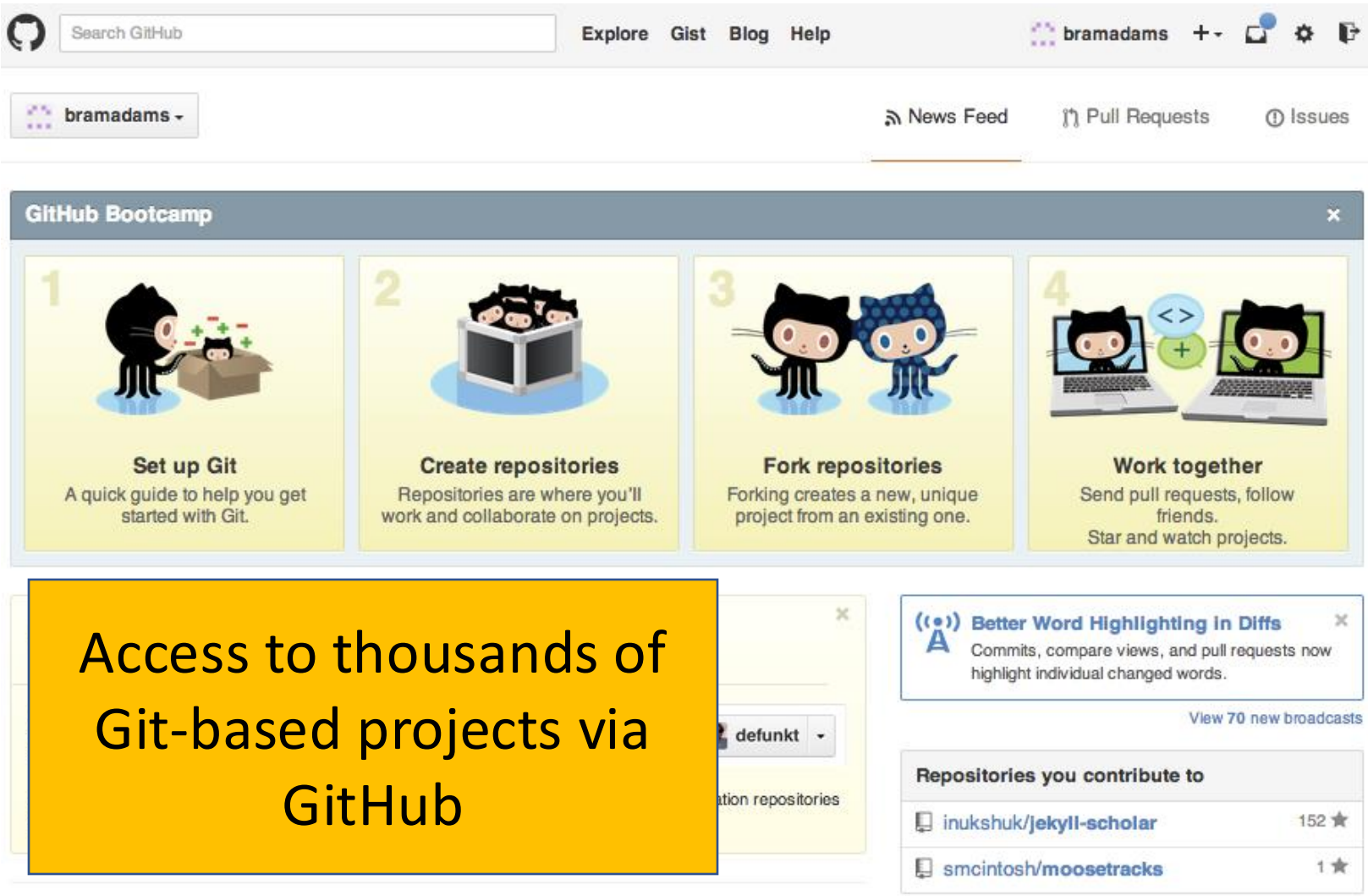
January 2020:
430K repositories
3.7 Million Users

How can we mine SE Data form GitHub

How can we mine SE Data

Easiest to obtain local copy (distributed version control!), and has distinction between authors and committers, but … branches can be pain to analyze

How can we mine SE Data



Access to thousands of Git-based projects via GitHub

How can we mine GitHub Data

GitHub Developer

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REST API v3

Reference Guides Libraries

Overview

This describes the resources that make up the official GitHub REST API v3. If you have any problems or requests, please contact GitHub Support or GitHub Premium Support.

i. Current version
ii. Schema
iii. Authentication
iv. Parameters
v. Root endpoint
vi. GraphQL global node IDs
vii. Client errors
viii. HTTP redirects
ix. HTTP verbs
x. Hypermedia

- Overview
  - Media Types
  - OAuth Authorizations API
  - Other Authentication Methods
  - Troubleshooting
  - API Previews
  - Versions
- Activity
- Checks
- Gists
- Git Data
- GitHub Actions
- GitHub Apps
- GitHub Marketplace
- Interactions
- Issues

How can we obtain GitHub data?

How can we mine GitHub Data

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  - Versions
- Activity

How can we obtain GitHub data?

There are rate-limit issues!

You are only allowed only a limited number of GitHub requests per hour

How can we mine GitHub Data

GitHub GraphQL API documentation

To create integrations, retrieve data, and automate your workflows, use the GitHub GraphQL API. The GitHub GraphQL API offers more precise and flexible queries than the GitHub REST API.

Overview

Start here View all →

Forming calls with GraphQL
Learn how to authenticate to the GraphQL API, then learn how to create and run queries and mutations.

Introduction to GraphQL
Learn useful terminology and concepts for using the GitHub GraphQL API.

Using GraphQL Clients
You can run queries on real GitHub data using various GraphQL clients and libraries.

Popular

Explorer

Public schema
Download the public schema for the GitHub GraphQL API.

Using pagination in the GraphQL API
Learn how to traverse data sets using cursor based pagination with the GraphQL API.

How can we obtain GitHub data?

<u>There are rate-limit issues!</u>
Use GraphQL API
Rate limit is less of an issue