On the Limits of Software Repository Mining

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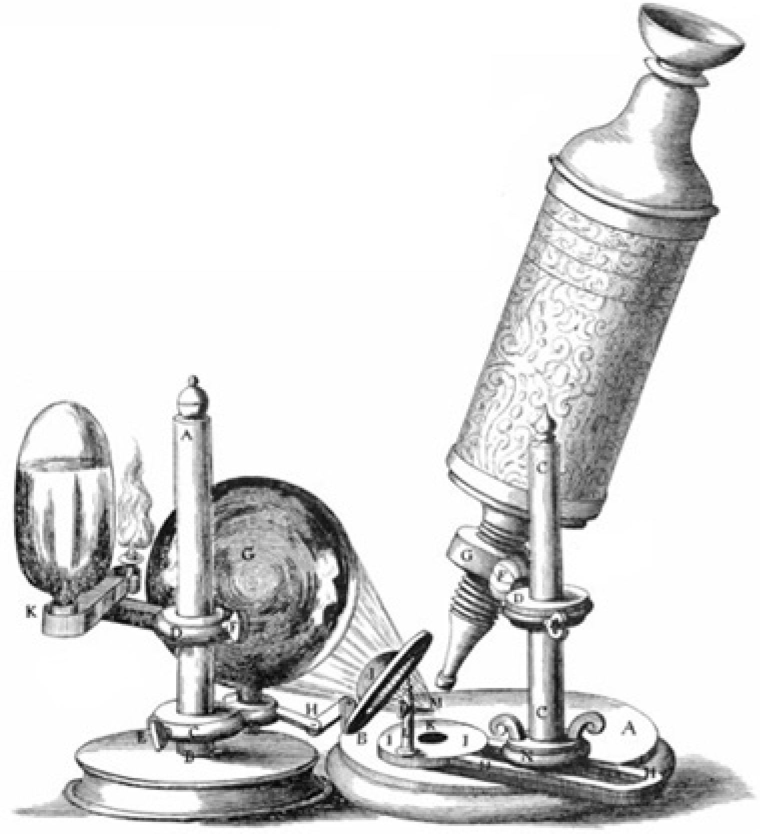
In the beginning…

- Emergence of large repositories of software project data
  - Open source movement + Forges

- Hmm, is it possible to do anything useful with this data?



Can we construct instruments to extract this data?

YES!

MSR in a Nutshell

Limited Data Sources

- Software engineering projects **create few data sources**
  - Source code repositories
  - Mailing list archives
  - Bug tracking database
  - Test case databases
  - Test execution data

  - … plus many special case repositories (app stores, Q&A sites, etc.)

- These are **traces of the actual activity**

- **A rich but biased** view of what happened on a project

Typical Kinds of Findings

- Descriptive
  - Quantitative understandings of what happened in a project
    - Lines of code, bug counts and locations, clone counts and locations, patterns and locations, identifiers
    - Static code properties and relationships
    - Timings (bug fix time)
    - Frequency distributions of all kinds
    - Visualizations
    - Relationships between data types (bug tossing)
    - … and many more
- Predictive
  - Using time series information to make predictions
    - Bug prediction, code size growth, …

What's wrong with that?

Core Limitation: Incomplete Picture

- Trace data is insufficient to fully understand software project phenomena

- Missing information:
  - Cost, political backdrop, project goals over time, marketplace expectations, interpersonal interactions, physical setting, deadline pressures, why participants find project to be meaningful, etc.

Bugs are costly
Sipho Mabona, The Plague, 2012

  - Messy! Mostly not capable of quantitative representation

Chair Story

Software Evolution

- To really understand how a software project has evolved, need to consider more than trace data
  - Need to perform a deep dive
- Historical analysis
  - Careful collection of information sources, interviews with key participants
  - Development of explanatory frameworks
- Social analysis
  - Understanding of social dynamics within team, relationship of team to broader organization
- **Evolution as the interplay of multiple technical and social forces and influences**

Core Limitation: Answering Why Questions

- MSR approach: **well suited to descriptive science**
- Good at answering **what** and **what happened** questions
- Not so ideal for answering **why** questions

Why Power Law Distributions?

- We know many phenomena in software have power law frequency distributions
  - Source file size, change size, number of subclasses, etc.

- Why?

- As in, why power law, instead of linear, or normal, etc.?

- No one ever explicitly instructs a developer to add code to files to maintain a power law size distribution!
  - An emergent phenomena

Power Law Generative Processes

- Newman (2005) surveys multiple generative models that can produce power law distributions:

- Preferential attachment (Yule process)
  - Entities get random increments of a property in proportion to their current value of that property
  - Example: Big cities attract more people than small cities

- Self-organized criticality
  - Entities added to system at a constant rate
  - Occasional reduction process
  - Example: adding sand to a sand pile, which occasionally slumps

- Can any of these processes explain power laws in software?

Simulate Software Generative Processes

- Use simulation as a tool to explore theories of power law formation
- Since power laws are emergent phenomena, need to execute basic processes to create emergence
- Focus of Zhonpeng Lin PhD work
- See also work by Turnu et al. 2011

Game Dev Story – a playable simulation

- Incomplete Picture
  - Software repositories are one (easily processed) source of project information, among many

- Answering Why Questions
  - Use simulation as a way theories of observed phenomena