ETH
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Empirical Software Engineering: Complexity Matters

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Empirical Software Engineering

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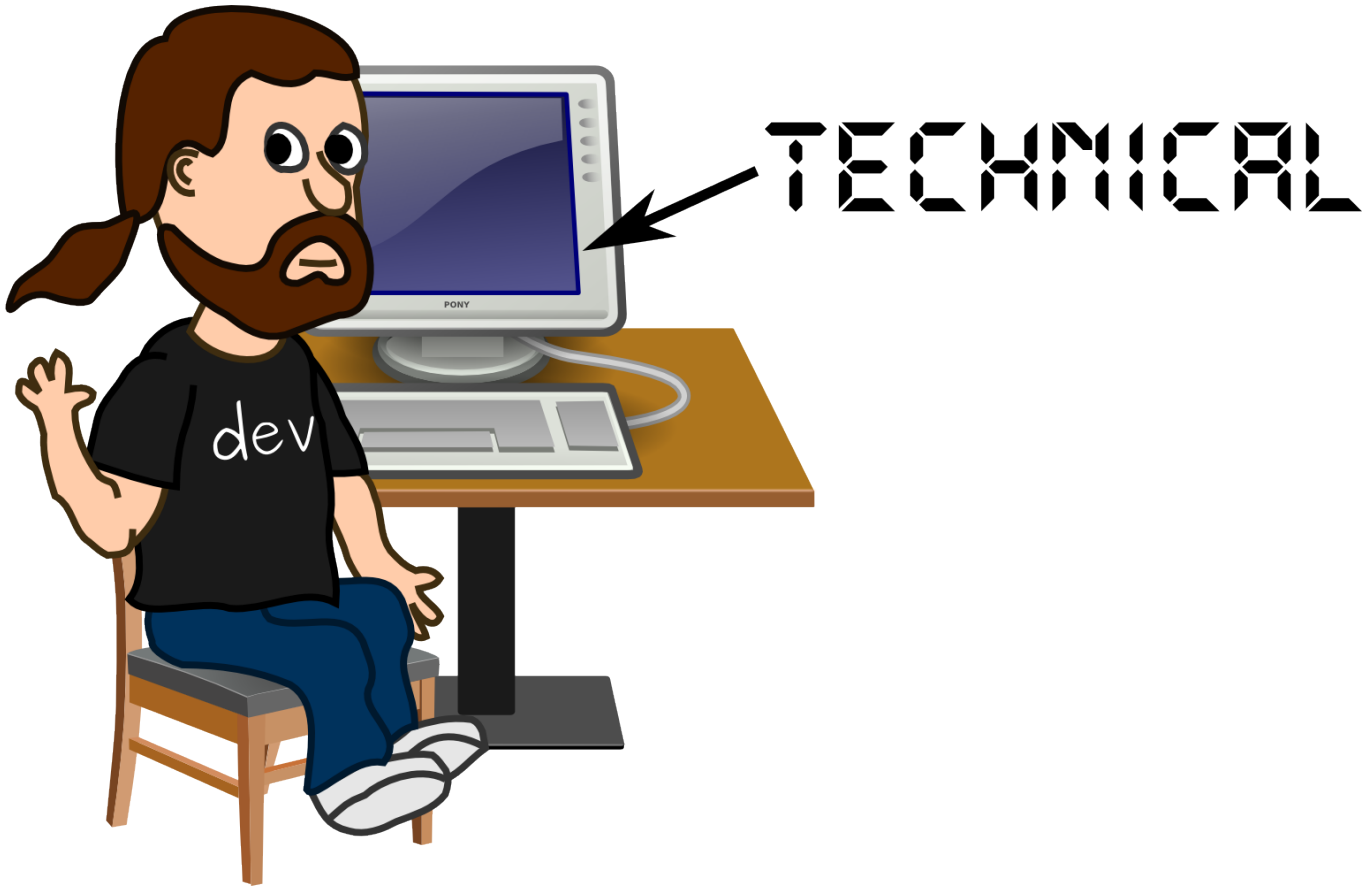

What Works Best and When?

- How do we optimize project performance?

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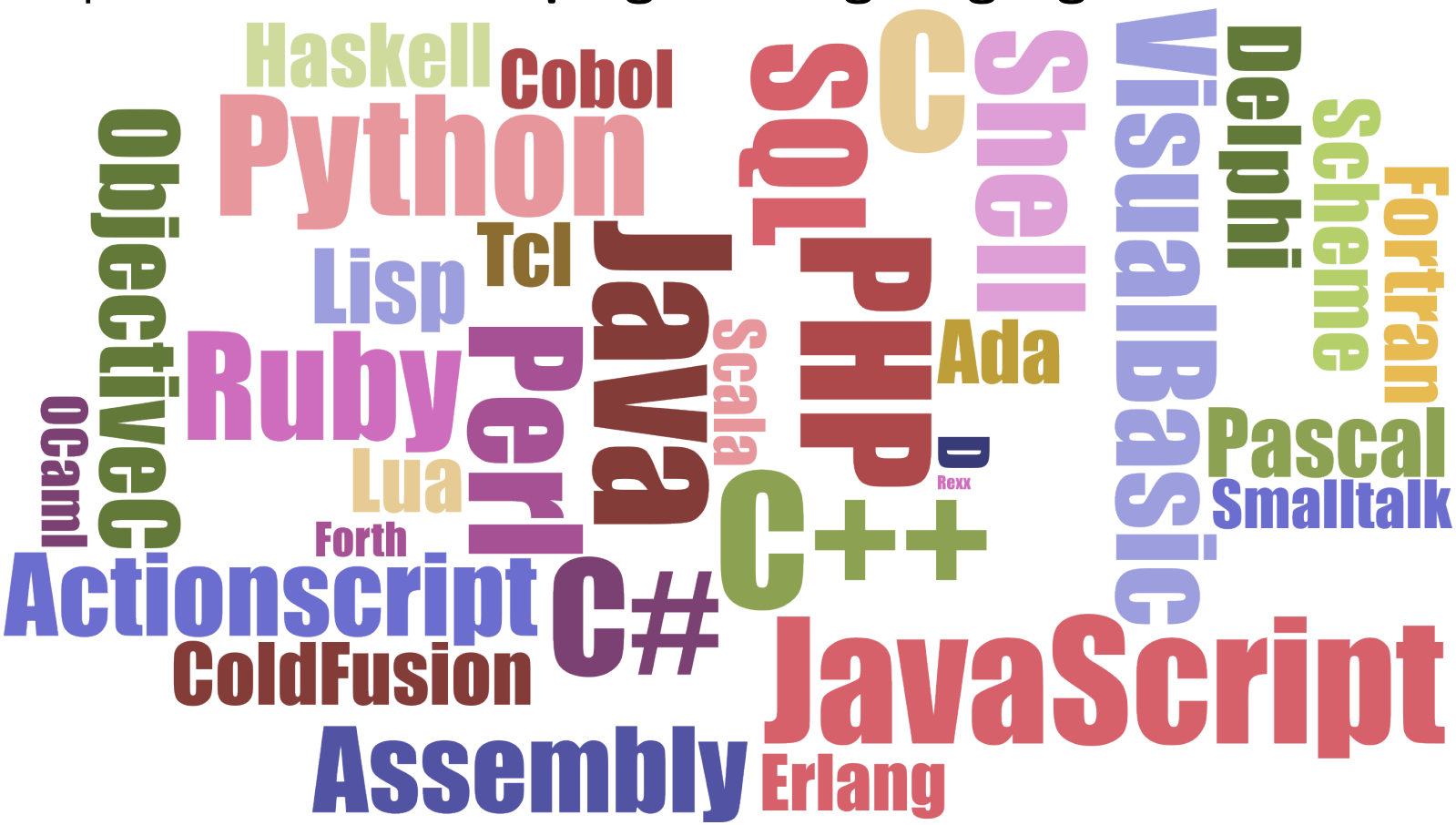
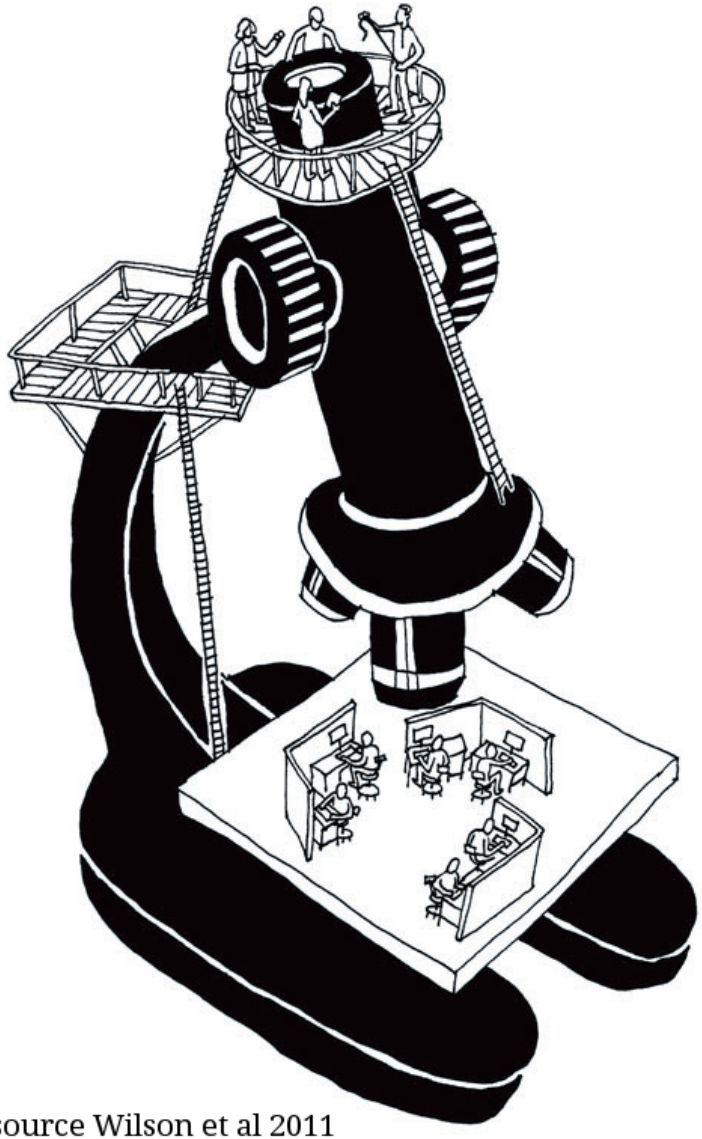
- How do we optimize project performance?
- Example: the choice of a **programming language**



based on raw data from LangPop.com 2011

Empirical (Scientific) Software Engineering



source Wilson et al 2011

– Pardon me, but what exactly is not trivial from what you have told us so far?

Software is Written By People

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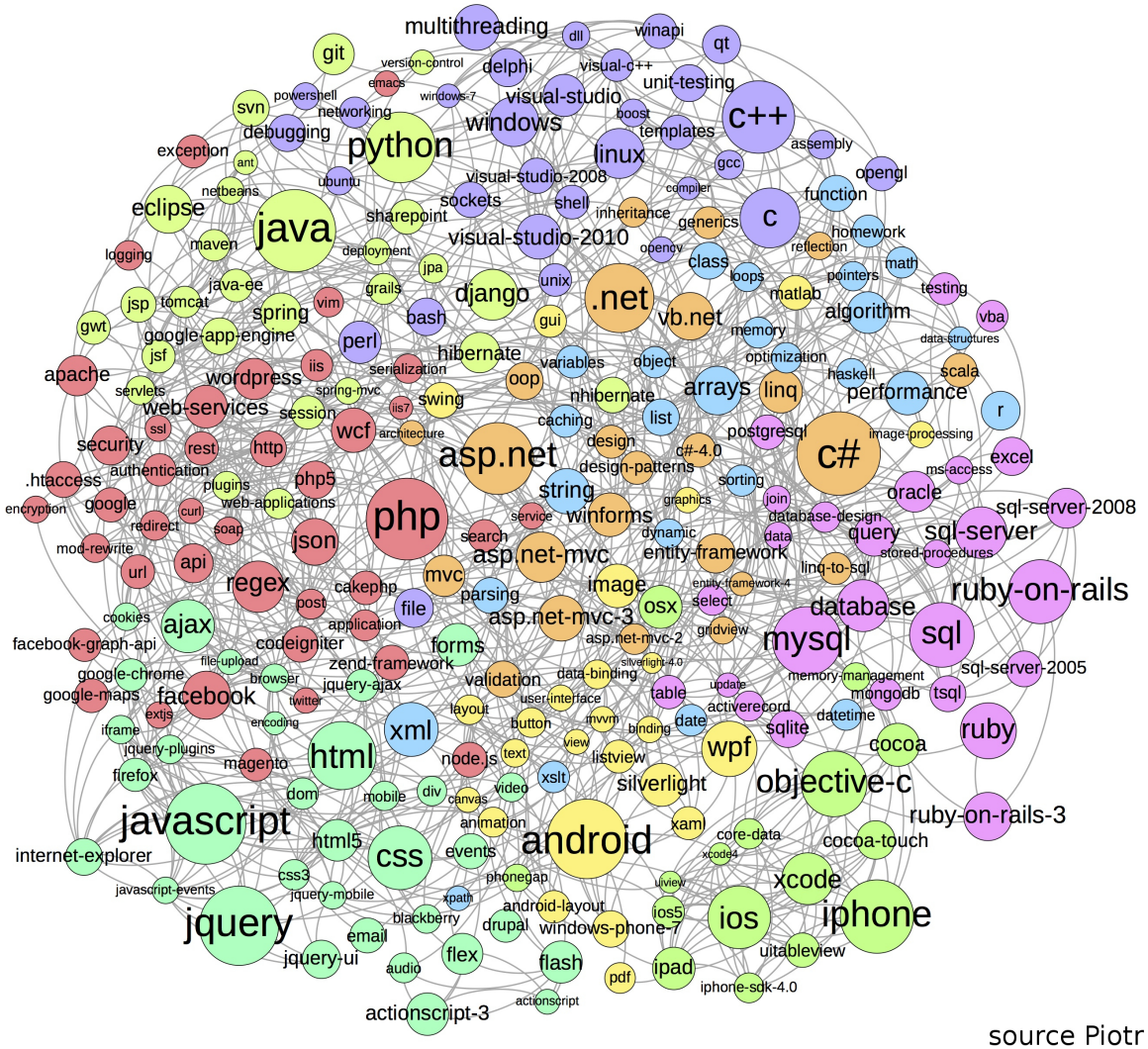
Catastrophic Complex Social Interactions

Millennium Bridge

– I knew it all along ...

How do We Handle Complexity?



source Piotr Migdal 2012

Network Science!

Networks in Collaborative Software Development

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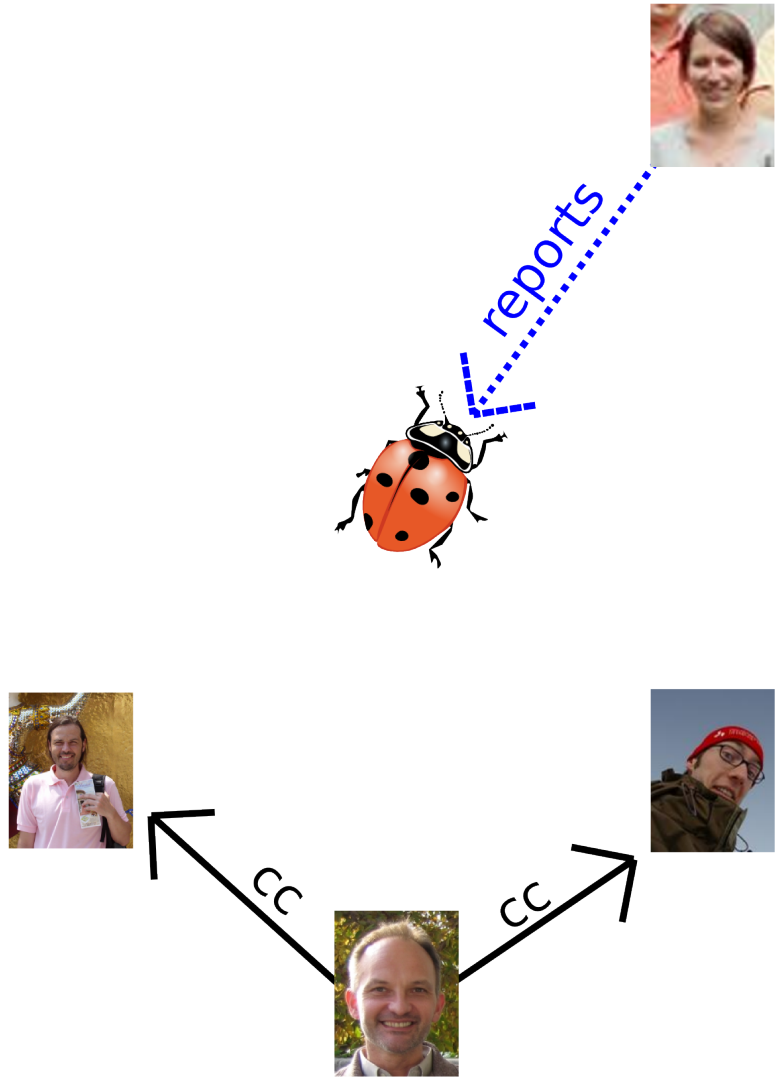
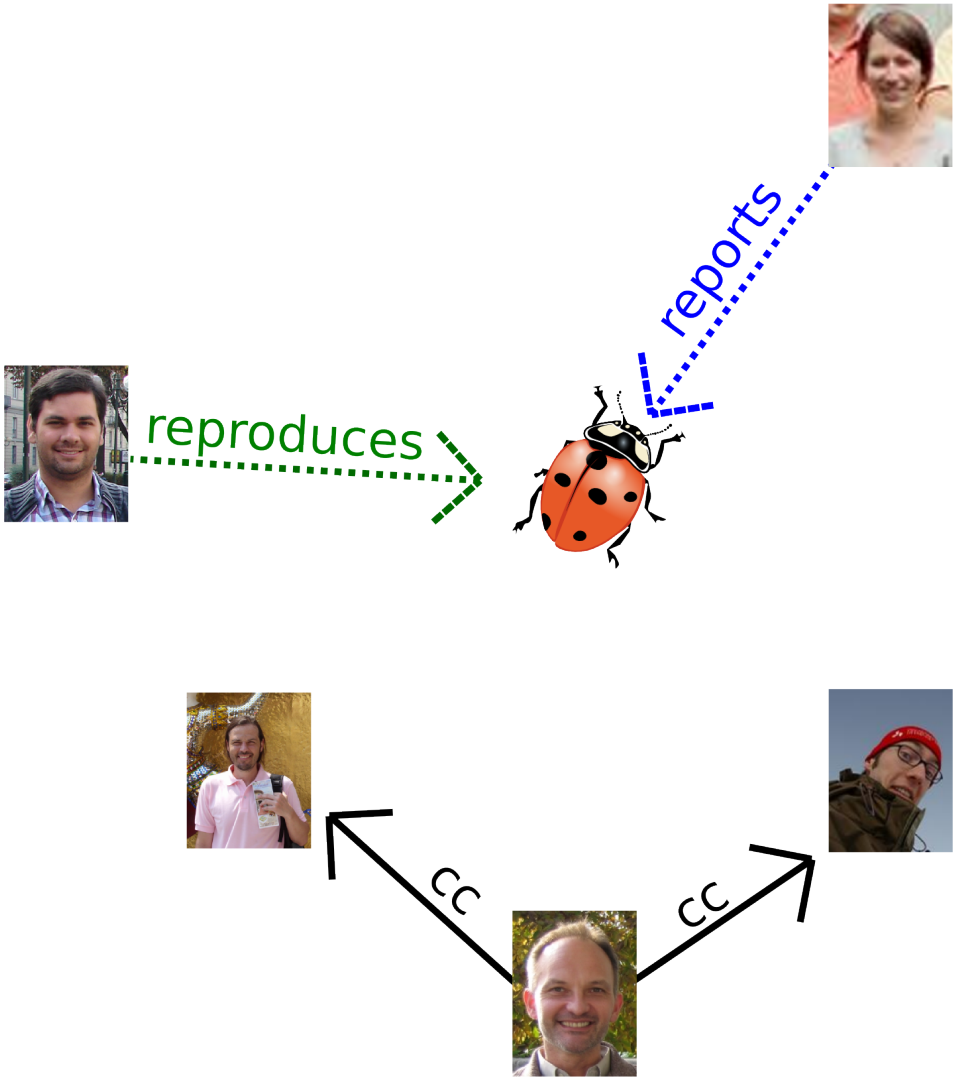
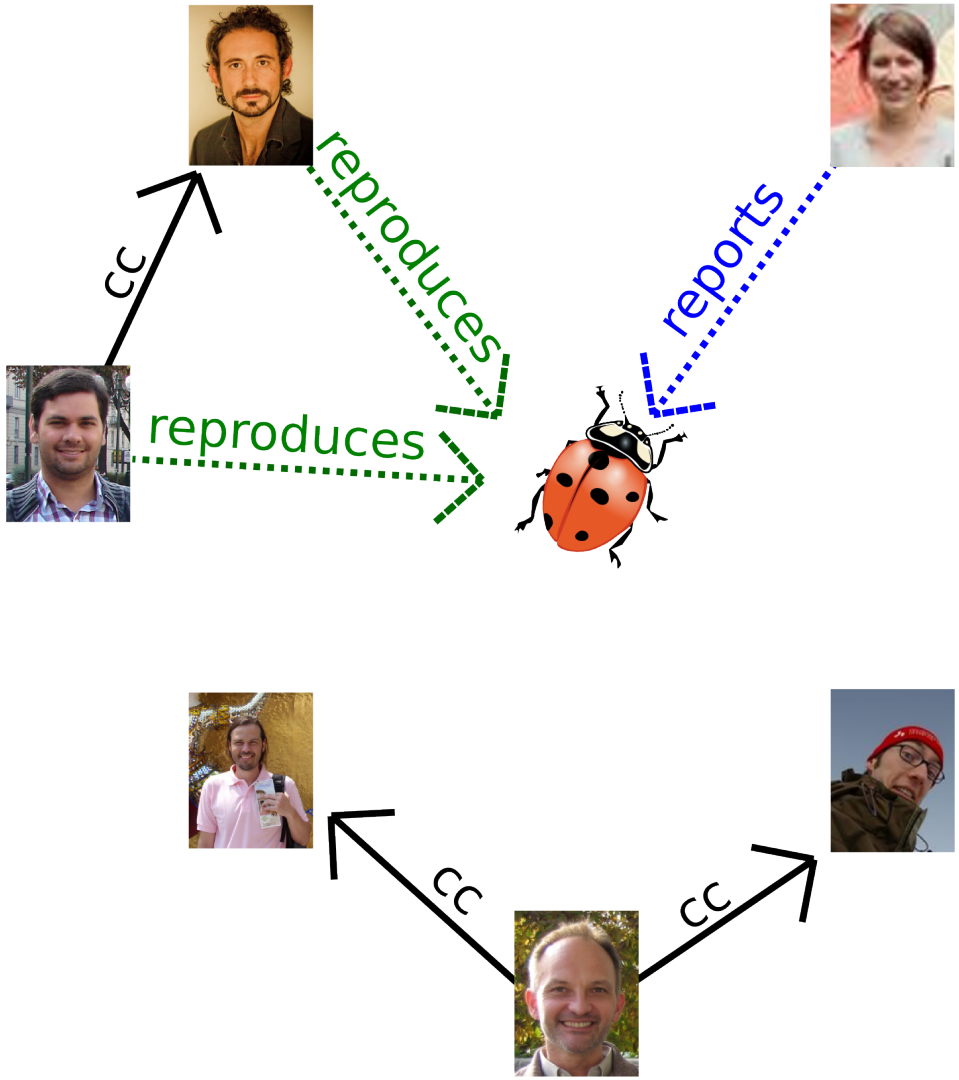


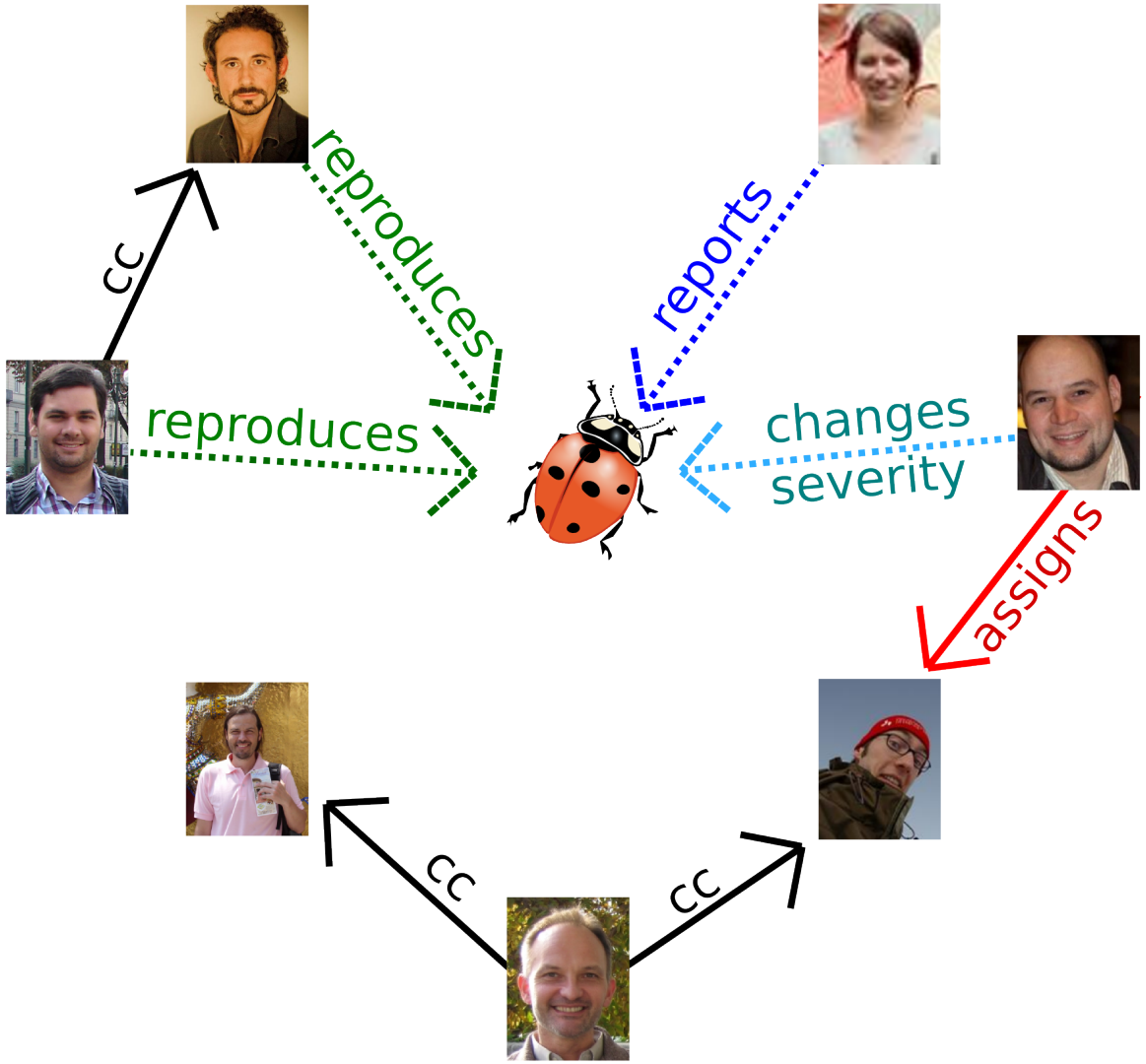
Networks in Collaborative Software Development



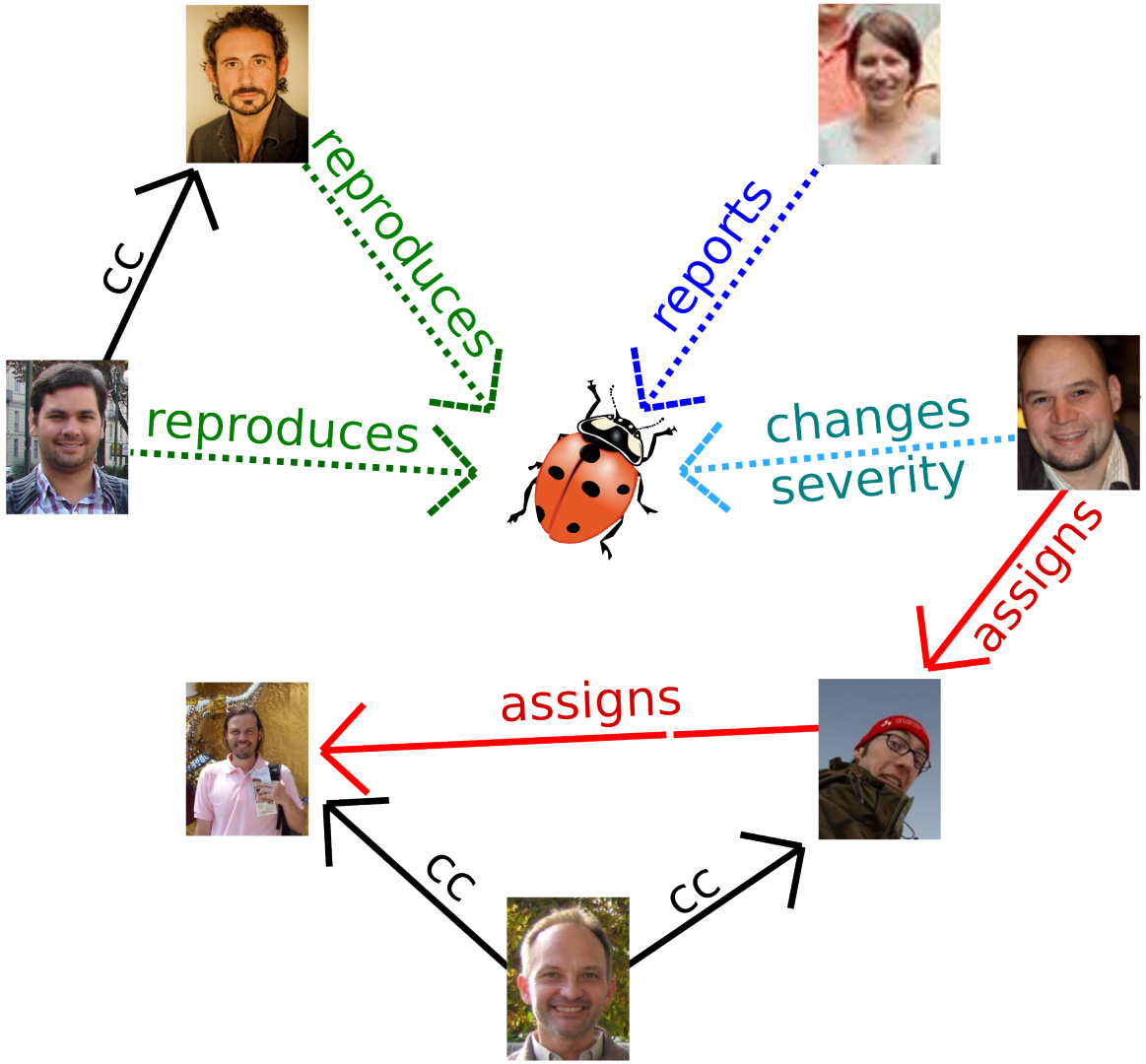
Networks in Collaborative Software Development



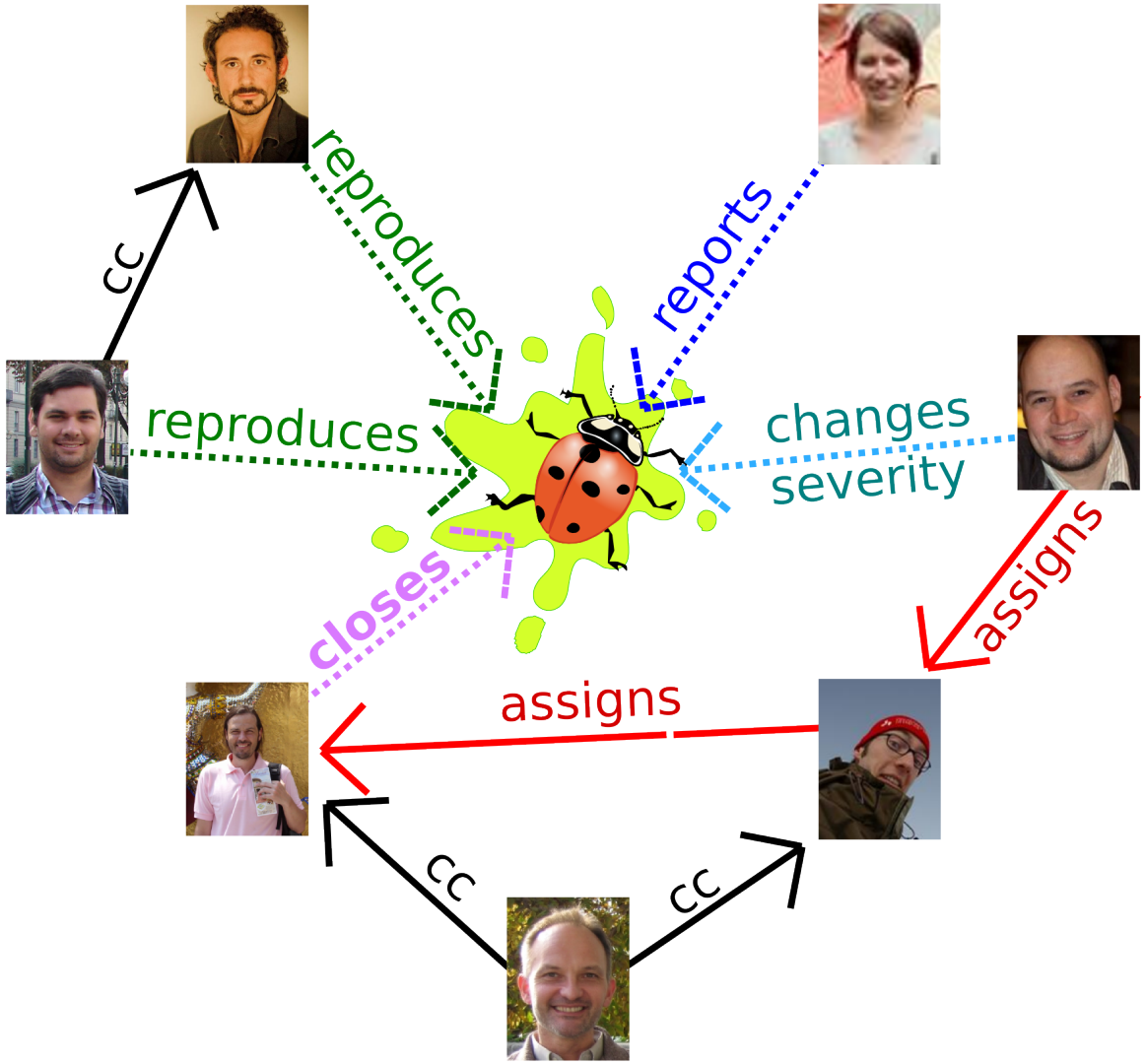
Networks in Collaborative Software Development



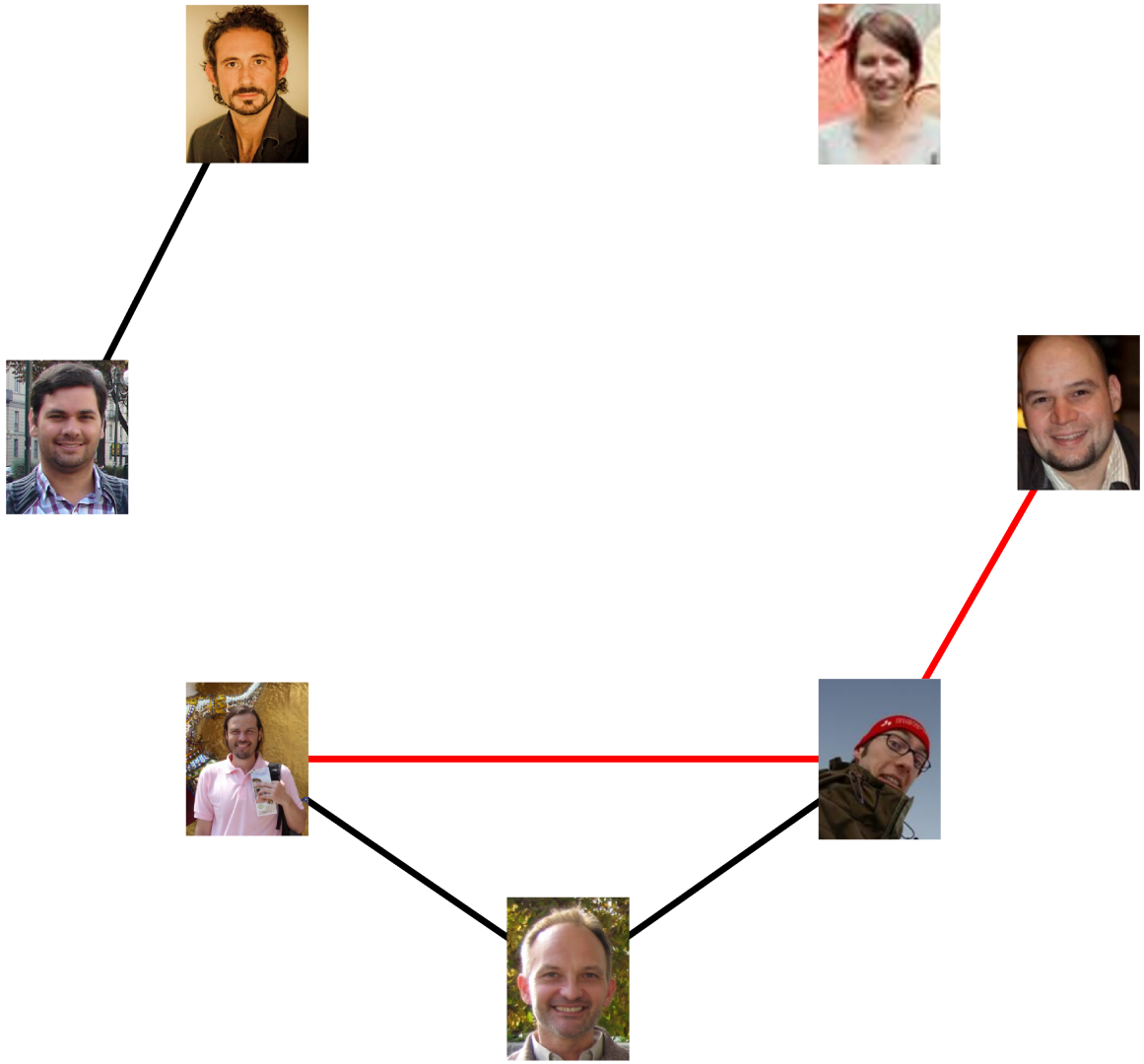
Networks in Collaborative Software Development



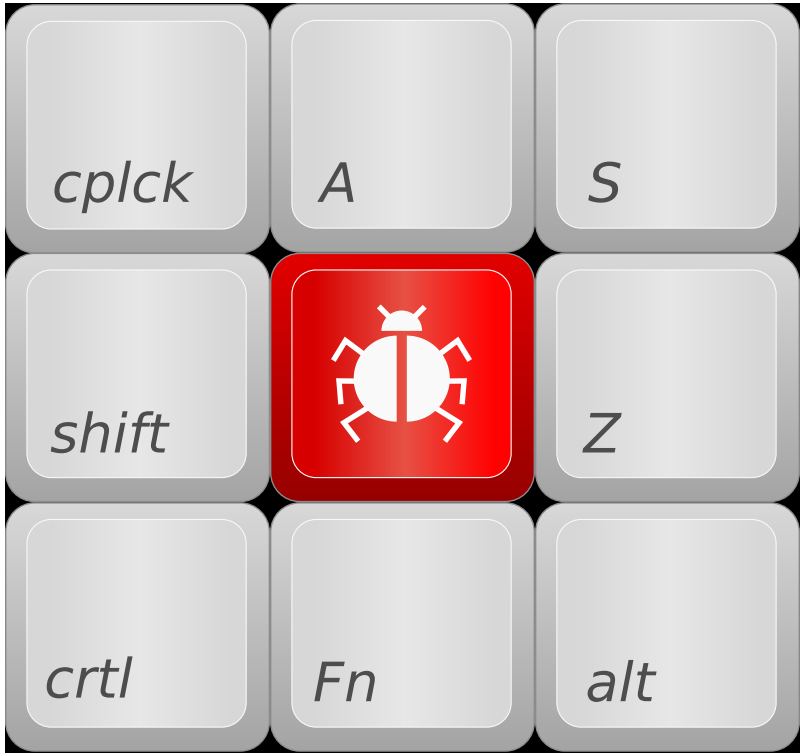
Networks in Collaborative Software Development



Networks in Collaborative Software Development

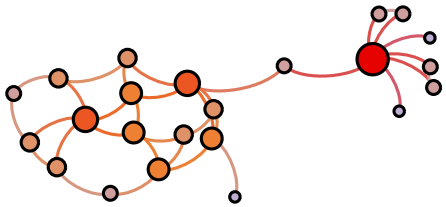


Who Writes Valid Bug Reports?

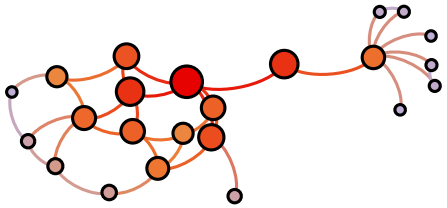


- **valid** bug report:
  resolved as FIX or WON'T FIX
- **faulty** bug report:
  resolved as DUPLICATE or INCOMPLETE or INVALID

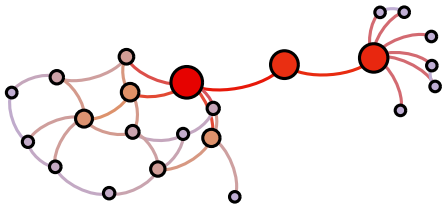
Who is Important in a Network? Depends ...



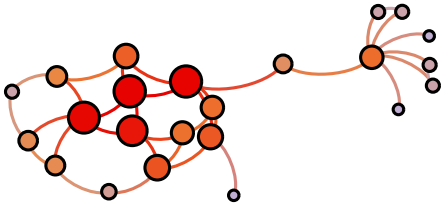
degree centrality



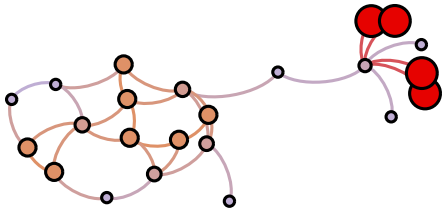
closeness centrality



betweeness centrality

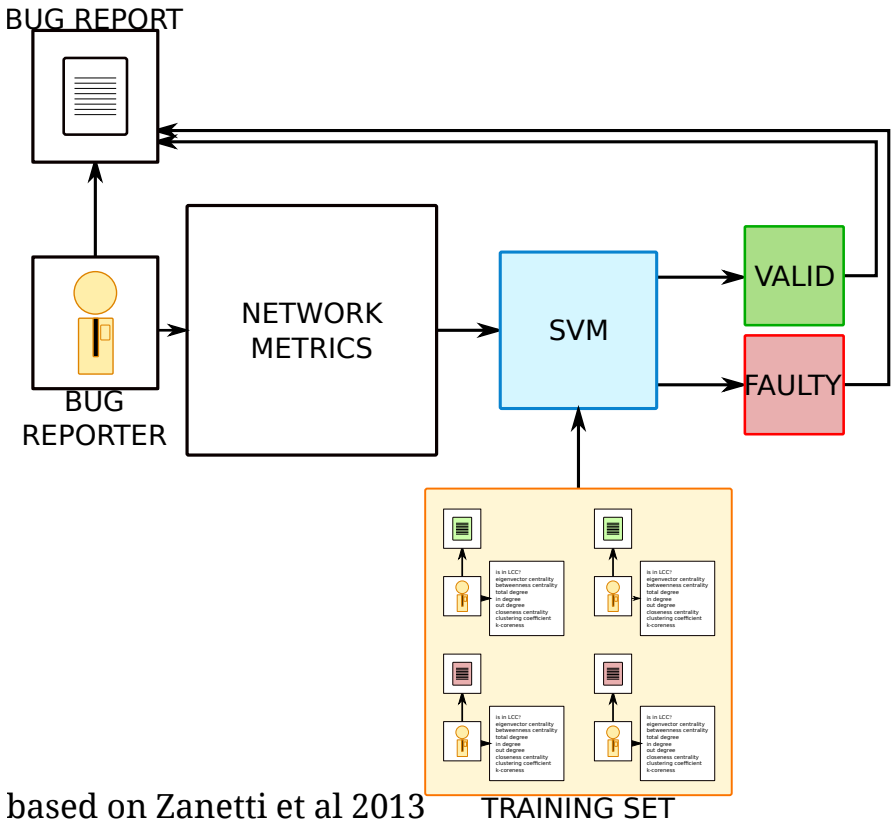


eigenvector centrality



clustering coefficient

Accurate Automatic Prioritization of Bug Reports



based on Zanetti et al 2013

max(precision)
VALID
90.3%

max(precision)
FAULTY
86.9%

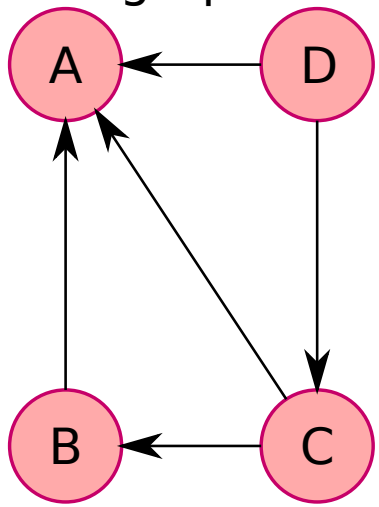
– Fascinating! Can you help me minimizing the actual number of bugs in the source code? I find humans to be very unreliable programmers ...

Source Code Can Also Be Seen as a Network

source code

```
class A {
        // definition of class A
};
class B {
        A* ab;
        // rest of definition of class B
};
class C {
        A* ac;
        B* bc;
        // rest of definition of class C
};
class D: public C {
        A* ad;
        // rest of definition of class D
};
```

graph

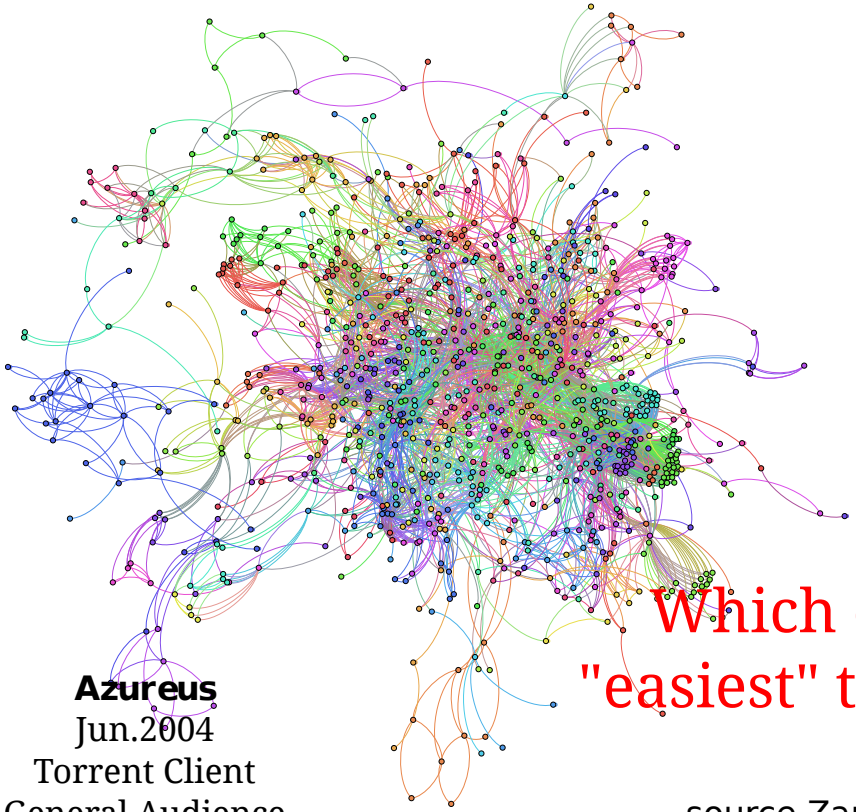


edge list:

B,A
C,A
C,B
D,C
D,A

based on Myers 2003

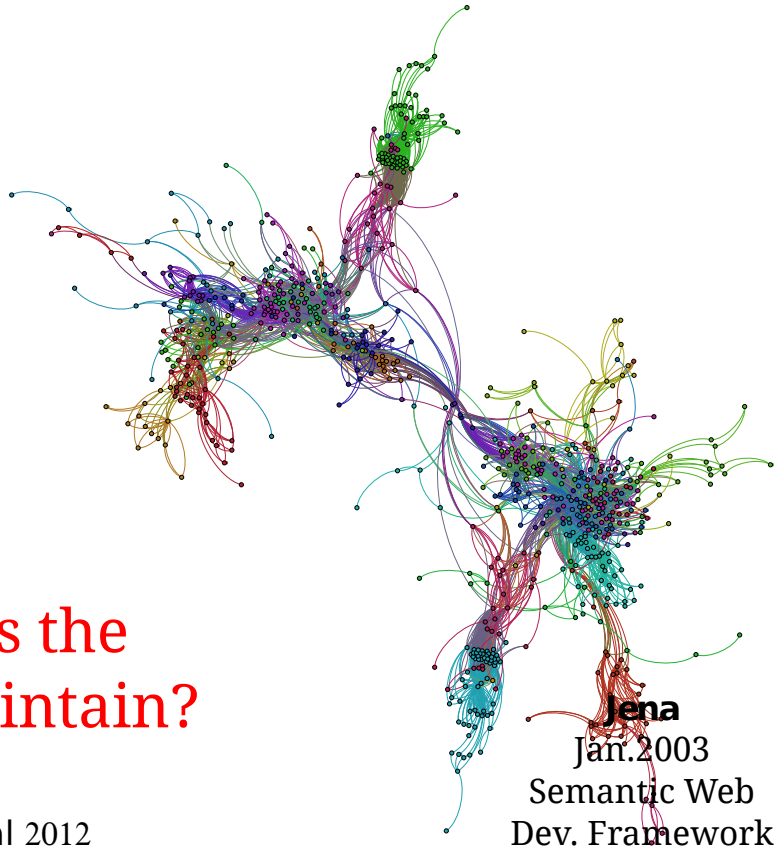
Source Code Can Also Be Seen as a Network



Azureus
Jun.2004
Torrent Client
General Audience

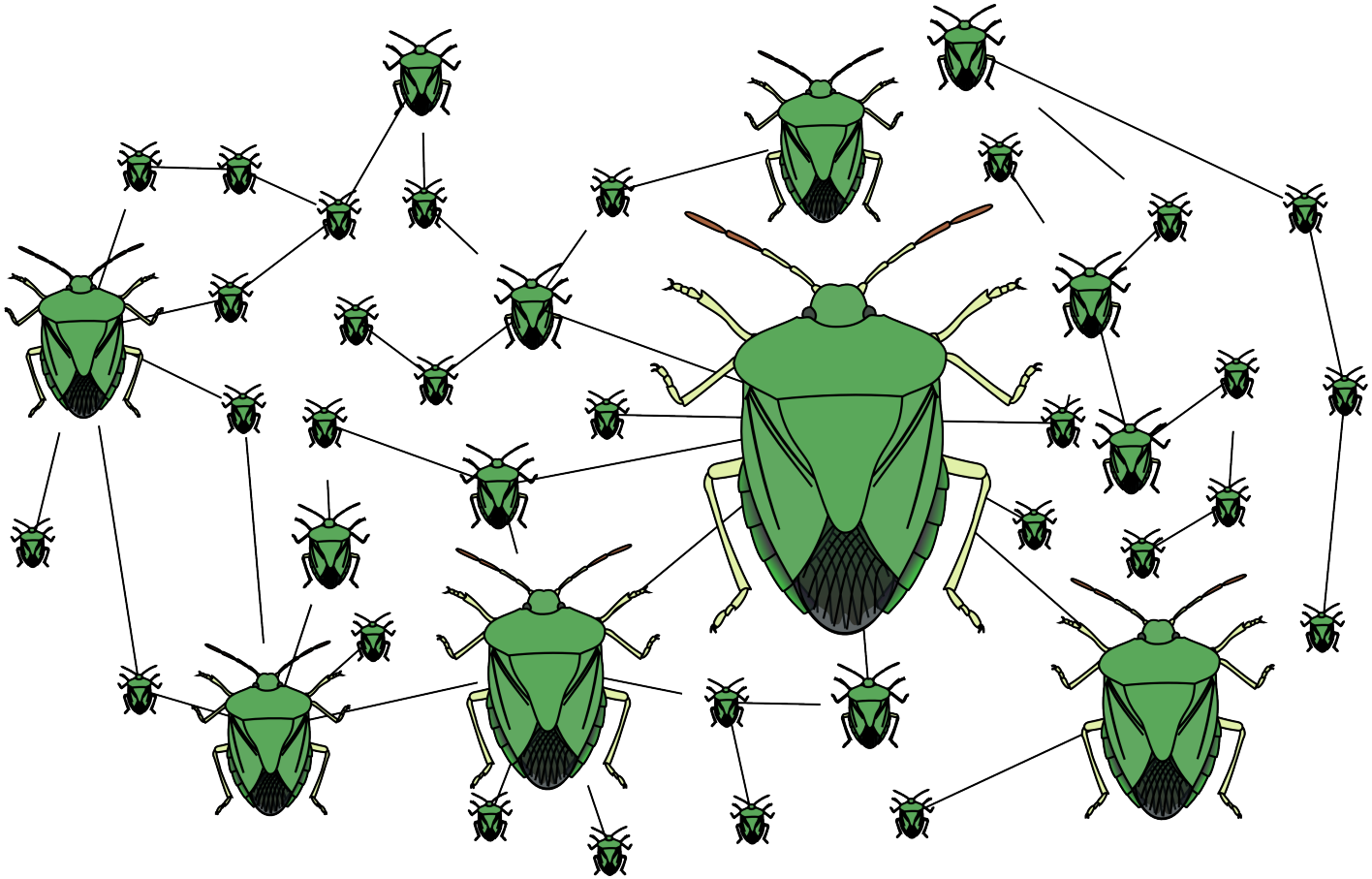
Which one is the
"easiest" to maintain?

source Zanetti et al 2012



Jena
Jan.2003
Semantic Web
Dev. Framework

Network Importance Influences Failure Severity



Bhattacharya et al (2012) show that the **importance of nodes** in a code network is indicative of the **severity of possible failures**

New Opportunities Ahead ... Go for It!

source StuckinCustoms 2007

Open Source Software for Network Analysis

- Libraries:
  NETWORKX (PYTHON)
  IGRAPH (PYTHON, R, C, RUBY)
- Visualization tools:
  GEPHI
  CUTTLEFISH
- Source code call graph generator:
  CODEVIZ
  DOXYGEN
  CDA

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