Does your mother know you're here?

Understanding software artifact provenance

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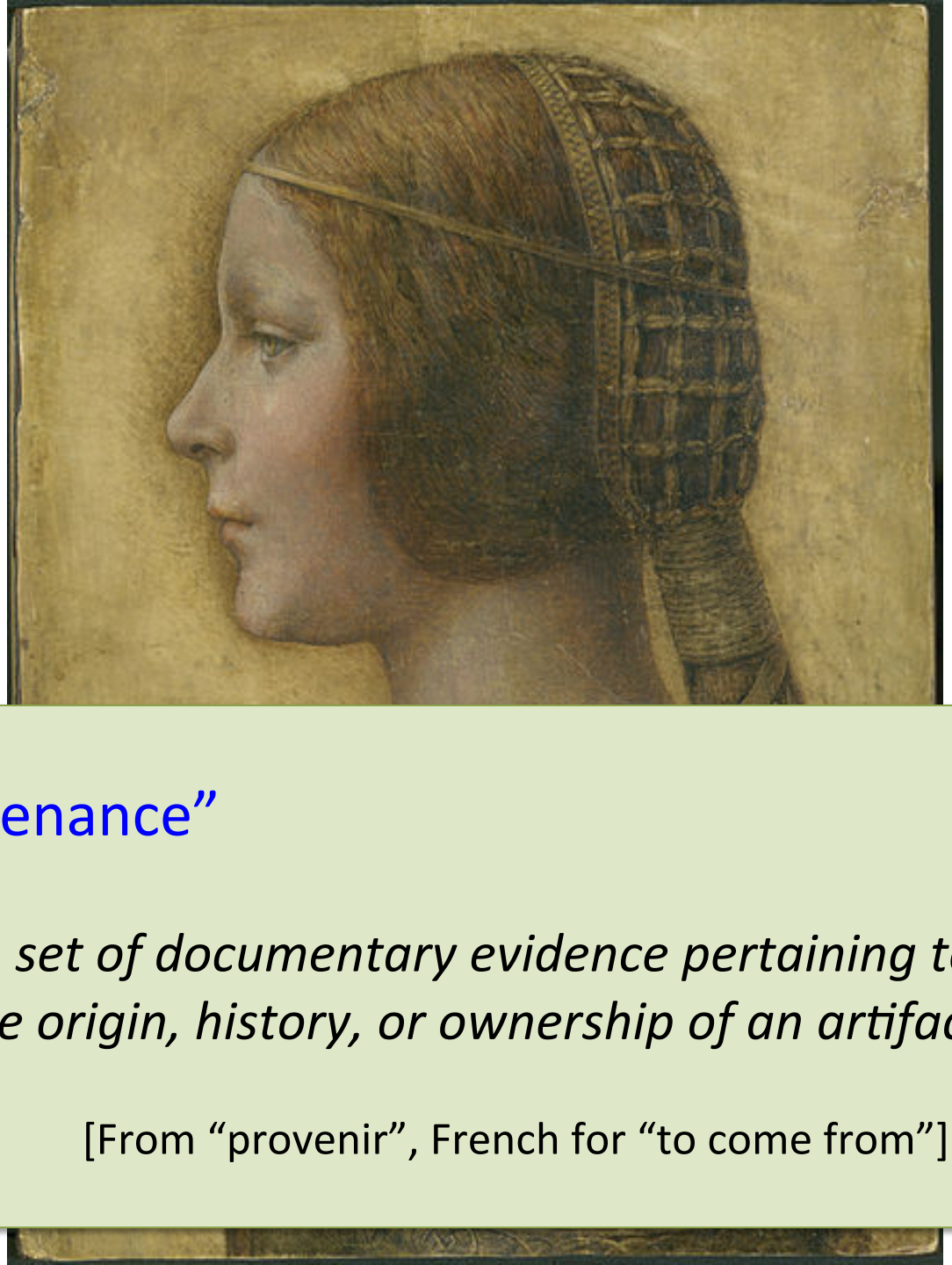
[visiting CWI / SWAT, Amsterdam until July 2012]

Software artifact provenance

An emerging problem area



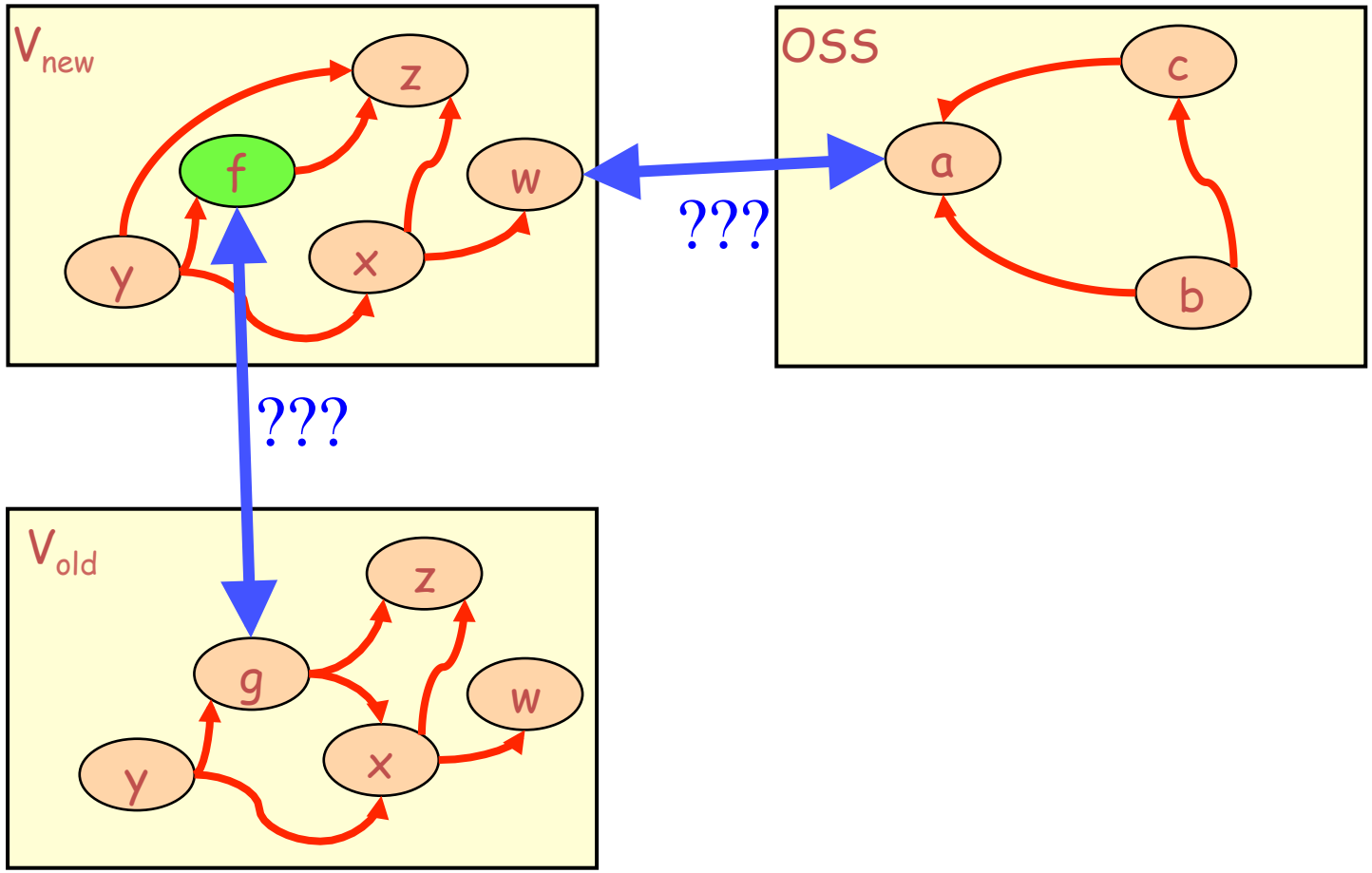
“Provenance”

A set of documentary evidence pertaining to the origin, history, or ownership of an artifact.

[From “provenir”, French for “to come from”]

Software artifact provenance

Origin analysis + copyright violation

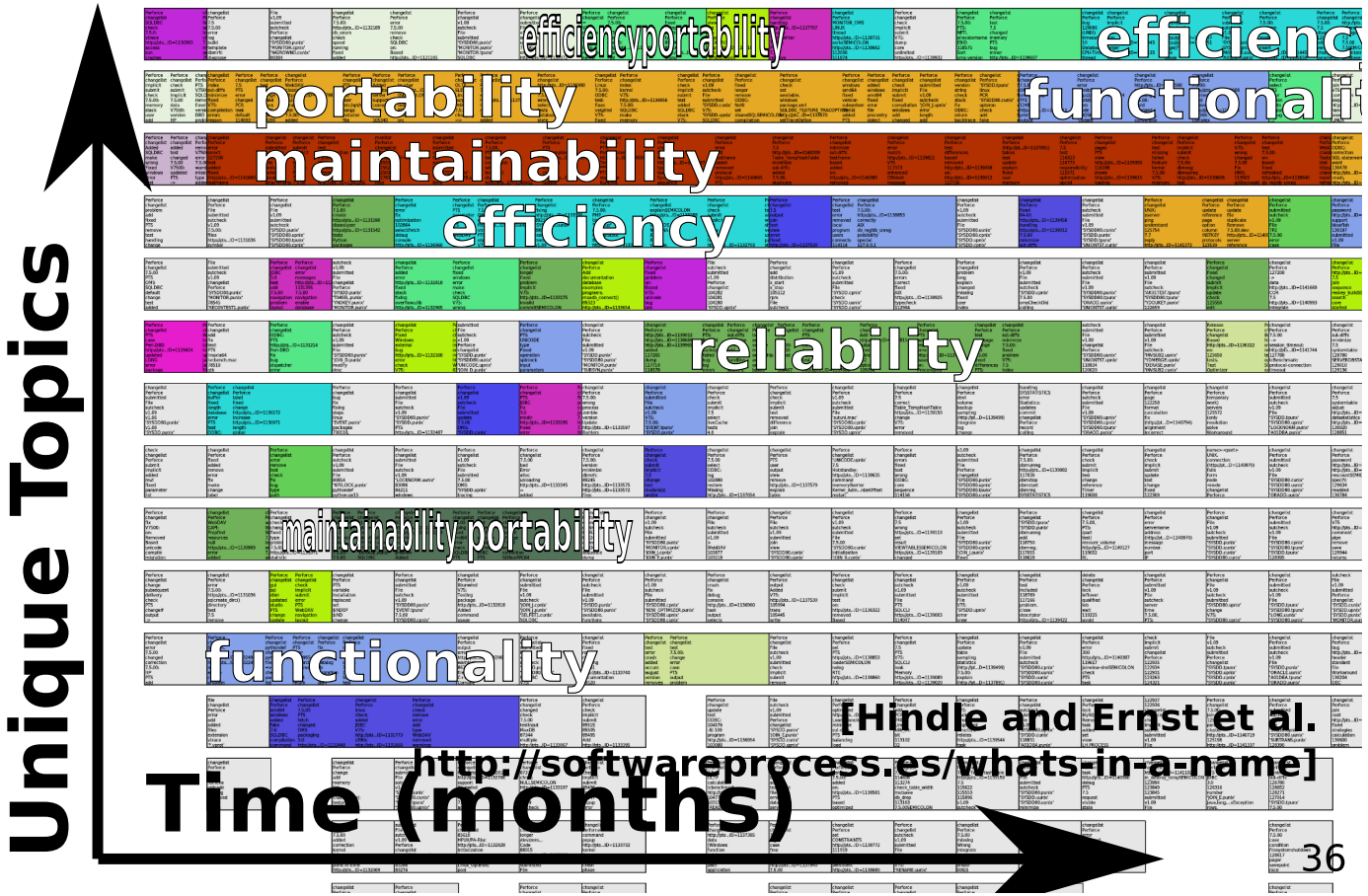


[Godfrey and Zou: TSE-05]

[Many authors]

Software artifact provenance

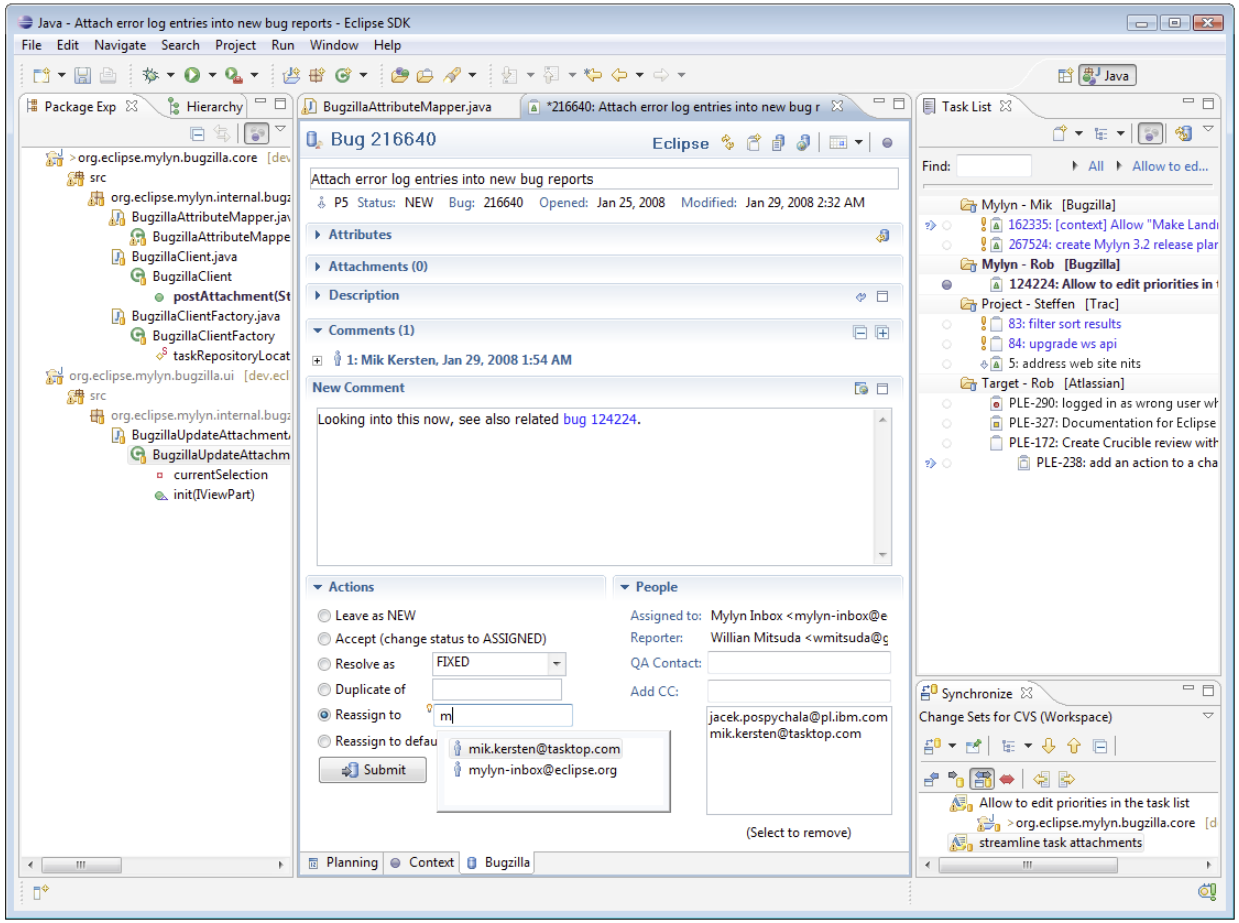
Developer email topic mining



[Hindle, Ernst, Godfrey, Mylopolous: MSR-11, EMSE to appear]

Software artifact provenance

Mylyn and inferring context



[Kersten and Murphy, AOSD-05]

Summary: Software artifact provenance

- Given a chunk of code, test suite, developer email topic, maintenance task, … we want to investigate its origin, evolution, and the supporting evidence:
  - *Who are you, really?*
  - *Where did you come from?*
  - *Does your mother know you're here?*

- Some problems:
  - Ground truth?
  - Artifact linkage?
  - Running matching algorithms on big data? **

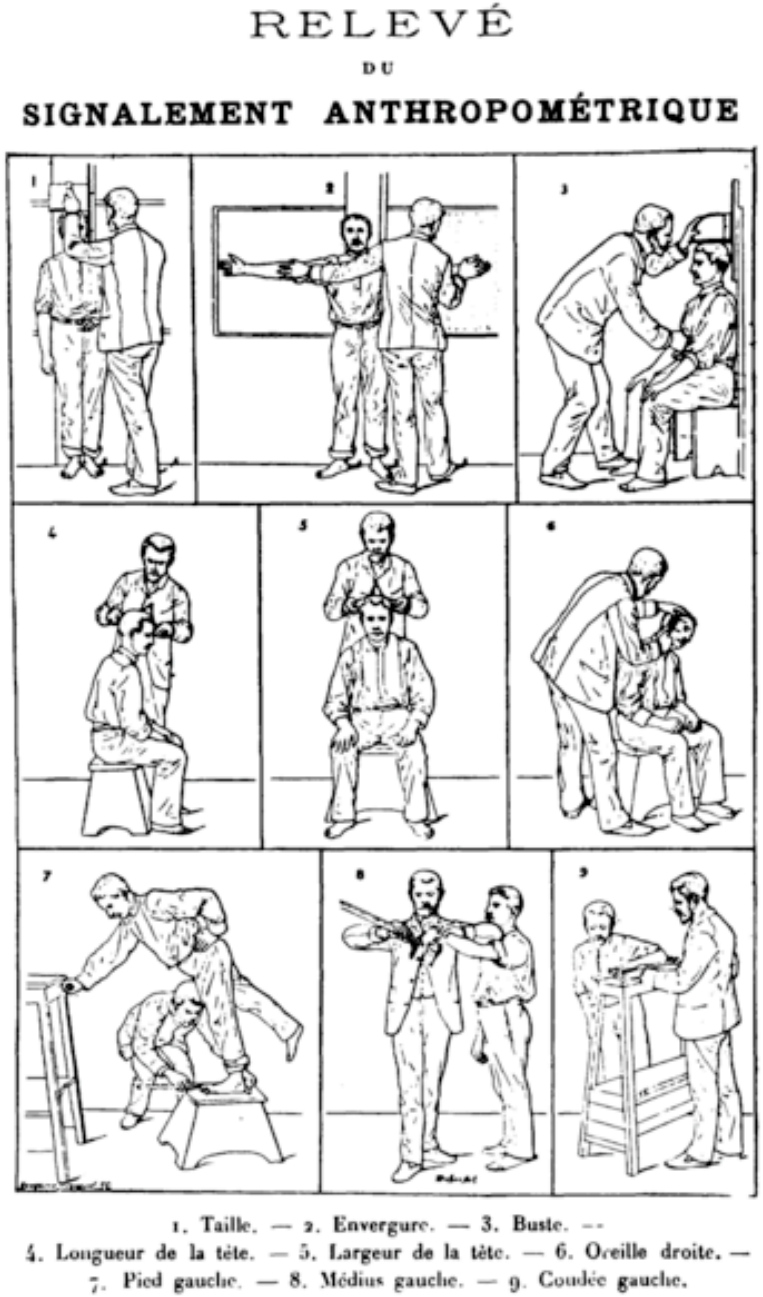
Software Bertillonage

A metaphor for attacking the provenance problem

Who are you?

Alphonse Bertillon (1853-1914)

The nose, as it cannot be disguised, is extremely important in identification. The types above, taking them from the left, show a low, narrow nose, a hooked nose, a straight nose, a snub nose, and a high, wide nose.



Forensic Bertillonage

1. Height
2. Stretch: Length of body from left shoulder to right middle finger when arm is raised
3. Bust: Length of torso from head to seat, taken when seated
4. Length of head: Crown to forehead
5. Width of head: Temple to temple
6. Length of right ear
7. Length of left foot
8. Length of left middle finger
9. Length of left cubit: Elbow to tip of middle finger
10. Width of cheeks

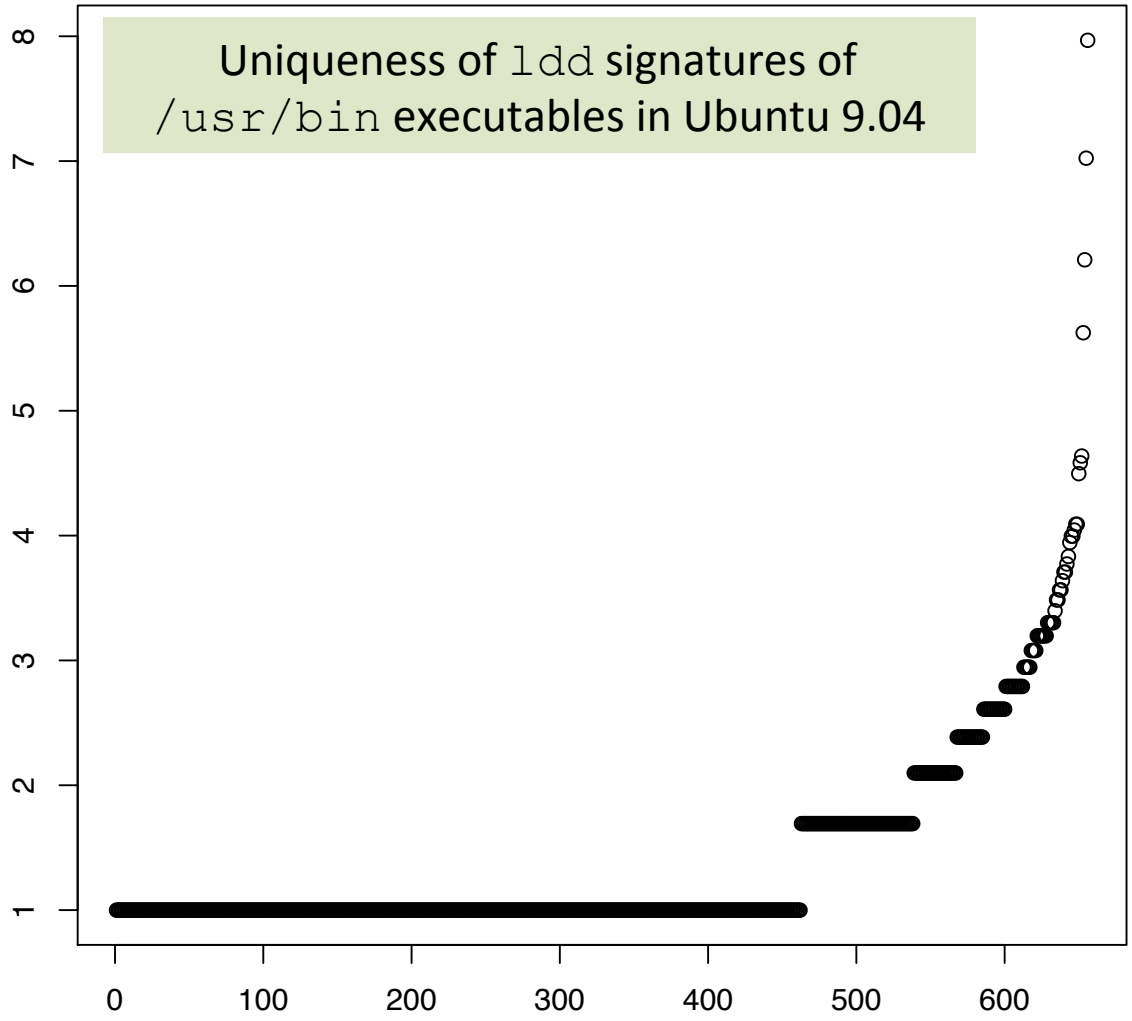
Software Bertillonage

- It's not fingerprinting or DNA analysis!
  - There may be not enough info / too much noise to make positive ID
  - You may be looking for a cousin or ancestor
  - You may be synthesizing something that doesn't exist elsewhere

- A good software Bertillonage metric should:
  - be computationally inexpensive
  - be applicable to the desired level of granularity / prog. language
  - catch most of the bad guys (recall)
  - significantly reduce the search space (precision)

Software Bertillonage

Matching library usage fingerprints



[Hindle, unpublished]

Software Bertillonage

Matching anchored signatures

Q: *Which version of library* `httpclient.jar` *is included in this Java application?*

Our approach:

1. Build master repos of class / method sig hashes from Maven2

2. Compare sig hashes of target app against master repos

[Davis, German, Godfrey, Hindle: MSR-11 and EMSE to appear]

Software Bertillonage

Matching anchored signatures

Q: *Which version of library* `httpclient.jar` *is included in this Java application?*

Our approach:

- Consider only class / method signatures
  - May not have source, compiler options may differ, …
- Build master repos of signature hashes from Maven2
  - Which has gaps, duplication, errors,
- Compare sig. hashes of target application against master repos
  - There will be false positives when API does not evolve
  - … so the effectiveness of narrowing search space depends on how much APIs evolve

[Davis, German, Godfrey, Hindle: MSR-11 and EMSE to appear]


Maven 2

Testing the extractor, sampling the data

- Randomly picked 1000 binary jars (from the 140K) for which there was also a source jar in Maven2
  - # of classes per binary archive: median: 5, max: 2138

- Binary-to-binary matching (bin2bin):
  - Each binary archive matched itself ☺
  - # of exact matches in Maven (due to duplication or unchanging API)
    - median: 5, max: 487

- Binary-to-source matching (bin2src):
  - Correct match was among top matches (median:4, max: 158): 966 times
  - Something else was a better match (test classes): 30 times
  - No matches suggested (compiler/extractor issues): 4 times

Industrial case study

Target system: An industrial e-commerce app containing 84 jars

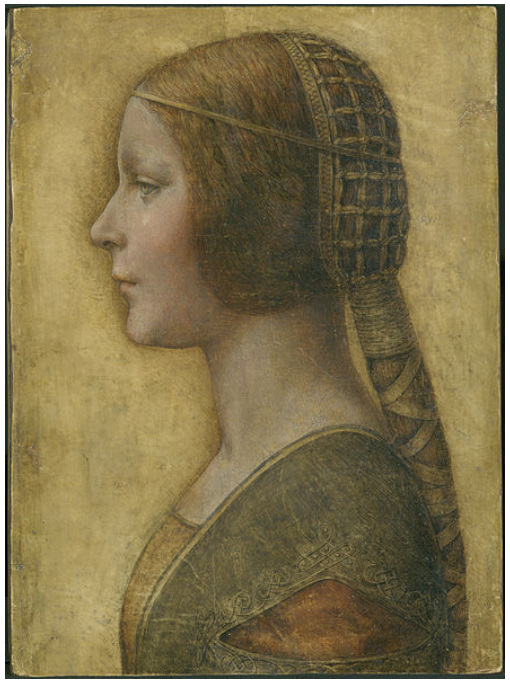
Q: How useful is the signature similarity index in finding the original *binary* archive for a given binary archive?

Q: How useful is the signature similarity index at finding the original *source* archive for a given binary archive?

Summary

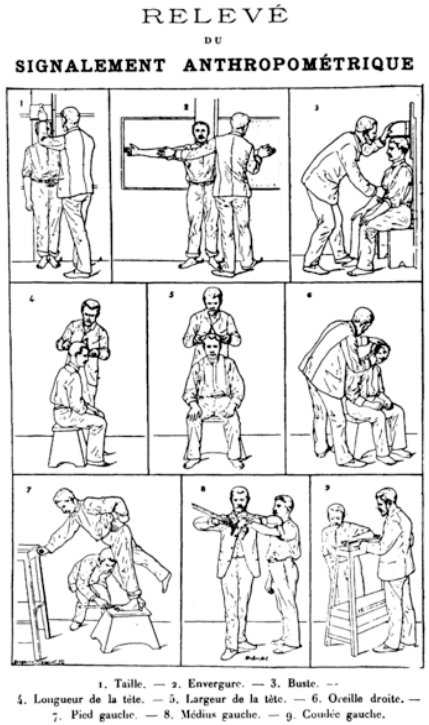
Who are you?

Software artifact provenance is a growing & important problem



Software Bertillonage

Cheap techniques applied widely, then expensive techniques applied narrowly



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