Provenance in the Wild

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What's the Problem?

- What does it mean to collect provenance when you don't control:
  - The data (types, format, organization, structure)
  - The operators
  - The environment in which its processed
- Can you impose/ extract any semantic meaning to provenance when it's collected by a herd of cats?

http://www.newsrealblog.com/wp-content/uploads/2011/04/Herding-Cats.jpg

What do the Cats do?

- They use data in arbitrary formats
  - Flat files
  - Unstructured, semi-structured, badly-structured
  - Proprietary formats
  - The cram twelve different kinds of data into a single container.
- Transformations are arbitrary code
  - Pick your favorite turing-complete language.
  - Apply said language to data.
  - Transformations can depend on the environment.
  - Repeat
- They move data around
  - Download objects from the web
  - Copy, rename objects
  - Replace objects
- They install new software
  - New programs
  - New libraries
  - New compilers

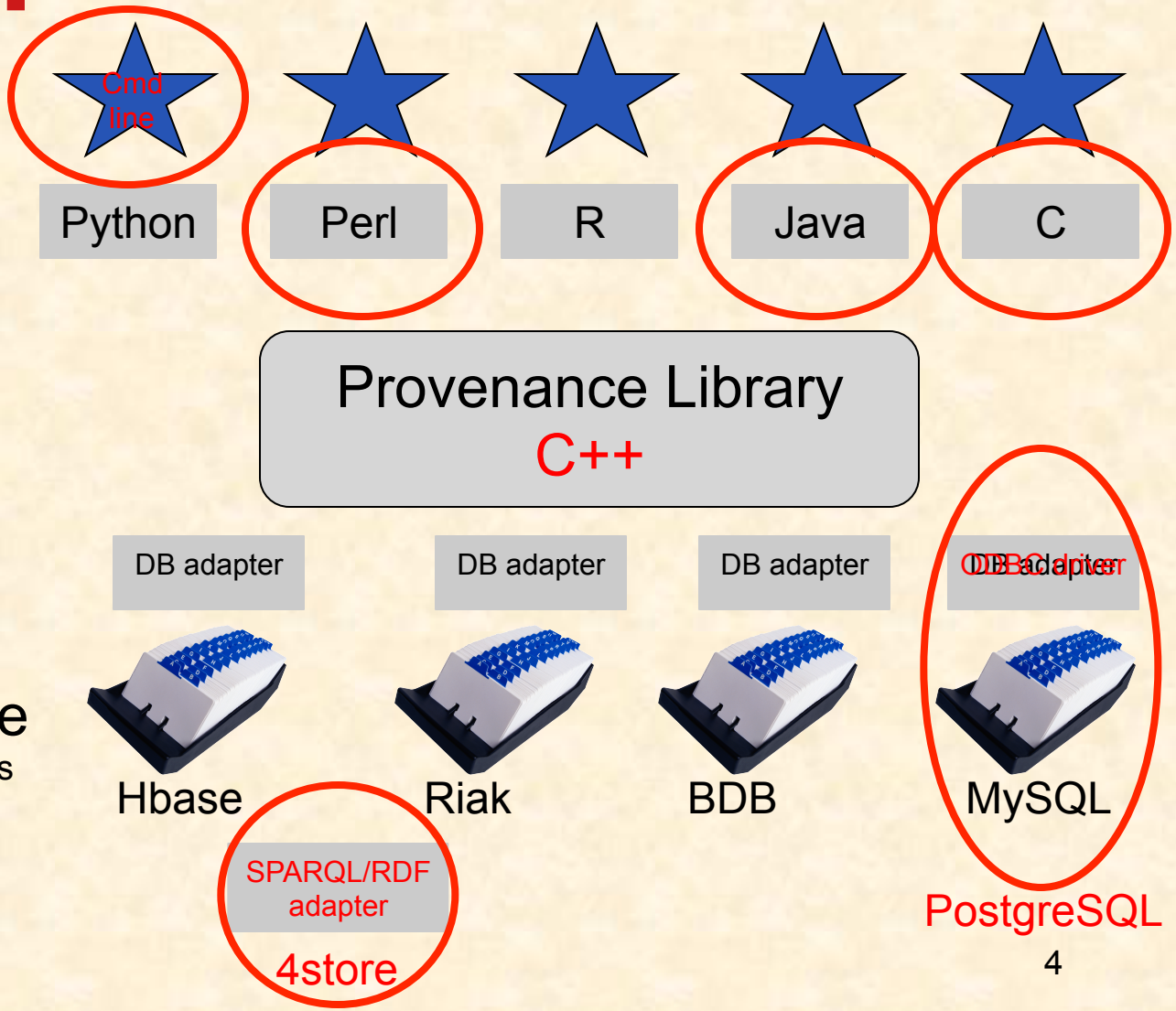
A Proposed Architecture

Applications
In multiple languages

Language adapters

Database adapters

Provenance Store
With multiple implementations



Why do we think this is a good idea?

- Heterogeneous environments are the norm.
- Provenance must span those environments.
- Users and/or applications can:
  - create connections that are implicit or unobservable by software systems.
  - Integrate both static and dynamic dependencies.

Bring provenance to the users rather than the users to the provenance.

Basic Use Model

- Connect to the library: `cpl_attach`
- Disclose provenance
  - Create/lookup objects: `cpl_create_object`, `cpl_lookup_object`
  - Disclose data flow: `cpl_data_flow`
  - Disclose control flow: `cpl_control_flow`
  - Add properties to objects: `cpl_add_property`
- Disconnect from the library: `cpl_detach`

Naming

- Goal is to allow interoperability with minimal coordination.
- Objects are identified by three parameters:
  - Namespace: the application or system component that "owns" the object. Examples: OS, a specific database, workflow engine or application, or a project.
  - Name: local name (unique within a namespace)
  - Type: file, process, or namespace-specific type
  - Version: cycle avoidance algorithm create versions

Additional Automatic Capture

- Capture object creation MAC address so that we can transmit provenance across a network (and still identify it).
- Capture provenance of provenance
  - Ties provenance to a specific instance of an application (e.g., a process).
  - Results in capture of command line arguments (e.g., size of the Java heap).

Use Case: GraphDB Bench

- A benchmark suite (and lots of experiments) to evaluate absolute and relative performance of graph databases.
- Instrument flow from the graph database to the benchmark operators to results.
- Modifications: 270 lines of code (out of 7500 total)
  - Most is cut and paste
- Result: every csv result file has provenance indicating which operations were run, what the source database was, etc.
- Helped us debug benchmark suite, identify missing benchmark results, etc.
- Integration with scripts led us to develop command-line tool to track directory creation, file copies, etc.

Discussion

- Won't this free for all lead to semantically meaningless provenance?
  - Some provenance is better than no provenance.
  - Users/application developers who care are likely to provide more semantically meaningful provenance than is available by less flexible systems.
- What do you do about missing provenance?
  - Some provenance is better than no provenance.
  - "Downstream" applications can connect upstream to bypass provenance oblivious applications.
- Bottom line: We make rope – make it possible to have provenance without requiring that analysts or programmers use specific languages or tools.