# Analysing Debian packages with Neo4j

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debian
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# Self introduction

- Logician by education, 20+ years in research on Theoretical Computer Science and Mathematical Logic at various universities
- Since one year working at Accelia Inc. (CDN/IT Service) on security and machine learning
- Debian Developer since about 20 years, mainly responsible for TeX related packages
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- Complete beginner with graph databases ;-)

# Why graph database?

- Preparing a recommender system for potential clients
- Natural way to represent the available data
- Learning something new
- Highly non-hierarchical data in graph database (many examples have a clear hierarchical structure)
- Reasonable sized (not too small) and meaningful content

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- Reasonable sized (not too small) and meaningful content
- Hip!(?)

# Overview

- Quick introduction to Debian
- Packages in Debian
- Ultimate Debian Database
- Representing packages as a graph (“Database schema”)
- Conversion from UDD to Neo4j
- Sample queries and visualizations
- Concluding remarks

# Introduction to Debian

# Debian

- Open source Linux distribution
- Developed (mostly) by volunteers
- Lots of offspring (e.g. Ubuntu)
- Strict license requirements (DFSG)
- About 31000 source packages building about 82000 binary packages

# Debian releases

## Stable

officially released, security support and updates

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Other releases: point releases for stable, oldstable, historic releases

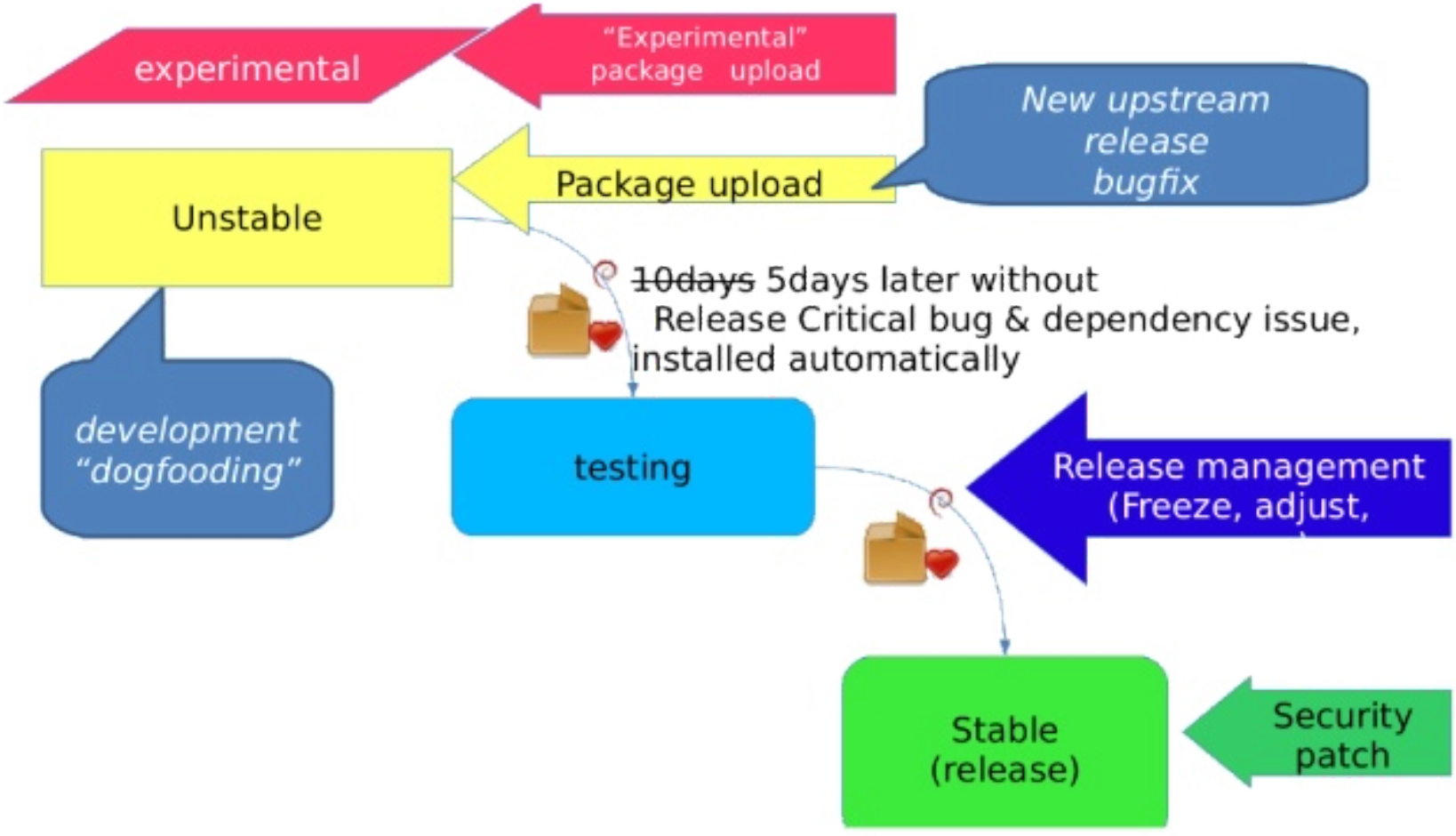
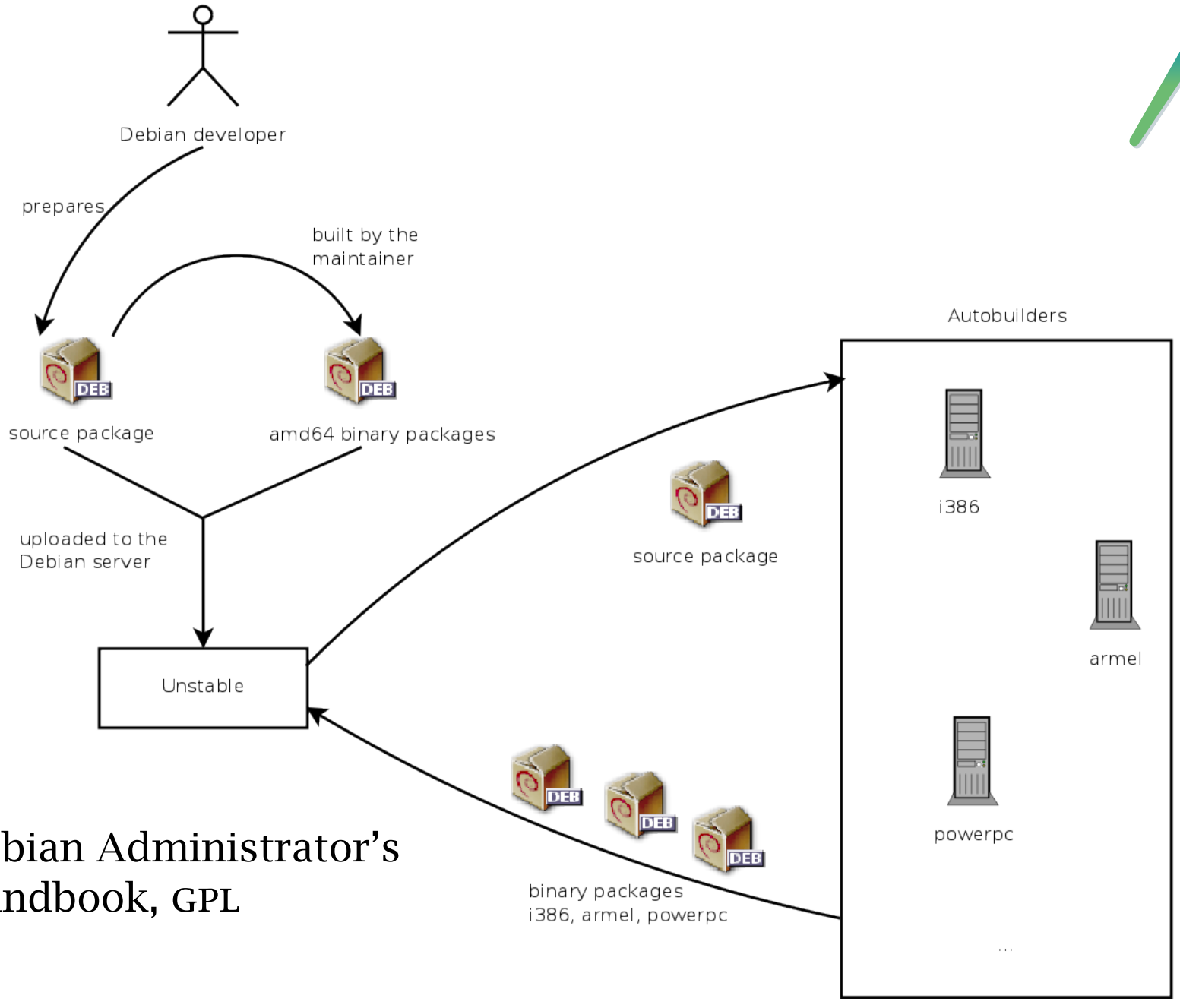



Image by Youhei Sasaki (CC-NC-SA)

# Packages in Debian

# Packages

- source packages and binary packages
- Developer uploads source package (and his own's arch binary package, or source-only upload)
- other architectures are built by auto-builders
- upload is included in unstable (or rejected)




Debian Administrator's Handbook, GPL

# Versions of packages in Debian

- current versions in sid, testing, stable, oldstable, security releases
- intermediate versions that did not end up in a release

## Example

`asymptote` package:
oldstable: 2.31-2, stable: 2.38-2, testing and sid: 2.41-2
other versions uploaded to unstable: 2.35-1, 2.35-2, 2.37-1, 2.38-1, 2.41-1, …

# Version numbers

[epoch:]upstream_version[-debian_revision]

## Examples

asymptote 2.41-2:

- upstream_version: 2.41
- debian_release: 2

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[epoch:]upstream_version[-debian_revision]

## Examples

asymptote 2.41-2:
  upstream_version: 2.41
  debian_release: 2

musixtex 1:1.20.ctan20151216-4:
  epoch: 1
  upstream_version: 1.20.ctan20151216
  debian_release: 4

# Components of a package

- Maintainer: who is responsible
- Uploaders: who is allowed to upload packages
- Section, Priority: relevant for structuring the huge set of packages
- Version
- dependency declarations
- lots of further fields

# Some caveats

- one source package can build many different binary packages
- the names of source package and binary package are not necessary the same (necessarily different when building multiple binary packages)
- binary packages of the same name (but different version) can be built from different source packages

# Dependencies

## for source packages

Build-Depends, Build-Depends-Indep, Build-Depends-Arch, Build-Conflicts, Build-Conflicts-Indep, Build-Conflicts-Arch

## for binary packages

Depends, Pre-Depends, Recommends, Suggests, Enhances, Breaks, Conflicts

## various formats of dependencies

```
Relation: pkg
Relation: pkg (<< version)
Relation: pkg | pkg
Relation: pkg [arch1 arch2]
```

# Ultimate Debian Database UDD

# The UDD

Imports data from a variety of sources:

- packages and source files, from both Debian and Ubuntu
- bugs from the Debian BTS
- popularity contest
- history of uploads
- history of migrations
- lintian (conformance check tool)
- orphaned packages
- debtags, carnivore, Ubuntu bugs, NEW queue, DDTP translations, …

# The UDD schemata

https://udd.debian.org/schema/

# UDD schemata

- highly de-normalized
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- lots of duplication without connections

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- highly de-normalized
- good example of grown-over-time schemata
- lots of duplication without connections
- a pleasure for any SQL fetishist ;-)

# Can we put the UDD into a Graph Database?

# Entities: first steps: source and binary packages

## source builds binary relation

Use different node types for (versioned) source and binary package; link increasing versions

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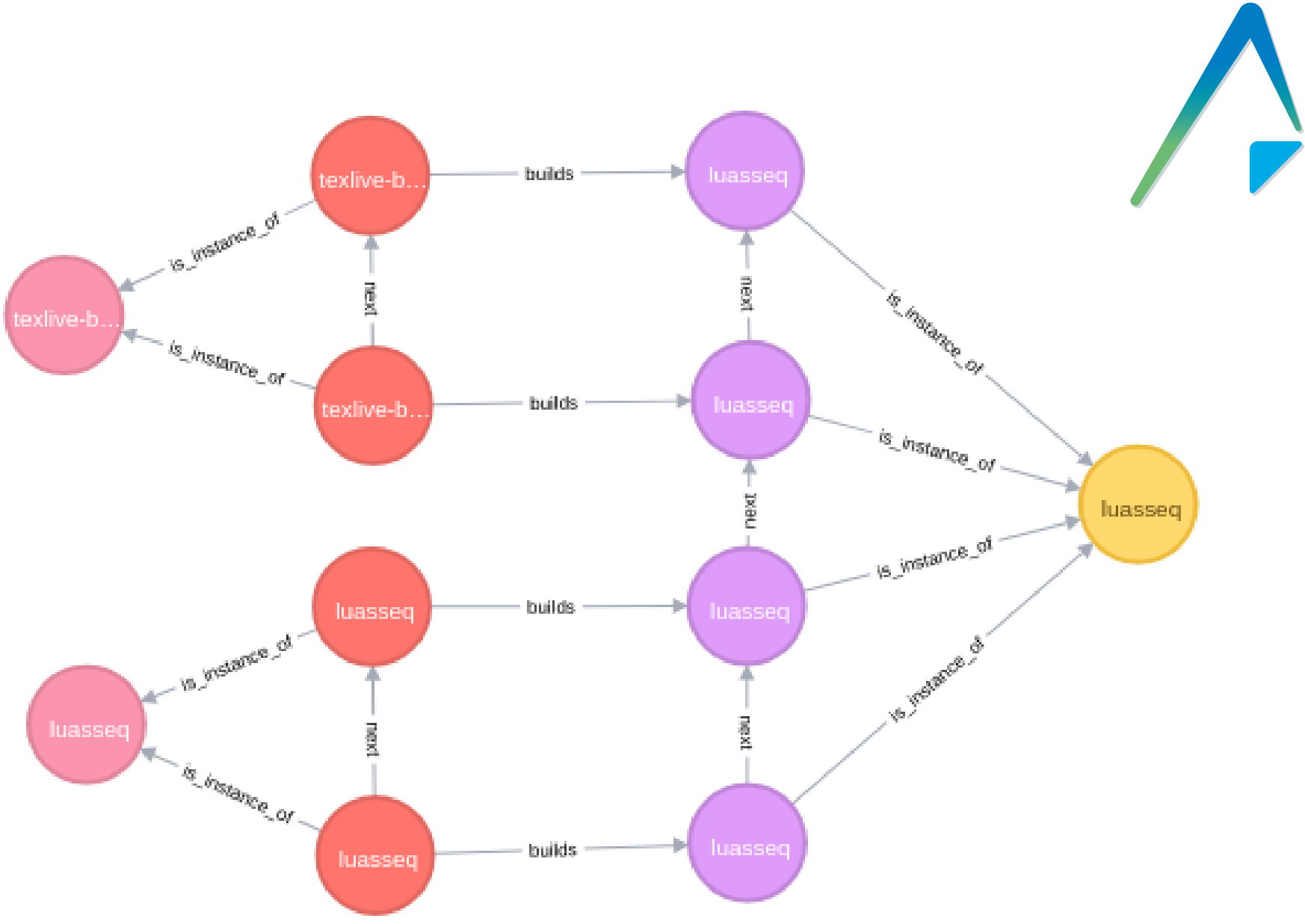
Use different node types for unversioned and versioned source and binary packages

## Node and relations (for now)

Nodes: `sp` (source package), `vsp` versioned source packages, `bp` (binary package), `vbp` versioned binary package

```
vsp -[:is_instance_of]-> sp
vbp -[:is_instance_of]-> bp
    sp -[:builds]-> bp
    vbp -[:next]-> vbp
    vsp -[:next]-> vsp
```

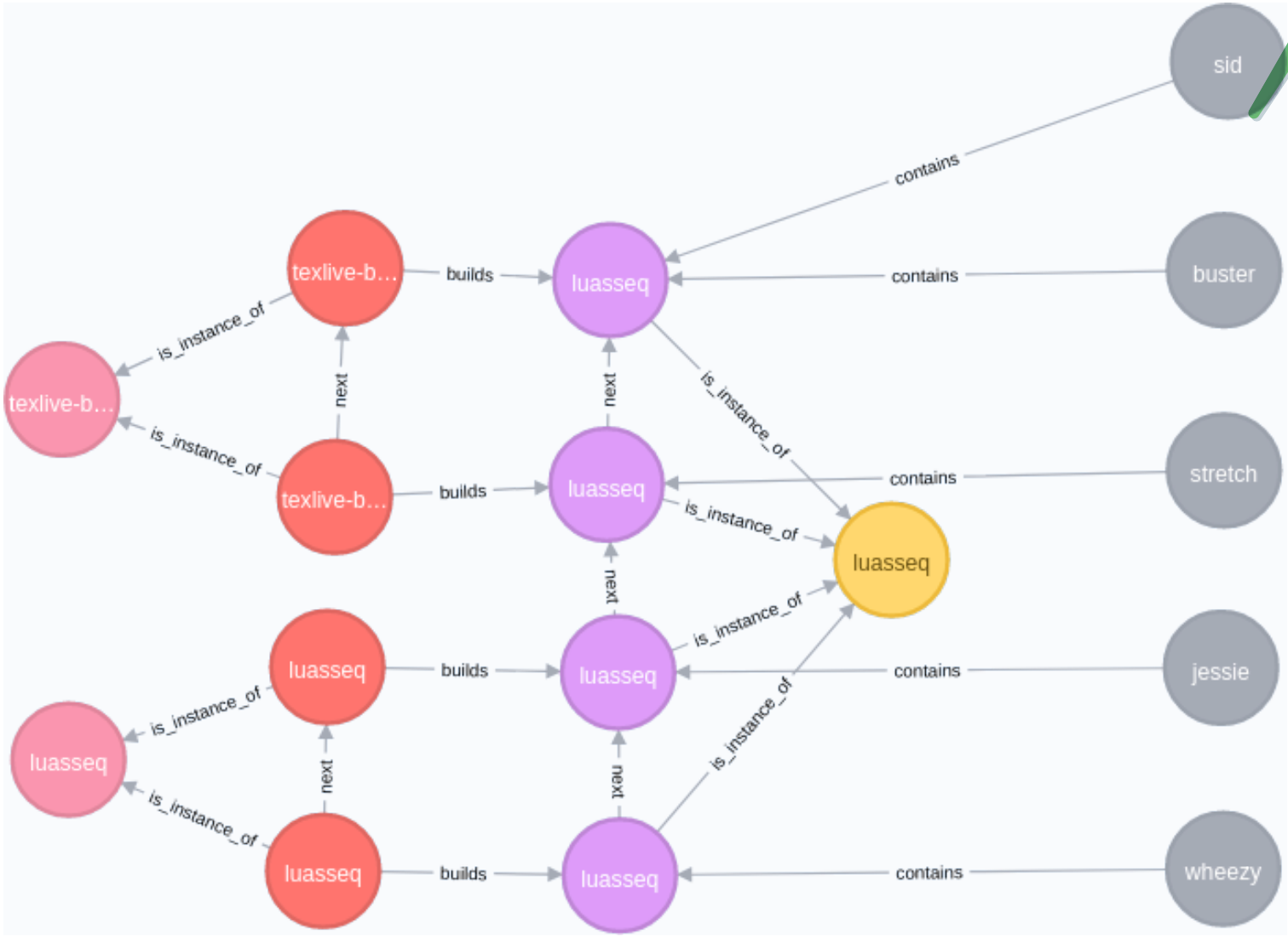

texlive-b…
builds
luasseq
is_instance_of
texlive-b…
next
is_instance_of
texlive-b…
builds
luasseq
next
is_instance_of
luasseq
next
luasseq
builds
luasseq
is_instance_of
luasseq
is_instance_of
next
luasseq
builds
luasseq
next
is_instance_of

# Suites

Register the binary packages that are included in a suite (release):

Node type: `suite`

```
suite -[:contains]-> vbp
```

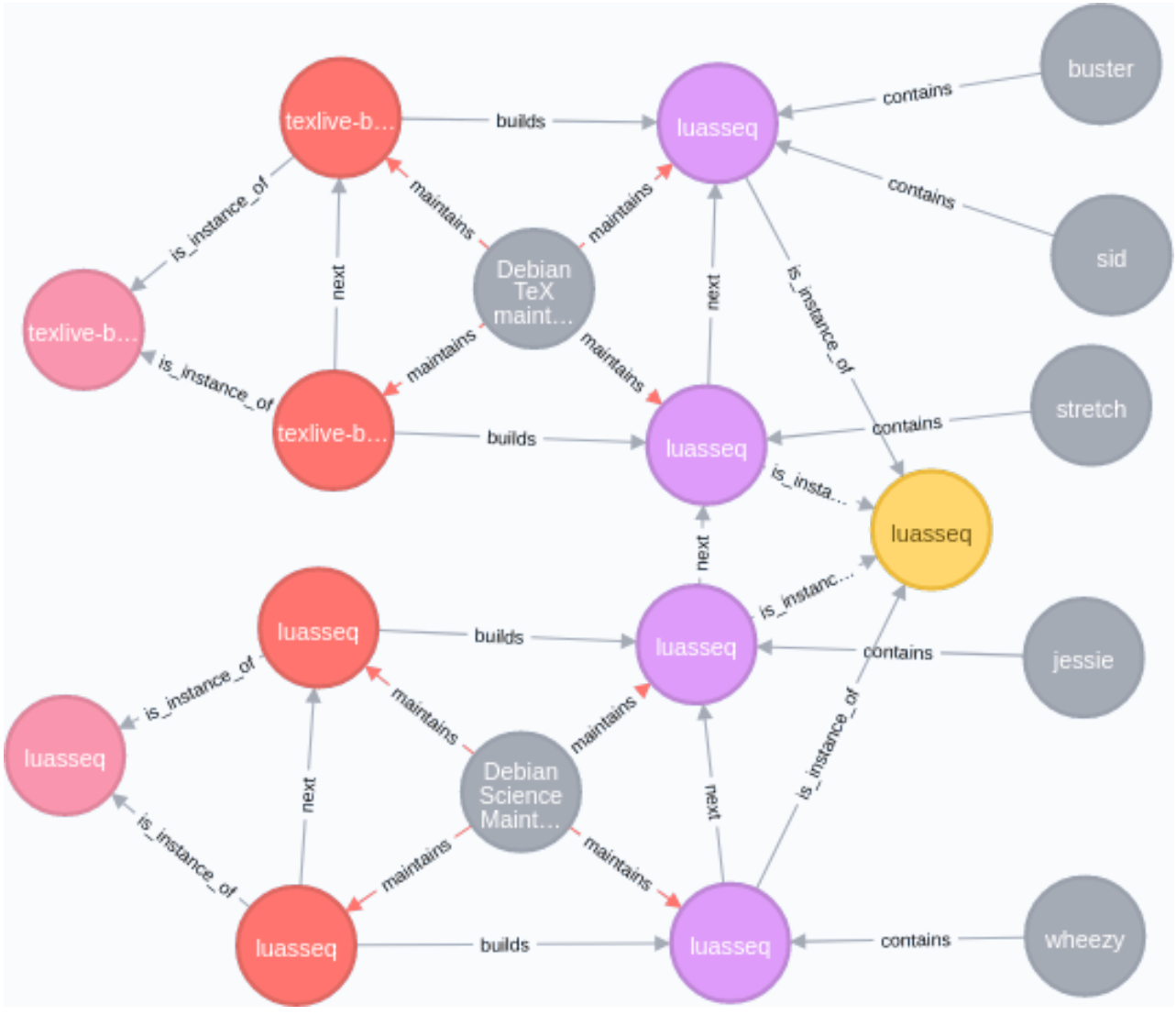

sid
contains
texlive-b…
builds
luasseq
contains
buster
is_instance_of
texlive-b…
next
next
is_instance_of
is_instance_of
texlive-b…
builds
luasseq
contains
stretch
is_instance_of
luasseq
next
luasseq
builds
luasseq
is_instance_of
contains
jessie
luasseq
is_instance_of
next
next
is_instance_of
is_instance_of
luasseq
builds
luasseq
contains
wheezy

# Maintainers

Register the maintainers of binary and source packages:

Node type: `mnt`

```
mnt -[:maintains]-> vbp
mnt -[:maintains]-> vsp
```

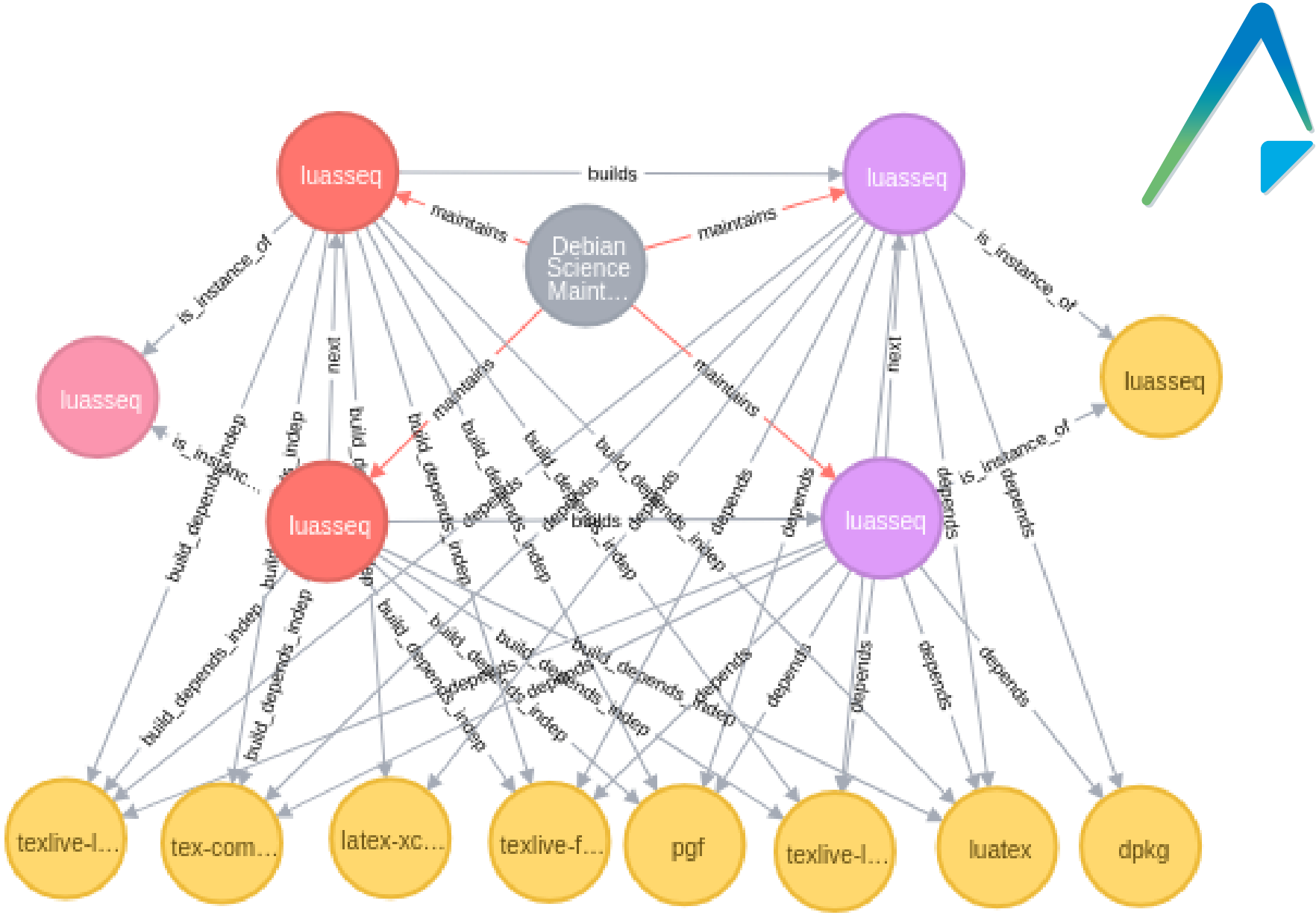

texlive-b…
builds
luasseq
contains
buster
is_instance_of
maintains
maintains
Debian TeX maint…
next
contains
sid
texlive-b…
is_instance_of
maintains
maintains
next
is_instance_of
texlive-b…
builds
luasseq
contains
stretch
is_insta…
luasseq
next
luasseq
builds
luasseq
is_instanc…
contains
jessie
is_instance_of
maintains
maintains
luasseq
Debian Science Maint…
next
is_instance_of
is_instance_of
maintains
maintains
luasseq
builds
luasseq
contains
wheezy

# Dependencies

Current state: dependency is represented as relation between a versioned (source/binary) package and *unversioned* binary package with additional properties (type of relation, version number)

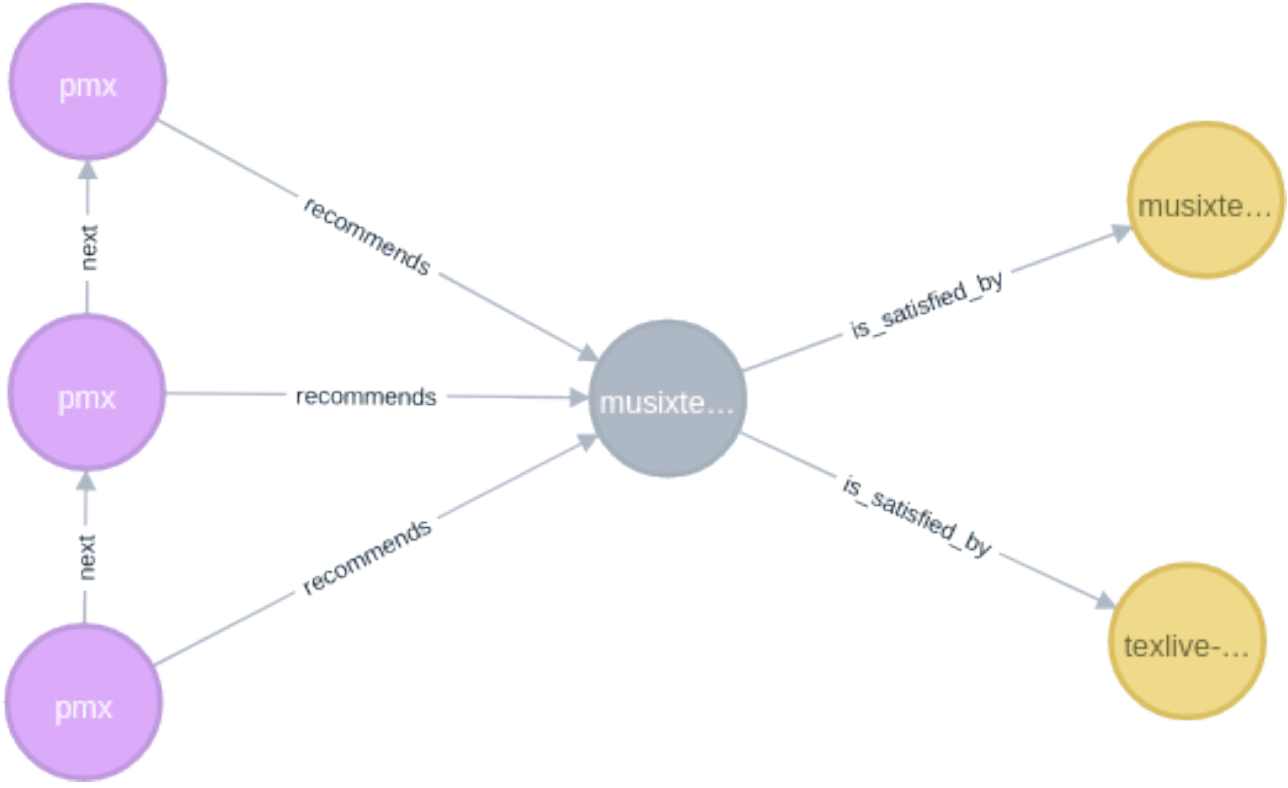
```
vbp -[:depends reltype: TYPE, relversion:
                    VERS]-> bp
```

Where TYPE is one of <<, <=, ==, >=, >>.
If it is an *unversioned* relation TYPE is none, and `relversion` is 1.


luasseq
builds
luasseq
maintains
maintains
Debian Science Maint...
is_instance_of
luasseq
maintains
maintains
next
next
is_instance_of
luasseq
luasseq
builds
luasseq
is_instance_of
build_depends_indep
depends
depends_indep
texlive-l...
tex-com...
latex-xc...
texlive-f...
pgf
texlive-l...
luatex
dpkg

# Alternative dependencies

Add a new node type `altdep` and a new relation `is_satisfied_by`.




`name` of the `altdep`:

```
musixtex (>= 1:0.98-1) | texlive-music
```

# Summary of Nodes and Relations

# Nodes and relations

## Nodes and attributes

- `mnt`: `name`, `email`
- `bp`, `sp`, `suite`, `altdeps`: `name`
- `vbp`, `vsp`: `name`, `version`

## Relations and attributes

- `breaks`, `build_conflicts`, `build_conflicts_indep`, `build_depends`, `build_depends_indep`, `conflicts`, `depends`, `enhances`, `is_satisfied_by`, `pre_depends`, `provides`, `recommends`, `replaces`, `suggests`: Attributes: `reltype`, `relversion`
- `builds`, `contains`, `is_instance_of`, `maintains`, `next`: no attributes

# Number of entities

## Nodes

suite: 28, mnt: 3510, altdeps: 8852, sp: 31889, bp: 154784, vsp: 81567, vbp: 247419

Total: 528049

## Relations

breaks: 58140, build_conflicts: 3377, build_conflicts_indep: 32, build_depends: 587087, build_depends_indep: 103097, builds: 234897, conflicts: 45402, contains: 358341, depends: 1843653, enhances: 6294, is_instance_of: 328986, is_satisfied_by: 22516, maintains: 328986, next: 162162, pre_depends: 11998, provides: 109171, recommends: 96187, replaces: 71535, suggests: 117656

Total: 4489516

# Conversion from UDD to Neo4j

# Conversion step 1: Getting the data

- UDD has a public mirror: `public-udd-mirror.xvm.mit.edu`
- Postgresql DB, use Perl, `DBI::PG` to get the various tables

# Conversion step 2: Into Neo4j

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- generate for each node/relation a `csv` with ids
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- run `neo4j-import`, takes a few seconds!

```
$ neo4j-import ...
...
IMPORT DONE in 11s 63ms.
Imported:
  528049 nodes
  4489516 relationships
  7540882 properties
Peak memory usage: 521.28 MB
```

# How to generate node/relation csv?

- Perl program parsing the `csv` files from psql
- generates a huge hash with all information (in fact more than currently evaluated)
- for each item generated a unique UUID
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Warning: the script needs currently about >16G of memory. Killed my laptop a few times.

# Sample queries

# Checking build-deps

Find all packages in Jessie that build depends on some version of `tex-common`:

```
match (BP:bp)<-[:build_depends]-(VSP:vsp)-[:builds]->
  (VBP:vbp)<-[:contains]-(S:suite)
  where BP.name="tex-common" and S.name="jessie"
  return BP, VSP, VBP, S
```

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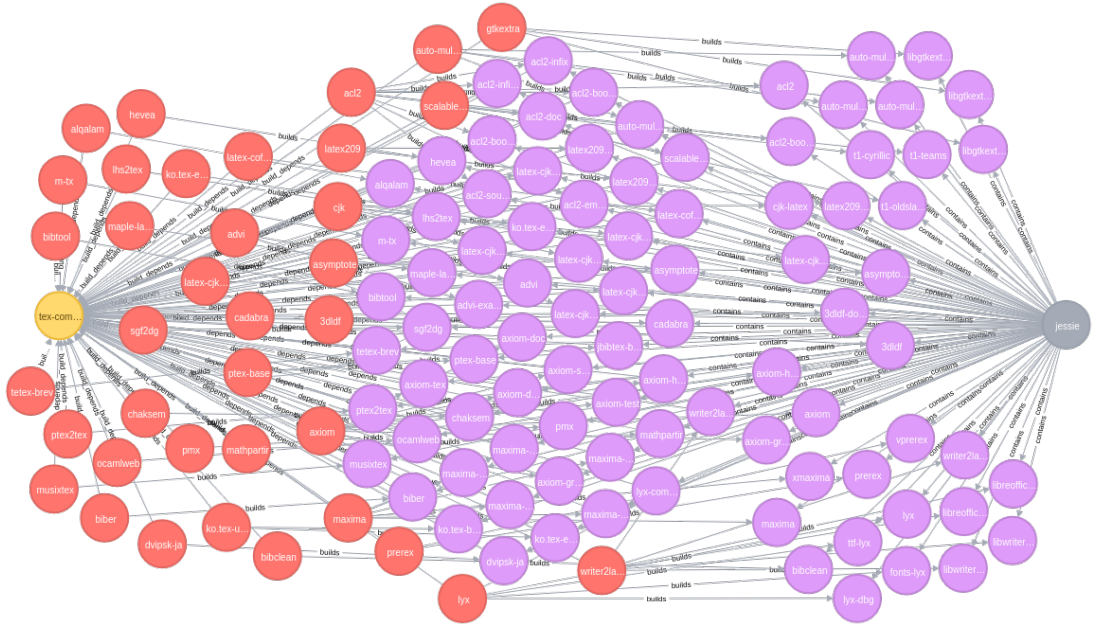

# Most depend on package in sid

Number of packages in sid that build depend on *X*, ordered by number of depending packages

```
match (S:suite)-[:contains]->(VBP:vbp)-[:builds]-
 (VSP:vsp)-[:build_depends]-(X:bp)
 where S.name = "sid"
 with X.name as pkg,count(VSP) as cntr
   return pkg,cntr order by -cntr
```

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```

gives: debhelper: 55438, dh-python: 9289, pkg-config: 9102

# Conclusions

# Lessons learned

- Finding a good representation is tricky – see below for future work
- Don’t use Cypher for importing any reasonable amount of data
- Conversion from an old/grown RDB is a pain
- Starting from scratch for a new application is fun
- Visualization in Chrome/Firefox is often a pain – depending on version and OS either the one or the other is better (why? no idea!)

# Future work – time allowing

- Include the bug database
- Include also intermediate releases by parsing the UDD table for uploads
- Rework dependency management
  I don't like the current status: I would prefer if the dependency points into the tree of vbp and has only an attribute for the relation type.
- After all that, rewrite the UDD dashboard and see how far it simplifies the SQL code.
- More graph theoretic: find dependency cycles, connected components etc

# Sources

Sources for the scripts as well as the slides are available on the Github project:

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