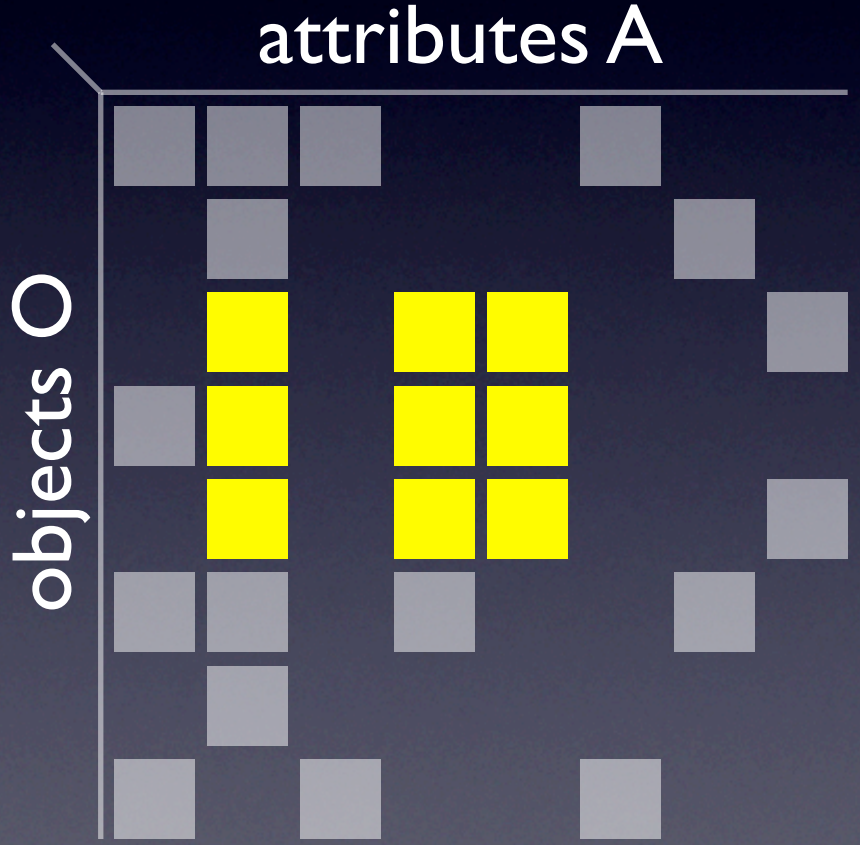
Formal Concept Analysis in Java

Daniel Götzmann

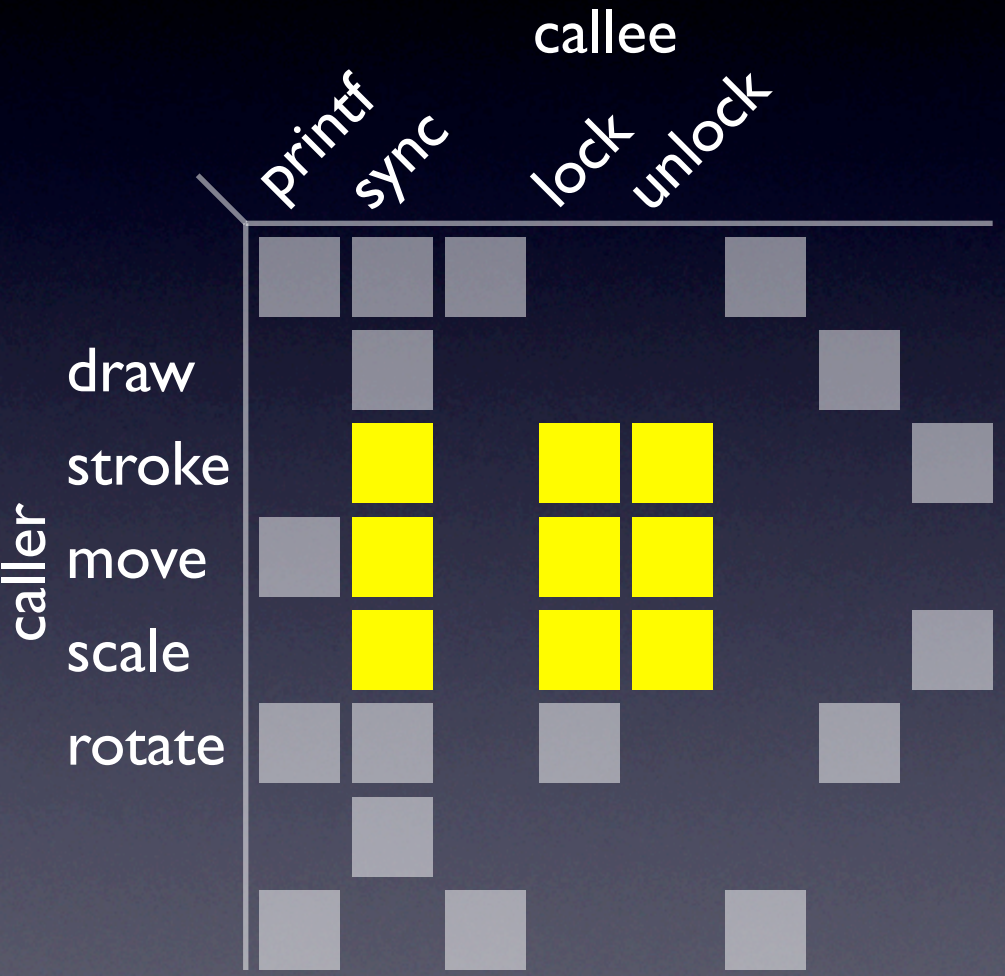
Concept Analysis



context $R \subseteq O \times A$

want to compute concepts

Concept Analysis

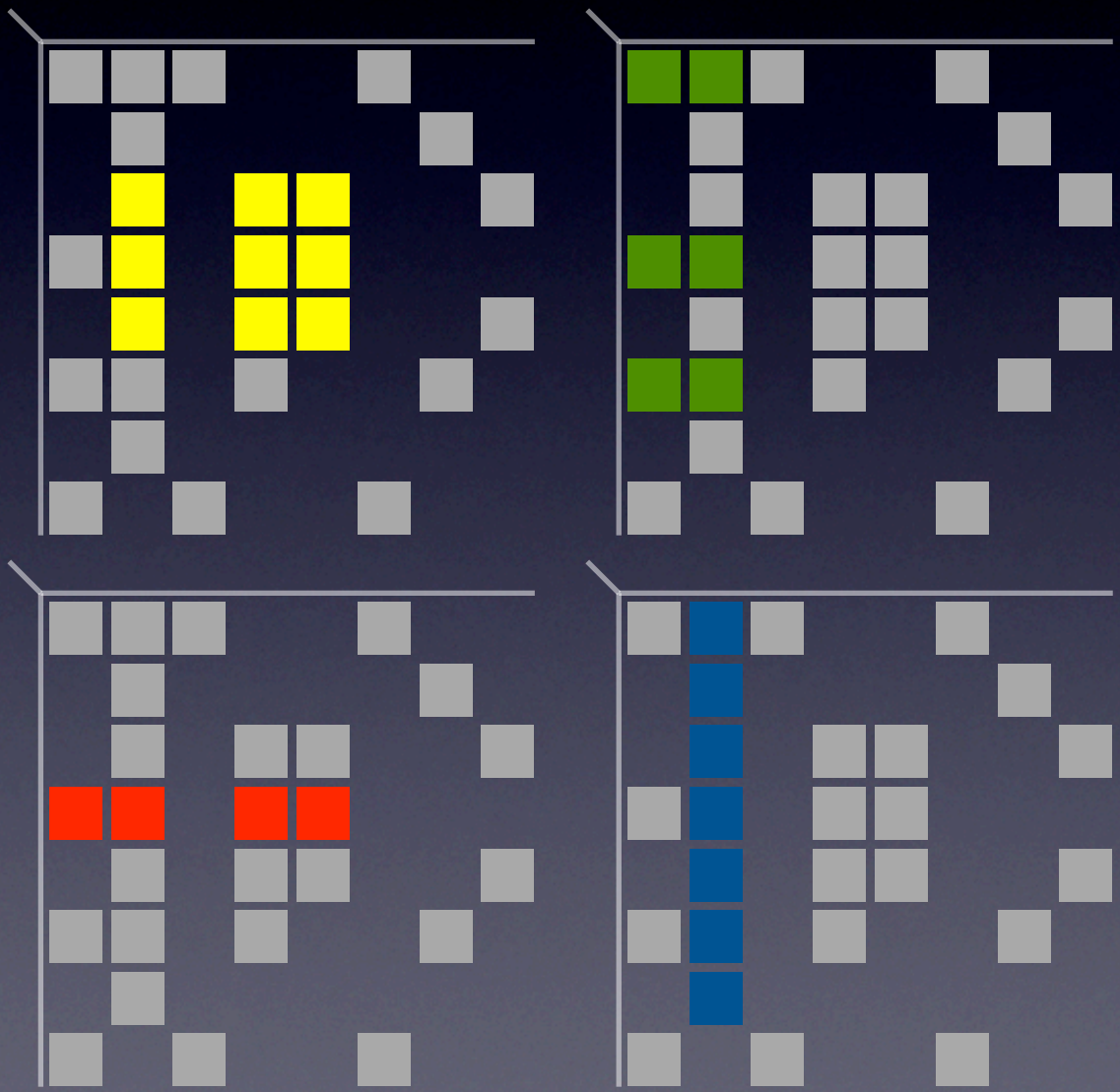


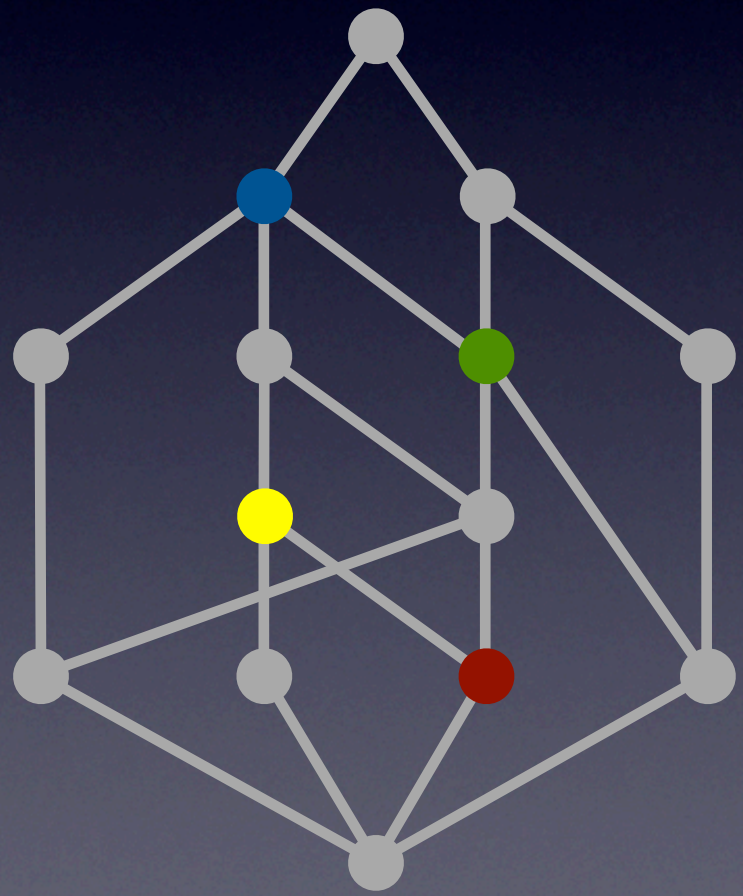
context R ⊆ O x A

want to compute concepts

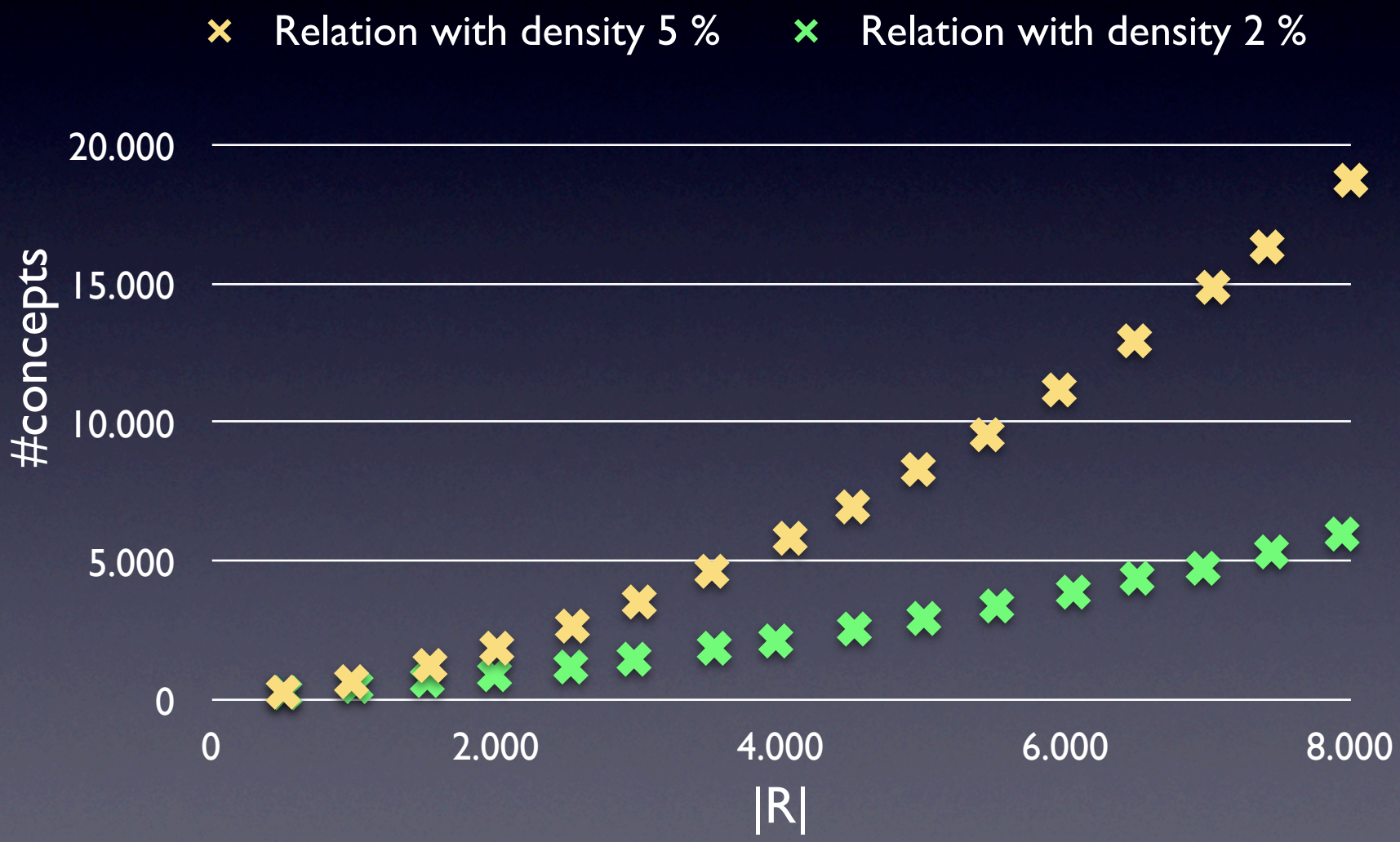
({stroke, move, scale},
{sync, lock, unlock})

Concept Lattice

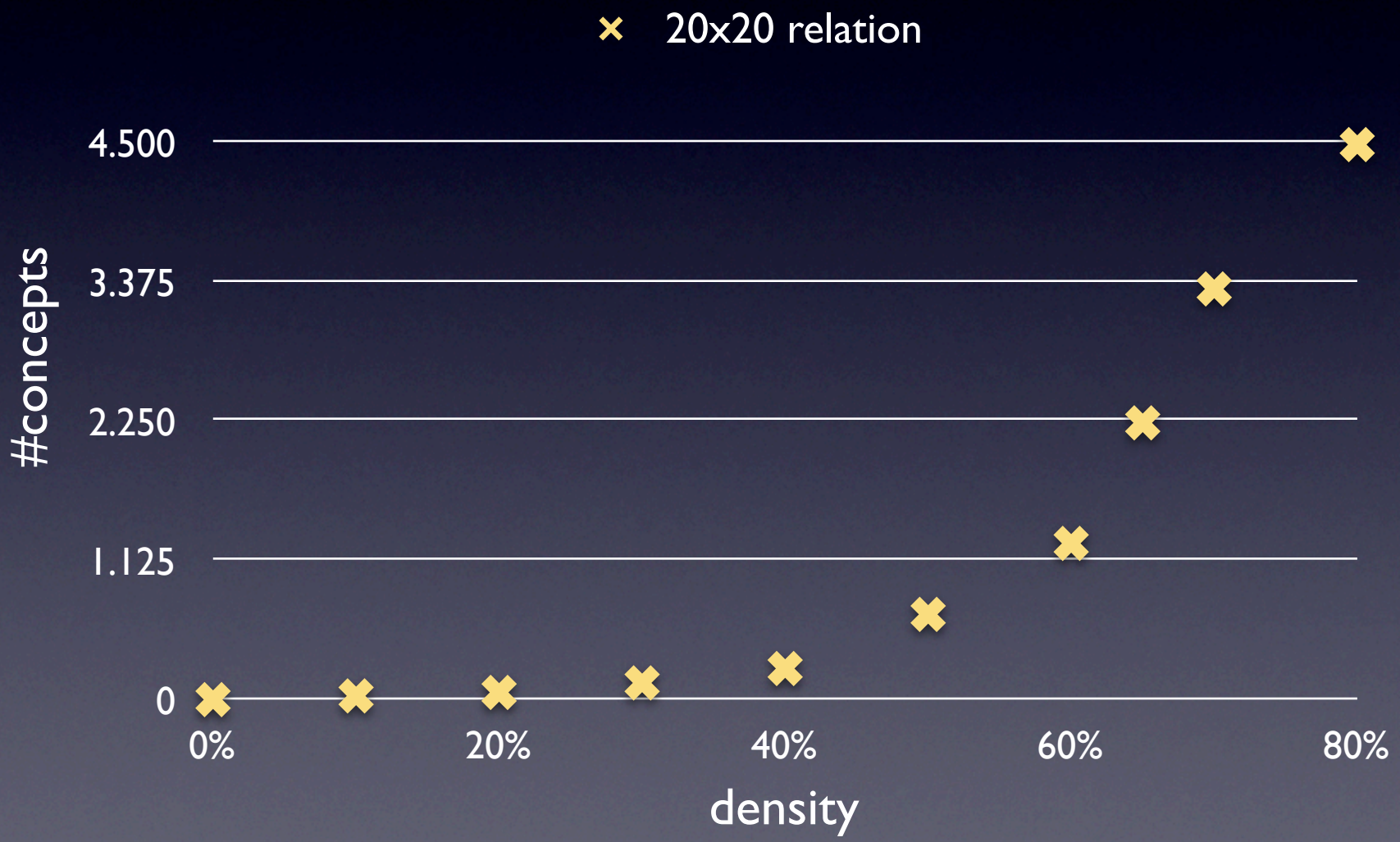




Lattice Size

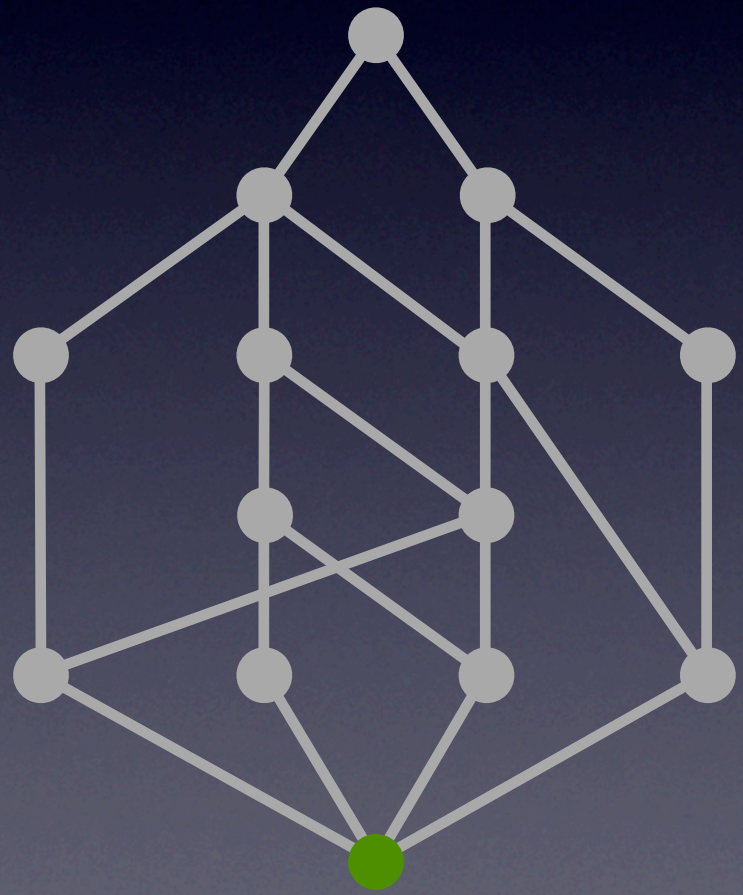


Worst Case Scenario



Algorithm

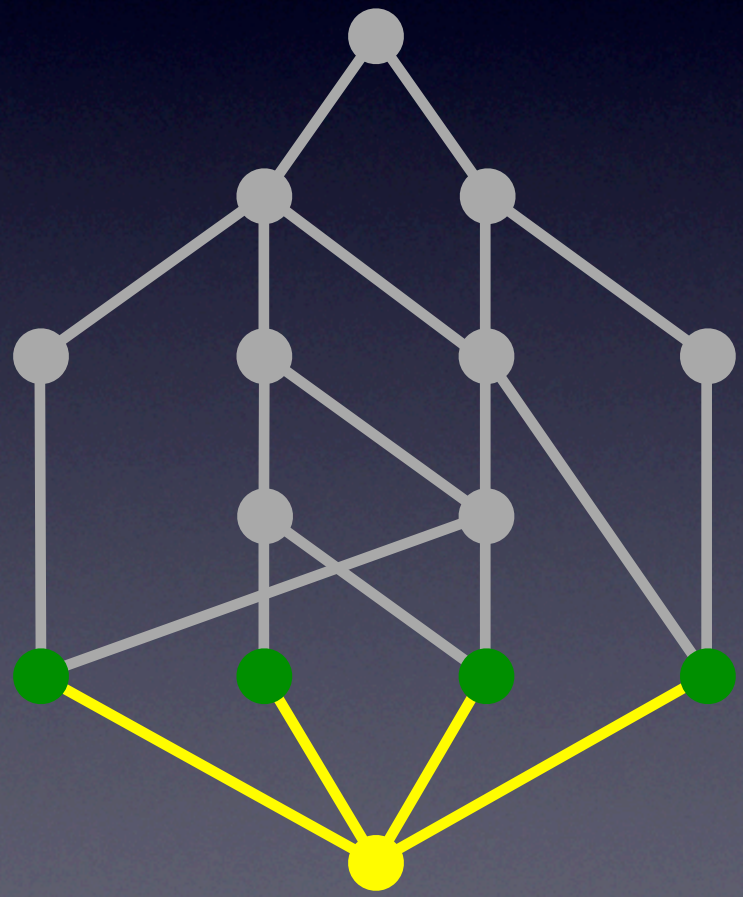
start at the bottom



Algorithm

start at the bottom

compute the upper neighbors recursively



Algorithm

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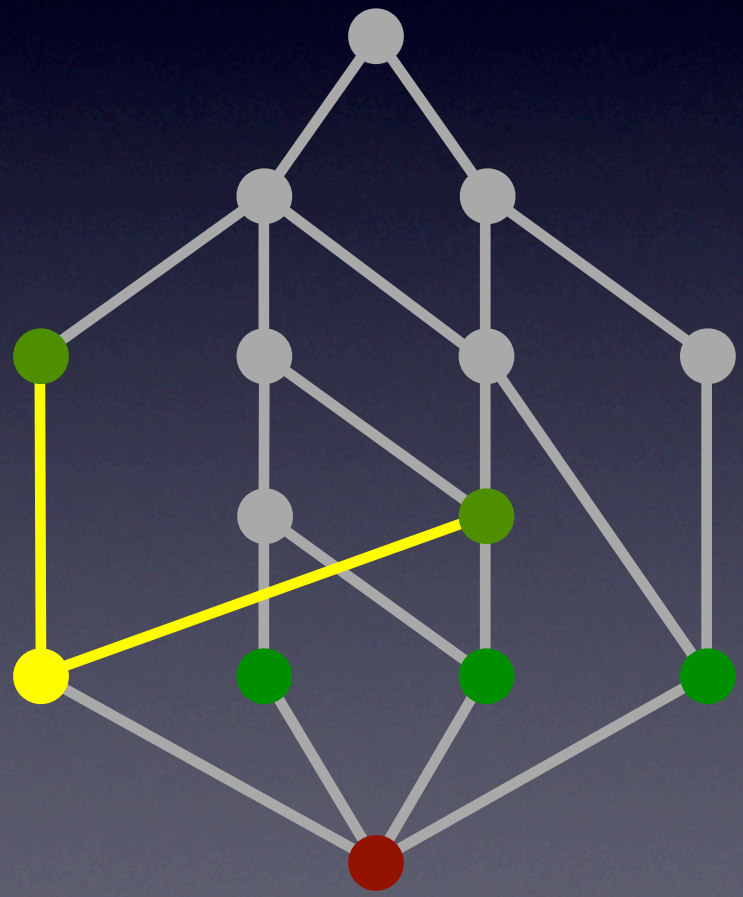
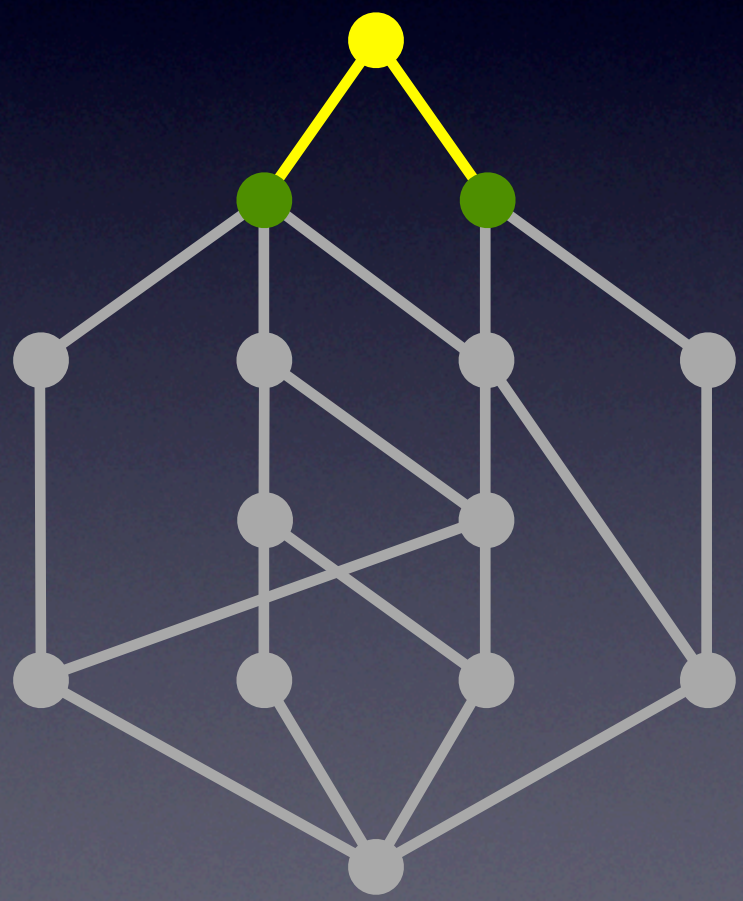


Algorithm

start at the bottom

compute the upper neighbors recursively

alternatively: start at the top



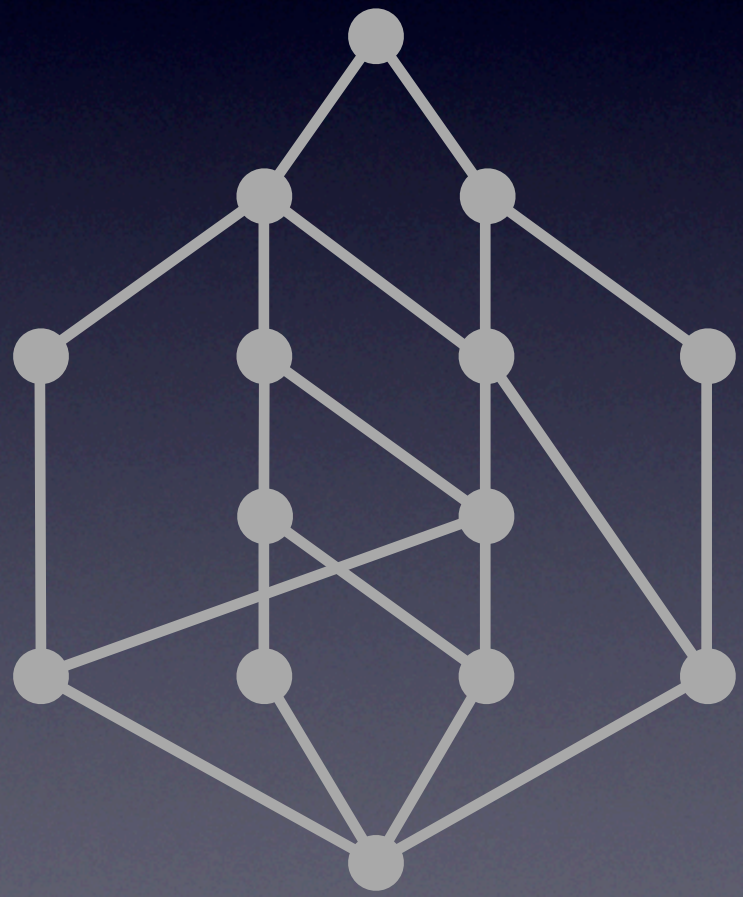
Algorithm

start at the bottom

compute the upper neighbors recursively

alternatively: start at the top

same idea for the edges

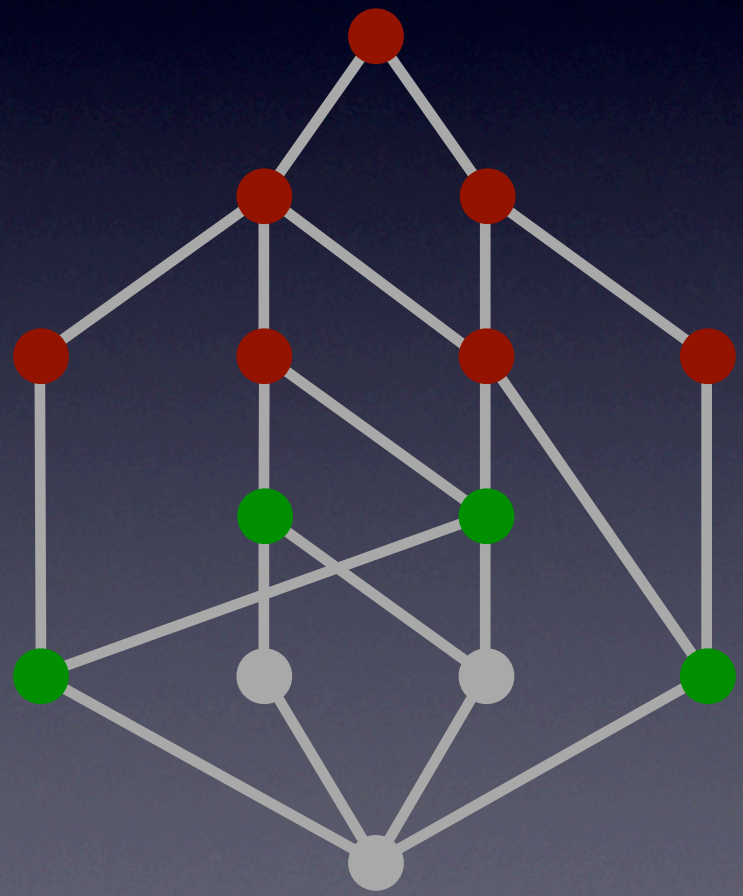


Implementation

iterators

don‘t pre-compute the entire lattice

less data in memory



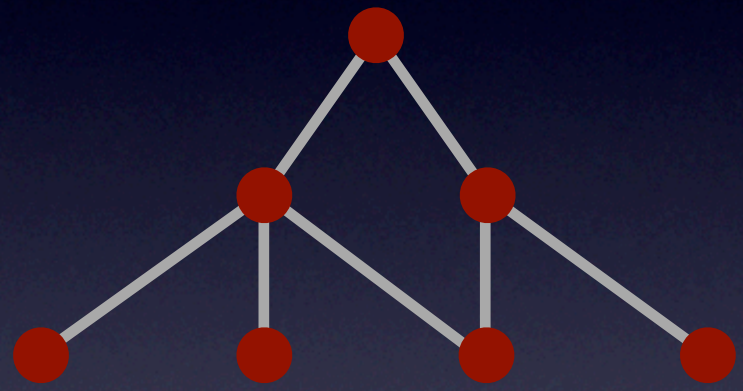
Implementation

iterators

don‘t pre-compute the entire lattice

less data in memory

only compute upper/lower parts of the lattice



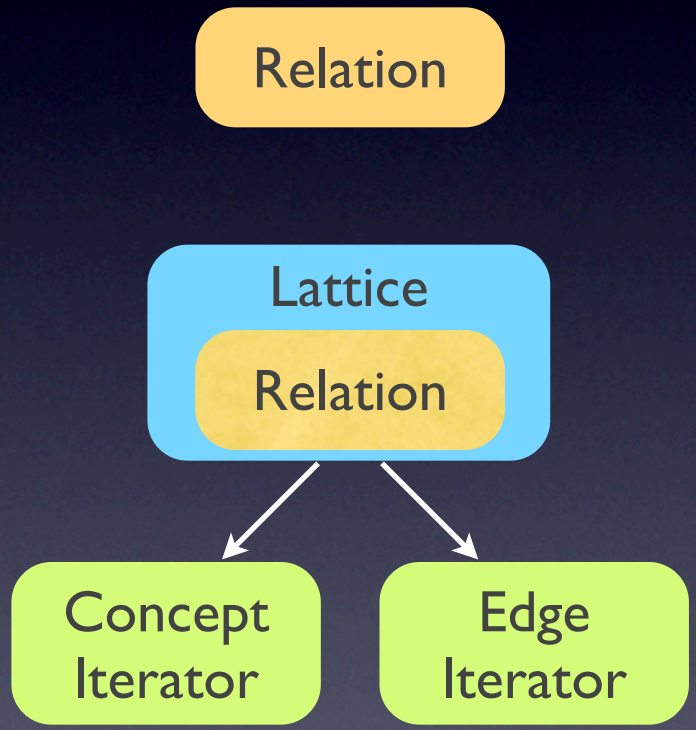
How to use it

generate a relation

generate a lattice for that relation

get an iterator from that lattice

use iterator as usual



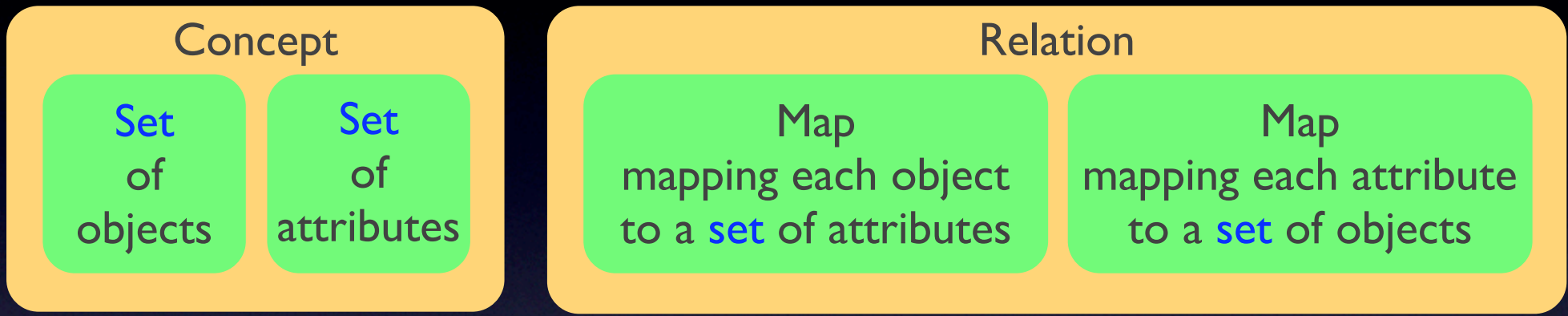
How to use it

```
Lattice lattice = new HybridLattice (rel);
Iterator<Concept> it = lattice.conceptIterator
                        (Traversal.TOP_ATTRSIZE);

while (it.hasNext()) {
    Concept c = it.next();
    System.out.println(c.toString());
}
```

How to use it

```
Lattice lattice = new HybridLattice (rel);
Iterator<Concept> it = lattice.conceptIterator
                              (Traversal.TOP_ATTRSIZE);

while (it.hasNext()) {
    Concept c = it.next();
    if (c.getAttributes().size > 10)
        break;
    System.out.println(c.toString());
}
```

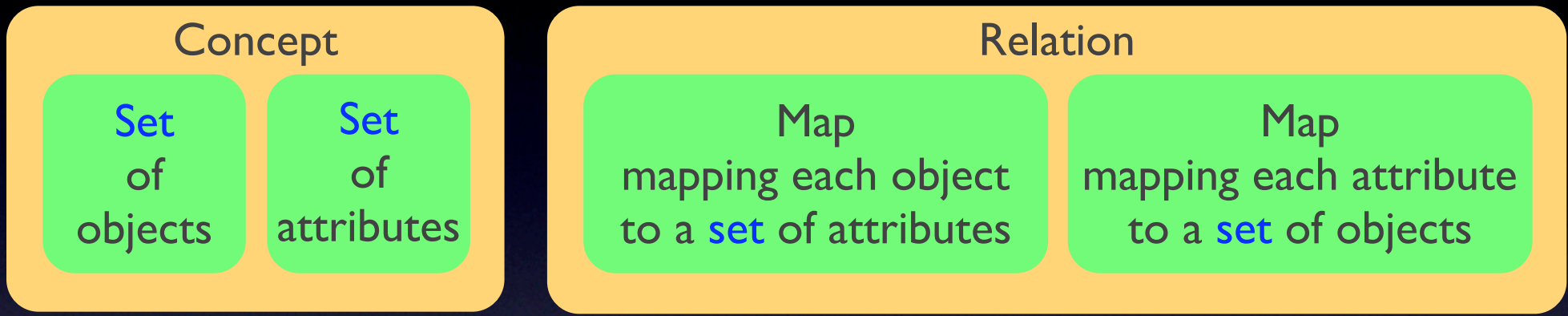
Data structures



Only allow java.lang.Comparable objects because

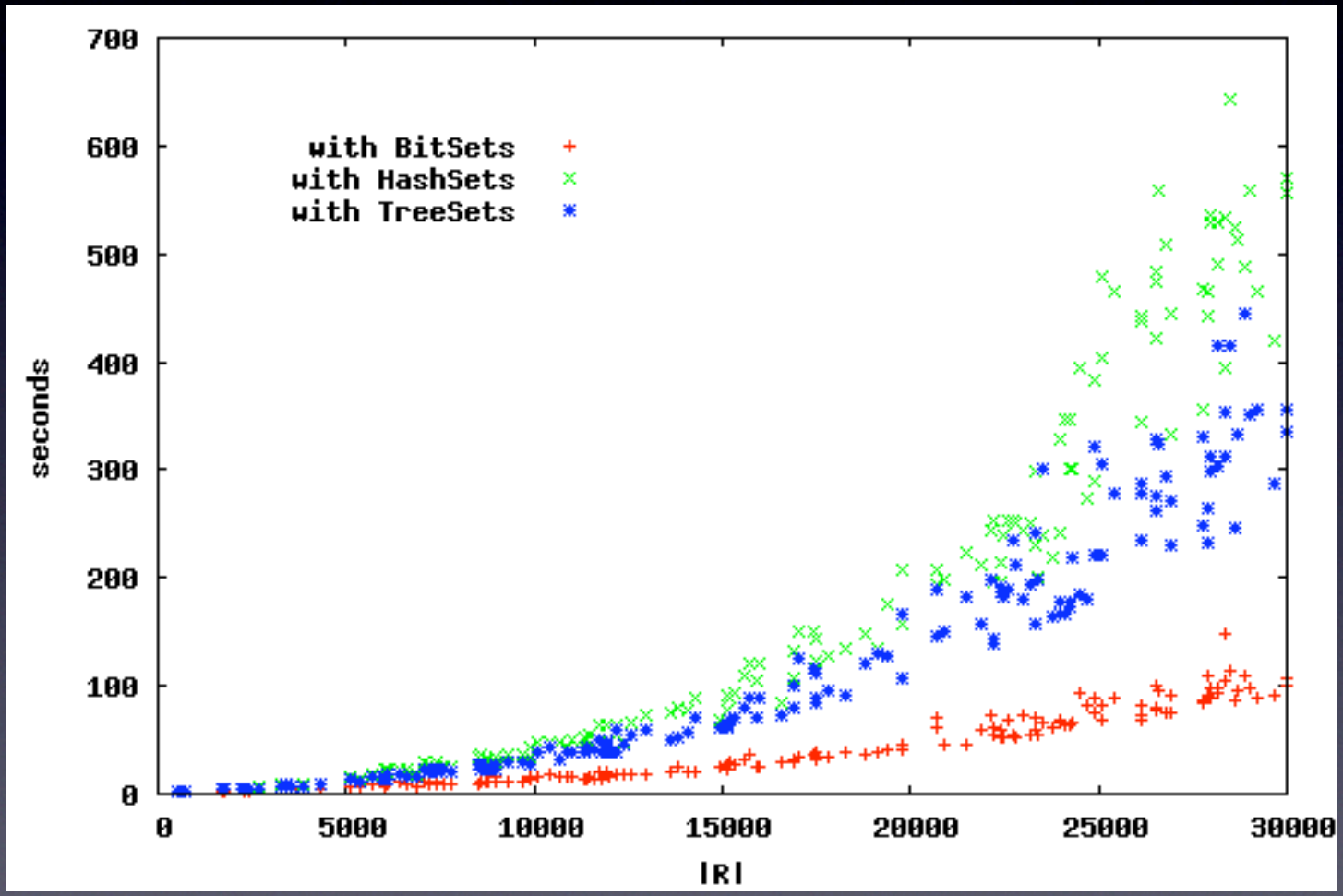
- they are usually immutable
- they can be sorted easily
- the user still has many possibilities

Data structures

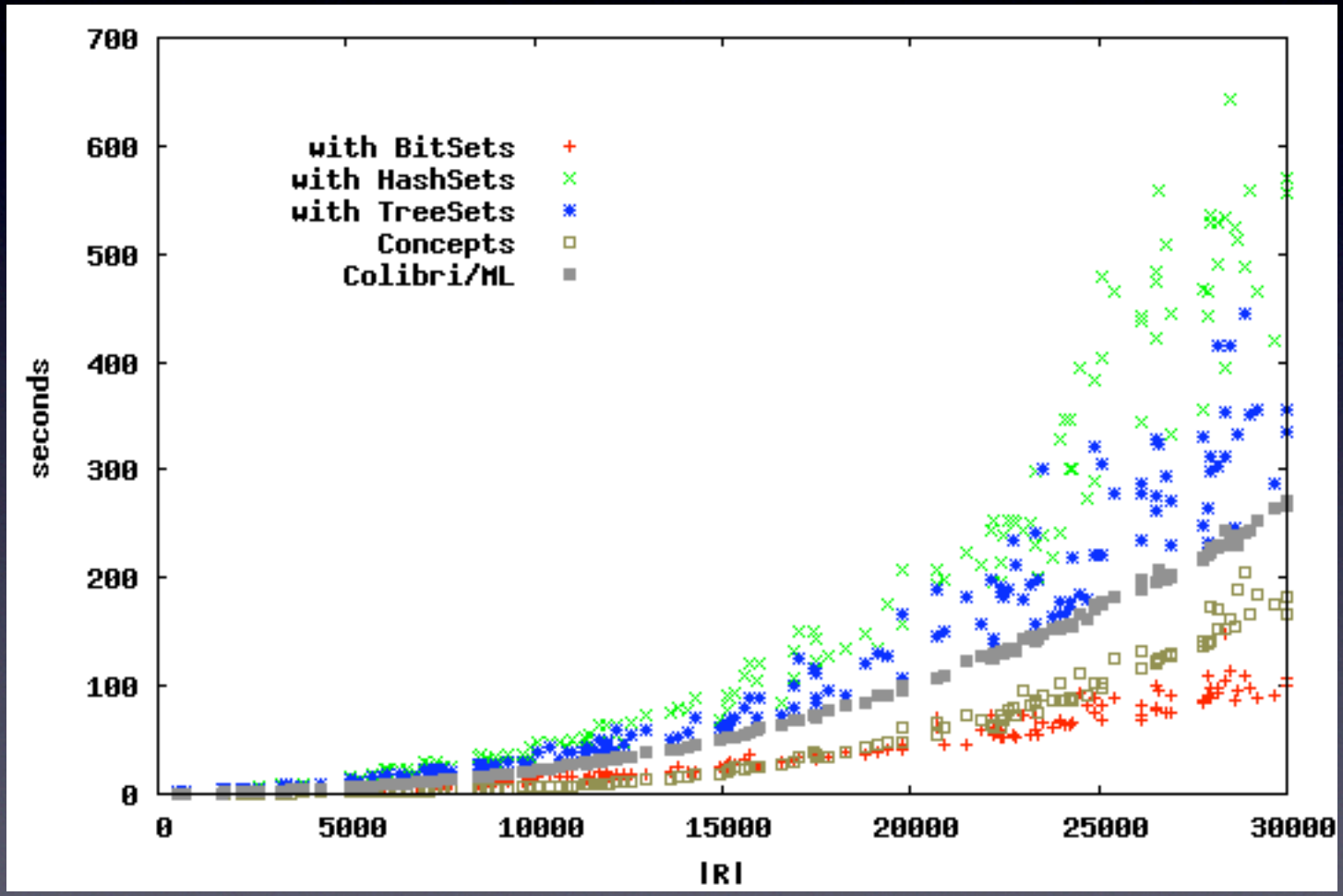


TreeSet	is a sorted set
HashSet	not sorted, but faster operations
BitSet	sorted, fast intersection operation, but can not be used directly

Performance



Performance



Correctness

JUnit tests

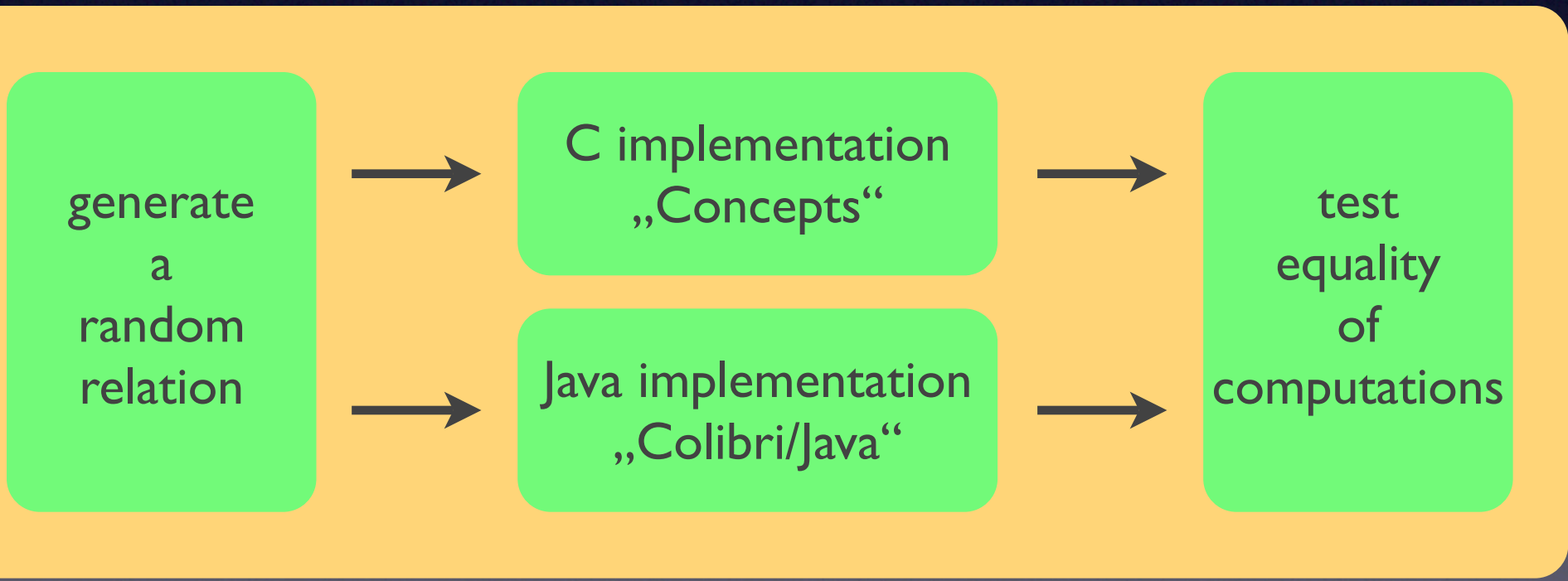
Problem:

Whether or not all concepts and edges are computed correctly can not be tested with unit tests.

Correctness

JUnit tests

+



Conclusion

Iterators are convenient to use.

BitSet-based data structure has best performance.

Good performance for large contexts with low density.

100% faster
than Colibri/ML

	|R| = 16000 density 1%	|R| = 30000 density 1%	|R| = 16000 density 4%
Bitset-based „Colibri/Java“	25 s	101 s	64 s
C implementation „Concepts“	24 s	166 s	586 s
ML implementation „Colibri/ML“	60 s	265 s	120 s

Next Step

clean up code

add some JavaDoc

release under GPL

publish at Google Code

become famous

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