Lucene: Generic Data Indexing

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WARNING

The following presentation contains egregious product placement and lots of text.

Indexing:

"The process of converting a collection of data into a format suitable for easy search and retrieval."

JIRA: Issue Search

JIRA

User: Mike Cannon-Brookes Filters | Profile | Log Out

HOME BROWSE PROJECT FIND ISSUES CREATE NEW ISSUE ADMINISTRATION QUICK SEARCH:

Filter: View Edit New Manage

You are currently using a new, unsaved search.
Save it as a filter

<< View & Hide View >>

Project:
- Bamboo
- BNP Consulting
- Citigroup Change Request
- Cohotion
- Confluence

Issue Type:
- Any
- Standard Issue Types
- Bug
- Improvement
- New Feature

Components / Versions

Fix For:
- Unreleased Versions
- 2.2.11
- 2.3.4
- 2.3.x
- 2.4.3

Components:
- Any
- No Component
- Administration
- Application Server Support
- Attachments

Affects Versions:
- Any
- No Version
- Released Versions
- 2.4.2
- 2.4.1

Text Search

Query:

Query Fields: Summary, Description, Comments, Environment

Issue Navigator

Displaying issues 1 to 10 of 10 matching issues. [Permlink]

Current View:
Browser (Current Fields | Printable | Full Content) | XML | RSS (Issues | Comments) | Word | Excel (All fields | Current fields) | Charts

Bulk Change: all 10 issue(s)
Configure your Issue Navigator

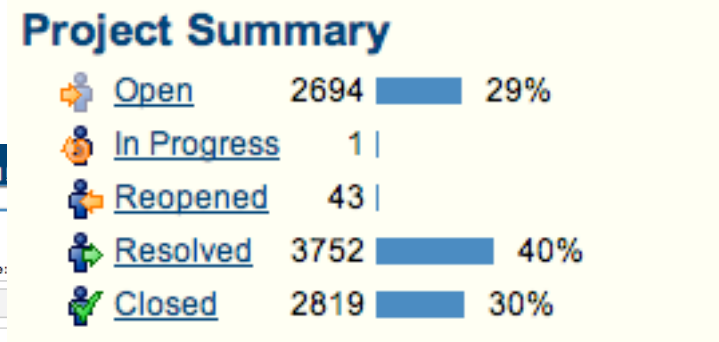
T	Key	Summary	Reporter	Assignee	Status	Res	Updated
	CONF-8078	Error page if new password doesn't match Crowd password validation	Matt Ryall	Unassigned	Open	UNRESOLVED	19/Mar/07
	CONF-8055	Document process for moving from evaluation to commercial cluster license	Matt Ryall	Unassigned	Open	UNRESOLVED	14/Mar/07
	CONF-8050	zip_src from tiny mce served without caching headers on extranet	Scott Farquhar	Matthew Jensen	Reopened	UNRESOLVED	19/Mar/07
	CONF-7987	${baseUrl} is not being substituted correctly in daily update email.	Rob Di Marco	Unassigned	Needs Verification	UNRESOLVED	12/Mar/07
	CONF-7975	Migrate c.a.c to hibernate user repository	Christopher Owen	Unassigned	Open	UNRESOLVED	12/Mar/07
	CONF-7893	Link to Plugin Repository is 'plugin.repository.link'	David Soul	Unassigned	Open	UNRESOLVED	12/Mar/07
	CONF-7774	Global Activity link on Space Activity page is not correct	Agnes Ro	Christopher Owen	Open	UNRESOLVED	18/Mar/07
	CONF-7456	Intermittent problem loading stylesheets and javascript on extranet	Scott Farquhar	Christopher Owen	In Progress	UNRESOLVED	19/Mar/07
	CONF-6953	RSS parsing and content-type problems	Matt Ryall	Unassigned	Open	UNRESOLVED	12/Mar/07
	CONF-6058	Group picker for page restrictions silently hides non-member groups, may need clarifying sentence added	David Soul	Unassigned	Open	UNRESOLVED	19/Mar/07

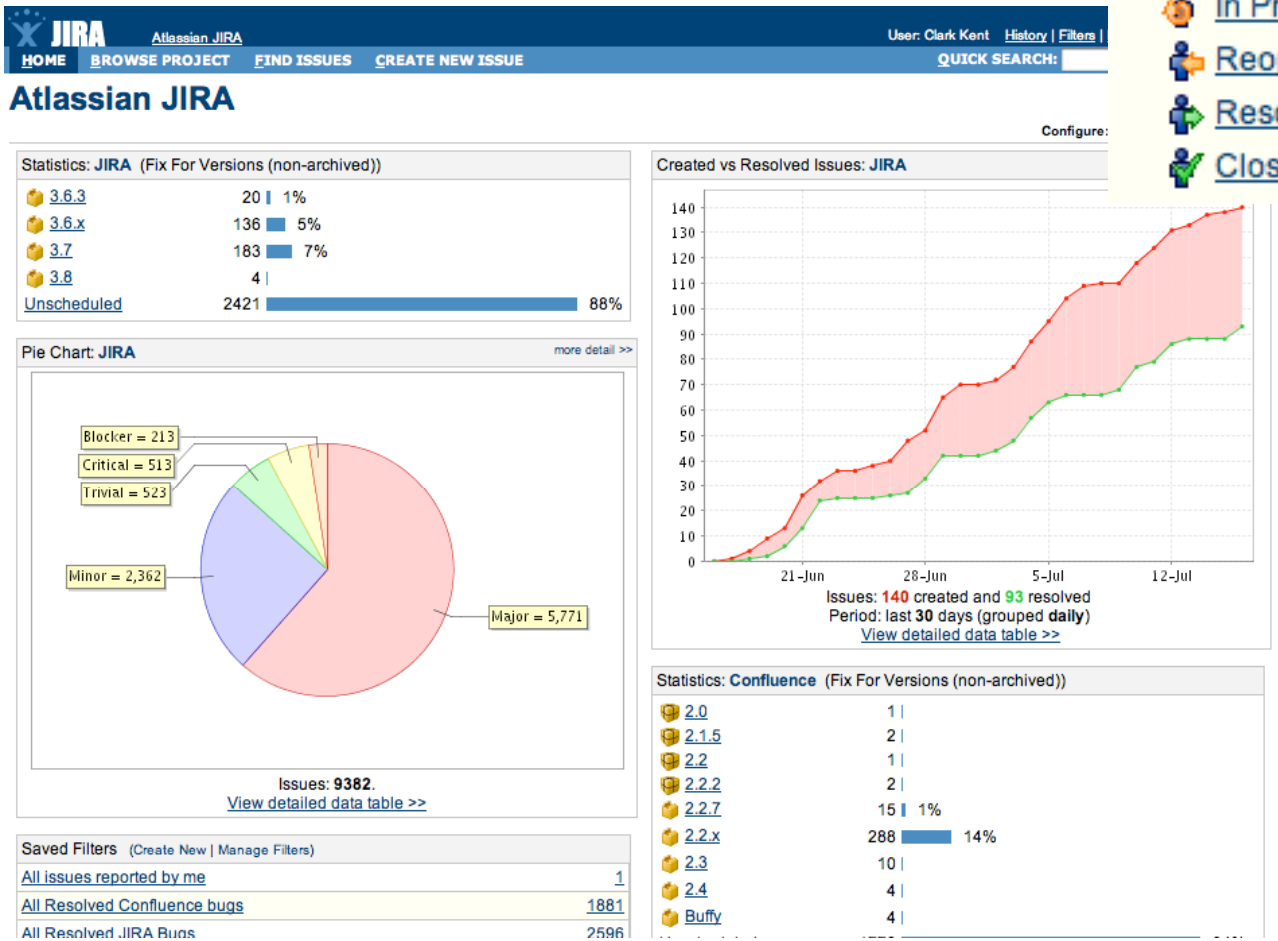
JIRA: Lucene History

- 1.4 - Use DB for all queries, Lucene only if full text search - results 'merged'
- 2.0 - Use Lucene for all search, Java for permissioning - results iterated over and non-view stripped
- 2.2 - Use Lucene for all queries including perms - sorting still done in Java
- 2.4 - Use Lucene for all queries, retrieving issues and displaying - no DB access at all!
- 3.0 - Switch "stats" over to using Lucene via HitCollectors

JIRA: Statistics

All from Lucene!



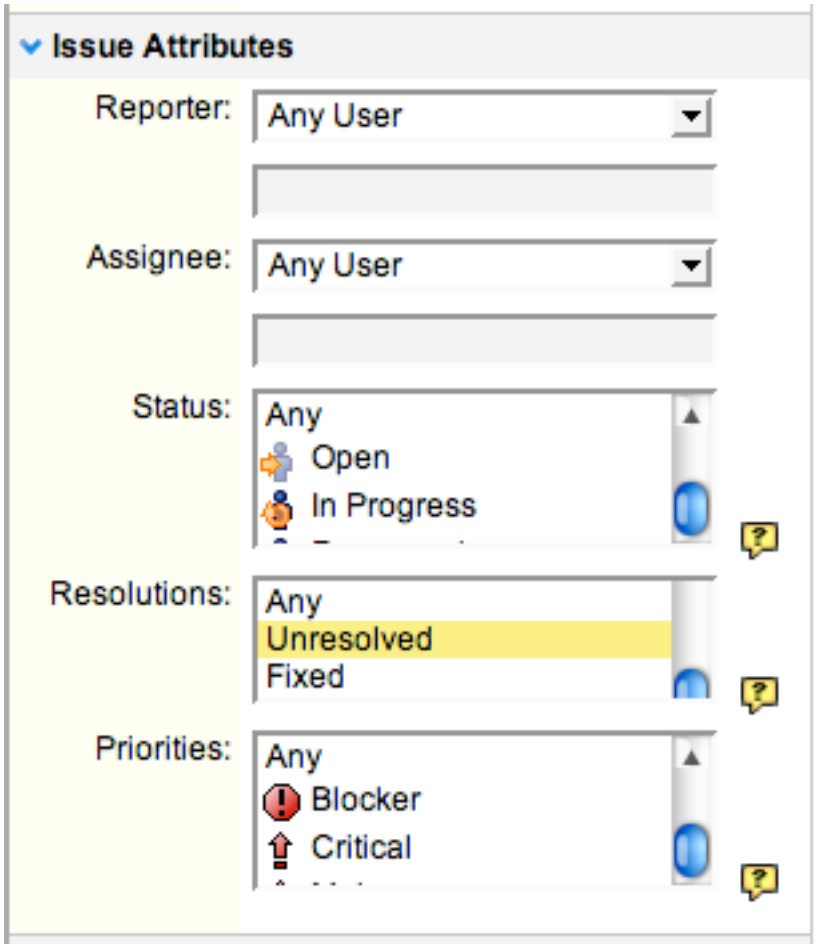


Lucene: Full Text Search

- **Text Analysis & Stemming**
  - **“Michael jogs in the park” > “michael, jog, park”**
- **Proximity Queries**
  - **“cat NEAR dog”**
- **Wildcard Queries**
  - **“jog*”, “j?g”**
- **Results returned scored by *relevance***

Lucene: Generic Data Indexing (GDI)

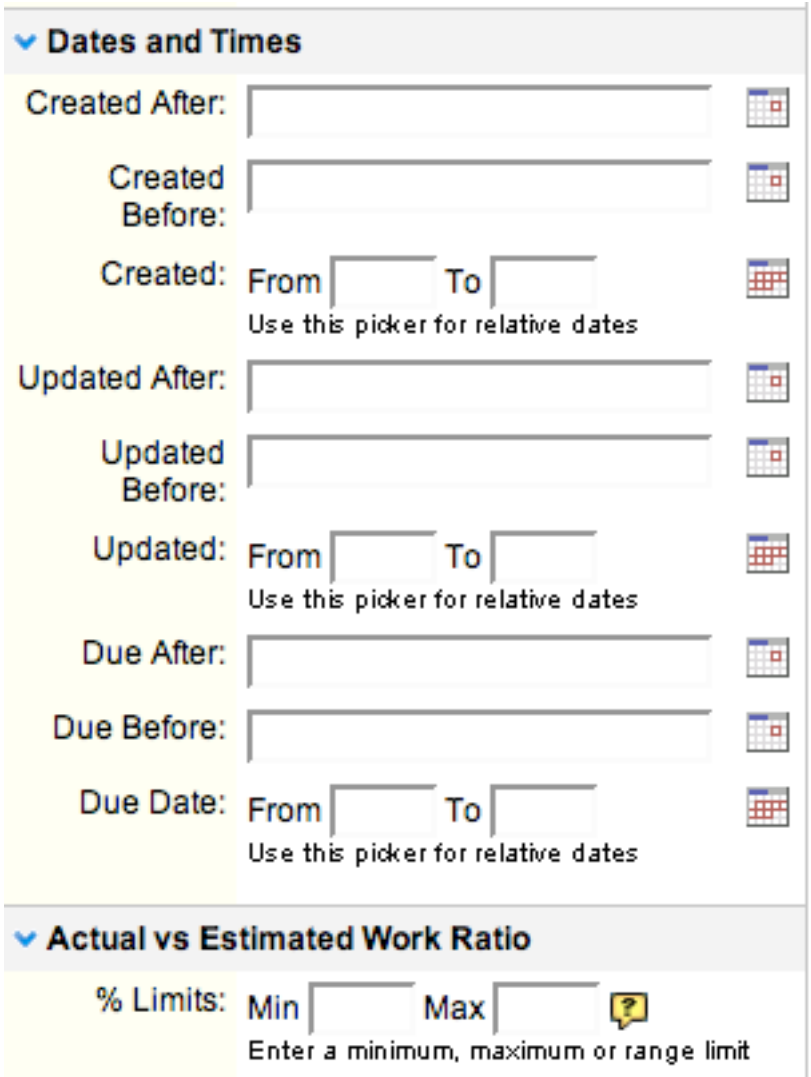
- ***Fast* retrieval of complex data objects**
  - **Built from one database, multiple databases, files, anywhere**
  - **Not a single table - just use a database index**



Lucene: Generic Data Indexing (GDI)

- **Powerful pre-built query tools**
  - **RangeQuery, BooleanQuery etc**

"select issues created between 2001 and 2004,
with no components, no versions,
still unresolved that have > 4 votes"



Lucene: Generic Data Indexing (GDI)

- **Results returned sorted in *custom order***
  - **Sort, SortField**

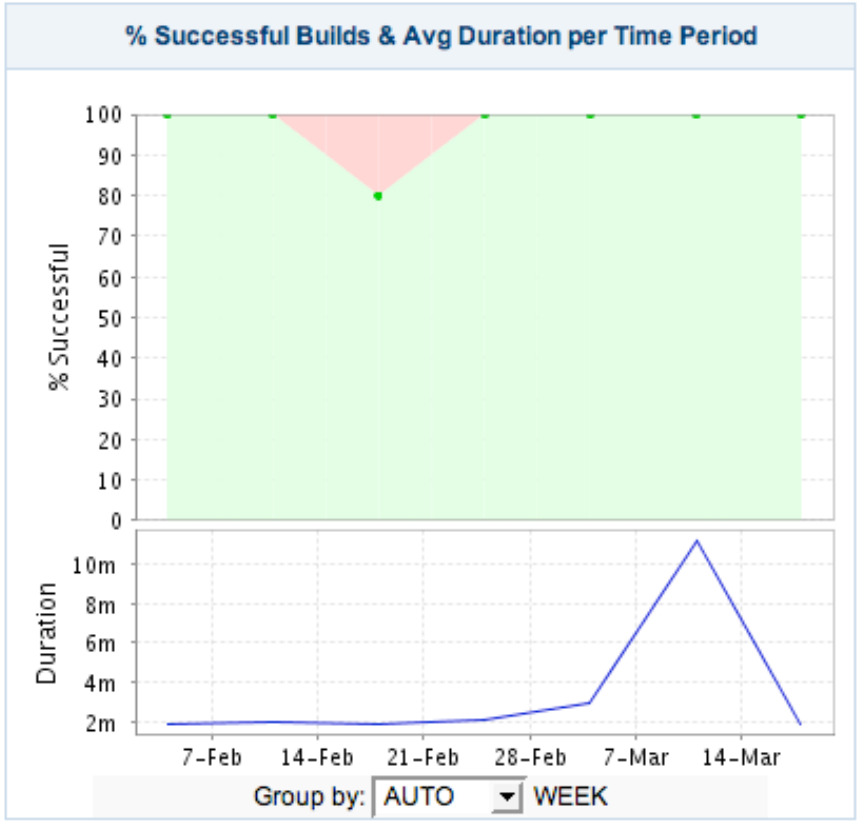
Key	Summary	F
CONF-8078	Error page if new password doesn't match Crowd password validation	N
CONF-8055	Document process for moving from evaluation to commercial cluster license	N
CONF-7987	${baseUrl} is not being substituted correctly in daily update email.	F
CONF-7975	Migrate c.a.c to hibernate user repository	C

Versions
Manage versions (displayed in the order of newest first)

Buffy	
2.5	
2.4.x	
2.4.3	
2.4.2	12/Mar/07
2.4.1	12/Mar/07
2.4	25/Feb/07
2.3.x	
2.3.4	
2.3.3	14/Feb/07

Lucene: Generic Data Indexing (GDI)

- **AOP-like result filtering and hit collection**
  - **QueryFilter and HitCollector**



		Pages				New	
	View	Create	Export	Restrict	Remove	Create	R
Eugene Katz	✓	✓	✓	✓	✓	✓	
Ivo Verlaek	✓	✓	✗	✗	✗	✗	
William Anderson	✓	✓	✓	✓	✓	✓	✓ ✓ ✓

Lucene: Generic Data Indexing (GDI)

- **Integrated full text search - only *if* you need it!**
- **"Free!"**

select issues created between 2001 and 2004,
with no components, no versions,
still unresolved that have > 4 votes
and match the query "dash"*

Database V1

Issues

Issue	Summary	Assignee	Reporter
JRA-1	Buy milk	Fred	
JRA-2	Collect laundry	Bill	Fred

Query: select * from issues where assignee = ‘fred’

Database V2

Issues

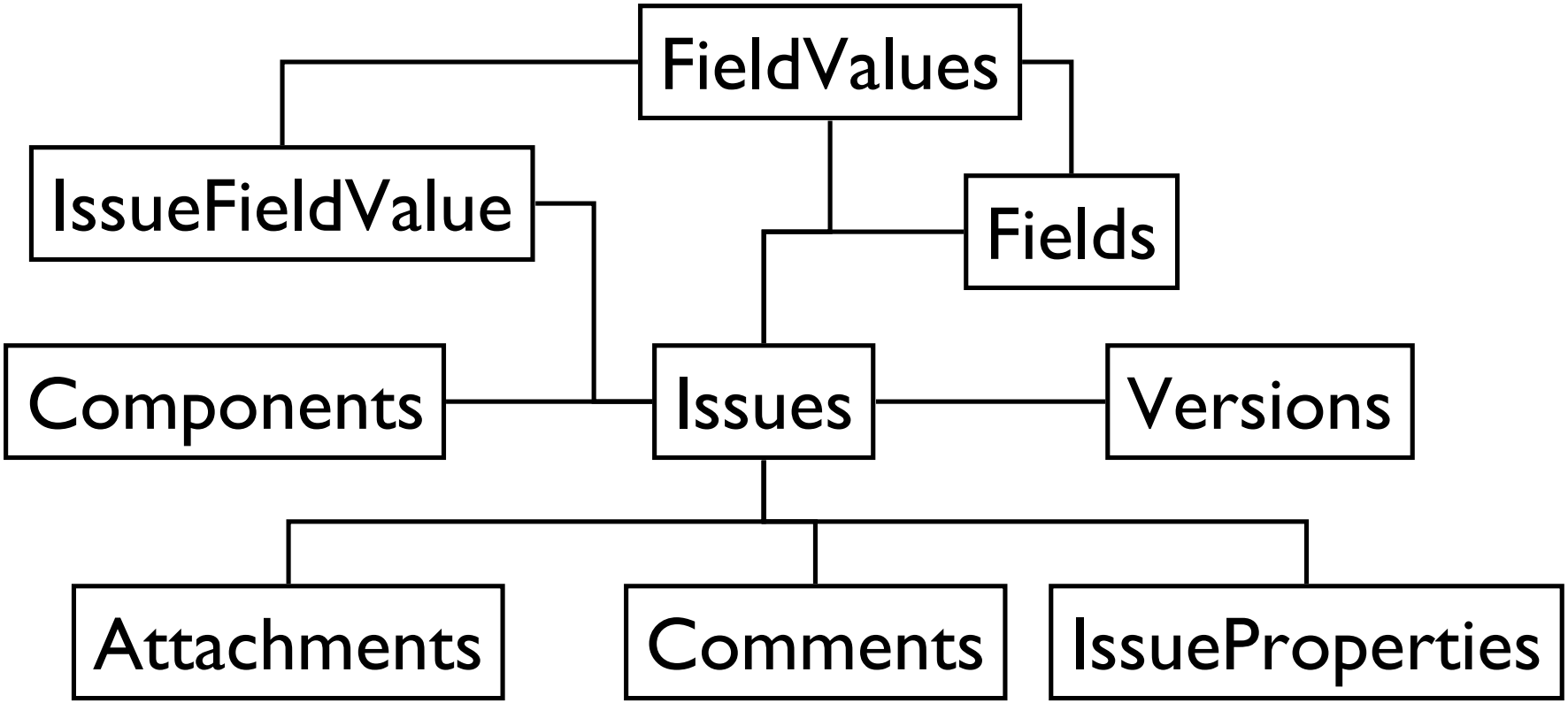
Issue	Summary
JRA-1	Buy milk
JRA-2	Collect laundry

Fields

Issue	Field	Value
JRA-1	Assignee	Fred
JRA-2	Assignee	Bill
JRA-2	Reporter	Fred

Query: select * from issues, fields
where fields.field = 'Assignee' and fields.value = 'fred'
And fields.issue = issues.issue

Database V3



Query: ? ? ?

How is Lucene fast?

Objects

object

field

reporter	**Bill**
assignee	**Fred**

reporter	**Jane**
assignee	**Fred**

reporter	**Fred**
assignee	**Bill**

How is Lucene fast?

Objects

reporter	**Bill**
assignee	**Fred**

reporter	**Jane**
assignee	**Fred**

reporter	**Fred**
assignee	**Bill**

Docs

docId: 1 →

docId: 2 →

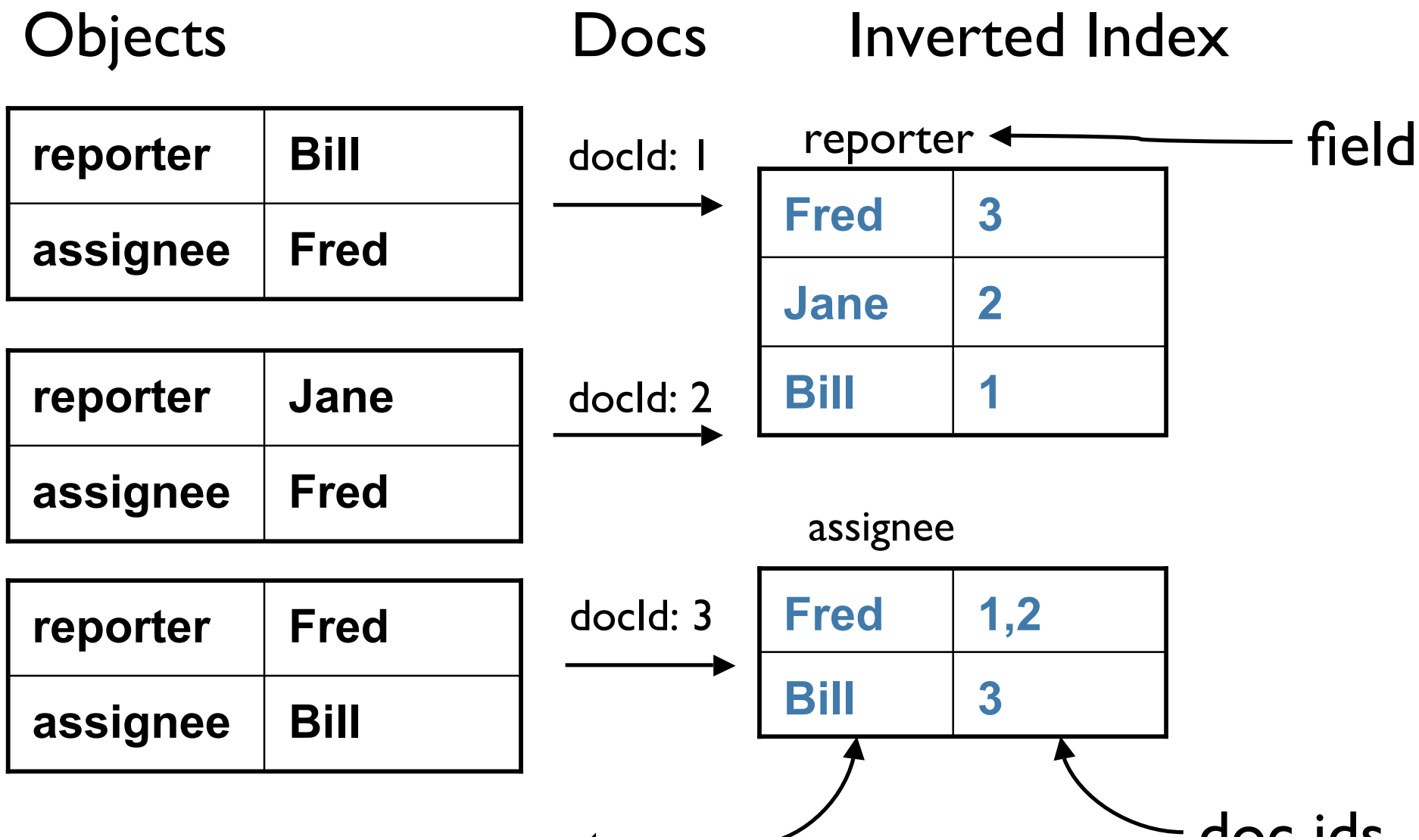
docId: 3 →

document

reporter : Bill
assignee : Fred
component : 1
component : 4
component : 5
created : 20070320

field : value …

How is Lucene fast?



How is Lucene fast?

Objects

reporter	Bill
assignee	Fred

reporter	Jane
assignee	Fred

reporter	Fred
assignee	Bill

Docs

docId: 1 →

docId: 2 →

docId: 3 →

Inverted Index

bitset

reporter

Fred	3	001
Jane	2	010
Bill	1	100

assignee

Fred	1,2	110
Bill	3	001

Advantages For Generic Data Indexing

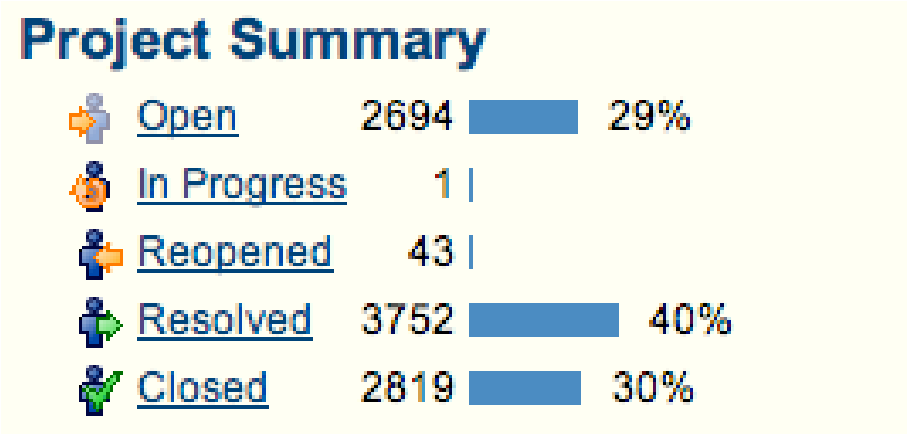
- **Store Denormalised Data**
  - **Issue object, fields - one single Lucene document**
  - **No record de-duplication needed as per SQL query**
- **Native Java API**
  - **Useful for things like sorting where a DB can't do it**
    - **Java specific sort algorithm for issue keys**
    - **Version sequencing - v. complex to do in DB**

Advantages For Generic Data Indexing

- **Constant time & capabilities**
  - **Our apps are cross platform, OS, JDK, database**
  - **Lucene works pretty much the same across all of them unlike SQL**
  - **Local file system access (most commonly) which is faster than DB as no network time**
- **Constant index format**
  - **Readable from Java, C, Perl, Ruby etc**
- **QueryFilters & HitCollectors!**

HitCollector

- Call back object for hit collection
- Great for statistical operations where content / score is irrelevant
  - JIRA - StatusHitCollector for ‘bucketing’
- Fast because:
  - Retrieve only fields you need
  - Minimum number of loops



HitCollector

```
public abstract void collect(int doc,
                             float score)
```

Called once for every non-zero scoring document, with the document number and its score.

If, for example, an application wished to collect all of the hits for a query in a BitSet, then it might:

```
Searcher searcher = new IndexSearcher(indexReader);
final BitSet bits = new BitSet(indexReader.maxDoc());
searcher.search(query, new HitCollector() {
    public void collect(int doc, float score) {
      bits.set(doc);
    }
  });
```

QueryFilter

- **AOP for query results**
- **BitSet representing possible matches**
  - **Complex in SQL to do, ends up being done in Java**
  - **Permissioning on top of any search**
    - **Construct once per request**
    - **Results are cached in the filter**

		Pages				News		Comments	
	View	Create	Export	Restrict	Remove	Create	Remove	Create	Remove
Eugene Katz	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ivo Verlaek	✓	✓	✗	✗	✗	✗	✗	✓	✓
William Anderson	✓	✓	✓	✓	✓	✓	✓	✓	✓

QueryFilter

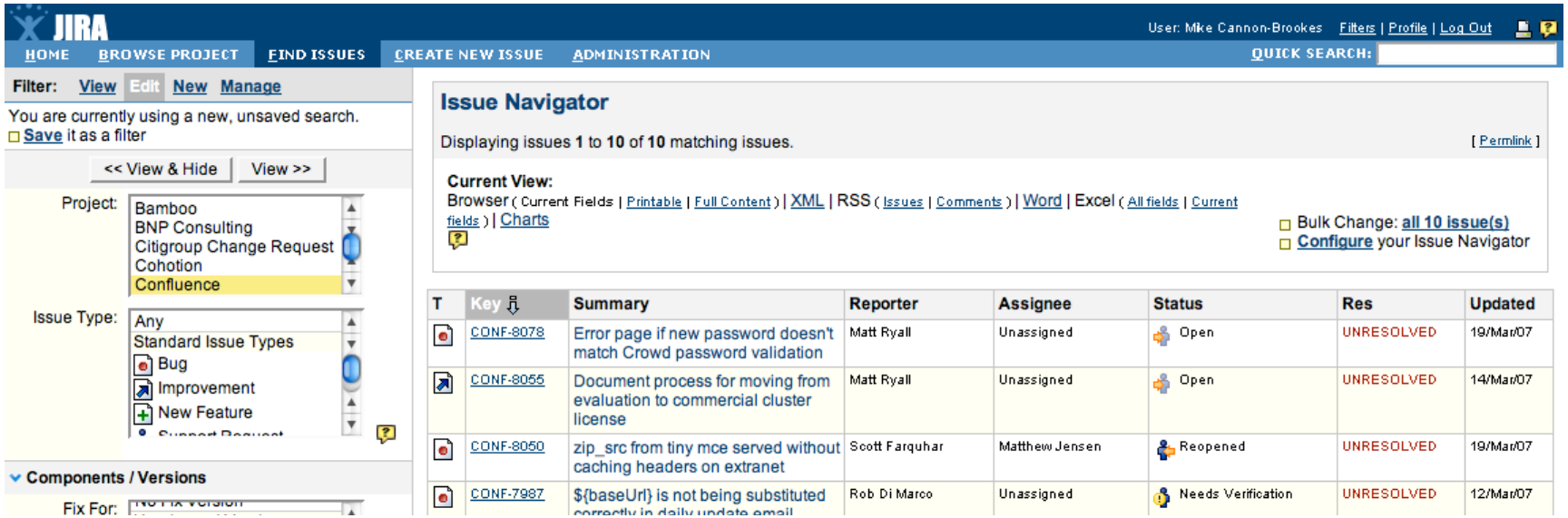
```
public BitSet bits(IndexReader reader)
            throws IOException
```

Description copied from class: `Filter`
Returns a BitSet with true for documents which should be permitted in search results, and false for those that should not.

Specified by:
`bits` in class `Filter`
Throws:
`IOException`

Atlassian: Examples Of Lucene Usage

- **JIRA - User driven queries an arbitrary data model**
  - **Plugins index/search their own 'fields' - future proof!**
  - **QueryFilters for permissions - cached per request**
  - **HitCollectors for all statistics / dashboard**



Atlassian: Examples Of Lucene Usage

- **Confluence - Full text search of wiki pages**
  - **SearchExtractor allows plugins to add meta data to documents**
  - **Also used to search attachment contents & metadata**
    - **eg image file sizes**
  - **Arbitrary 'page set' retrieval**
  - **QueryFilter used extensively for security**

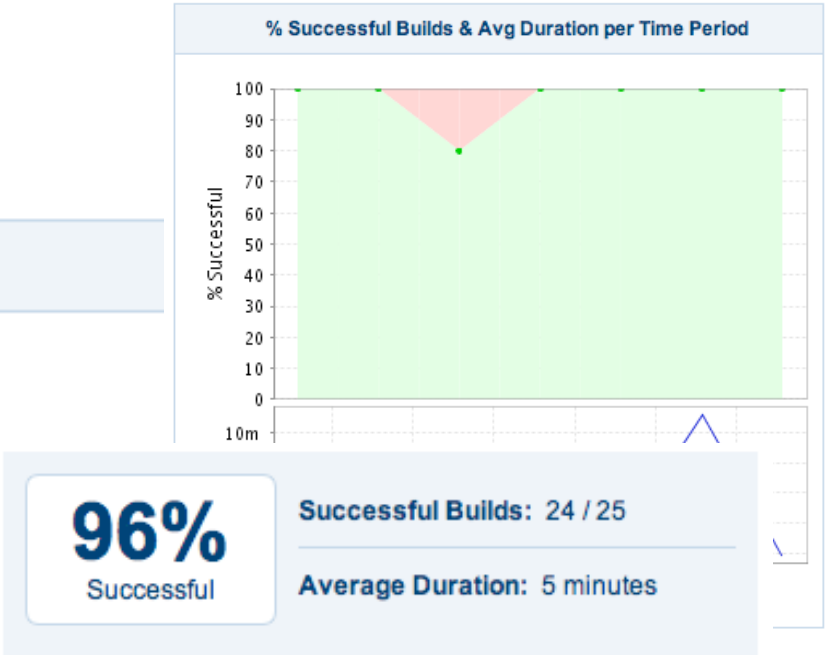
		Pages				News		Comments	
	View	Create	Export	Restrict	Remove	Create	Remove	Create	Remove
Eugene Katz	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ivo Verlaek	✓	✓	✗	✗	✗	✗	✗	✓	✓
William Anderson	✓	✓	✓	✓	✓	✓	✓	✓	✓

Atlassian: Examples Of Lucene Usage

- **Bamboo - Build telemetry statistics via Lucene**
  - **Fast over millions of rows - data on every test/suite/build run, ever.**
  - **Use Lucene to aggregate data into useful statistics**
  - **HitCollectors used extensively for telemetry data**

Recent Failures

- Average time to fix a failure: **2 days, 19 hours, 16 minutes**
- Average number of builds between fixes: **1 builds**
- The longest time taken to fix a failure is **2 days, 19 hours, 16 minutes**
- The greatest number of builds taken to fix a failure is **1**, from failure sta



Problems For GDI

- **One Big Singleton**
  - Updates require serialization - indexes are write once, read many
  - Jira vs Confluence different access/write strategies
- **Delete / Update Operations**
  - Lucene wasn't built for fast changing data
  - Delete operation is just a flag op & Update requires delete / re-add
  - Fixed in Lucene 2.1 - http://issues.apache.org/jira/browse/LUCENE-565
- **Writing Is Expensive**
  - Opening/closing reader/writers proportional to index size

Problems For GDI

- **Timing Of index.optimise()**
  - **Indexes get fragmented - optimise() defrags**
  - **Tricky to time this as v. slow on large indexes**
  - **Eden space strategy can solve this**
    - **Small index for ‘updated’ data, large for ‘old’ data**
    - **Optimize large index rarely, small frequently - like GC.**
    - **MultiIndexSearcher allows search on multiple indexes like one**

Problems For GDI

- **Non Transactional**
  - **DB can have data that index misses, or vice versa**
  - **Compass is a solution here - haven't tested**
  - **Otherwise, architect correct design knowing Lucene**
- **Optionitis**
  - **Write settings can require a lot of knowledge and tuning**
  - **eg MAX_MERGE_DOCS**
- **Local storage - can be a problem in a cluster**
  - **See my other presentation for clustering strategies!**

GDI Lucene Usage Models

- **JIRA**
  - **Synchronous indexing > tricky locking problems at scale**
  - **More updates than creates > heavier index load**
    - **Fixed with Lucene 2.1!**
  - **Slower updates, statistics always correct**
- **Confluence**
  - **Asynchronous indexing**
  - **Updates are queued, flushed every minute**
  - **Clusterable and faster 'net' time for user**
  - **'Recent Updates', 'Search' up to 1 min inaccurate**

Tips

- Use derived data only, so can be recreated at will
- Store -1 for null because nature of fields
  - Can't query Lucene for ‘lack of a field’ - ie “No Component”
- Keep open a single searcher and 'flip it' after writing
- ThreadLocals are valuable in web apps
  - Use for Searchers, BooleanQueries and QueryFilters that are expensive to create per search but don’t change per request (10s of queries per request)
- Understand Lucene to adjust your usage to your app
- Index dates to highest granularity possible, prevent term explosion
  - Remember Lucene storage? YYMMDD vs YYMMDDHHmmSSSS

Links

- **Luke - useful tool to examine indexes**
  - **http://www.getopt.org/luke**
- **Lucene In Action - *awesome* book**
  - **http://www.lucenebook.com**
- **Compass - Lucene abstraction framework**
  - **http://www.opensymphony.com/compass**

Q & A

P.S. Java guru? Atlassian needs engineers!

- Sydney or San Francisco.

http://www.atlassian.com/about/jobs

Email me: mike@atlassian.com