The Representation and Storage of Combinatorial Block Designs

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April 15, 2009

Outline

Combinatorial Block Designs

Project Intro

External Representation

Design Database

Web Interface

System Deployment

System Overview

Conclusions

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What are Block Designs?

- Multiset of subsets of points

$$D = (B, V)\,;\; B = \{\, b \,|\, b \subset V \,\}$$

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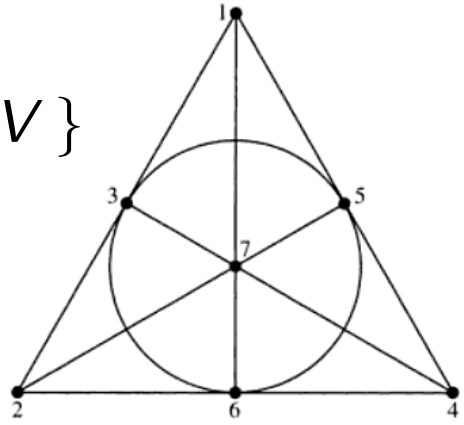

Figure 1 A block design.

- Example (Fano Plane)

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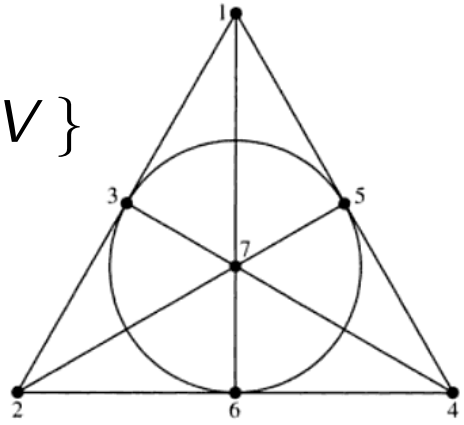

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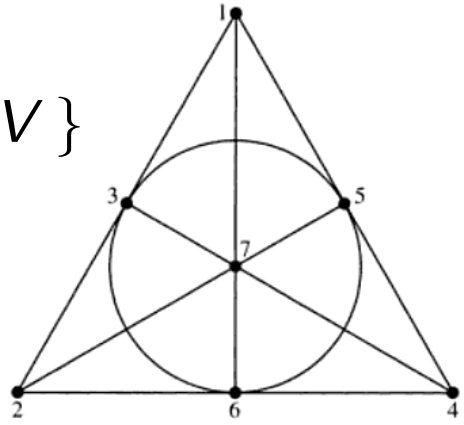

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- Hamming codes were discovered as a block design 5 years earlier [Cam08].

Project Phases

- External Representation of Block Designs
- Block Design Database
- Web Interface

Project Motivation

- Searching for block designs
- Central block design repository
- Concise readable representation

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What is the Ext Rep?

- Method of communicating designs
- Communicating design properties
- Invented at the Queen Mary University of London
- Platform Independent
- User Agents = Human | Software
- Ext Rep $v2$ published mid 2004

Ext Rep *v*3

- *v*2 in XML
- *v*3 in JSON
- Enhanced Structure
- Enhanced Functionality

```
<blocks ordered="true">
    <block><z>0</z><z>1</z><z>2</z></block>
    <block><z>0</z><z>3</z><z>4</z></block>
    <block><z>0</z><z>5</z><z>6</z></block>
    <block><z>1</z><z>3</z><z>5</z></block>
    <block><z>1</z><z>4</z><z>6</z></block>
    <block><z>2</z><z>3</z><z>6</z></block>
    <block><z>2</z><z>4</z><z>5</z></block>
</blocks>
```

(a) v2 [CDMS03]

```
"blocks" : [
  [0, 1, 2], [0, 3, 4], [0, 5, 6],
  [1, 3, 5], [1, 4, 6], [2, 3, 6],
  [2, 4, 5]
]
```

(b) v3 [DN08]

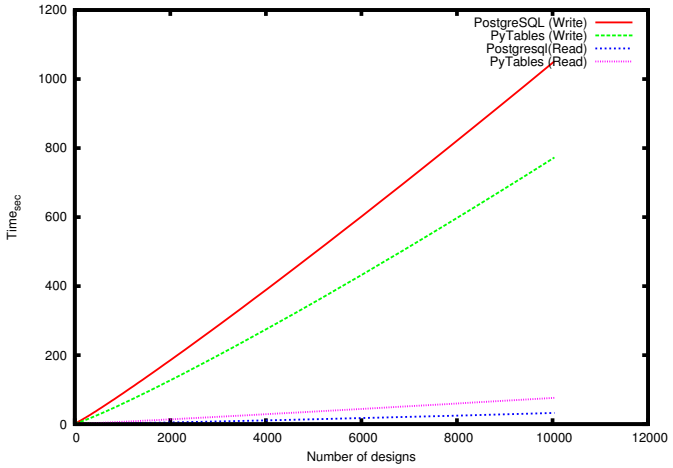
Figure: *blocks* in ExtRep versions

Implementing the Conversion

- Automated Conversion
- Custom JSON Parser
  - Stream Parsing
  - Flexible internal representation
  - YAJL, callback based C library

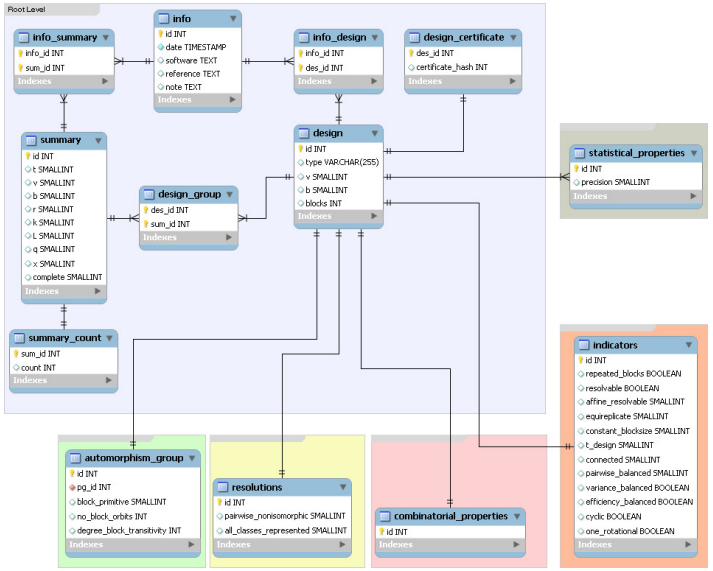
Database Engine

- DBMS Options
  - Hierarchical DBMS HDF5
  - Relational DBMS PostgreSQL
- PostgreSQL Prevailed
  - Faster reads
  - Simpler to Implement



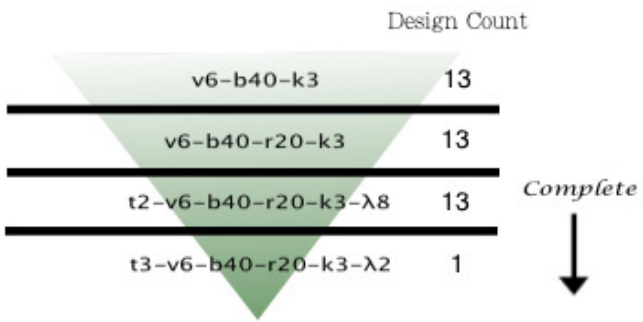
Designing the Database

- Ext Rep structure is Tree Like
- Table per optional Sub-Tree
- Foreign Keys
- List → Many-to-Many
- Automating the Transformation



Populating the Database

- Callback Parsing
- Isomorphic Rejection
- Categorizing Designs



Query Engine

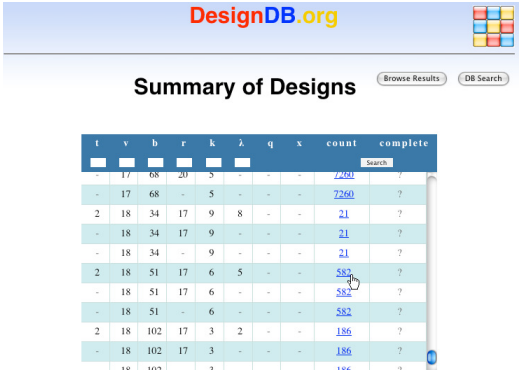
- Encapsulated Design
- Query Language
- User/Session Management

```
{
  "designs" : [{
    "statistical_properties"  :  {
      "canonical_variances"  :  {
        "value" :  {
          "canonical_variance": [
            ["<", 0.34], [">", 0.22]
          ]
        }
      }
    }
  }]
}
```

Figure: Query Example

Web Interface

- Pylons Framework
- Query Interface
- Interface with Query Engine
- Displaying Designs on the Web



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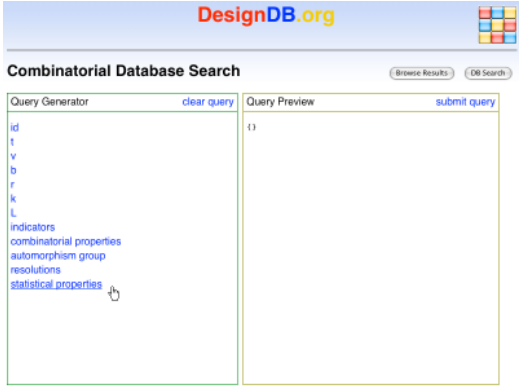

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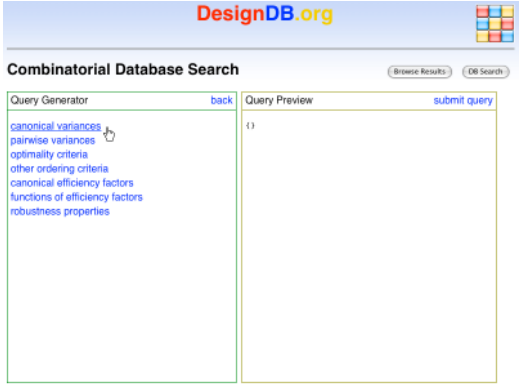

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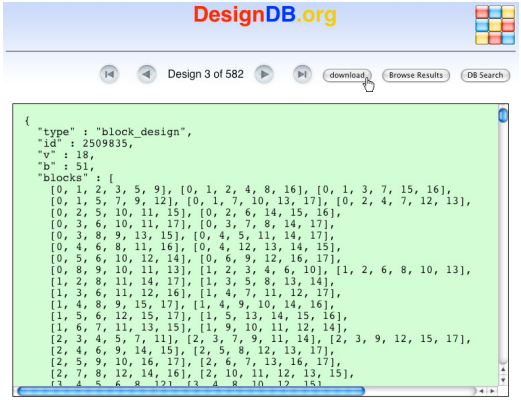
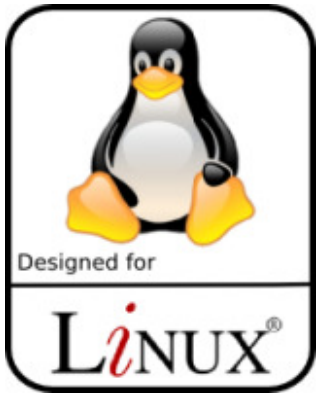


System Deployment

- Designed for Unix
- Apache2 w/ Mod Wsgi
- Load testing



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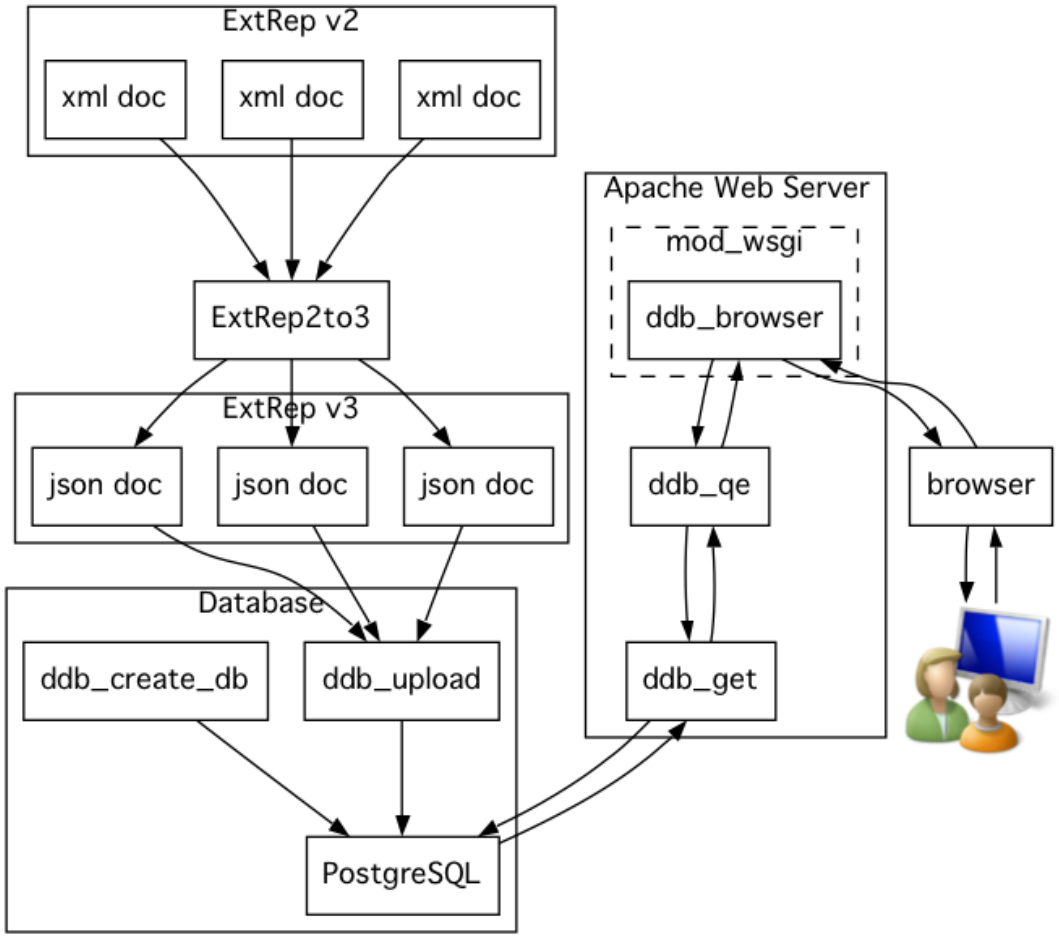
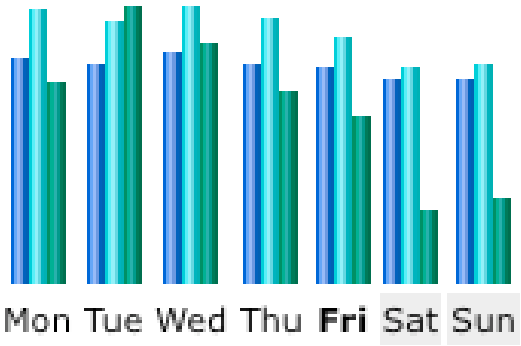


Figure: Design DB Overview

System Overview & Usage



Day	Pages	Hits	Bandwidth
Mon	590.75	715.25	9.10 MB
Tue	570.25	688.50	12.54 MB
Wed	602	721.75	10.97 MB
Thu	577.20	694.20	8.77 MB
Fri	565.80	648	7.61 MB
Sat	534.25	564	3.31 MB
Sun	536.75	572.75	3.89 MB

Figure: Web Visit Aggregates for Weekdays in January 2009

System Overview & Usage

Visits duration		
Number of visits: 414 - Average: 852 s	Number of visits	Percent
0s-30s	236	57 %
30s-2mn	40	9.6 %
2mn-5mn	23	5.5 %
5mn-15mn	16	3.8 %
15mn-30mn	4	0.9 %
30mn-1h	8	1.9 %
1h+	84	20.2 %
Unknown	3	0.7 %

Figure: Web Visit Durations for January 2009

System Overview & Usage

	Countries		Pages	Hits	Bandwidth
?	Unknown	ip	10088	10151	6.74 MB
	United States	us	6313	7761	135.38 MB
	Great Britain	gb	155	443	18.54 MB
	European country	eu	128	231	7.97 MB
	Canada	ca	107	316	10.61 MB
	Italy	it	75	101	2.67 MB
	Germany	de	53	187	12.80 MB
	Australia	au	27	105	11.18 MB
	Spain	es	18	94	6.40 MB
	France	fr	15	46	2.93 MB
	Others		72	325	25.90 MB

Figure: User Countries - January 2009

Conclusion

- Combinatorial & Statistical Designs
  - Ext Rep $v3$
  - Design DB
  - Web Interface
- Computer Science
  - System Integration
  - Source Code
  - Evaluation of Open Source Software

Thank You

Questions?

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Future Plans

- Ext Rep Extension
- RDBMS Alternatives
- Interface Personalization
- High Performance
- System Upgrade (Python, Pylons, SqlAlchemy, YAJL)
- Application Programmers Interface
- Accepting Contributions (Uploading)