Welcome!

MongoDB schema design

PHP Benelux - Leuven, Belgium - Mar 28th, 2012

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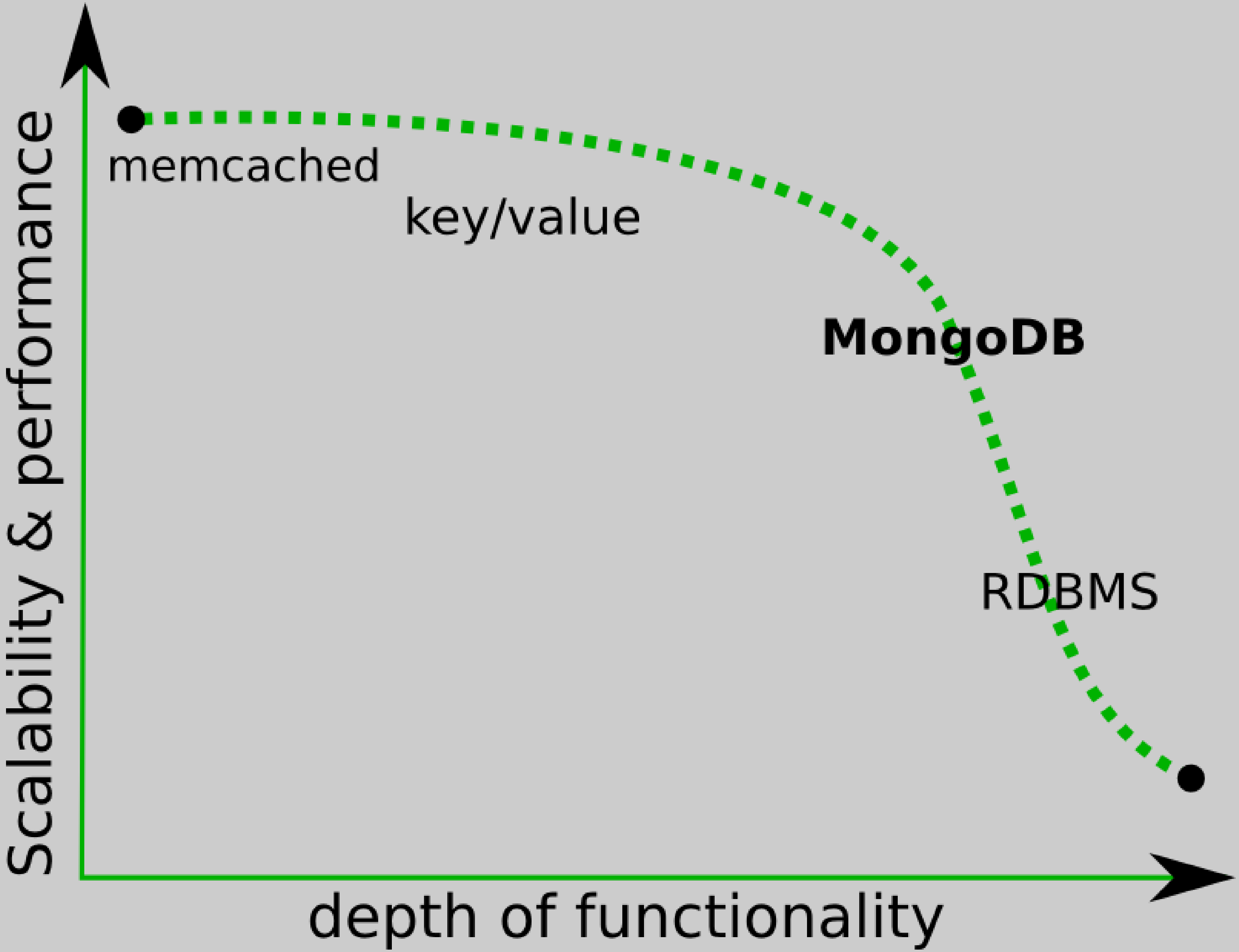
About Me

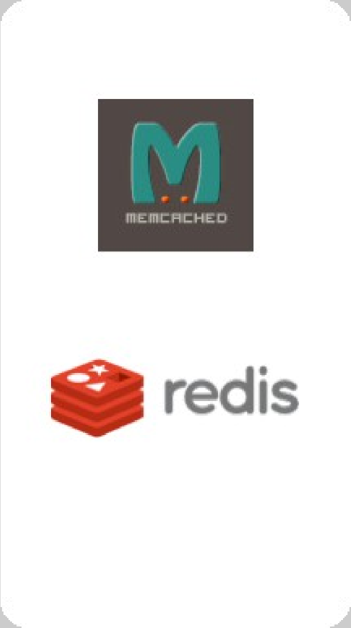
Derick Rethans

- Dutchman living in London
- PHP mongoDB driver maintainer for 10gen (the company behind mongoDB)
- Author of Xdebug
- Author of the mcrypt, input_filter, dbus, translit and date/time extensions

Database landscape



NoSQL



Key/value

Cassandra
HBASE
riak
amazon web services
Amazon DynamoDB

Column

Neo4j
the graph database
sones

Graph

CouchDB
relax
mongoDB
terrastore

Document

Terminology

- JSON Document: the data (row)
- Collection: contains documents (table, view)
- Index
- Embedded Document (~join)

Documents

- Stored as BSON (Binary JSON)
- Can have embedded documents
- Have a unique ID (the _id field)
- Are schemaless

Simple document:

```
{
   "_id" : ObjectId("4cb4ab6d7addf98506010001"),
   "handle" : "derickr",
   "name" : "Derick Rethans"
}
```

Document with embedded documents:

```
{
  "_id" : "derickr",
  "name" : "Derick Rethans",
  "talks" : [
    { "title" : "Profiling PHP Applications",
      "url" : "http://derickrethans.nl/talks/profiling-phptour.pdf",
    },
    { "title" : "Xdebug",
      "url" : "http://derickrethans.nl/talks/xdebug-phpbcn11.pdf",
    }
  ]
}
```

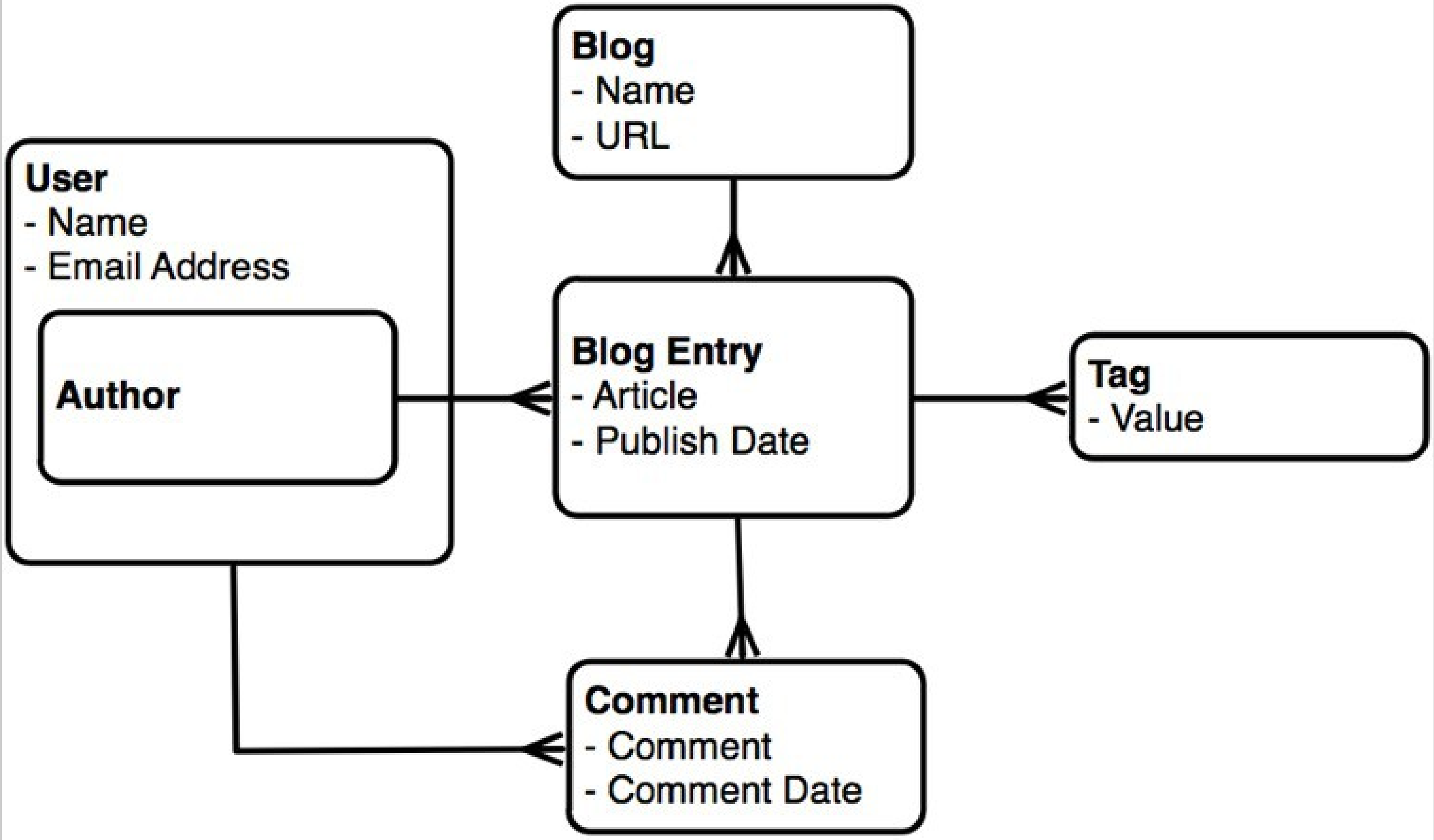
RDBMS: Normalisation

- 1970 E.F.Codd introduces 1st Normal Form (1NF)
- 1971 E.F.Codd introduces 2nd and 3rd Normal Form (2NF, 3NF)
- 1974 Codd & Boyce define Boyce/Codd Normal Form (BCNF)
- 2002 Date, Darween, Lorentzos define 6th Normal Form (6NF)

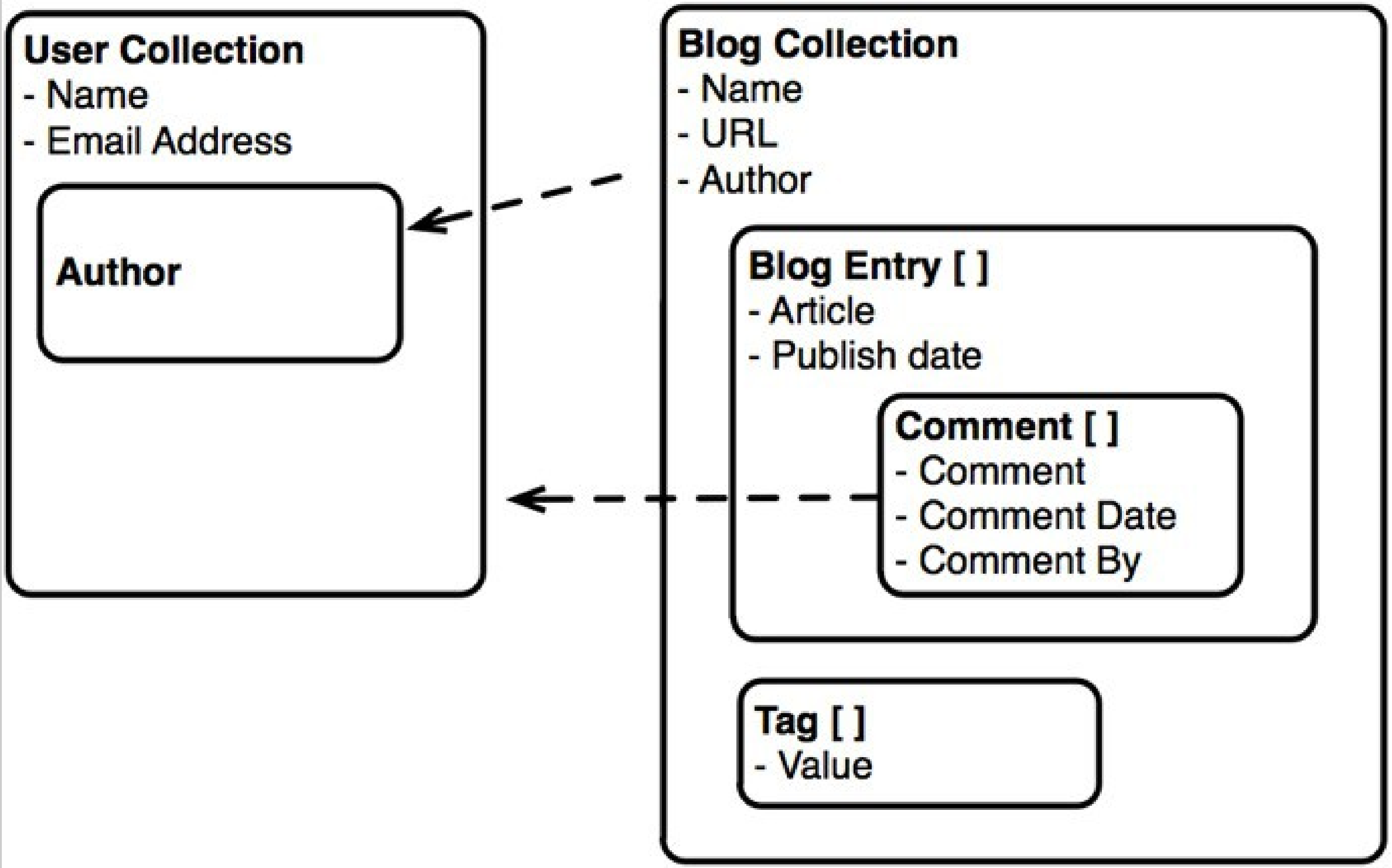
Goals:

- Avoid anomalies when inserting, updating or deleting
- Minimize redesign when extending the schema
- Make the model informative to users
- Avoid bias towards a particular style of query

Blog in a RDBMS



Blog in MongoDB



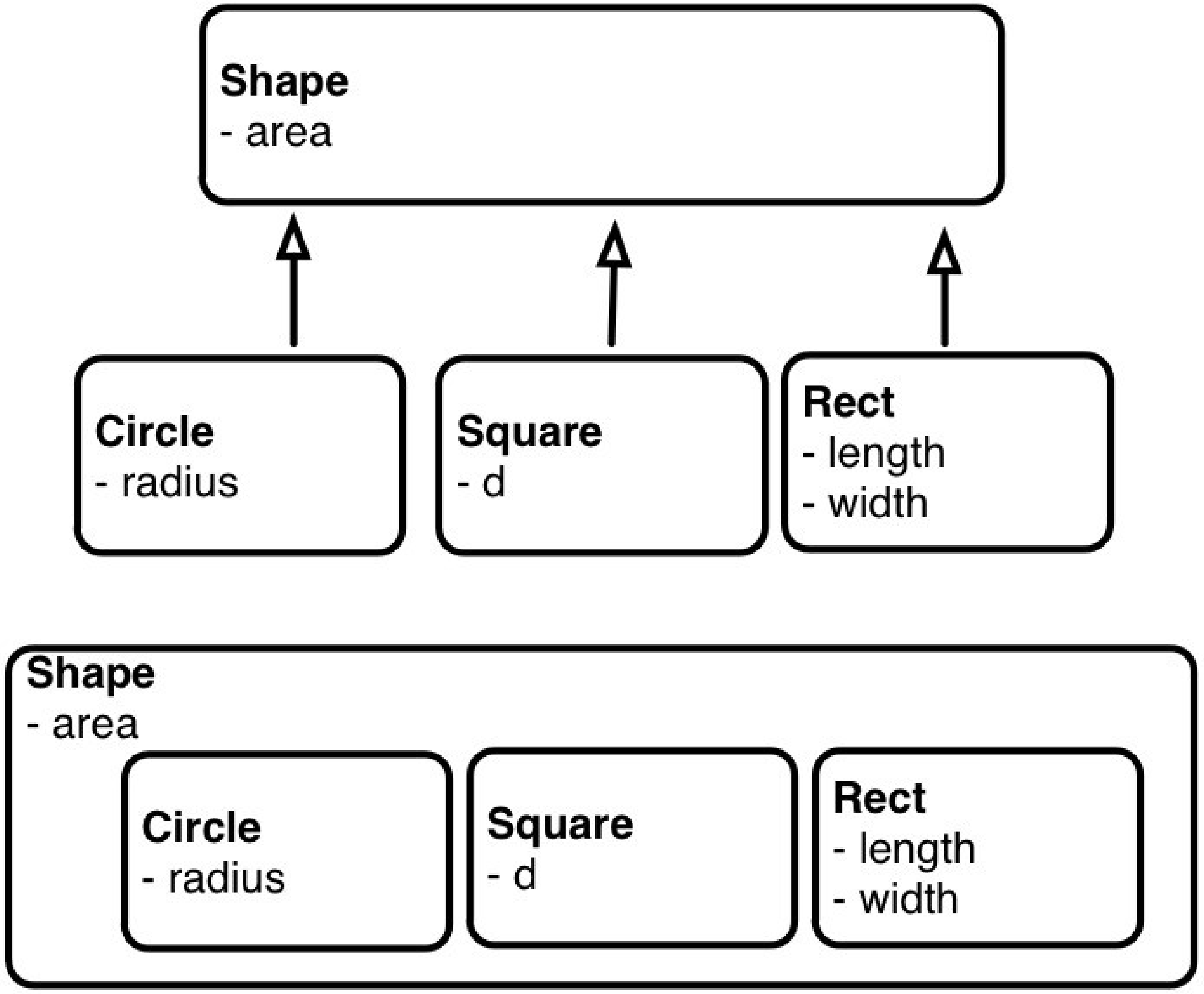
Schema considerations

- Access Patterns?
- Read / Write Ratio
- Types of updates
- Types of queries
- Data life-cycle

Considerations

- No Joins
- Document writes are atomic

Inheritance



Single table inheritance - RDBMS

- +---+
- +---+
-

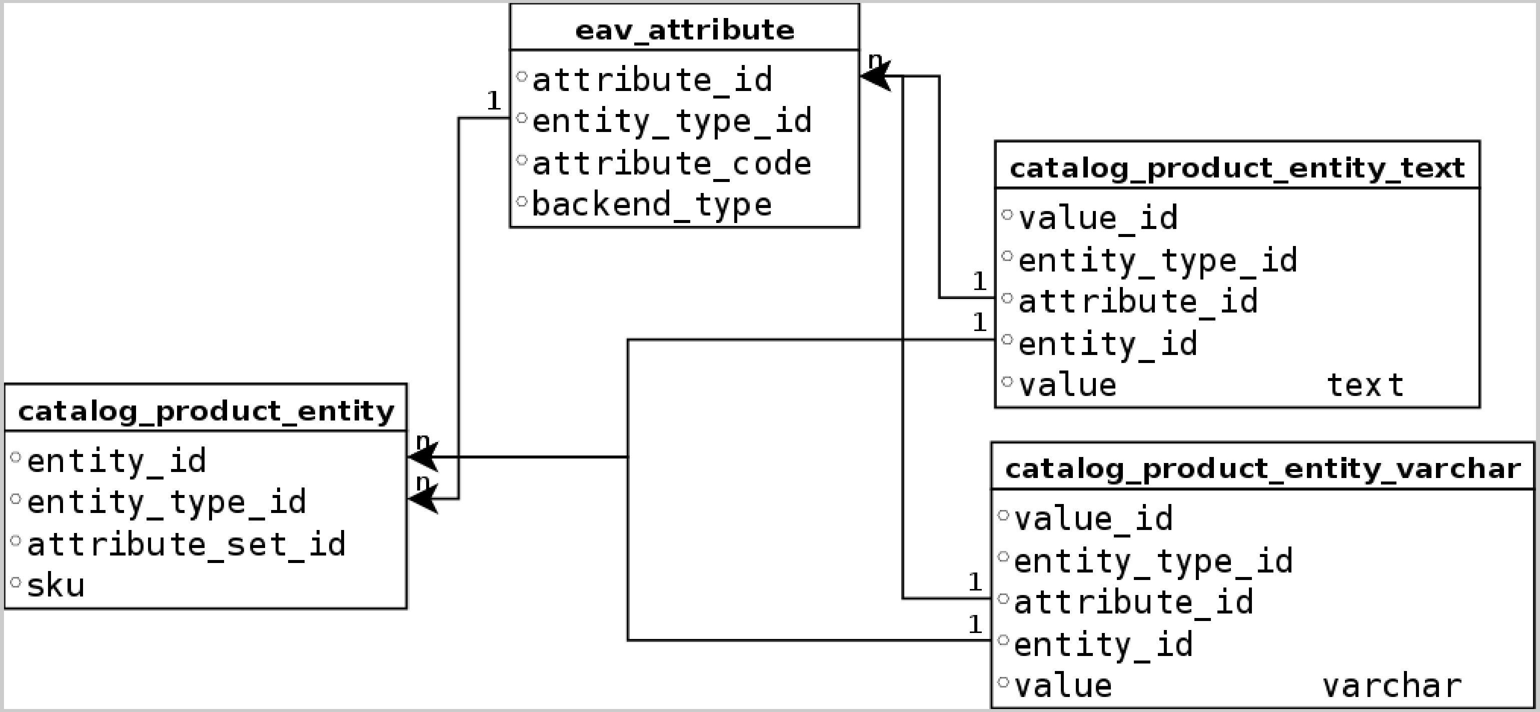
Single table inheritance - MongoDB

```
{ _id: "1", type: "circle", area: 3.14, radius: 1}

{ _id: "2", type: "square", area: 4, d: 2}

{ _id: "3", type: "rectangle", area: 10, length: 5, width: 2}
```

Inheritance

- Simple to query across sub-types
- Indexes on specialized values will be small

EAV: Entity Attribute Value



```
SELECT cpe.entity_id, value AS name
FROM catalog_product_entity cpe

INNER JOIN eav_attribute ea
    ON cpe.entity_type_id = ea.entity_type_id

INNER JOIN catalog_product_entity_varchar cpev
    ON ea.attribute_id = cpev.attribute_id AND
      cpe.entity_id = cpev.entity_id

WHERE ea.attribute_code = 'name'
```

EAV: Entity Attribute Value

```
SELECT entity_id, attribute_code, value
FROM catalog_product_entity_text cpev
JOIN eav_attribute ea ON cpev.attribute_id = ea.attribute_id;

| entity_id | attribute_code       | value              |
+-----------+----------------------+-------------------+
|         1 | description          | Cute elephpant    |
|         1 | short_description    | It&#39;s cute     |
|         1 | meta_keyword         | NULL              |

SELECT entity_id, attribute_code, value
FROM catalog_product_entity_int cpev
JOIN eav_attribute ea ON cpev.attribute_id = ea.attribute_id;

| entity_id | attribute_code        | value |
+-----------+-----------------------+-------+
|         1 | status                |     1 |
|         1 | visibility            |     4 |
|         1 | tax_class_id          |     2 |
```

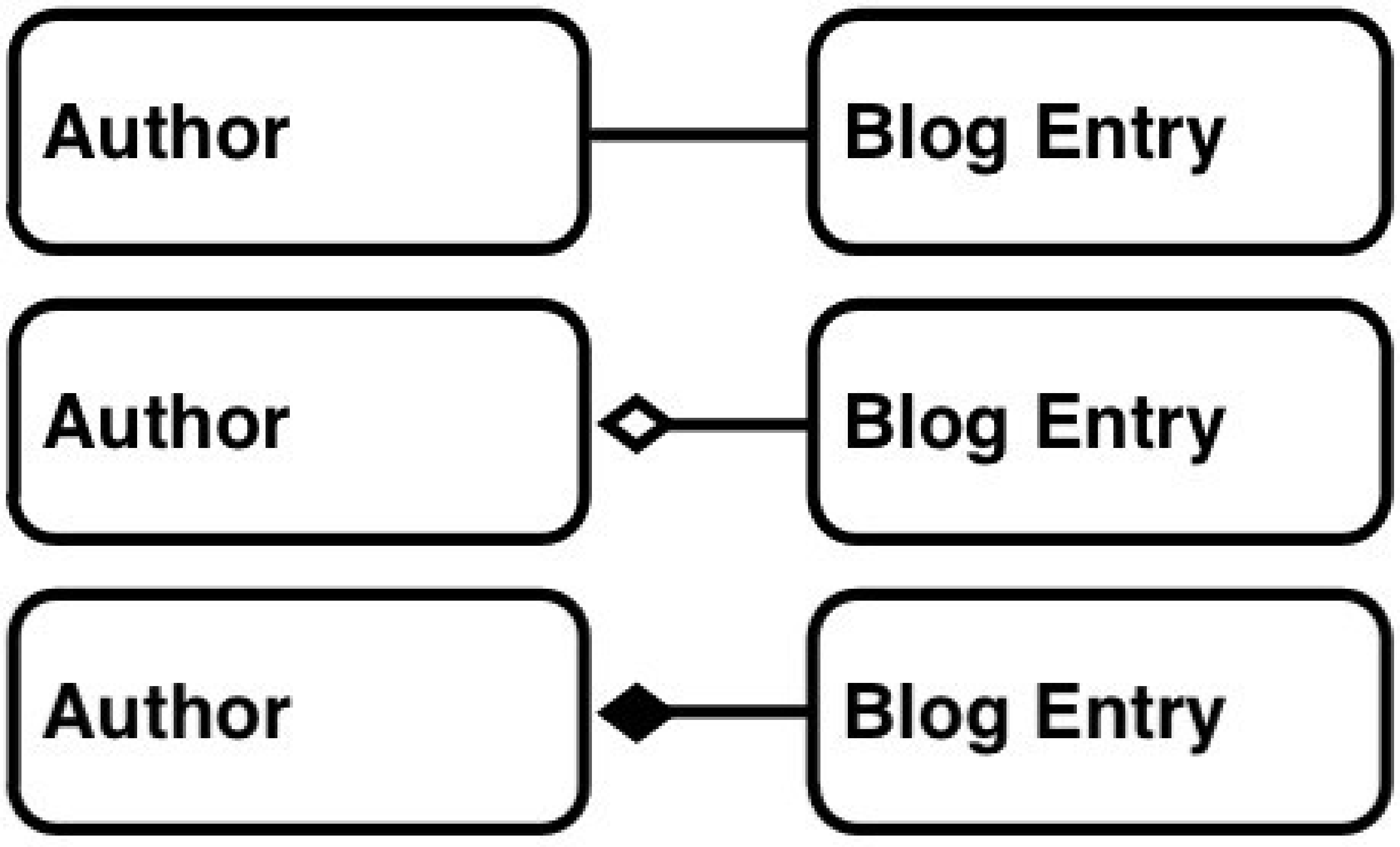
In MongoDB

```
{
    '_id': 1,
    'name' : 'Elephpant',
    'url_key': 'elephpant',
    'description': 'Cute elephpant',
    'short_description': "It's cute",
    'status': 1,
    'visibility': 4,
    'tax_class_id': 2,
}
```

One to Many (1:n)

One to Many relationships can specify:

- degree of association between objects
- containment
- life-cycle



One to Many (1:n)

Embedded Array / Array Keys

- slice operator to return subset of array
- some queries harder e.g find latest comments across all documents

```
blogs: {
  author: "Hergé",
  date: "Tue Mar 28 2012 12:41:29 GMT",
  comments: [
    {
      author: "Kyle",
      date: "Tue Mar 28 2012 12:41:54 GMT",
      text: "great book"
    }
  ]
}
```

One to Many (1:n)

Embedded Tree

- single document
- natural
- hard to query

```
blogs: {
  author: "Hergé",
  date: "Tue Mar 28 2012 12:41:29 GMT",
  comments: [
    {
      author: "Kyle",
      date: "Tue Mar 28 2012 12:41:54 GMT",
      text: "great book"
      replies: [
        { author: "Derick", ... }
      ]
    }
  ]
}
```

One to Many (1:n)

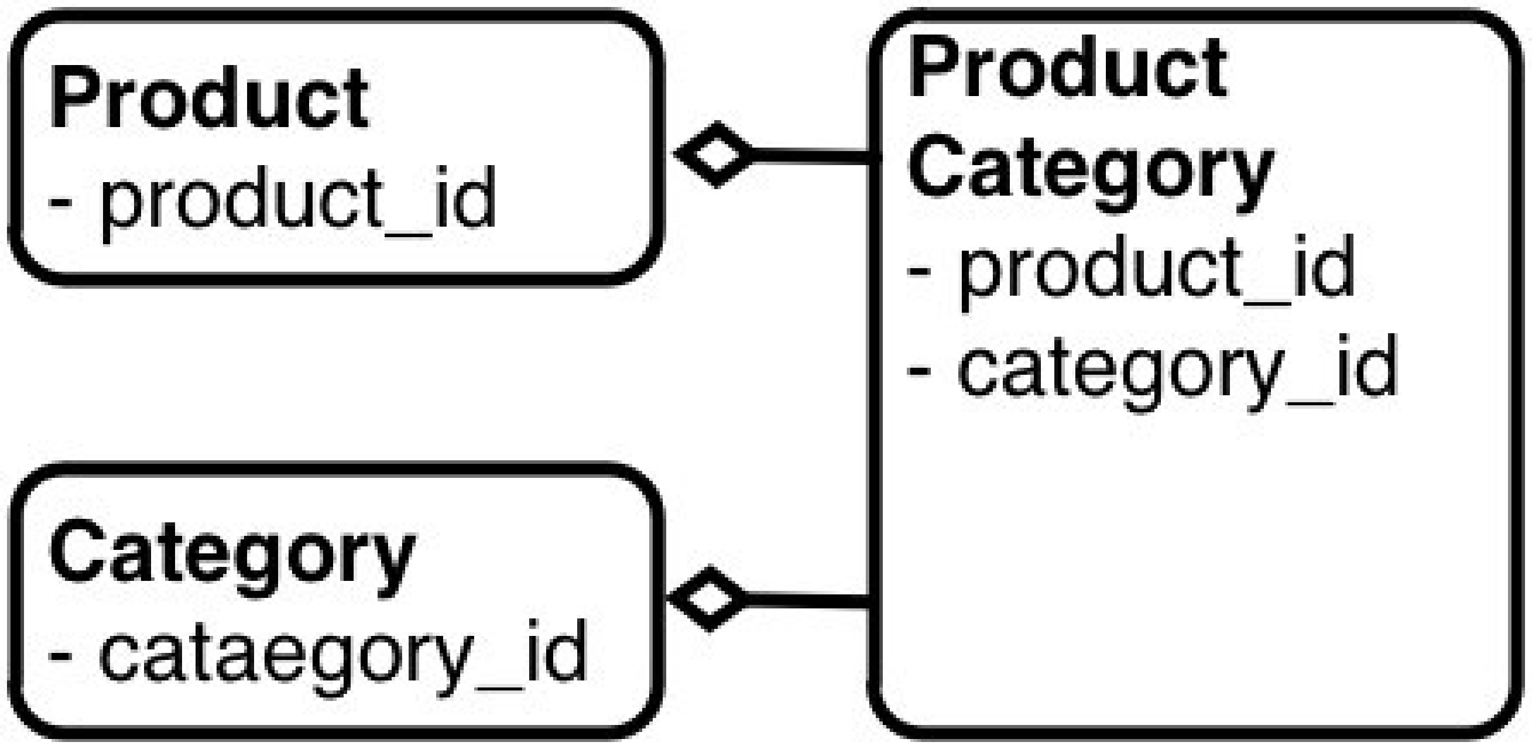
Normalised (with two collections)

- most flexble
- more queries

```
blogs: {
  author: "Hergé",
  date: "Tue Mar 28 2012 12:41:29 GMT",
  comments: [
    { comment: ObjectId("1") }
  ]
}

comments: {
  _id: "1",
  author: "Kyle",
  date: "Tue Mar 28 2012 12:41:54 GMT",
}
```

Many to Many (n:m)

- products can be in many categories
- category can have many products



Many to Many (n:m)

```
products:
{ _id: 10, name: "Blue elephpant", category_ids: [ 4, 7 ] }
{ _id: 11, name: "Pink elephpant", category_ids: [ 4, 8 ] }

categories:
{ _id: 4, name: "toys",            product_ids: [ 10, 11 ] }
{ _id: 8, name: "everything pink", product_ids: [ 11 ] }
```

All categories for a given product (pink elephpant):

```
db.categories.find( { product_ids: 11 } );
```

All products for a given category (toys):

```
db.products.find( { category_ids: 4 } );
```

Updates need to be done in two collections

Many to Many (n:m) - alternative 1

```
products:
{ _id: 10, name: "Blue elephpant", category_ids: [ 4, 7 ] }
{ _id: 11, name: "Pink elephpant", category_ids: [ 4, 8 ] }

categories:
{ _id: 4, name: "toys"           }
{ _id: 8, name: "everything pink"}
```

All categories for a given product (pink elephpant):

```
product = db.products.find( { category_ids: 4 } );
db.categories.find( { _id: { $in: product.category_ids } } );
```

All products for a given category (toys):

```
db.products.find( { category_ids: 4 } );
```

Many to Many (n:m) - alternative 2

```
products:
{ _id: 10, name: "Blue elephpant" }
{ _id: 11, name: "Pink elephpant" }

categories:
{ _id: 4, name: "toys",            product_ids: [ 10, 11 ] }
{ _id: 8, name: "everything pink", product_ids: [ 11 ] }
```

All categories for a given product (pink elephpant):

```
db.categories.find( { product_ids: 11 } );
```

All products for a given category (toys):

```
category = db.categories.find( { category_ids: 4 } );
db.products.find( { _id: { $in: category.product_ids } } );
```

Embedding versus Linking

Embedding

- Simple data structure
- Limited to 16MB
- Larger documents
- How often do you update?
- Will the document grow and grow?

Linking

- More complex data structure
- Unlimited data size
- More, smaller documents
- What are the maintenance needs?

Tips and hints: array keys

Don't do:

```
temperature: {
  _id: 42,
  points: [
    { 1332942067: 17.3 },
    { 1332942118: 17.5 }
  ]
}
```

instead, do:

```
temperature: {
  _id: 42,
  points: [
    { ts: 1332942067, temp: 17.3 },
    { ts: 1332942118, temp: 17.5 }
  ]
}
```

Define and document your keys!

Tips and hints: pre-page results

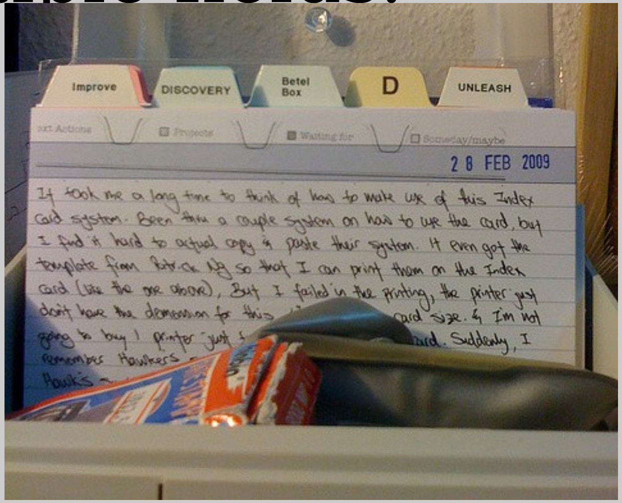
```
article: {
  _id: 42,
  title: "Xdebug saves you time!"
}
```

```
comments:
{
  _id: 42,
  page: 0,
  comments: [
    { ts: 1332942067, author: "Derick", comment: "It also costs a lot of time to write!" },
    { ts: 1332942118, author: "...", comment: "..." },
    ...
  ]
},
{
  _id: 42,
  page: 1,
  comments: [
    { ts: 1332942261, author: "Derick", comment: "blah blah" },
    { ts: 1332942482, author: "...", comment: "..." },
  ]
}
```

A bit more work when updating, but a lot easier to retrieve

Indexes

- Just like a relational database, mongoDB also benefits from indexes.
- Every collection has (automatically) an index on _id.
- Indexes can be on single or multiple fields.
- MongoCursor->explain().


Improve
DISCOVERY
Betel Box
D
UNLEASH
Next Actions
Projects
Waiting for
Someday/maybe
28 FEB 2009
It took me a long time to think of how to make use of this Index card system. Been thru a couple system on how to use the card, but I find it hard to actual copy & paste their system. It even got the template from Patrick Ng so that I can print them on the Index card (like the one above), But I failed in the printing, the printer just don't have the dimension for this card size. & I'm not going to buy ! printer just card. Suddenly, I Remember Hawkers
Hawk's

```
<?php ini_set('xdebug.var_display_max_depth',
 $m = new Mongo;
 $c = $m->demo->elephpants;
 $c->drop();

 $c->insert( array( '_id' => 'ele1', 'name' => 'Jumbo' ) );
 $c->insert( array( '_id' => 'ele2', 'name' => 'Tantor' ) );

 var_dump( $c->find( [ '_id' => 'ele1' ] )->explain() );
 ?>
```

Indexes

```
<?php ini_set('xdebug.var_display_max_depth', 1);
$m = new Mongo;
$c = $m->demo->elephpants;
$c->drop();

$c->insert( [ '_id' => 'ele1', 'name' => 'Jumbo' ] );
$c->insert( [ '_id' => 'ele2', 'name' => 'Tantor' ] );
$c->insert( [ '_id' => 'ele3', 'name' => 'Stampy' ] );

var_dump( $c->find( [ 'name' => 'Jumbo' ] )->explain() );
?>
```

Indexes

```
<?php ini_set('xdebug.var_display_max_depth', 1);
$m = new Mongo;
$c = $m->demo->elephpants;
$c->drop();

$c->ensureIndex( [ 'name' => 1 ] );

$c->insert( [ '_id' => 'ele1', 'name' => 'Jumbo' ] );
$c->insert( [ '_id' => 'ele2', 'name' => 'Tantor' ] );
$c->insert( [ '_id' => 'ele3', 'name' => 'Stampy' ] );

var_dump( $c->find( [ 'name' => 'Jumbo' ] )->explain() );
?>
```

More about indexes

- Compound indexes:

  $myCol->ensureIndex([_id: 1, ts: -1])
- Searching with regexp: ^:

  $myCol->find(['name' => new MongoRegex('/^tan/i')])
- 2d index wants longitude, latitude (as in GeoJSON):

  $myCol->insert([_id: 42, loc: [6.43, 52.1233]]);

  $myCol->insert([_id: 42, loc: { long: 6.43, lat: 52.1233 }]);

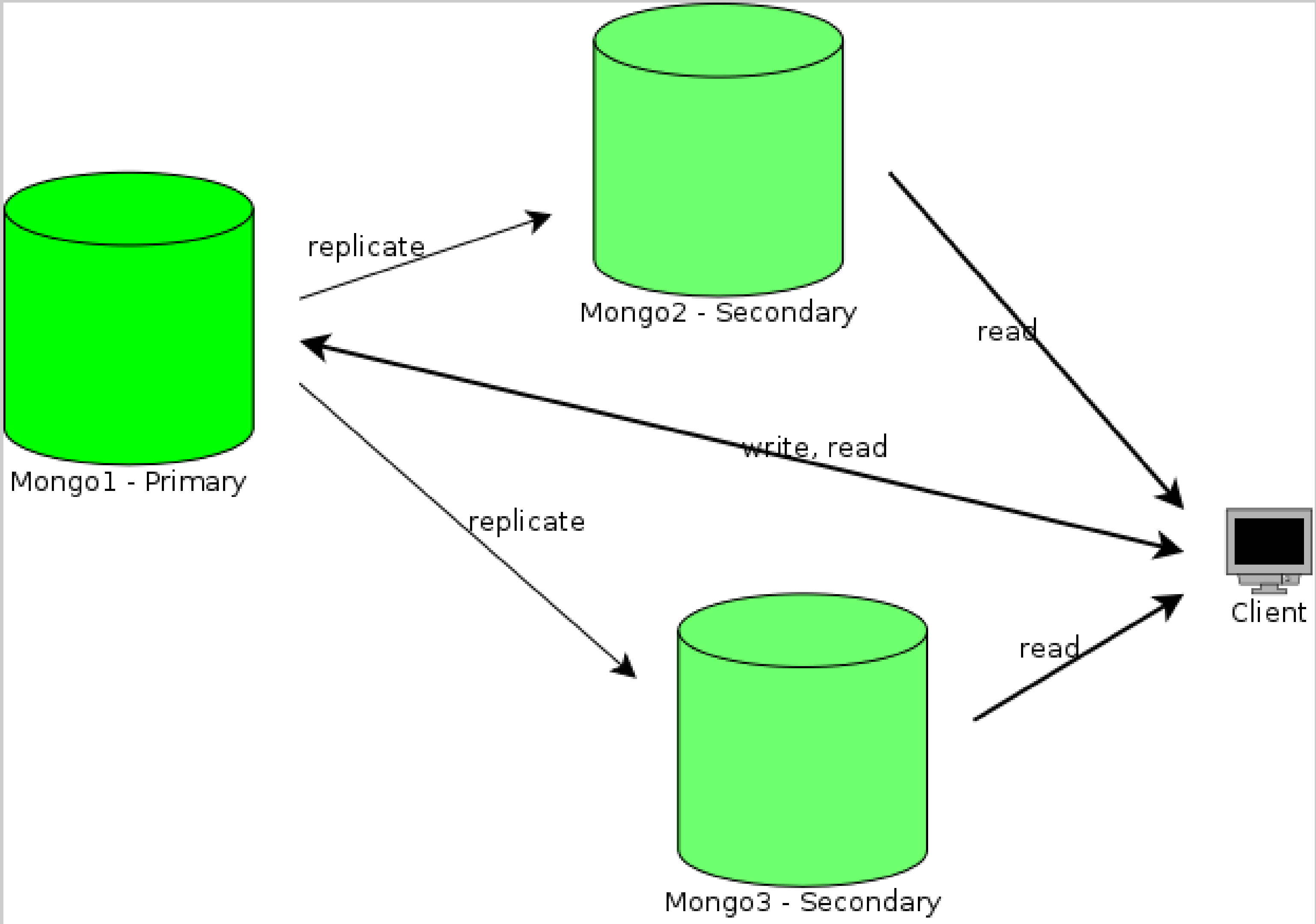
  $myCol->insert([_id: 42, loc: { latitude: 6.43, longitude: 52.1233 }]);

Geospatial Indexes

Helps you with finding POIs (pubs!) in a 2D space

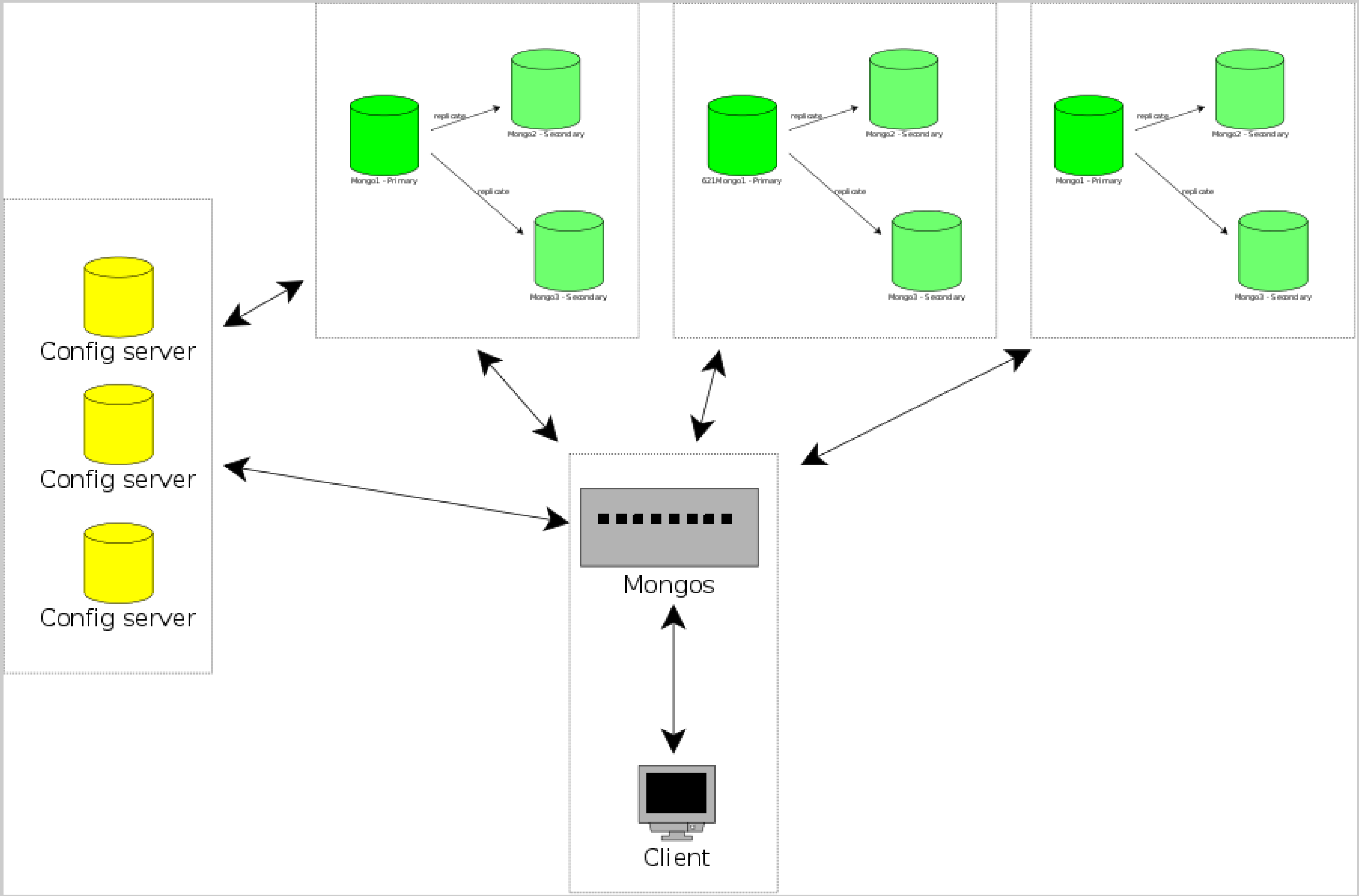
```
<?php
$m = new Mongo; $c = $m->demo->pubs; $c->drop();

$c->ensureIndex( array( 'l' => '2d' ) );
$c->insert([ 'name' => 'Betsy Smith',   'l' => [ -0.193, 51.537 ] ]);
$c->insert([ 'name' => 'London Tavern', 'l' => [ -0.202, 51.545 ] ]);

$closest = $m->demo->command( [
    'geoNear' => 'pubs',
    'near' => [ -0.198, 51.538 ],
    'spherical' => true,
] );

foreach ( $closest['results'] as $res ) {
  printf( "%s: %.2f km\n", $res['obj']['name'], $res['dis'] * 6378 );
}
?>
```

Replication



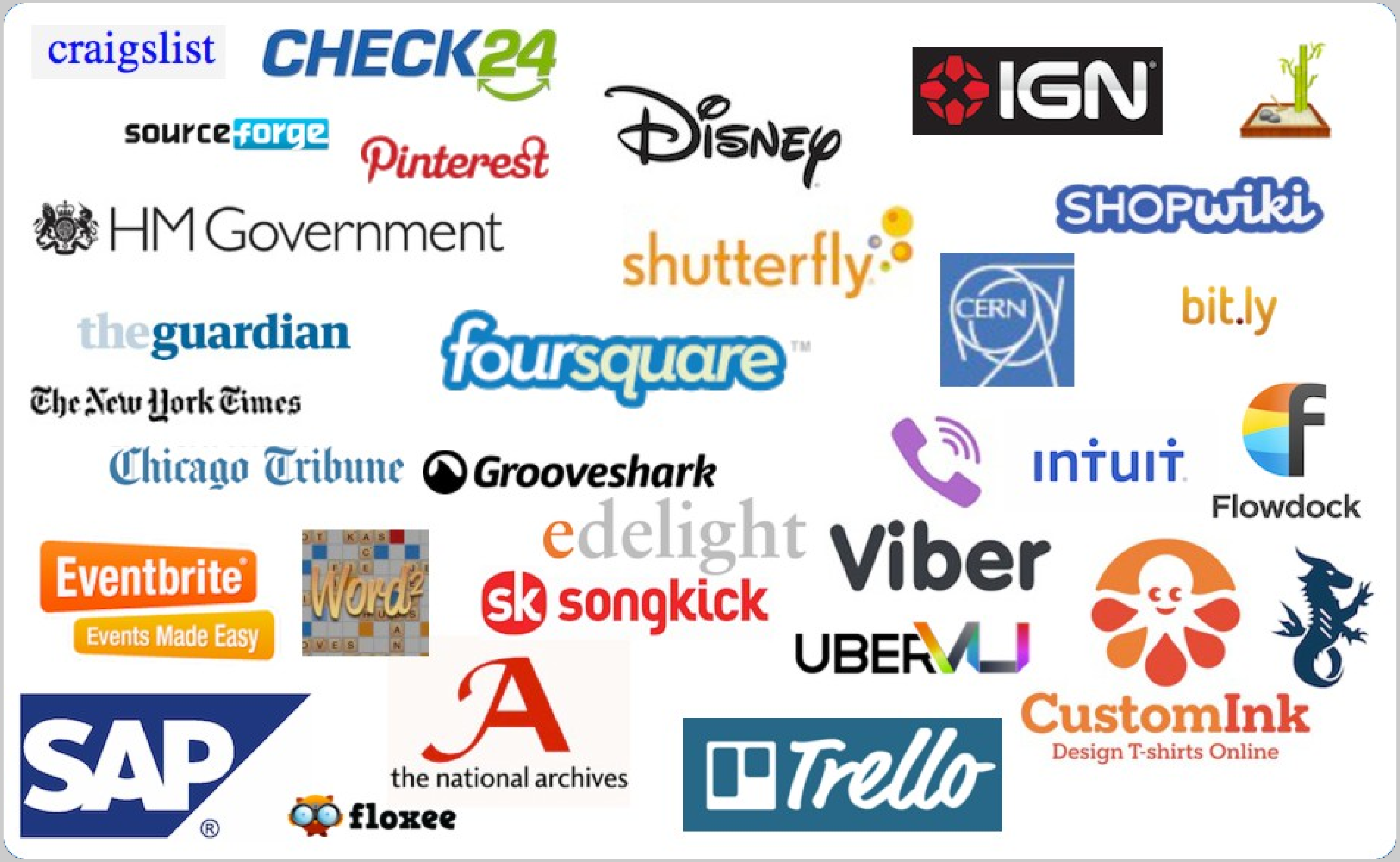
- Failover/Availability
- Scaling reads
- Primaries, secondaries and arbiters
- Odd number to prevent split brain

Sharding

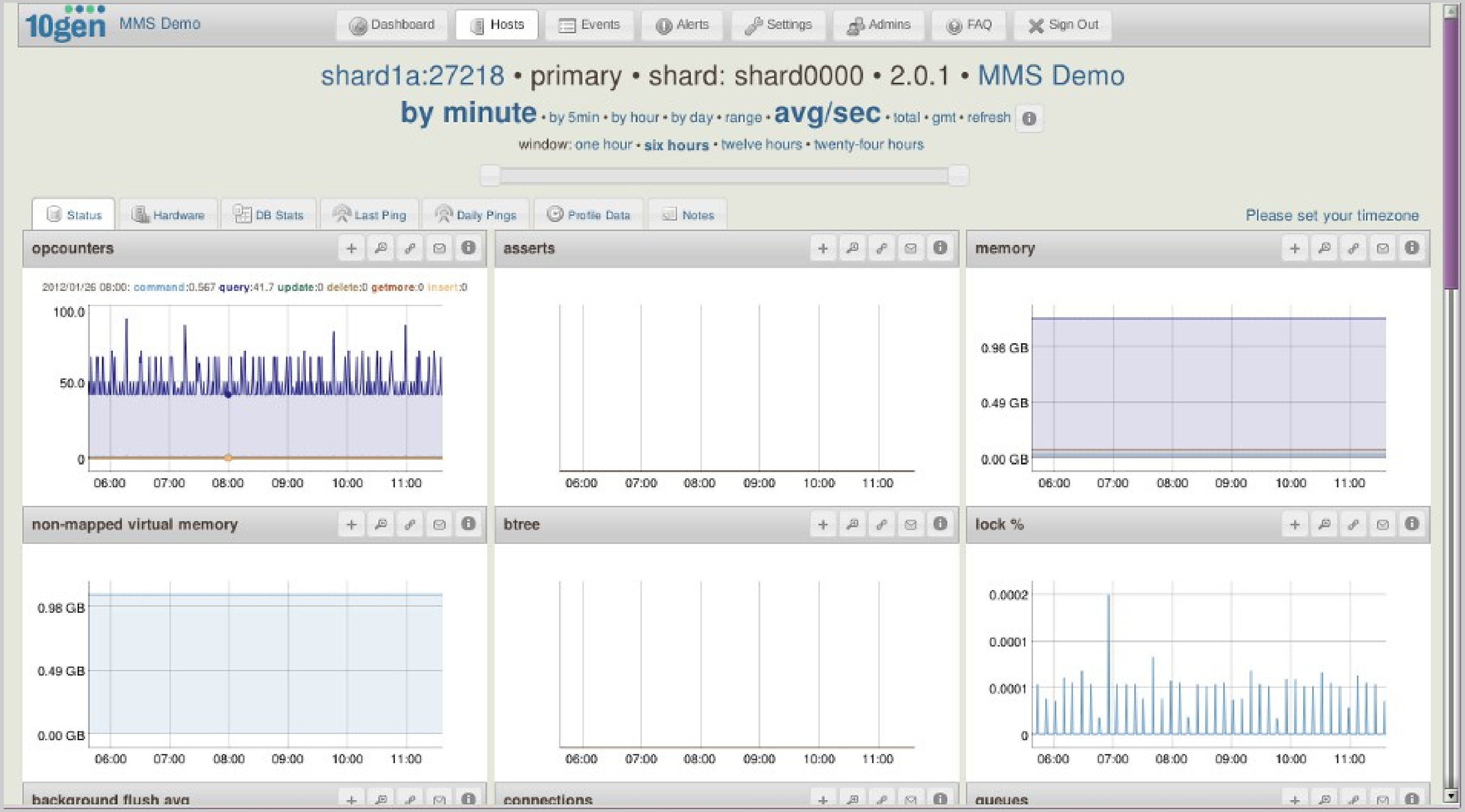


- Scaling writes and reads
- Config servers, router (mongos) and replica sets

Who uses MongoDB?



MMS



shard1a:27218 • primary • shard: shard0000 • 2.0.1 • MMS Demo

by minute • by 5min • by hour • by day • range • avg/sec • total • gmt • refresh

window: one hour • six hours • twelve hours • twenty-four hours

Please set your timezone

2012/01/26 08:00: command:0.567 query:41.7 update:0 delete:0 getmore:0 insert:0

Resources

- Slides: http://derickrethans.nl/talks/:-:talk_id:-:
- Contact me: Derick Rethans: @derickr, derick@10gen.com
- Feedback: