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Reporting on Rails

ActiveRecord and ROLAP Working Together

WIP Edition

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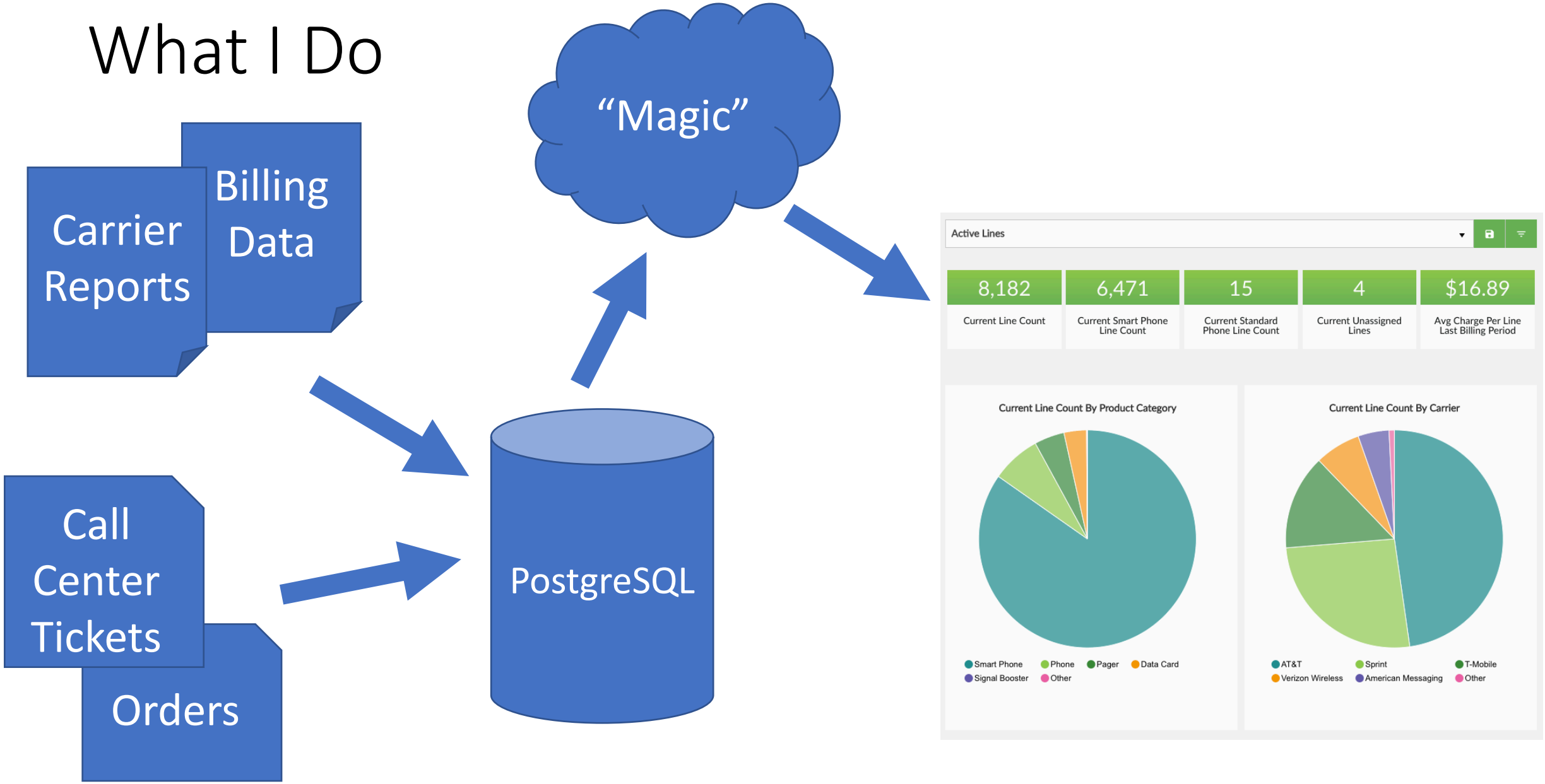
IndyRB March 2017

Who am I?

- Senior Developer at MOBI Wireless Management
  - Billing and Reporting Team
  - ”Nearly one million devices under management.” ~ Our Marketing
- Seven Years Working with Rails
- Mario Kart Connoisseur

What I Do


"Magic"
Billing Data
Carrier Reports
Call Center Tickets
Orders
PostgreSQL
Active Lines
8,182
Current Line Count
6,471
Current Smart Phone Line Count
15
Current Standard Phone Line Count
4
Current Unassigned Lines
$16.89
Avg Charge Per Line Last Billing Period
Current Line Count By Product Category
Smart Phone
Phone
Pager
Data Card
Signal Booster
Other
Current Line Count By Carrier
AT&T
Sprint
T-Mobile
Verizon Wireless
American Messaging
Other

Today’s Talk

- Define “reporting”
- Industry standard terminology for “reporting”
- Ways of organizing your data for “reporting”
- How much can Rails do out of the box?

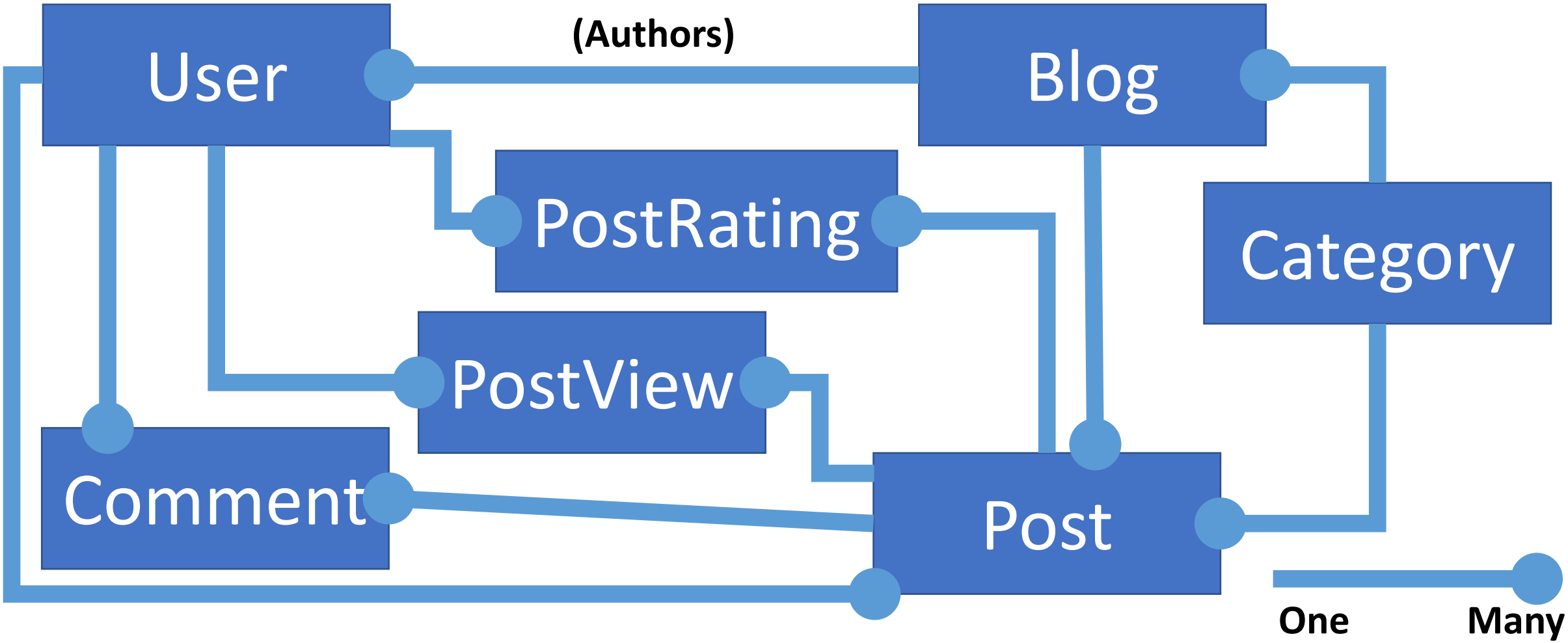
The Scenario

- You are: Lead Developer
- Median
  - Semi-successful blog site
  - ~60,000 registered users
  - ~1 million blog entries
  - ~1.8 million comments

(I spent way too much time on this fake logo)

The Scenario

Just a rough estimate / example.
Don't bother memorizing this.



The Scenario

- Feature Request: Build a series of dashboards to **report** on our data
  - Blog dashboard for authors
  - Overall dashboard for site admins
- Allow for user-defined filtering

- *Where do you begin?*

What is “reporting”?

- Data is stored in our data stores (RDBMS)
  - Worthless to humans
  - Useful to computers
- What’s useful? *Information*
- Reports turn data into information for humans
- Reports answer specific questions

What do you want to answer?

- For owners
  - What is the total number of blogs by category?
  - How many users are signing up month over month?
  - Which posts are the most viewed?
- For blog authors
  - How many users have viewed a post over the past 7 days?
  - How many comments are left on posts on average?
  - Which are my top 5 rated posts?
  - How many people have viewed posts for category _____?
  - How many posts have each of my blog's authors written?

What is “OLAP”?

- **O**nline **A**nalytical **P**rocessing
- “…the technology behind many Business Intelligent (BI) applications. OLAP is a powerful technology for data discovery, including capabilities for limitless report viewing, complex analytical calculations, and predictive “what if” scenario planning.”

  From: http://olap.com/olap-definition/

- Data is organized into “data cubes”
  - Comprised of dimensions and measures
    - Buyer
    - Amount
    - Date sold (Date, Month, Quarter, Year)
  - Every combination known and calculated ahead of time
- Large amounts of preprocessed data stored in a warehouse for the express purpose of fast querying
- Commonly deals with aggregate data (count, max, min)

What is “**R**OLAP”

- **R**elational **O**n**l**ine Analytical **P**rocessing
- OLAP functionality implemented with a RDBMS
- **Dynamic queries** generated for reports
- Uses standard database **tables** and **relations**
- May be implemented on both **transactional** data (OLTP) and **warehouse** data
- Tables organized in a star and/or snowflake schema

Couple notes…

- We don’t want “bloat” in our result set
- No ActiveRecord instances (Less memory)
- Generic, uniformed data (Arrays of rows)
- Only get the information we care about

Terminology

- Fact Table (Sometimes called “Fact Model”)
- Dimension
  - Members (Labels)
  - Hierarchy
- Dimension Filters (also known as just “Filters”)
- Measure
- Metric

Fact Table/Model

- The primary table where information is derived from in a report
  - Fact columns – Commonly numeric columns
  - Dimension columns – values that may be grouped together or references other tables

SQL: FROM clause

Rails: ActiveRecord model

What is the total number of blogs by category?

How many comments are left on posts on average?

Dimension

- A point in the data where you can ”slice and dice” fact model info
  - Sales rep
  - Date of purchase
  - State of an order in a state machine
- Lives on fact table or as a foreign key to another table

SQL: JOIN, GROUP BY

Rails: ActiveRecord relation or attribute

What is the total number of blogs by category?

How many posts have each of my blog’s authors written?

Dimension Hierarchy

- Related attributes on a dimension used to “drill up” and “drill down”
- Found on dimensions which are relations to a fact model

Examples:

- Dates: Date, Month, Quarter, Year
- Mobile Phone: Model, Manufacture, OS, Wireless Technology

Dimension Members (Dimension Labels)

- Information related to a dimension
- When on fact table, the label is the column
- When on a relation, a field representing the hierarchy level

Dimension Filters (or just “Filters”)

- Not a “real” OLAP term
- Takes advantage of querying capabilities of RDBMS
- Allows for more fine-grained reporting
- Can be part of the metric or user specified

SQL: WHERE

Rails: where(), scopes, ransack

Measure

- A column in a table (usually numeric) used in aggregations
  - Average, Sum, Maximum, etc
- Examples:
  - Total amount in a sale
  - Number of units used in a transaction

SQL: A column in a fact table

Rails: ActiveRecord attribute

Metric

- A measured value; The subject of the report
- The thing you actually want to answer

SQL: The query

Rails: All the things

What is the total number of blogs by category?

How many posts have each of my blog's authors written?

Terminology

ROLAP	SQL	Rails
Fact Table	FROM	ActiveRecord Model
Dimension	JOIN, GROUP BY	AR Relations, joins(), group()
Dimension Filter	WHERE	Scopes, where(), ransack
Measure	Numeric Column	Model Attribute
Metric	Query	All the above

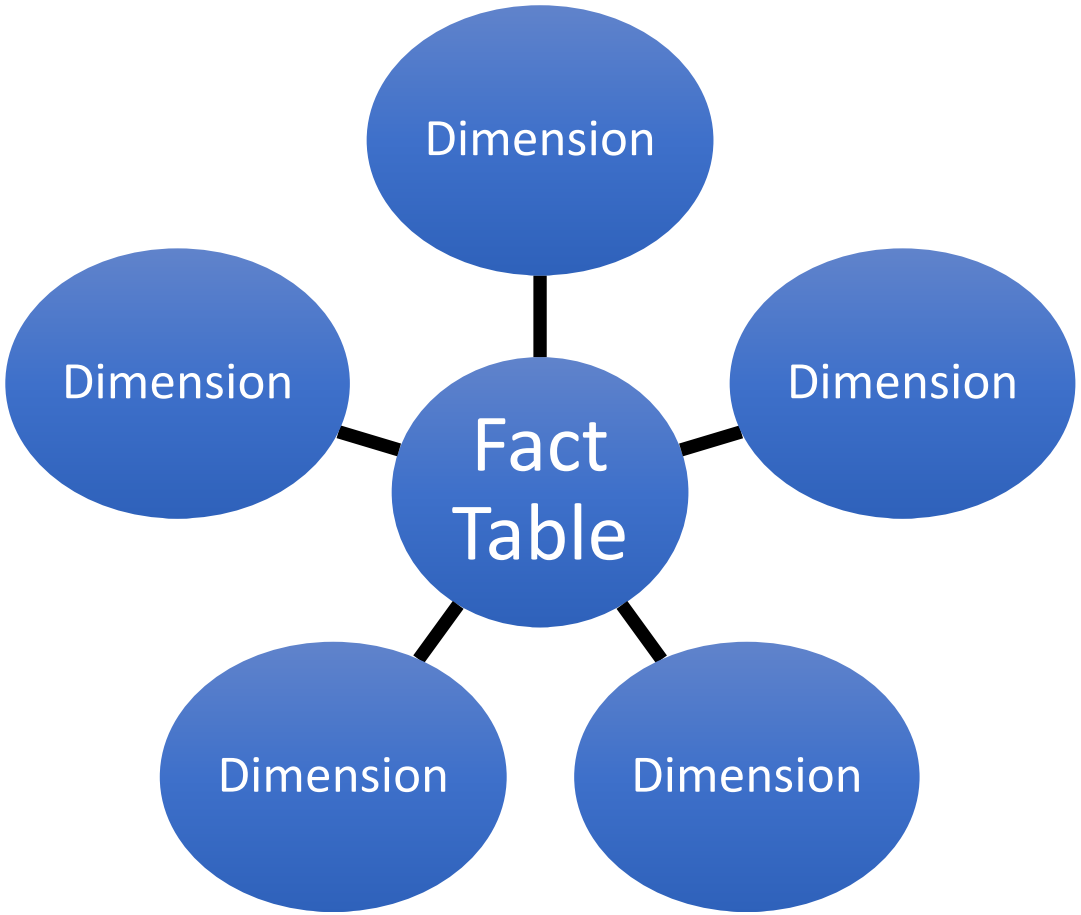
(comment_count on posts)

How many comments were left on posts created today grouped by post category?

Star Schema

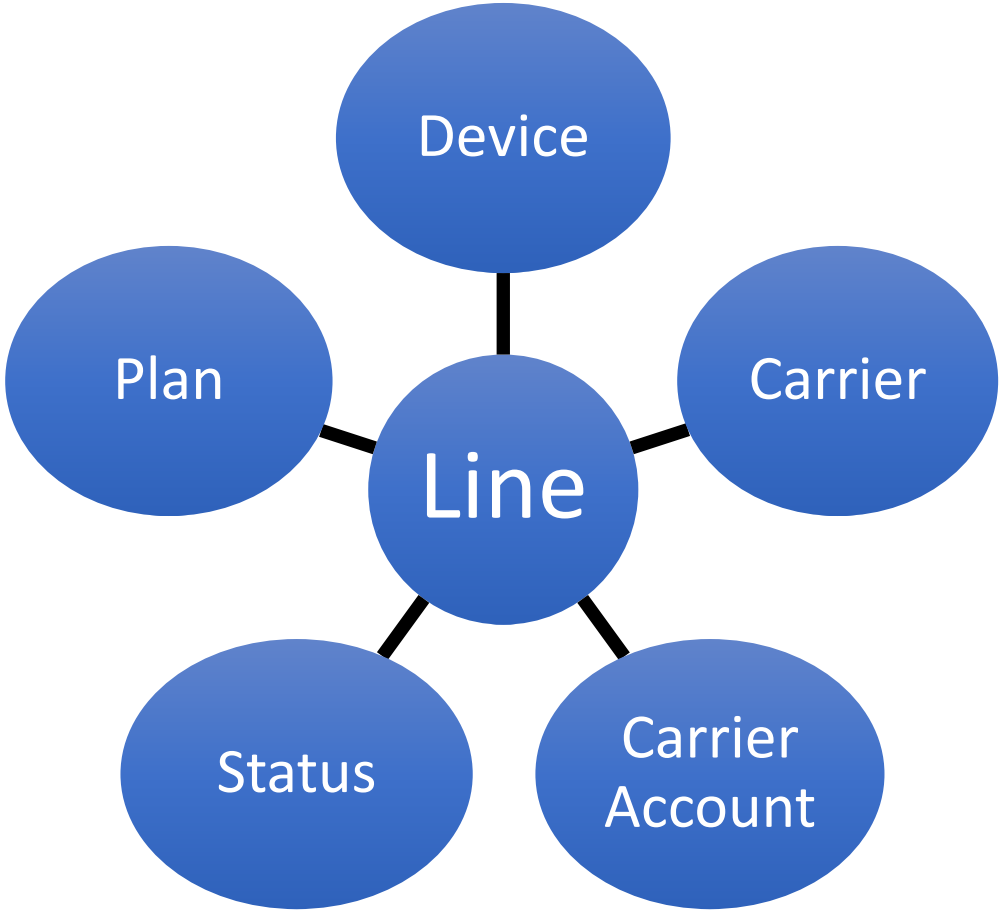
- A design pattern for organizing data in a data warehouse
- Allows for queries to be efficient and fast
- Fact table holds core business information / processes
  - A sale
  - A bank transaction
- Fact table holds foreign keys that branch out into dimension tables
- Fact table may also hold non-foreign dimensions as columns
- Other option: Snowflake Schema

Star Schema



- Primary driving force of a report in the middle
- Consists primarily of measures, foreign keys and dimensions that live on the fact table
- belongs_to / has_one branch out to relations via foreign keys
- More detailed info lives on dimensions
- Prefer dimensions tables over dimensions living on the fact table
- **DOES NOT SUPPORT has_many relationships (well)**

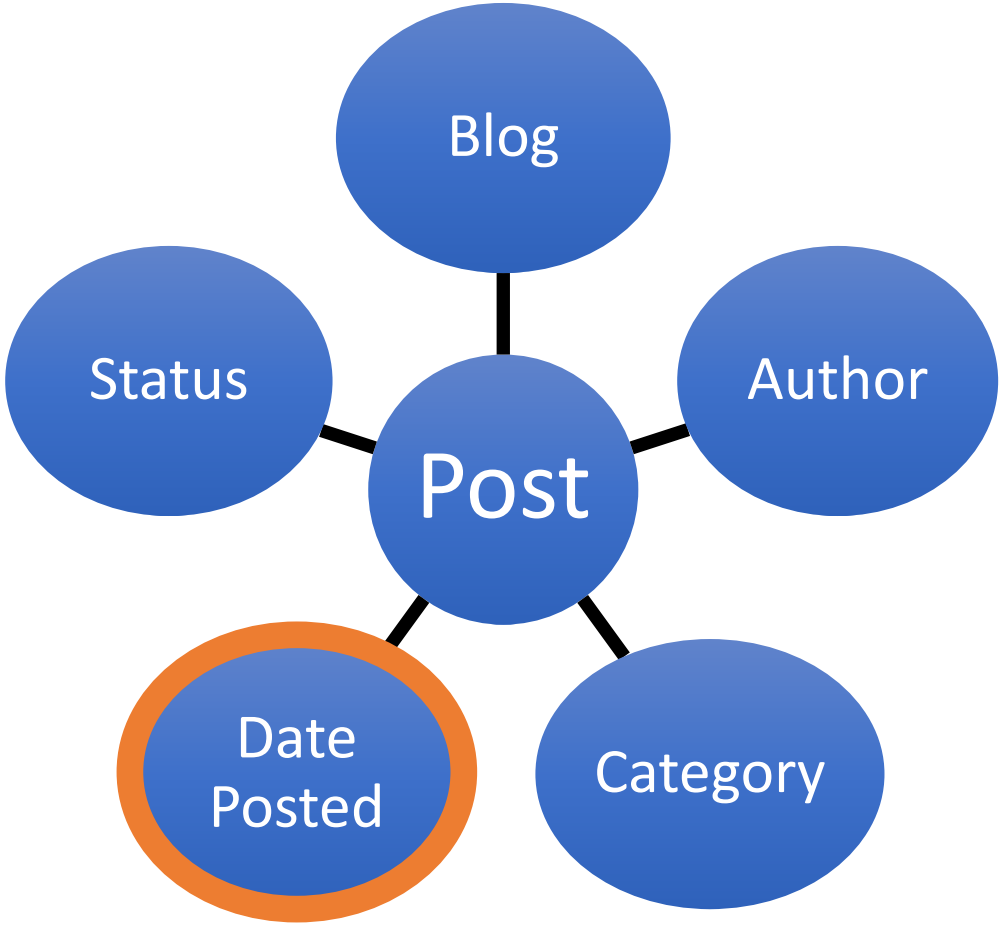
Star Schema



MOBI®

Overly simplified example

Star Schema

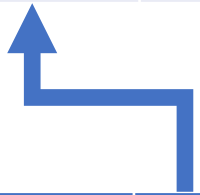


Dates as Dimensions

- Want to report by Quarter? Year? Month?
- Date functions on date columns can't use a regular index
- Simple join + group/filter is quicker

date_dimensions

id	date	mday	month	year	quarter	wday
20170509	2017-05-09	9	5	2017	2	3
20170510	2017-05-10	10	5	2017	2	4
20170511	2017-05-11	11	5	2017	2	5
20170512	2017-05-12	12	5	2017	2	6



posts

id	posted_at_id	blog_id	author_id	title	content
16	20170509	123	15	….	….
17	20170510	342	90	….	….
18	20170511	123	15	….	….
19	20170512	586	76	….	….

Great! ActiveRecord can do all that… right?

- ActiveRecord's internals can provide all the information needed to *construct* ROLAP *queries*
- Relationship information (joins and grouping)
- Filtering capabilities (Scopes, where(), ransack)
- Ability to select out specific columns

Great! ActiveRecord can do all that… right?

- No programmatic way to easily group by all non-aggregate columns
  - You can group by relations and get objects back or by columns, not both
  - Can result in multiple queries resulting in ActiveRecord objects instanciated
- Aggregation methods do not allow for full control over multiple columns returned
  - select() is ignored
  - group() can muck with the SELECT clause
- No clear way to have “stock metrics” that can be reusable for different dashboards
- No way to describe a fact table or metrics in ROLAP terms
- No decent way to defining what a user can filter metrics on

Options?

- Manually write hardcoded ActiveRelation queries?
  - Not very DRY
  - Complex logic for applying dimensions and filters
- Write a queryer yourself?
  - ActiveRecord provides most of the information you want
  - Could result in dirtying up models
- Switch your application to squeel?
  - Ship’s sailed for most apps
  - Requires management buy-in for a rewrite

active_reporting

- https://github.com/t27duck/active_reporting
- Implements a DSL for describing fact models, dimensions, filters
- Build ready-made metrics to run reports on
- Uses ActiveRecord to build a query and execute it on the database
- Does not dirty up ActiveRecord (only one new method)
- Not quite done yet (sad face)

active_reporting - FactModel

```
class PostFactModel < AR::FM
    use_model ‘Post’

end
```

```
class Post < AR::Base


end
```

active_reporting – FactModel - Dimensions

```
class PostFactModel < AR::FM
  …

  dimension :blog
  dimension :category
  dimension :some_column

  …
end
```

- Define specific columns or relations for dimensions
- Relation-based dimensions include identifier column and label in report results

active_reporting – Heirarchy + Labels

```
class DateDimFactModel < AR::FM
   …

 default_dimension_label :date

 dimension_hierarchy [
  :date, :month, :year, :quarter
 ]
   …
end
```

- Default label is “name”
- Defining a hierarchy allows for specifying different columns to group by while dimensioning

active_reporting – Dimension Filters

```
class DateDimFactModel < AR::FM
  …
  dimension_filter :scope_on_model

  dimension_filter :by_author_id,
       ->(x) { where(author_id: x) }

  dimension_filter :title_cont,
     as: :ransack
  …
end
```

- Define available filters
- Scopes defined on the ActiveRecord Model
- Defined just for the fact model using scope syntax
- Optional way to fallback to ransack on the AR model

active_reporting – Metric

```
m1 = ActiveReporting::Metric.new(
    :post_count_by_author,
    fact_model: PostFactModel,
    dimensions: [:author]
)

m2 = ActiveReporting::Metric.new(
    :comment_count,
    fact_model:   PostFactModel,
    measure:      :comment_count,
    aggregate:    :sum
)
```

- Describes a question to answer
- Declare
  - Fact Model
  - Dimensions
  - Measure
  - Aggregate (defaults to count)

active_reporting – Report

```
m2 = ActiveReporting::Metric.new(
    :comment_count,
    fact_model:   PostFactModel,
    measure:      :comment_count,
    aggregate:    :sum
)

r = ActiveReporting::Report.new(
    m1,
    dimensions: [:blog],
    dimension_filter: {
      blog_id_eq: [123, 456]
    }
)
```

- Builds and executes the report
- Takes a pre-build metric and expands on it
- Add additional dimensions and filters (ie, user input)
- Returns simple array of hashes

active_reporting – Report

```
> r.run
=> [
  {
    comment_count: 742,
    blog_identifier: 123,
    blog: ‘Some Blog’
  },
  {
    comment_count: 623,
    blog_identifier: 456,
    blog: ‘Some Other Blog’
  },
]
```

```
SELECT
  SUM(posts.comment_count)
    AS comment_count,
    blogs.id AS blog_identifier,
    blogs.title AS blog
FROM posts
JOIN blogs ON blog.id =
posts.blog_id
WHERE posts.blog_id IN(123, 456)
GROUP BY blogs.id, blogs.title
```

A Limitation of ActiveRecord

- Extremely difficult to easily join against the same table twice and filter independently

- SupportTicket.
  joins(:creator, :assignee).
  where(????)

```
class SupportTicket
  belongs_to :creator,
      class_name: ‘User’

   belongs_to :assignee,
      class_name: ‘User’
end
```

Other Database Considerations

- Try not to have to make “multiple jumps” to tables
  - has_one :through can let us “cheat”, but query isn’t necessarily optimal
  - Keep dimensions “one deep” when focusing on Star Schema
- Star/Snowflake Schema does not support one-to-many and many-to-many relationships (very well)
- Index liberally where needed
  - Foreign keys
  - Columns commonly used for filtering
  - Use EXPLAIN [ANALYZE]
  - INSERTS will be ”slower” as you move to a more warehouse-like database
- Read-only replicating slaves
- Shard or schema separation

Outgrowing OLTP: Entering “Real” Data Warehousing

- ROLAP functions well enough for OLTP (Transactional) data, but overtime more data leads to slower queries
- Running aggregates on the fly will eventually become too slow
  - Rails counter caches
  - Pre-calculated aggregates (Rebuilt via background jobs)
- Copy/move “historical” data into ”rollup tables” and report on them
  - Data is no longer “live”
  - Data is stamped out once
  - Pre-determined aggregates and summation of data
  - Note: Rolling aggregations can cause a loss in dimension data

The End

- WIP Gem: https://github.com/t27duck/active_reporting
- Slides: https://github.com/t27duck/showandtell
- Twitter: @t27duck