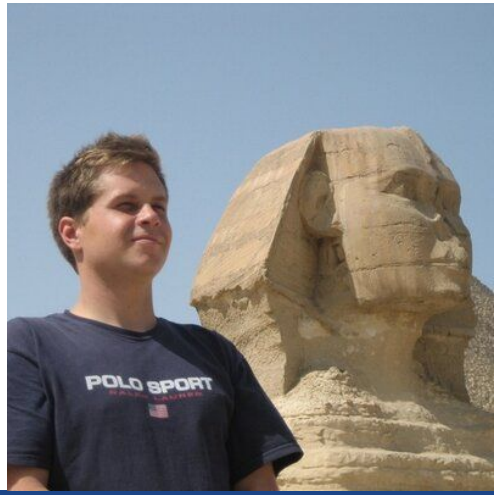
Relational (Anti-)Patterns

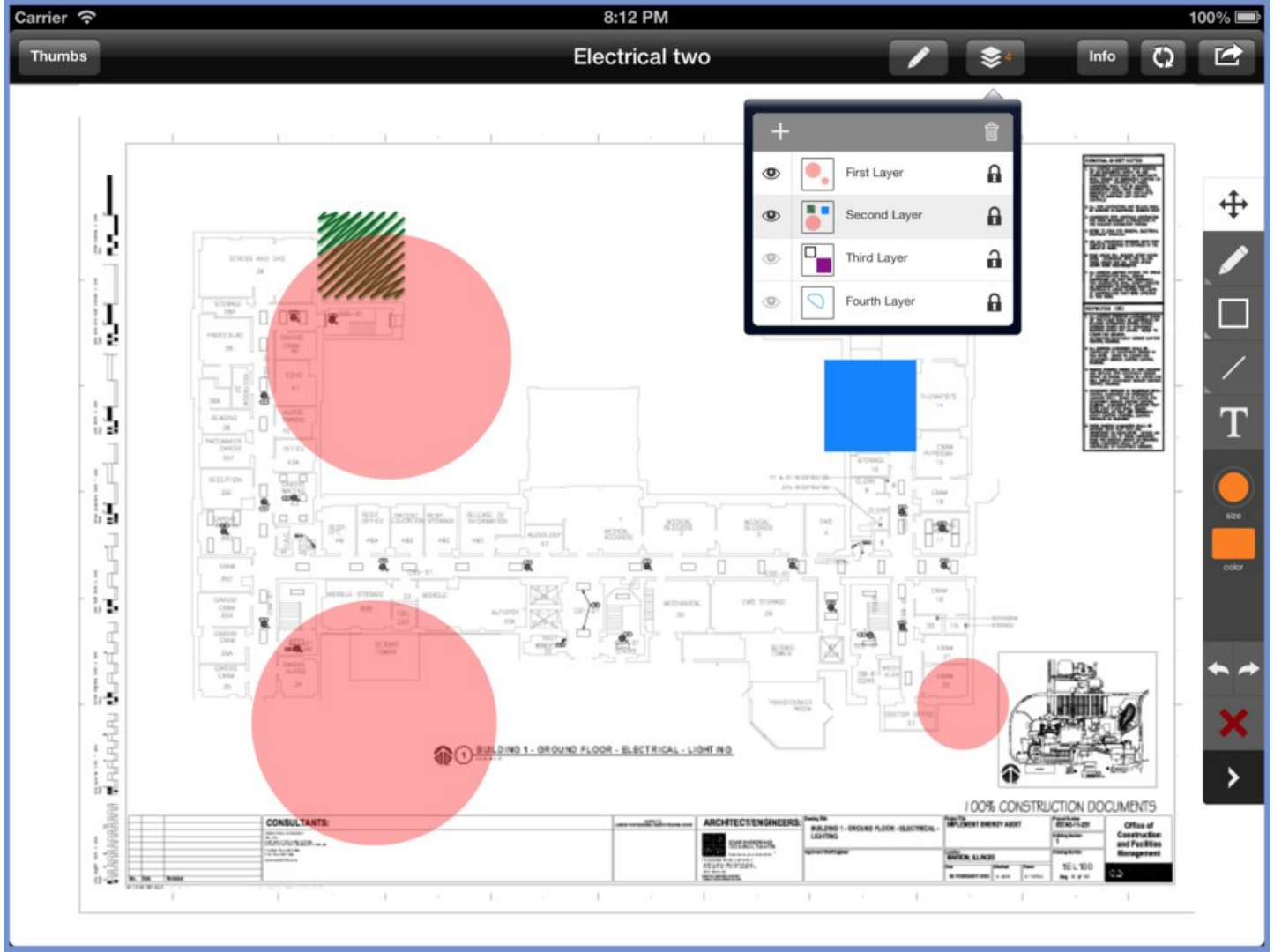
How *not* to design your database

```
{
  "Brad Urani" : "Staff Engineer",
  "Company" : " PROCORE ",
}
```




TOUGH
DECISIONS
AHEAD


CORNELL
CO.,INC.


Carrier
8:12 PM
100%
Thumbs
Electrical two
Info
First Layer
Second Layer
Third Layer
Fourth Layer
size
color
BUILDING 1 - GROUND FLOOR - ELECTRICAL - LIGHTING
100% CONSTRUCTION DOCUMENTS
CONSULTANTS:
ARCHITECT/ENGINEERS:
Office of Construction and Facilities Management


WOMEN
IN CONSTRUCTION
Engage.
Educate.
Empower.
procore.com/wic

What is Scale?

20,000,000 rows scanned / sec
30,000 transactions / sec
6 TB

1.5 TB RAM
64 Cores

BUDGET

Export

Budget | Configurable Views | Forecasting | Legacy Budget Snapshots (0) | Change History (414)

CREATE NEW BUDGET LINE ITEM

Sub Job	Cost Code	Category	Original Budget	
N/A	Select a Cost Code		$ 0.00	+ Add

Last synced with Sage 300 8 days 23 hours 13 minutes and 26 seconds ago.
Please note: While all JTD/Direct costs have been updated, there may be items in your ERP system that have not been added to the Budget in Procore.

COST CODE DETAIL

Cost Code	Category	Original Budget	Revised Budget	Committed Costs	Direct Costs	Pending Cost Changes	Projected Costs	Forecast To Complete	Estimated Cost At Completion	Projected Over/Under	Job To Date Costs
Division 01 - General Conditions											
01-010004 - A/E Fees	O	$ 1,490,000.00	$1,490,000.00	$0.00	$0.00	$0.00	$0.00	$1,490,000.00	$1,490,000.00	$0.00	$1,571,975.41
01-010004 - A/E Fees	S	$ 2,100.00	$2,100.00	$0.00	$0.00	$0.00	$0.00	$2,100.00	$2,100.00	$0.00	$0.00
01-010005 - A/E Reimbursables	O	$ 300.00	$300.00	$0.00	$297.50	$0.00	$297.50	$2.50	$300.00	$0.00	$297.50
01-010005 - A/E Reimbursables	S	$ 6,000.00	$6,000.00	$0.00	$0.00	$0.00	$0.00	$6,000.00	$6,000.00	$0.00	$0.00
01-010006 - Administrative Personnel	B	$ 1,000.00	$1,000.00	$0.00	$104,150.99	$0.00	$104,150.99	$0.00	$104,150.99	($103,150.99)	$104,150.99
01-010006 - Administrative Personnel	L	$ 3,689,355.00	$3,689,355.00	$0.00	$643,129.53	$0.00	$643,129.53	$3,046,225.47	$3,689,355.00	$0.00	$643,129.53
01-010006 - Administrative Personnel	O	$ 489,355.00	$489,355.00	$0.00	$396.30	$0.00	$396.30	$488,958.70	$489,355.00	$0.00	$396.30
01-010006 - Administrative Personnel	PD	$ 0.00	$0.00	$0.00	$60,120.00	$0.00	$60,120.00	$0.00	$60,120.00	($60,120.00)	$60,120.00
01-010007 - Admin. Personnel-Fleet Card	O	$ 36,600.00	$36,600.00	$0.00	$45,395.99	$0.00	$45,395.99	$0.00	$45,395.99	($8,795.99)	$45,395.99
01-010007 - Admin. Personnel-Fleet Card	Z	$ 0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
01-010008 - Admin. Personnel-Car Rentals	O	$ 30,000.00	$30,000.00	$0.00	$5,448.29	$0.00	$5,448.29	$24,551.71	$30,000.00	$0.00	$5,448.29

Create Snapshot
Re-send to ERP
Lock Budget

IMPORT BUDGET CSV

Download Template
Choose File | No file chosen
Need Help? Import

VIEWS

Cost Code Detail
Cost Code Summary (Read Only)

FILTERS

Sub Job: None
Division: All
Category: All

Clear All | Apply

CUSTOM REPORTS

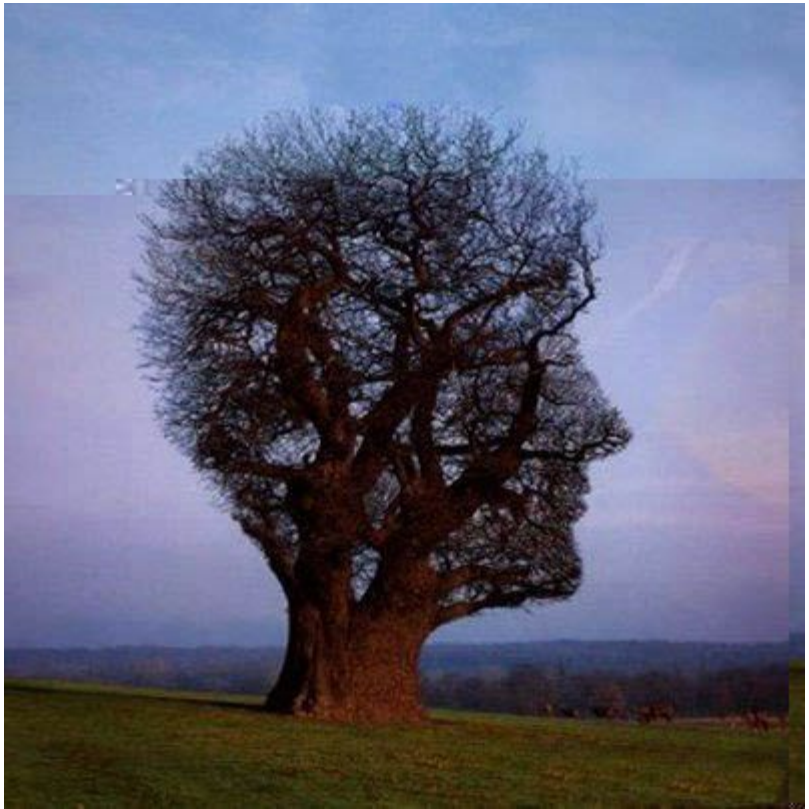
+ New

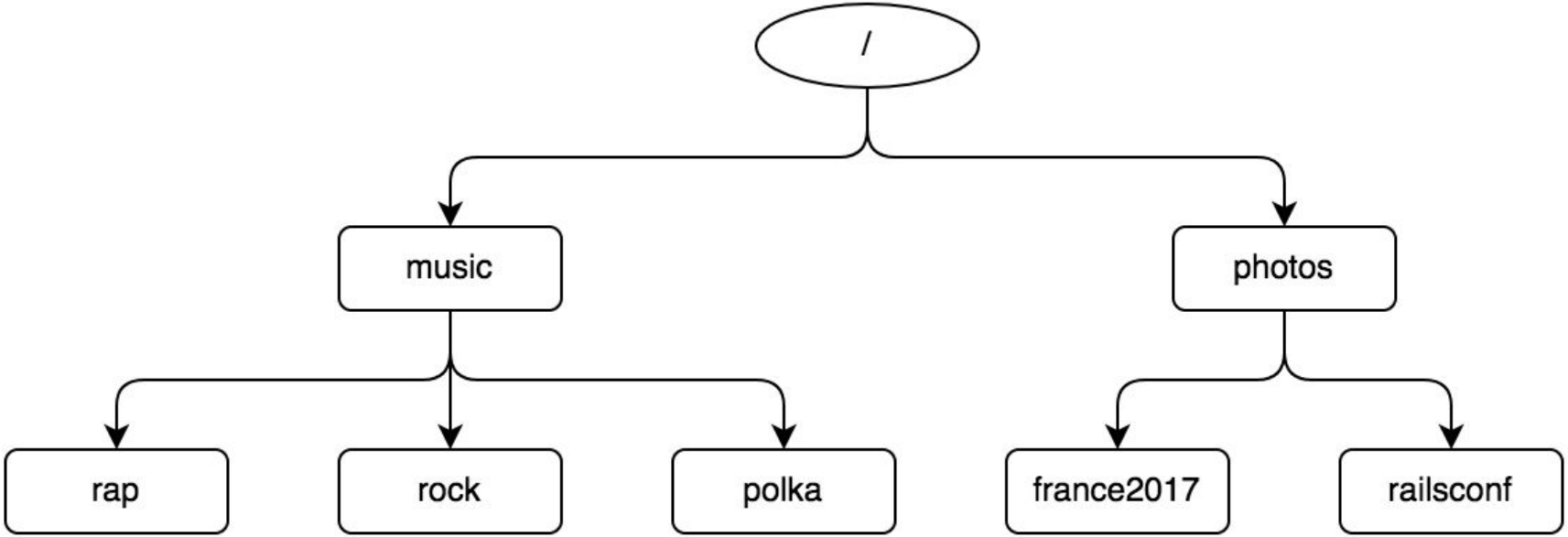
Minimize Sidebar

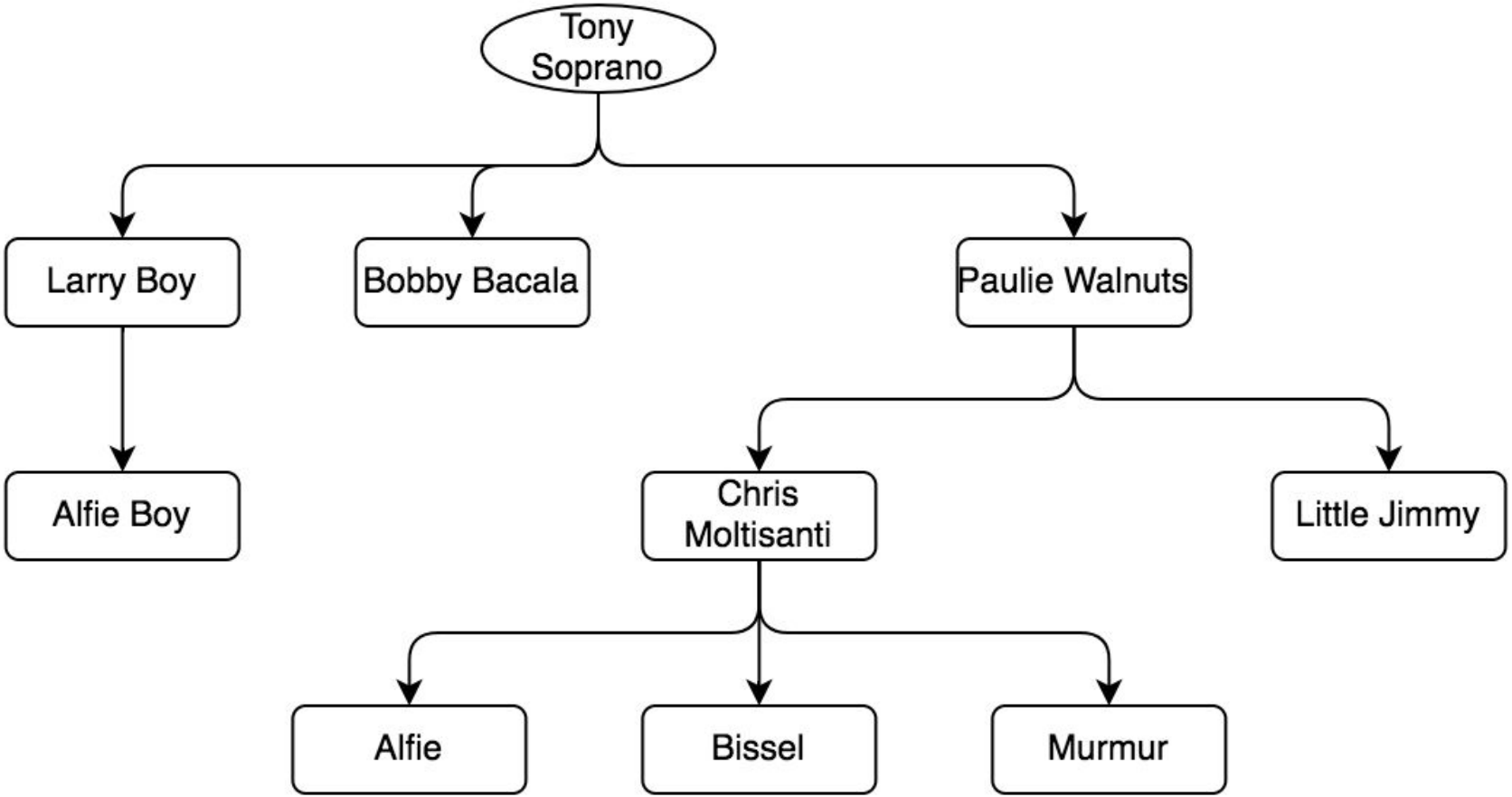

Don't forget
developer
happiness

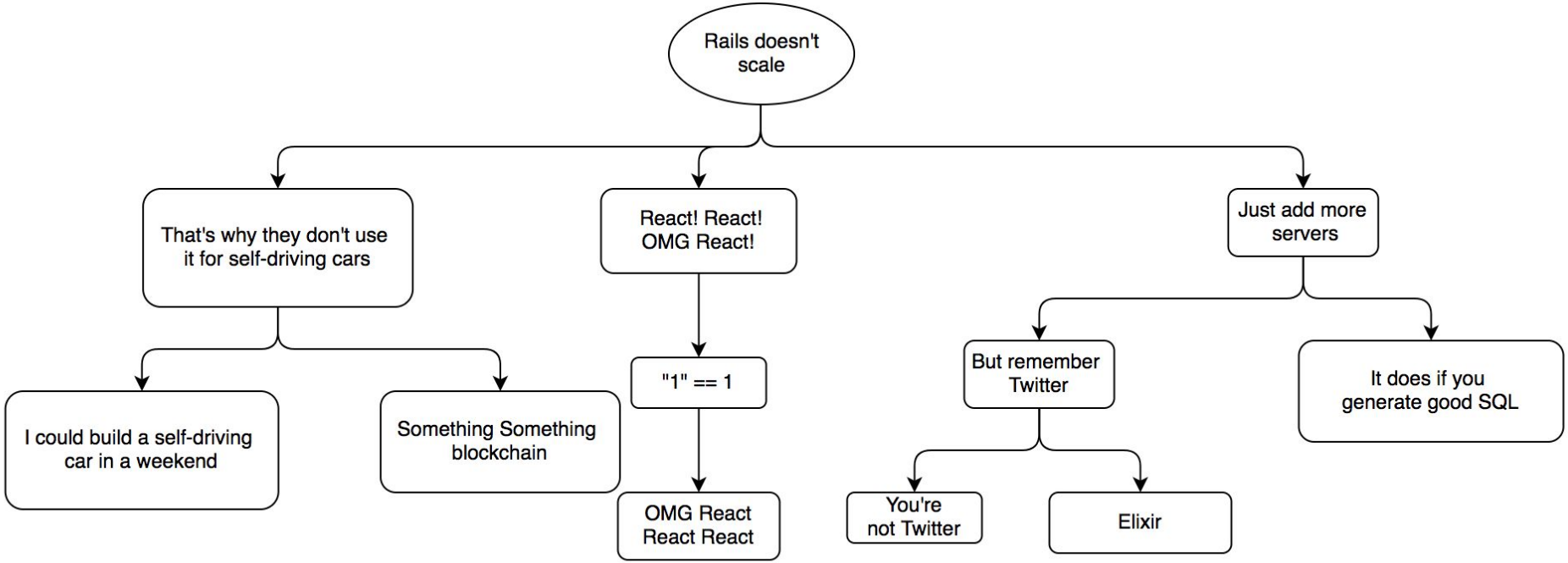

A shark will probably eat me

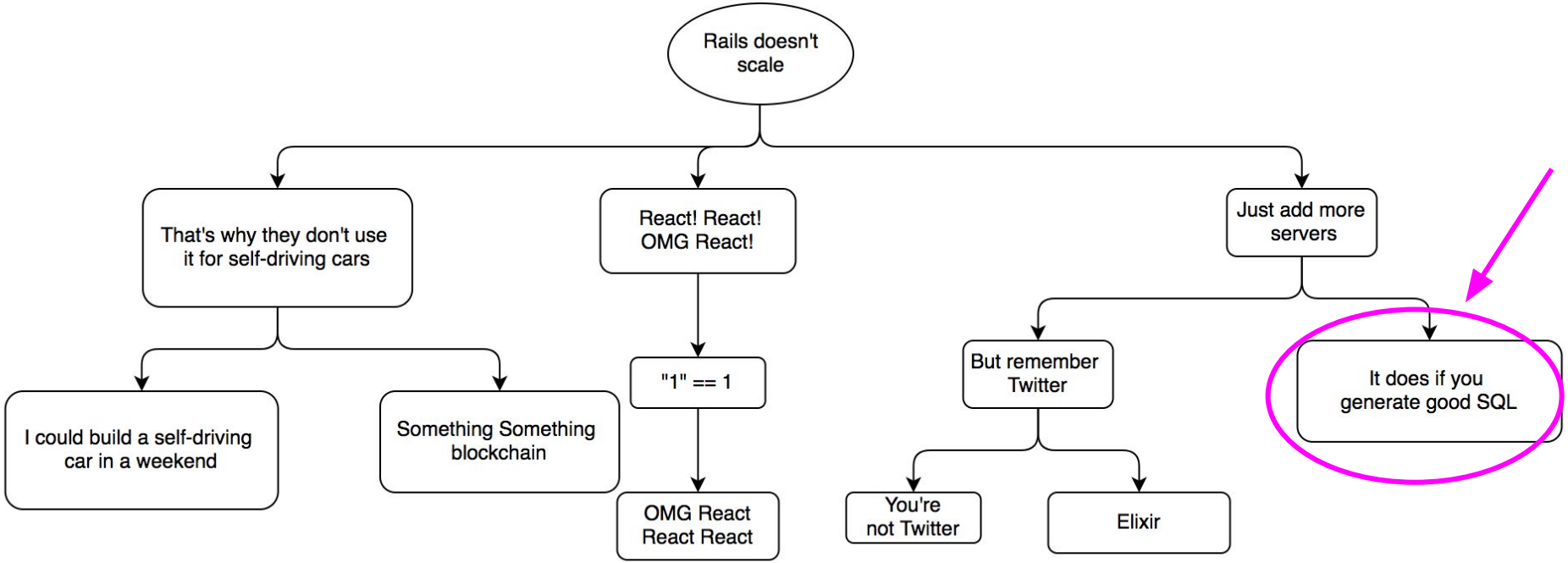
Trees




/
music
photos
rap
rock
polka
france2017
railsconf


Tony Soprano
Larry Boy
Bobby Bacala
Paulie Walnuts
Alfie Boy
Chris Moltisanti
Little Jimmy
Alfie
Bissel
Murmur


Rails doesn't scale
That's why they don't use it for self-driving cars
React! React! OMG React!
Just add more servers
I could build a self-driving car in a weekend
Something Something blockchain
"1" == 1
OMG React React React
But remember Twitter
It does if you generate good SQL
You're not Twitter
Elixir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That's why they don't use it for self-driving cars
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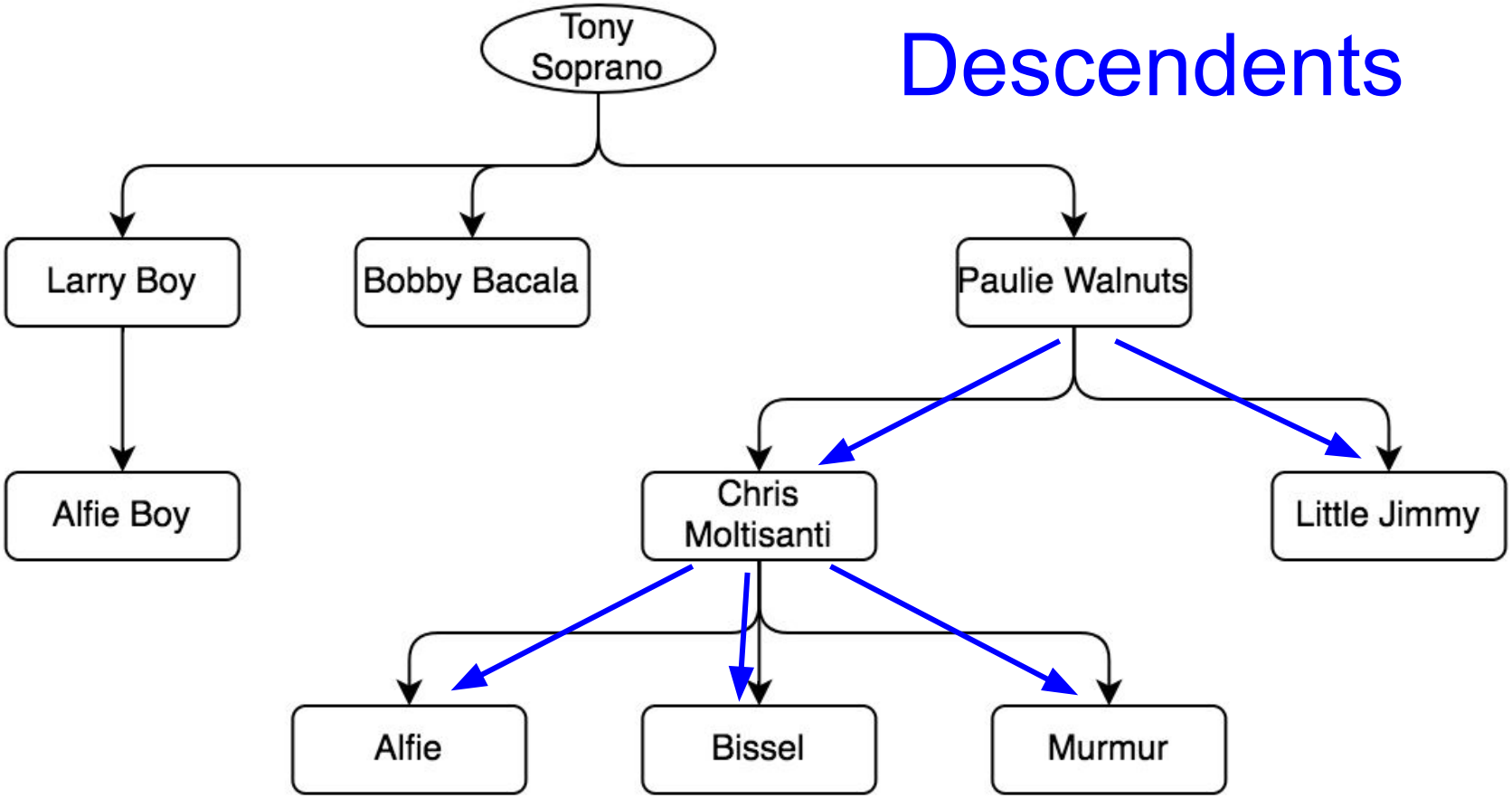
Just add more servers
I could build a self-driving car in a weekend
Something Something blockchain
"1" == 1
OMG React React React
But remember Twitter
It does if you generate good SQL
You're not Twitter
Elixir

(Anti)-Pattern

Naive Tree

employees	
id	**manager_id**
1	NULL
2	1
3	1
4	2

Descendents



```sql
SELECT *
FROM employees e1
LEFT JOIN employees e2 ON e1.id = e2.manager_id
LEFT JOIN employees e3 ON e2.id = e3.manager_id
LEFT JOIN employees e4 ON e3.id = e4.manager_id
LEFT JOIN employees e5 ON e4.id = e5.manager_id
WHERE e1.manager_id IS NULL;
```

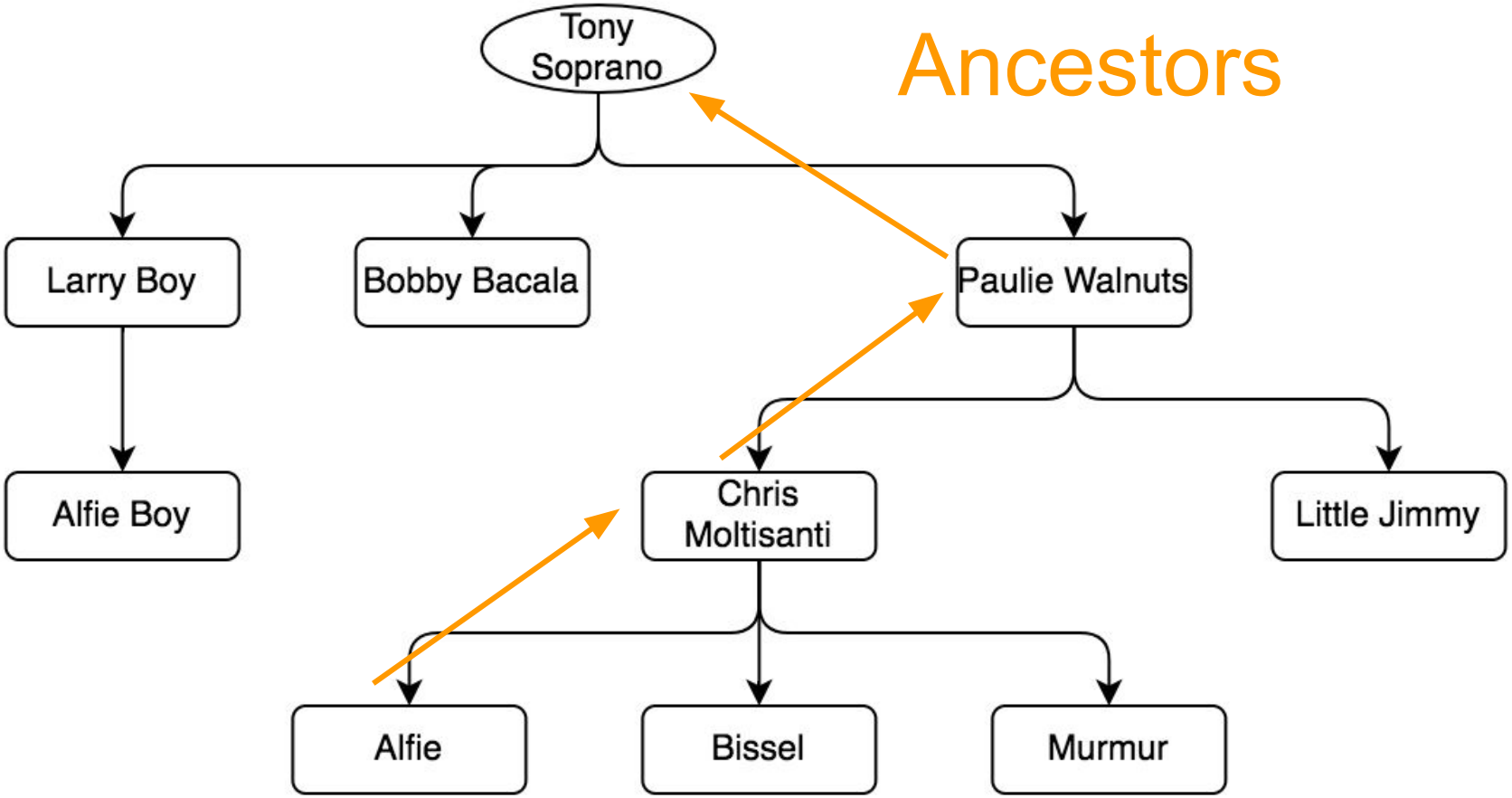
```sql
SELECT * FROM employees e WHERE e.manager_id IS NULL;

SELECT * FROM employees e WHERE e.manager_id IN (1);

SELECT * FROM employees e WHERE e.manager_id IN (2,3,4);

SELECT * FROM employees e WHERE e.manager_id IN (5,6,7,8,9);

SELECT * FROM employees e WHERE e.manager_id IN (10,11,12,13,14)
```

Recurse or suffer!!!

```
(
  cte_query_defini
  Anchor member
  UNION ALL
  cte_query_defini
  Recursive member
  references cte_nam
)
-- Statement using
```

```
WITH RECURSIVE descendants AS
( SELECT parent, child AS descendant, 1 AS level
    FROM employees
  UNION ALL
    SELECT d.parent, s.child, d.level + 1
    FROM descendants AS d JOIN source s ON d.descendant = s.parent
)
SELECT *
FROM descendants
ORDER BY parent, level, descendant;
```

Ancestors


Tony Soprano
Larry Boy
Bobby Bacala
Paulie Walnuts
Alfie Boy
Chris Moltisanti
Little Jimmy
Alfie
Bissel
Murmur

The Mob

- Tony Soprano
  - Larry Boy
    - Alfie Boy
  - Bobby Bacala
  - Paulie Walnuts
    - Chris Moltisanti
      - Alfie
      - Bissel
      - Murmur
    - Little Jimmie

Paginating

Counting

Deleting?

Reparenting

Updating?

Inserting

```
WITH RECURSIVE CTE AS (
      SELECT cc.*
           , nextval('erp_cost_codes_id_seq') AS new_id
           , ARRAY[cc.id] as path
           , false as cycle
      FROM cost_codes cc
      WHERE cc.biller_id = #{biller_id}
      AND cc.biller_type = '#{biller_type}'
      AND cc.parent_id IS NULL
      AND cc.deleted_at IS NULL
   UNION ALL
      SELECT cc.*
          , nextval('erp_cost_codes_id_seq') AS new_id
          , path || cc.id
          , cc.id = ANY(path)
      FROM CTE
      INNER JOIN cost_codes cc ON CTE.id = cc.parent_id
      WHERE cc.biller_id = #{biller_id}
      AND cc.biller_type = '#{biller_type}'
      AND cc.deleted_at IS NULL
      AND NOT cycle
)
  INSERT INTO erp_cost_codes (id, parent_id, biller_id, biller_type, procore_cost_code_id, code, name, sortable_code, parent_sortable_code, standard_cost_code_id, crea
    SELECT C1.new_id as id
         , C2.new_id as parent_id
         , #{erp_biller_id || 'NULL'} AS biller_id
         , #{erp_biller_type ? "'" + erp_biller_type + "'" : 'NULL'} AS biller_type
         , C1.id as procore_cost_code_id
         , C1.code
         , C1.name
         , C1.sortable_code
         , C2.sortable_code as parent_sortable_code
         , C1.standard_cost_code_id
         , clock_timestamp() as created_at
         , clock_timestamp() as updated_at
      FROM CTE C1
 LEFT JOIN CTE C2 on
   C1.parent_id = C2.id
 ON CONFLICT DO NOTHING;
```

```
WITH RECURSIVE CTE AS (
      SELECT cc.*
           , nextval('erp_cost_codes_id_seq') AS new_id
           , ARRAY[cc.id] as path
           , false as cycle
      FROM cost_codes cc
      WHERE cc.biller_id = #{biller_id}
      AND cc.biller_type = '#{biller_type}'
      AND cc.parent_id IS NULL
      AND cc.deleted_at IS NULL
   UNION ALL
      SELECT cc.*
          , nextval('erp_cost_codes_id_seq') AS new_id
          , path || cc.id
          , cc.id = ANY(path)
      FROM CTE
      INNER JOIN cost_codes cc ON CTE.id = cc.parent_id
      WHERE cc.biller_id = #{biller_id}
      AND cc.biller_type = '#{biller_type}'
      AND cc.deleted_at IS NULL
      AND NOT cycle
)
  INSERT INTO erp_cost_codes (id, parent_id, biller_id, biller_type, procore_cost_code_id, code, name, sortable_code, parent_sortable_code, standard_cost_code_id, crea
    SELECT C1.new_id as id
         , C2.new_id as parent_id
         , #{erp_biller_id || 'NULL'} AS biller_id
         , #{erp_biller_type ? "'" + erp_biller_type + "'" : 'NULL'} AS biller_type
         , C1.id as procore_cost_code_id
         , C1.code
         , C1.name
         , C1.sortable_code
         , C2.sortable_code as parent_sortable_code
         , C1.standard_cost_code_id
         , clock_timestamp() as created_at
         , clock_timestamp() as updated_at
      FROM CTE C1
 LEFT JOIN CTE C2 on
   C1.parent_id = C2.id
 ON CONFLICT DO NOTHING;
```

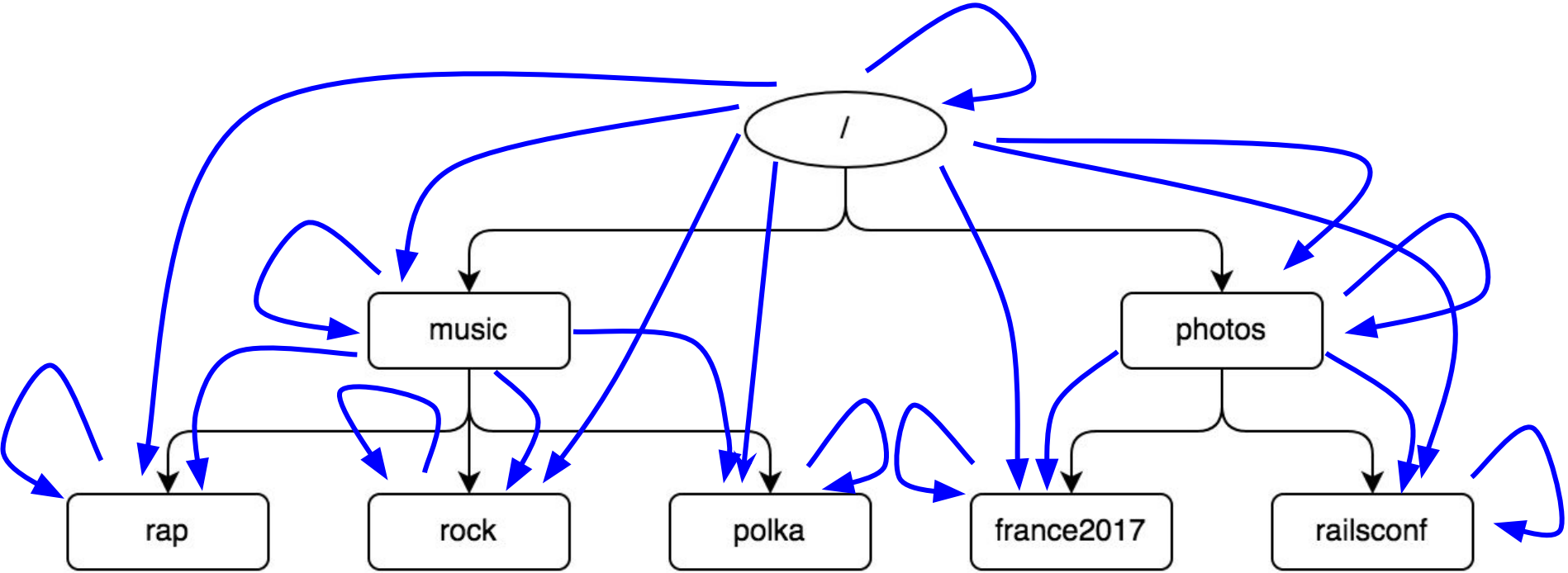
Naive Trees

- Simple
- Referential Integrity
- Disk Space

Naive Trees

- You don't need descendents
- You can cache (changes don't happen often)

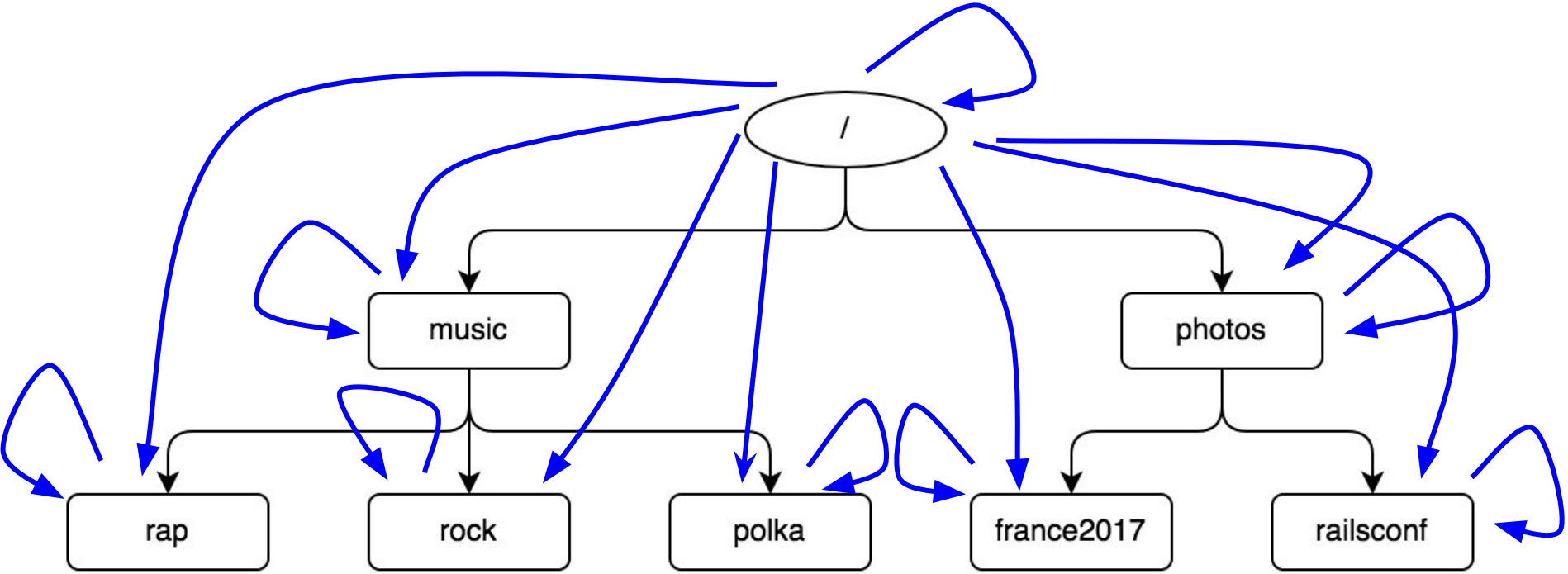
Closure Tree


/
music
photos
rap
rock
polka
france2017
railsconf

id	parent_id	name
1	NULL	/
2	1	music
3	1	photos
4	2	rap
5	2	rock
6	2	polka

id	parent_id	name
1	NULL	/
2	1	music
3	1	photos
4	2	rap
5	2	rock
6	2	polka

ancestor_id	descendent_id
1	1
1	2
1	3
1	4
1	5
2	2
2	4
2	5
2	6
3	3
4	4
5	5
6	6


/
music
photos
rap
rock
polka
france2017
railsconf

Descendents

```
SELECT f.*
FROM folders f
JOIN folder_trees ft ON f.id = ft.descendent_id
WHERE t.ancestor_id = 2;
```

Performance:

- `ancestors`: 1 SELECT.
- `descendants`: 1 SELECT.
- `siblings`: 1 SELECT.

ClosureTree / **closure_tree**

Watch 37 | Star 1,118 | Fork 159

Code | Issues 44 | Pull requests 3 | Projects 0 | Wiki | Insights

Easily and efficiently make your ActiveRecord models support hierarchies https://closuretree.github.io/closure...

closure-tree ruby nested-hashes tree-structure rails activerecord ancestry nested-set hierarchy hierarchies descendants parent child

870 commits | **12** branches | **80** releases | **51** contributors | MIT

Branch: **master** | New pull request | Create new file | Upload files | Find file | Clone or download

mceachen prep v6.6.0 — Latest commit 9baa885 on Jul 11

gemfiles	prep 6.5.0, add ar 5.1 appraisal	4 months ago
img	added docs for digraph and updated to 4.1.0.rc1	4 years ago
lib	prep v6.6.0	2 months ago
spec	Additional specificity for Rails 5.1	2 months ago
.gitignore	Codacy	11 months ago
.rspec	don't rebuild in the middle of prepending siblings.	3 years ago
.travis.yml	prep 6.5.0, add ar 5.1 appraisal	4 months ago
.yardopts	switch from rdoc to yard	6 years ago
Appraisals	prep 6.5.0, add ar 5.1 appraisal	4 months ago
CHANGELOG.md	prep v6.6.0	2 months ago
Gemfile	Bye bye rails 4.0	2 years ago
MIT-LICENSE	* version bump	a year ago
README.md	s/mceachen/ClosureTree/	2 months ago

```ruby
class Employee < ActiveRecord::Base
  has_closure_tree
end
```

```
ancestors
descendents
parent
children
root
leaves
depth
```

```
Person.find_or_create_by_path([
  {name: 'Grandparent'},
  {name: 'Parent'},
  {name: 'Child'}
])
```

Mutation:

- `create`: 2 INSERTs
- reparent: 3 INSERT/UPDATEs

closure_tree (the gem)

- Speed
- No recursion
- Referential integrity
- Single table inheritance
- Deterministic ordering
- MySQL, PostgreSQL, and SQLite
- Easy migration

closure_tree

- No `pgbouncer` (concurrency is hard)
- Possibly not as fast as...

Materialized Path

id	path	name
1	1/	/
2	1/2/	music
3	1/3/	photos
4	1/2/4/	rap
5	1/2/5/	rock
6	1/2/6/	polka

Descendents

```sql
SELECT *
FROM folders f
WHERE f.path LIKE '1/4/%';
```

Organise ActiveRecord model into a tree structure

321 commits | 5 branches | 11 releases | 49 contributors | MIT

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

kbrock committed on GitHub Merge pull request #357 from tilsammans/readme-generate-index-migration ... Latest commit 3b042ad 19 days ago

gemfiles	Dropping official support for rails 4.0 and 4.1	4 months ago
lib	Fix order_by_ancestry_and	a month ago
test	mac specific tests	a month ago
.coveralls.yml	Fixing coveralls	4 years ago
.gitignore	Ignore locked gemfiles	2 years ago
.travis.yml	Add ruby 2.4 support in travis.	4 months ago
Appraisals	Dropping official support for rails 4.0 and 4.1	4 months ago
CHANGELOG.md	bump 3.0.1	2 months ago
Gemfile	ruby 1.9.3 support	11 months ago
MIT-LICENSE	Update copyright date	a year ago

ancestry

- Limits ~ 23 level deep
- No referential integrity

Ancestors x 10 runs

```
ancestry          0.01
closure_tree      0.03
```

Descendents x 10 runs

```
ancestry         0.014
closure_tree      0.02
```

Reynard Hilman

But...

```
descendants.count
```

Closure tree is ~175X faster!

Paginating

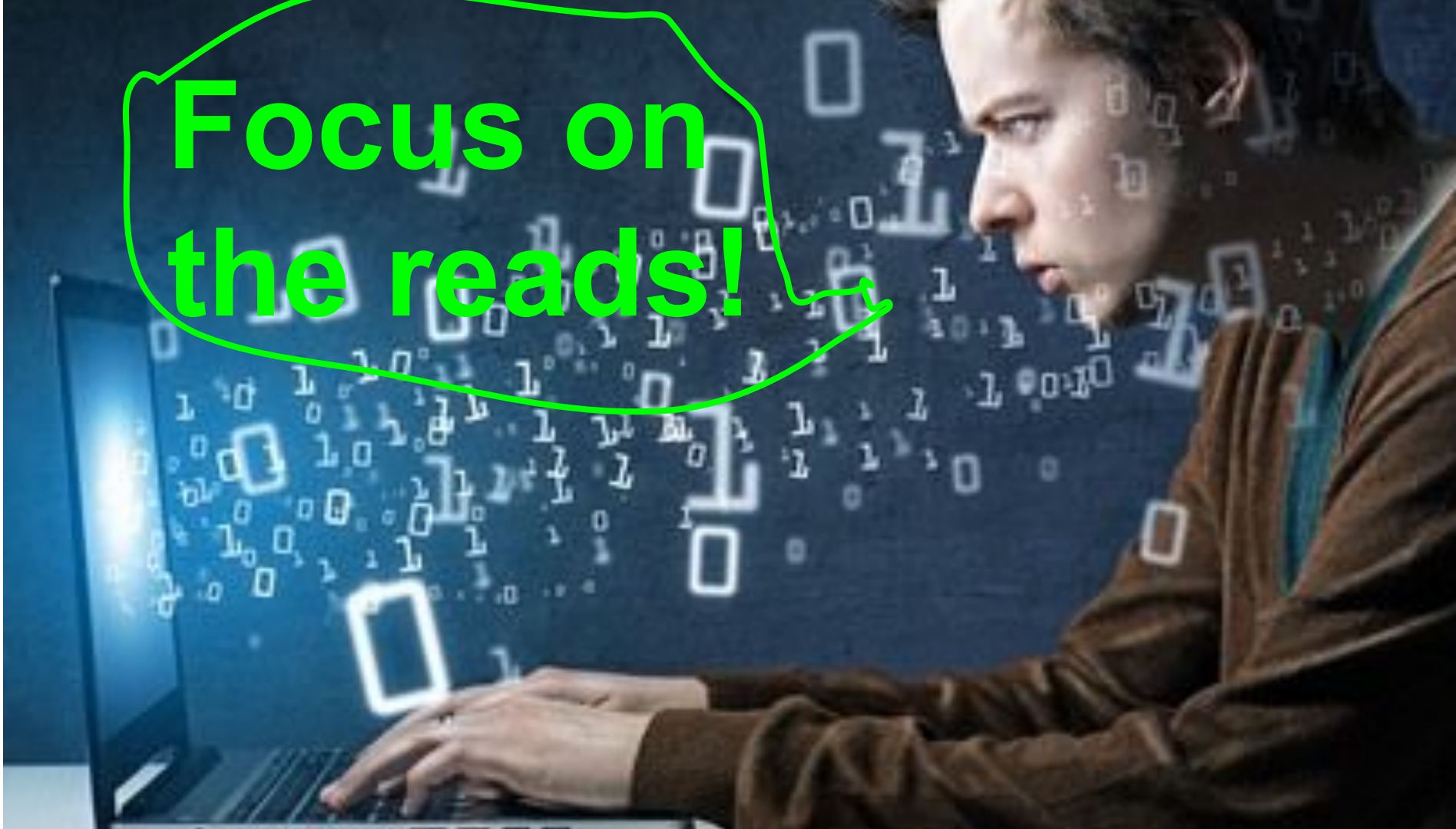
Counting

Deleting?

Reparenting

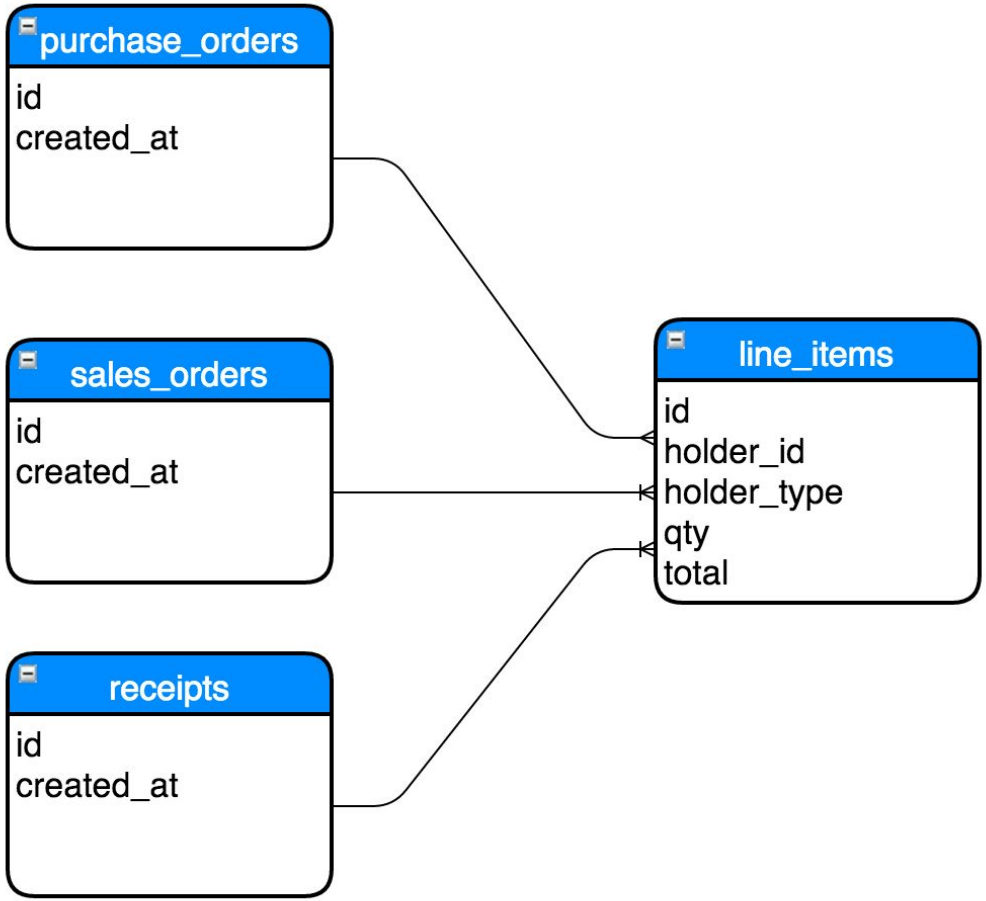
Updating?

Inserting

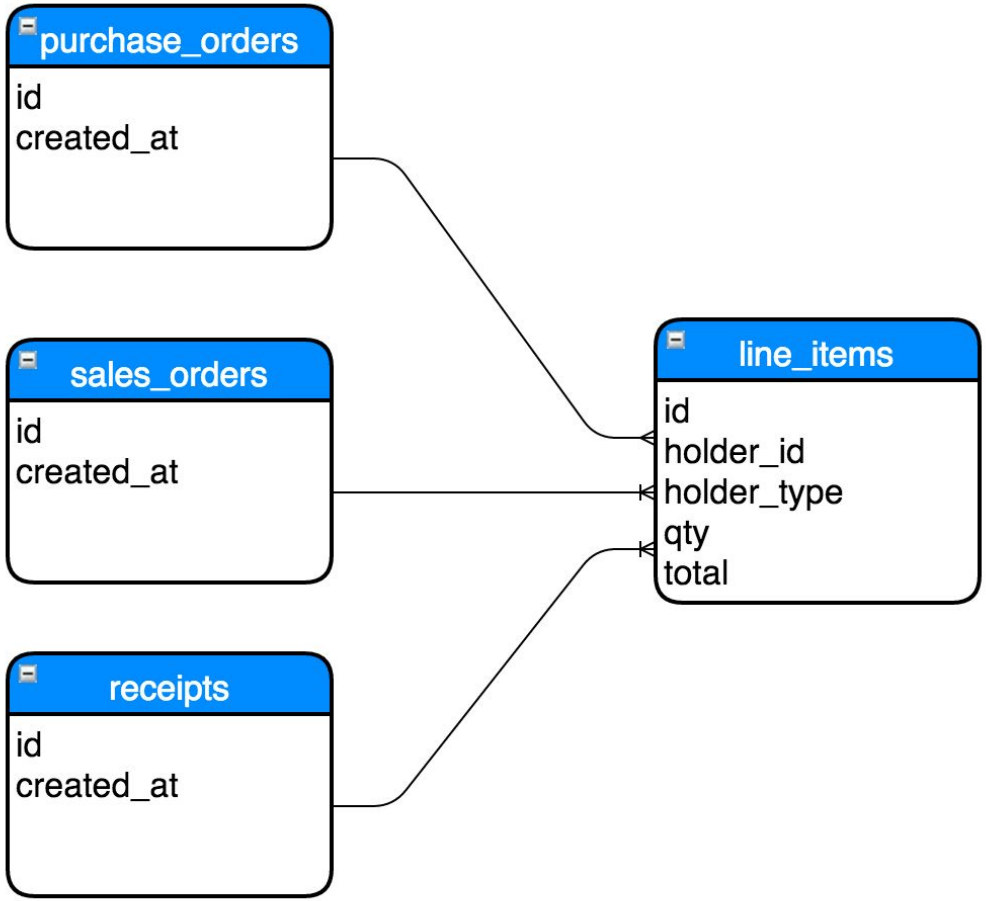

Focus on
the reads!

(Anti)-Pattern

Polymorphic Relationship

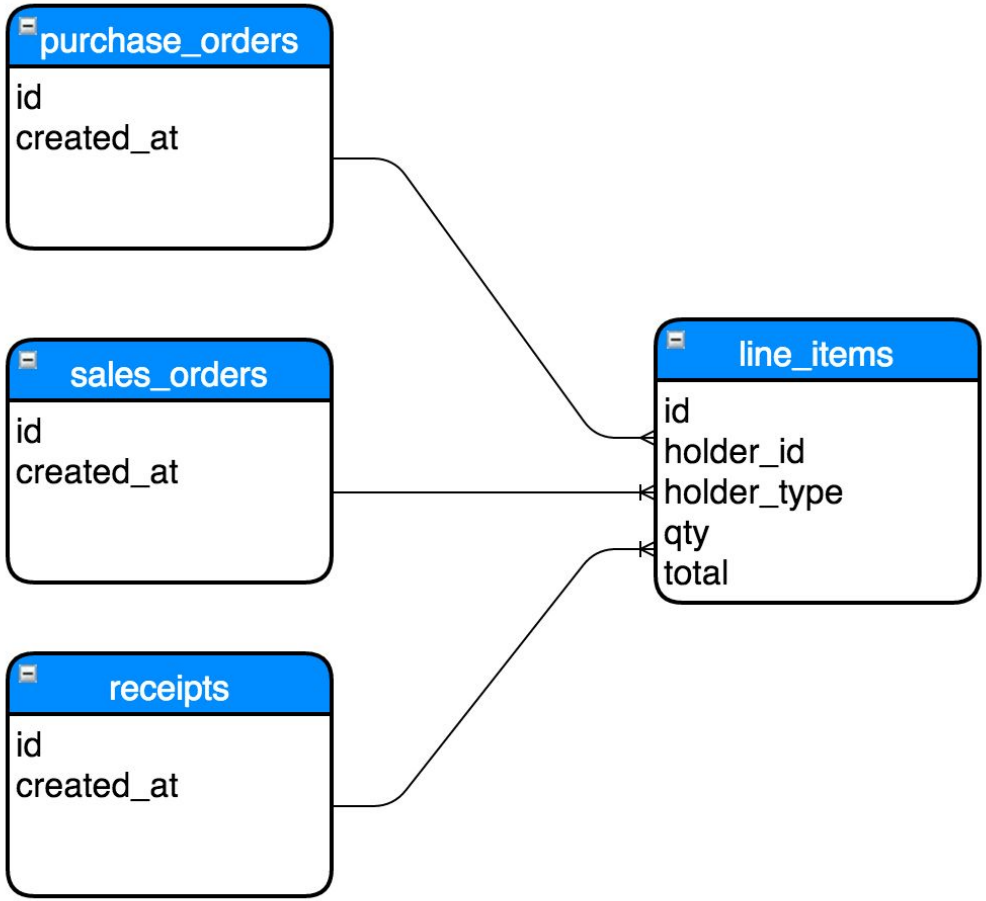

purchase_orders
id
created_at
sales_orders
id
created_at
receipts
id
created_at
line_items
id
holder_id
holder_type
qty
total

id	holder_id	holder_type
1	1	SalesOrder
2	1	SalesOrder
3	1	SalesOrder
4	2	PurchaseOrder
5	2	PurchaseOrder
6	2	PurchaseOrder



Advantages

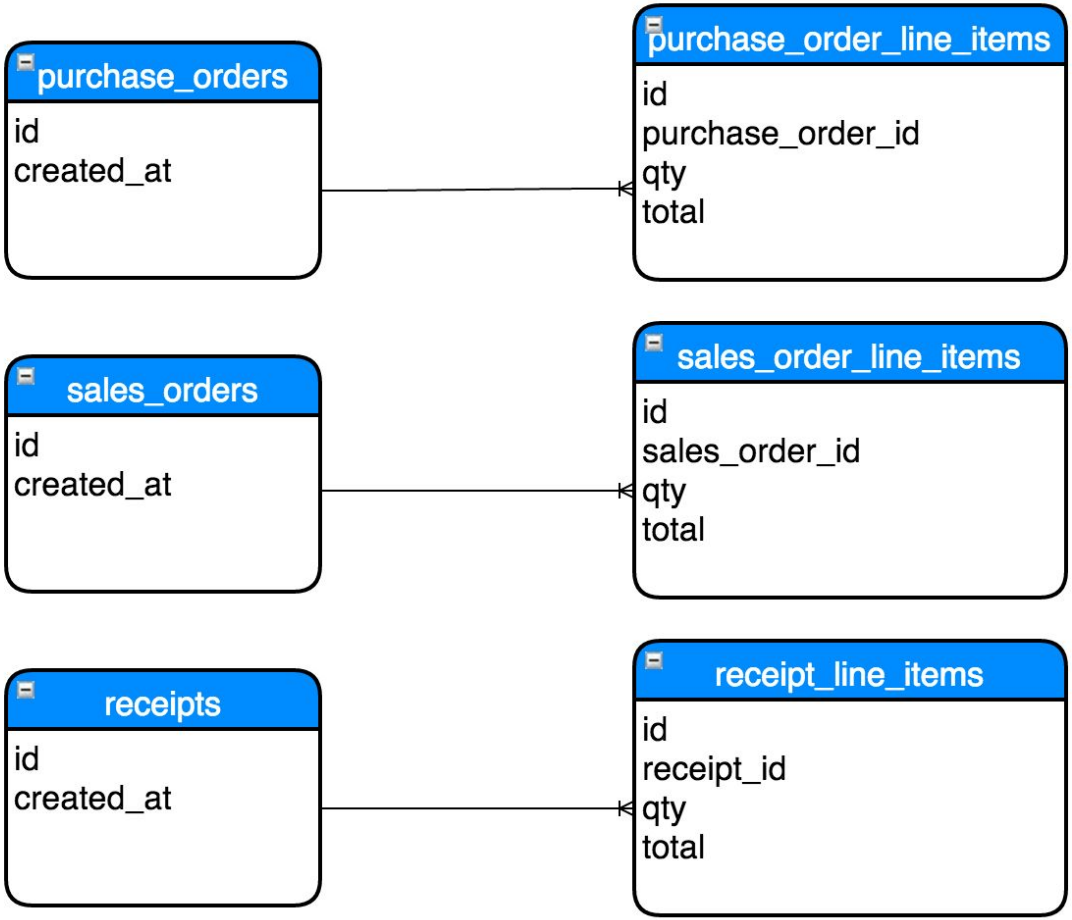
- Built into Rails
- Easy to add more



Disadvantages

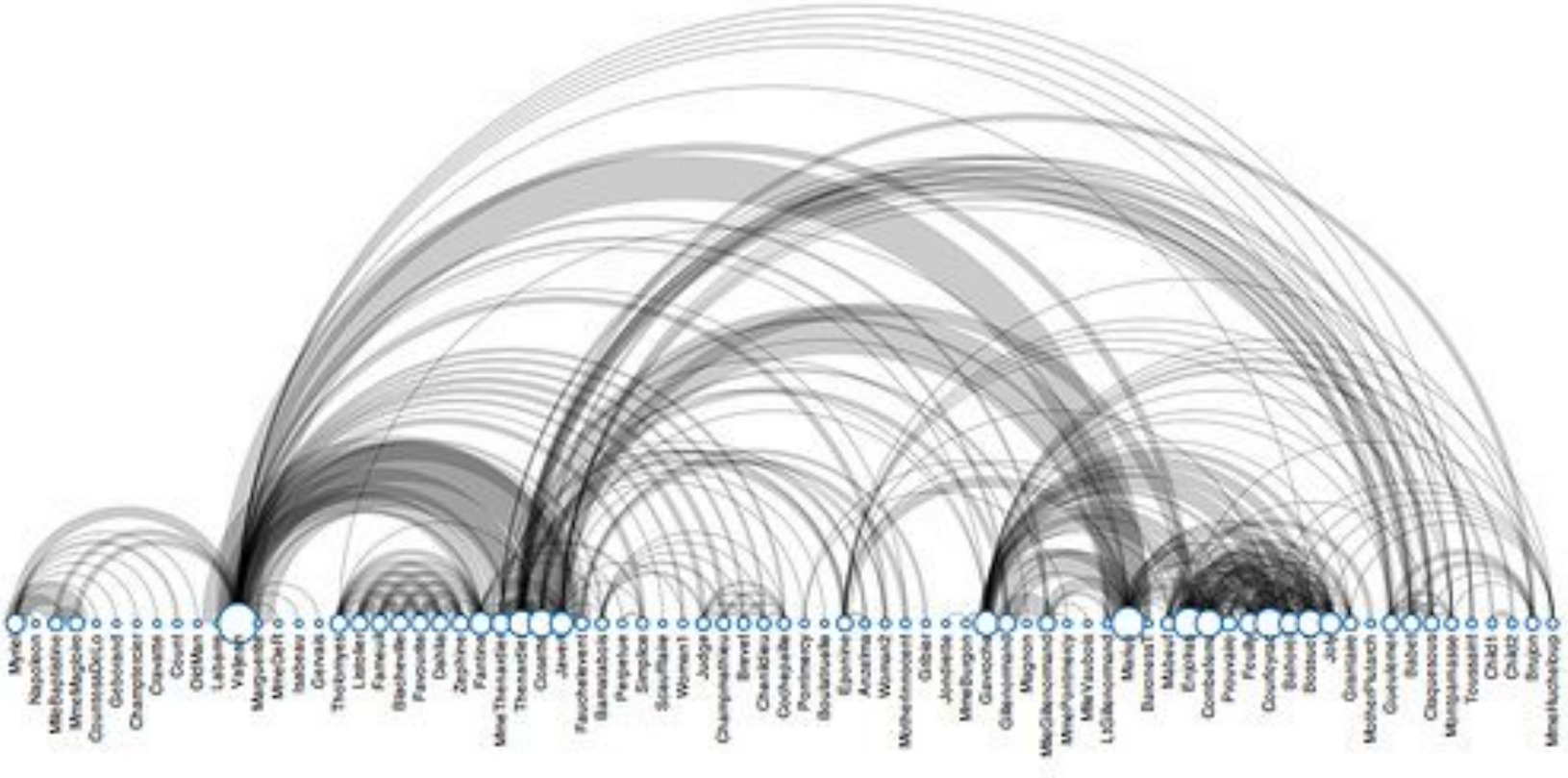
- **No foreign key**
- No cascading delete
- Confusing column names
- 2 join conditions
- `holder_type` is extra data

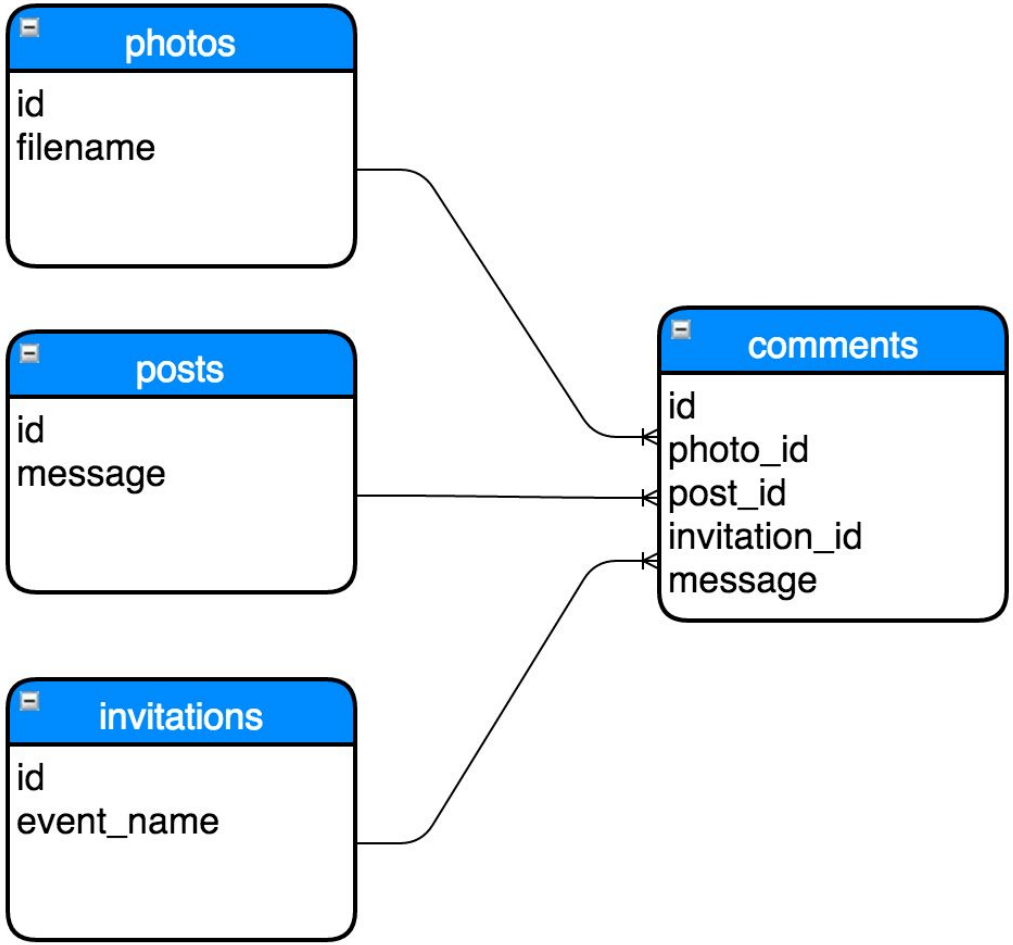
Separate Tables


purchase_orders
id
created_at
purchase_order_line_items
id
purchase_order_id
qty
total
sales_orders
id
created_at
sales_order_line_items
id
sales_order_id
qty
total
receipts
id
created_at
receipt_line_items
id
receipt_id
qty
total

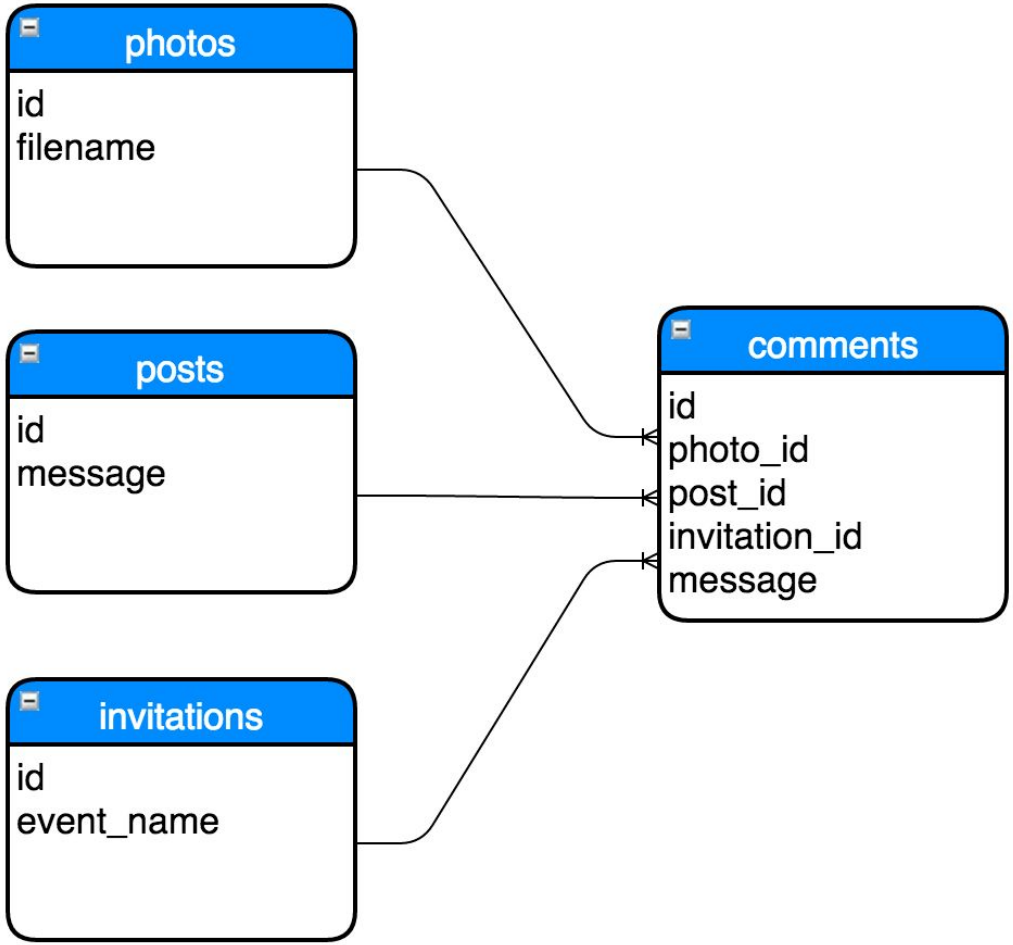
It's OK
to not
be DRY

Exclusive Arcs



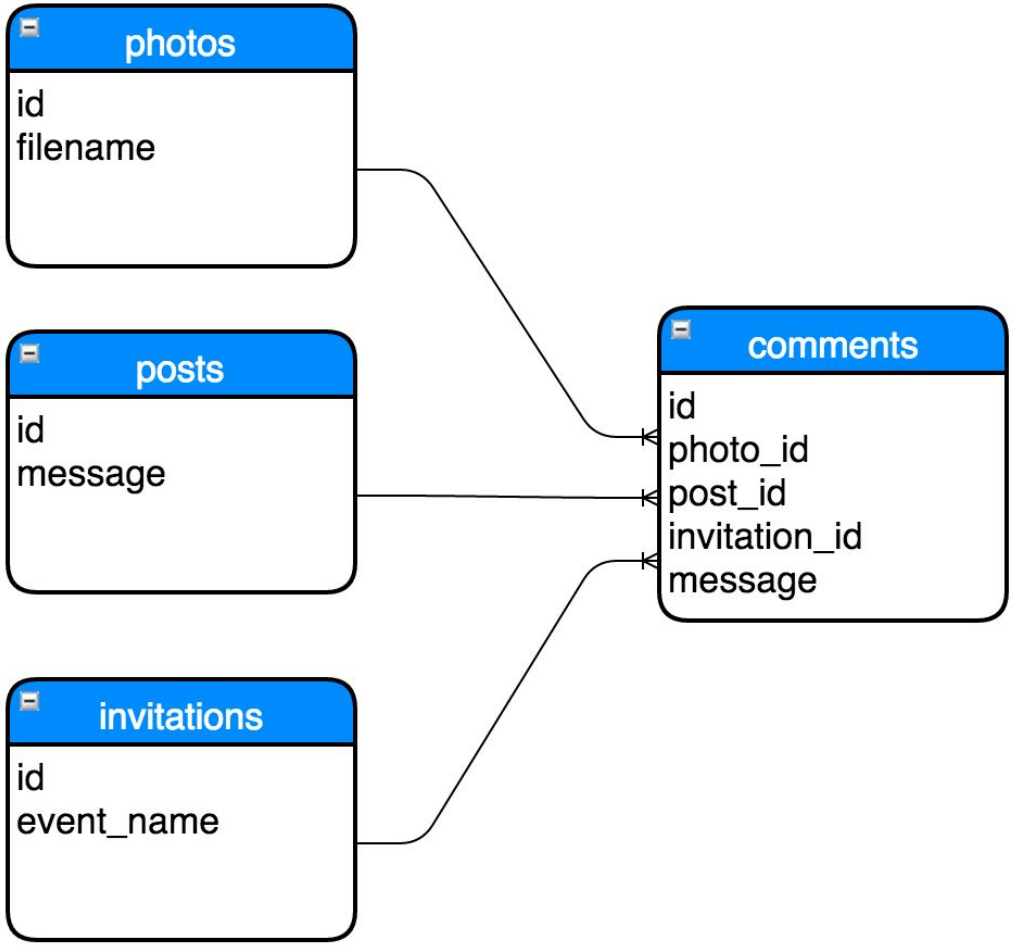

photos
id
filename
posts
id
message
comments
id
photo_id
post_id
invitation_id
message
invitations
id
event_name

id	comment	post_id	photo_id	invitation_id
1	...	1	NULL	NULL
2	...	2	NULL	NULL
3	...	NULL	NULL	18
4	..	NULL	NULL	18
5	...	NULL	NULL	21
6	...	NULL	4	NULL



Advantages

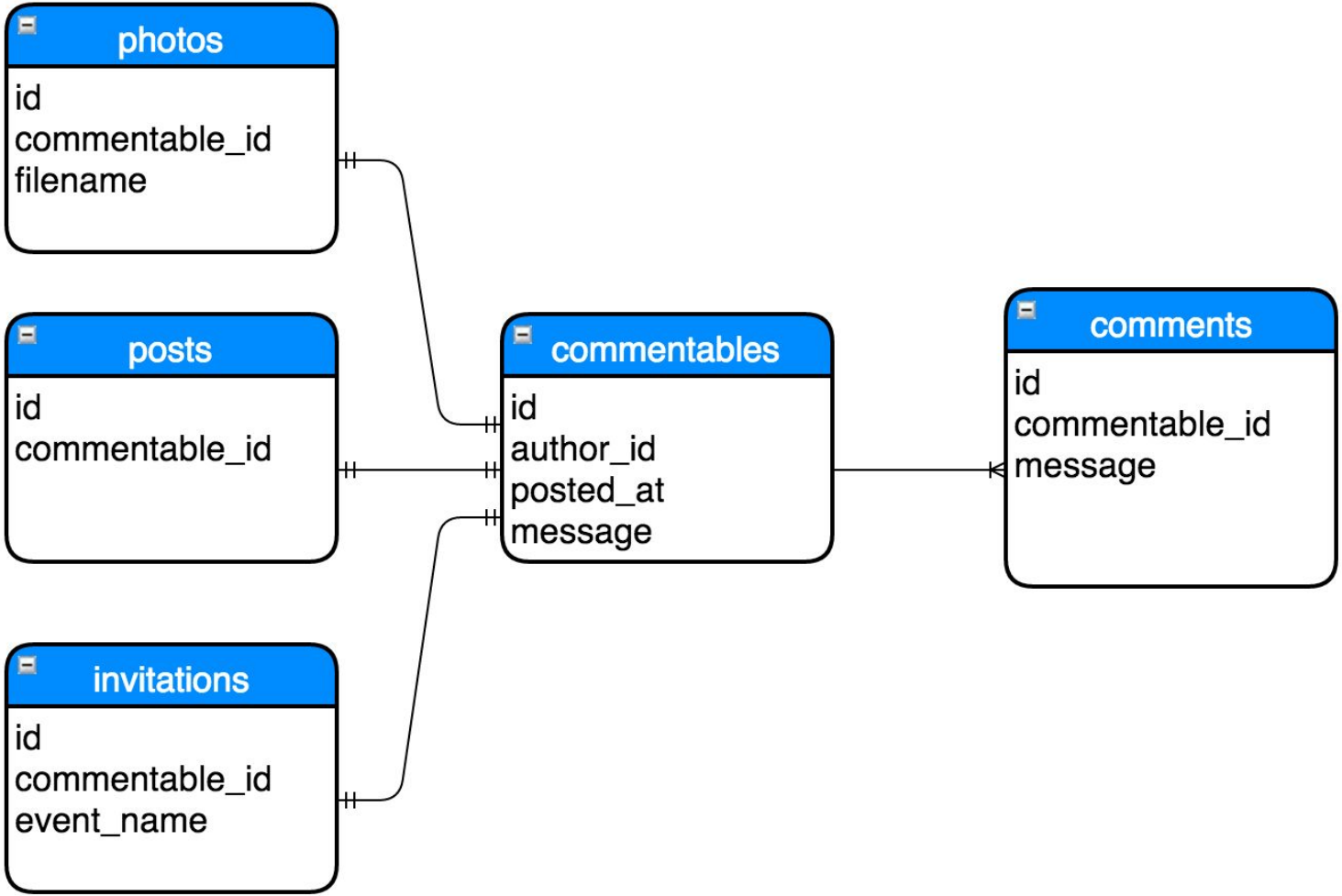
- **Foreign key constraints**
- Cascading delete



Disadvantages

- Possible mistakes
- More migrations

Base Parent Table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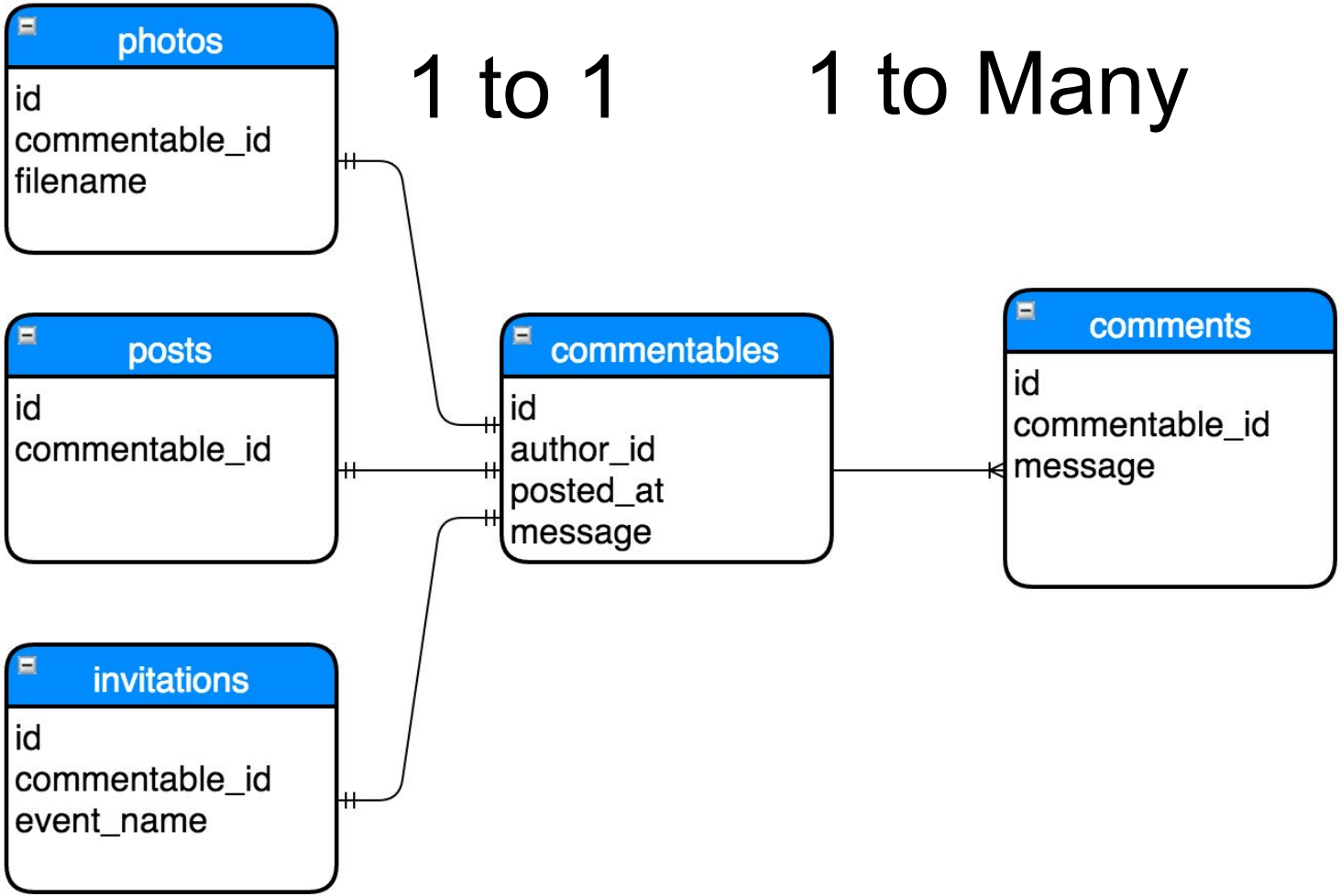
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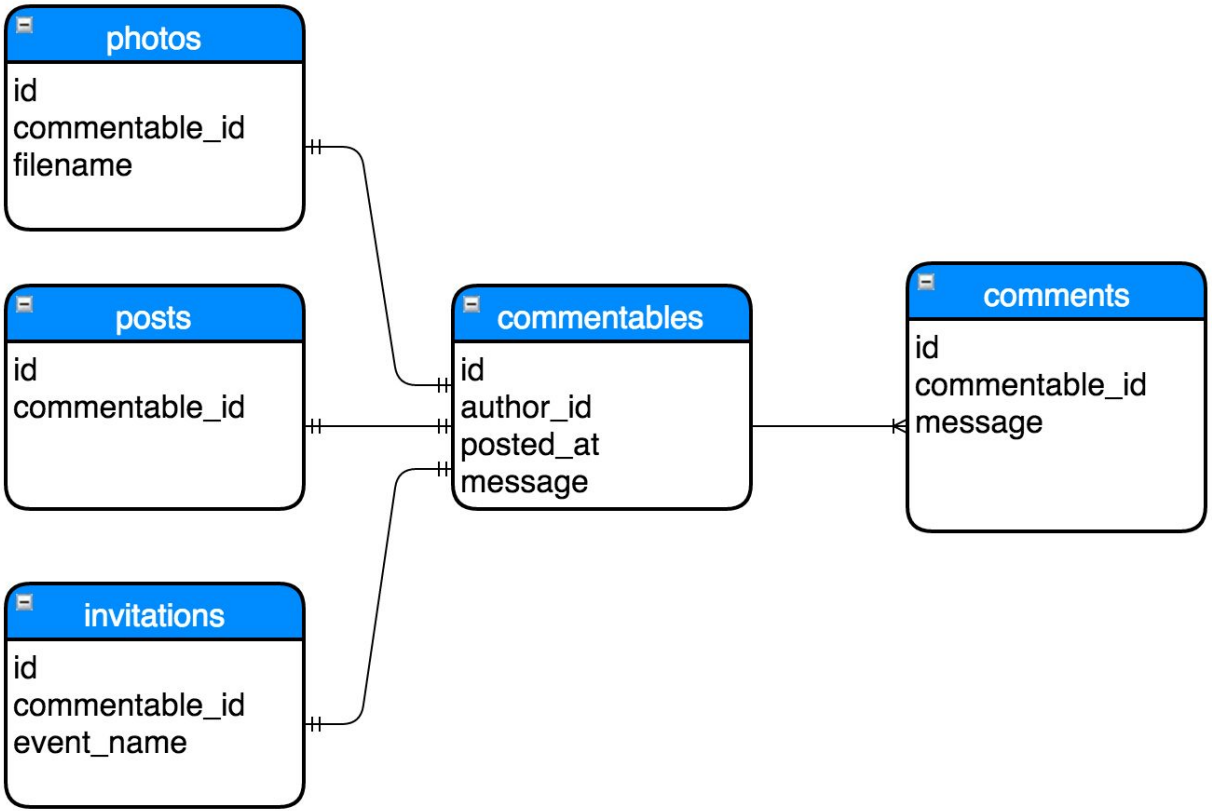
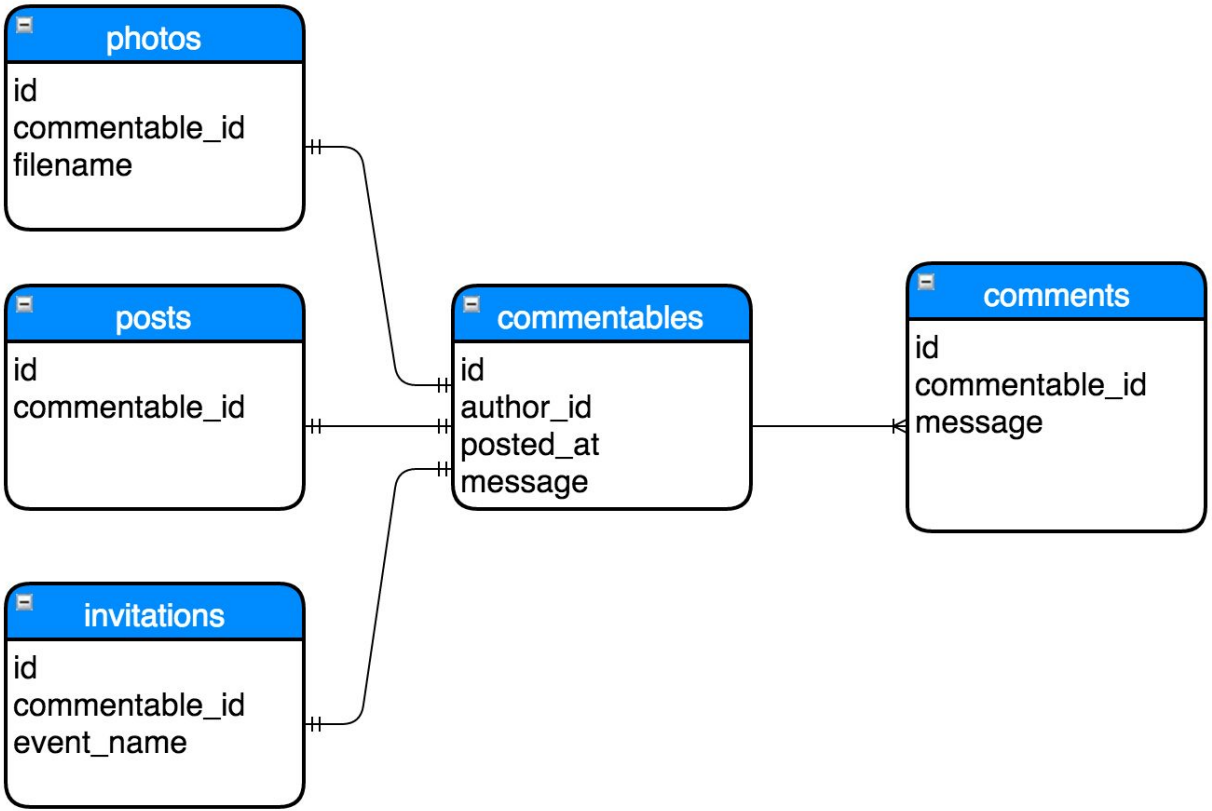


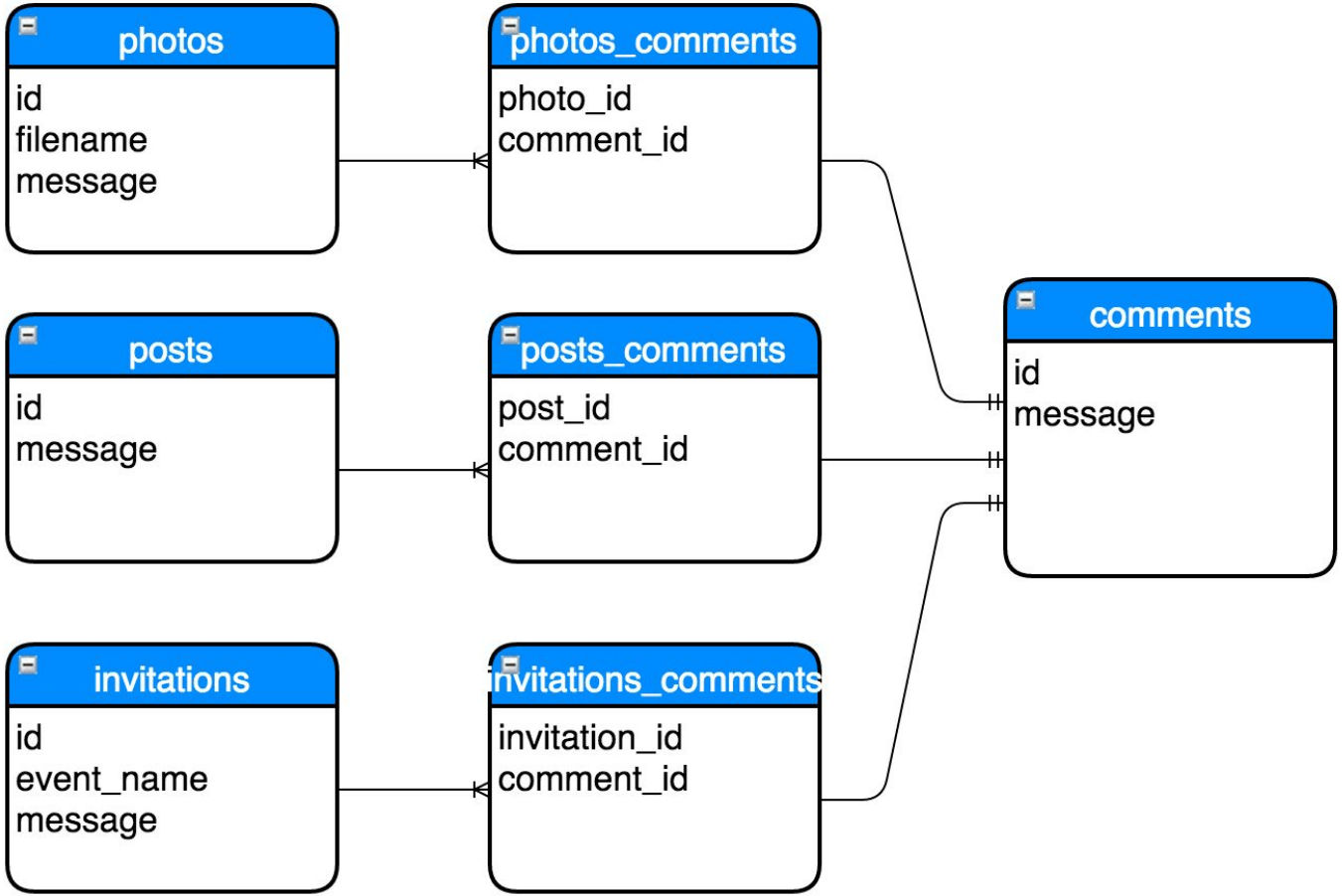
Advantages

- **No mistakes**
- DRY



Disadvantages

- 2 Joins
- 1-way street
- Errors still possible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Dozens of possible parent types….

Dozens of possible parent types….

POLYMORPHIC RELATIONSHIP

Simple and *mostly* safe...

Simple and *mostly* safe...

EXCLUSIVE ARCS

Safe, with shared fields...

Safe, with shared fields...

BASE PARENT TABLE

Performance vs. Simplicity

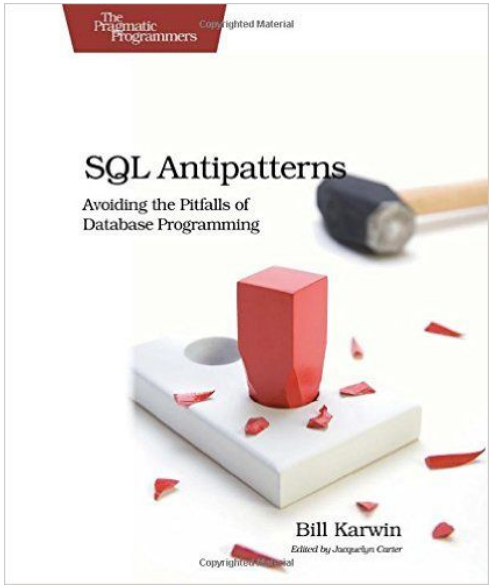
Correctness vs. Convenience

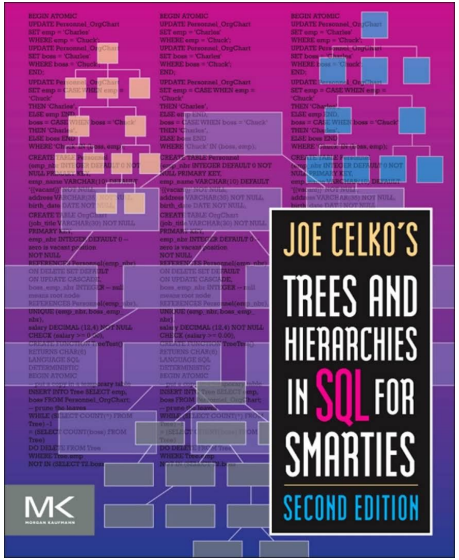
MAKE GOOD CHOICES


I avoided
recursive
SQL Hell!

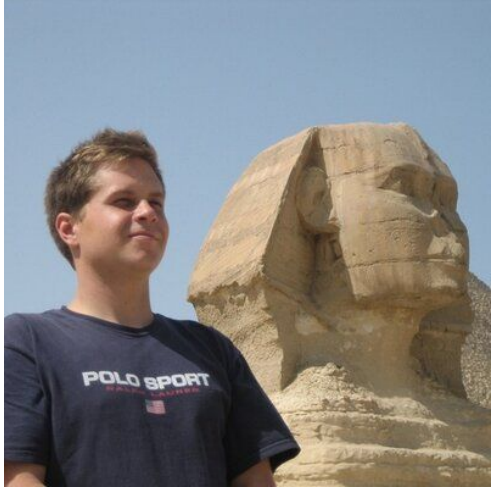
Resources

- http://www.hilman.io/blog/2015/09/comparing-ancestry-and-closure_tree/





Who am I?



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I work in Santa Barbara at

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