Schema Design

schema, n. — a representation of a plan or theory in the form of an outline or model.

Schemas

- **Table Schema (i.e. relation schema)**
  - What is the table called?
  - What columns does it have? What are their data types?

- **Database Schema**
  - What tables are in the database?
  - How are tables related?

Data Modeling

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  - …in a way that makes writing the program easy
  - …while remaining flexible for future changes
  - …oh, it also has to be fast (enough).

Designing a Schema

- **Analysis**
  - What does my program need to output?
  - What data will I need to produce that output?
- **Conceptual Design**
  - Conceptual entities and their relationships
- **Logical Design**
  - In a SQL database: What are my tables, attributes, and relationships?
  - In a program: What are my functions and data structures?
- **Physical Design**
  - JavaScript code, CREATE TABLE statements

Designing a Schema

What we'll focus on today

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Example: A Journal
Analysis

- I want a program to keep my journal in.
- I want to be able to enter the **text** of each journal entry.
- I want to be able to see journal entries **chronologically**.

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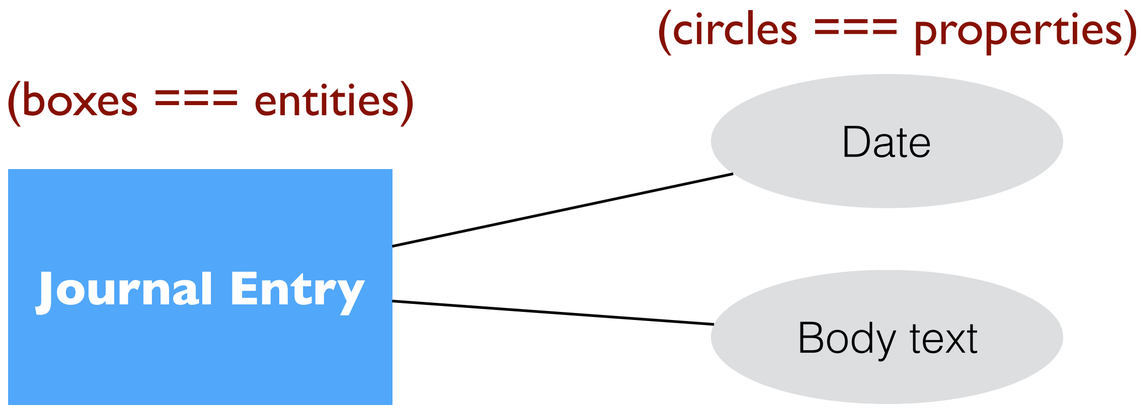
Entity Relationship Diagram (ERD)
Conceptual Design



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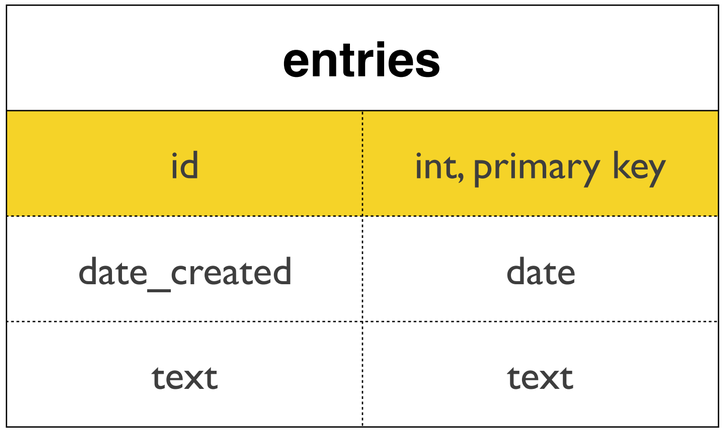
Logical Design



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All done!

- **Oh wait, I forgot a couple of things**
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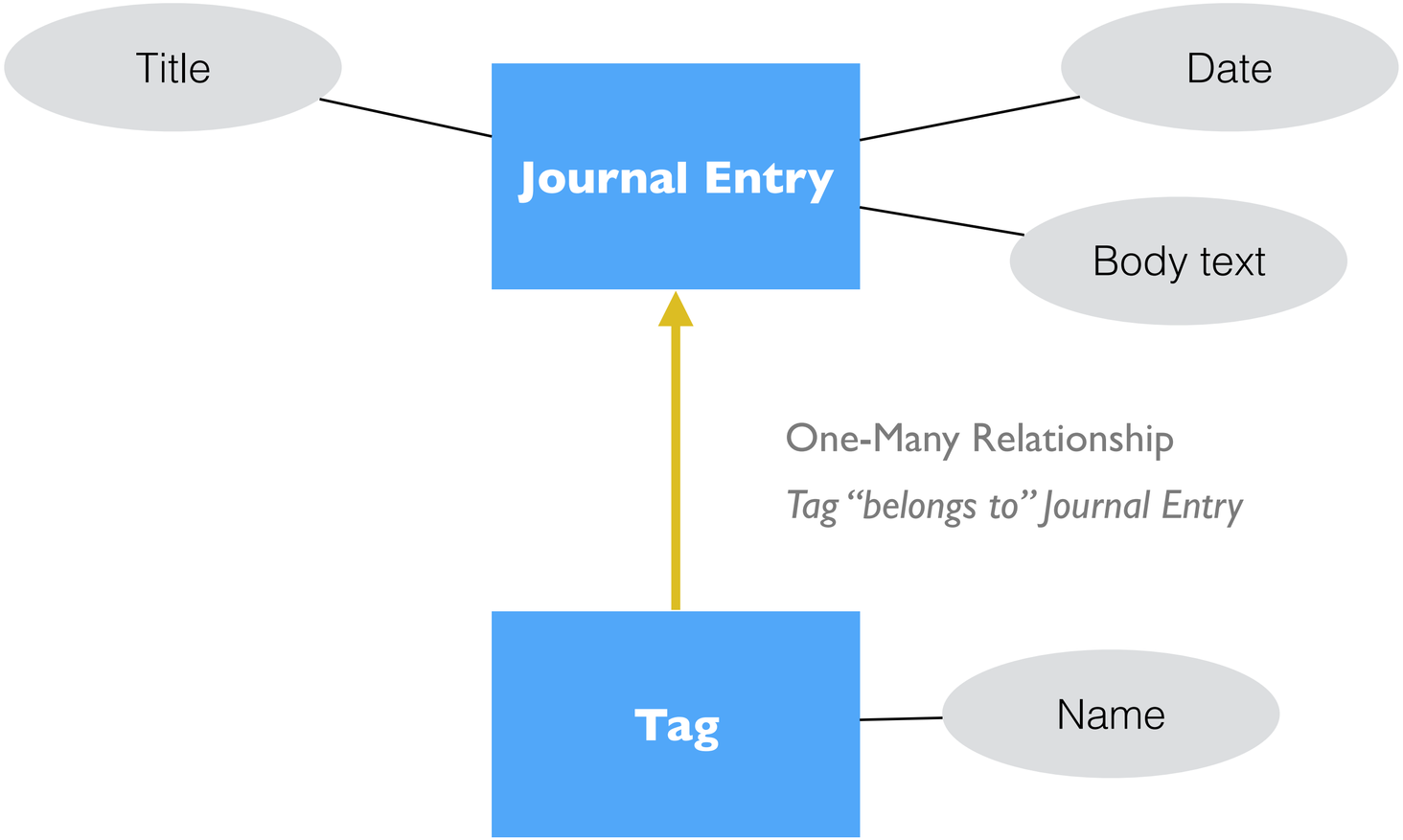
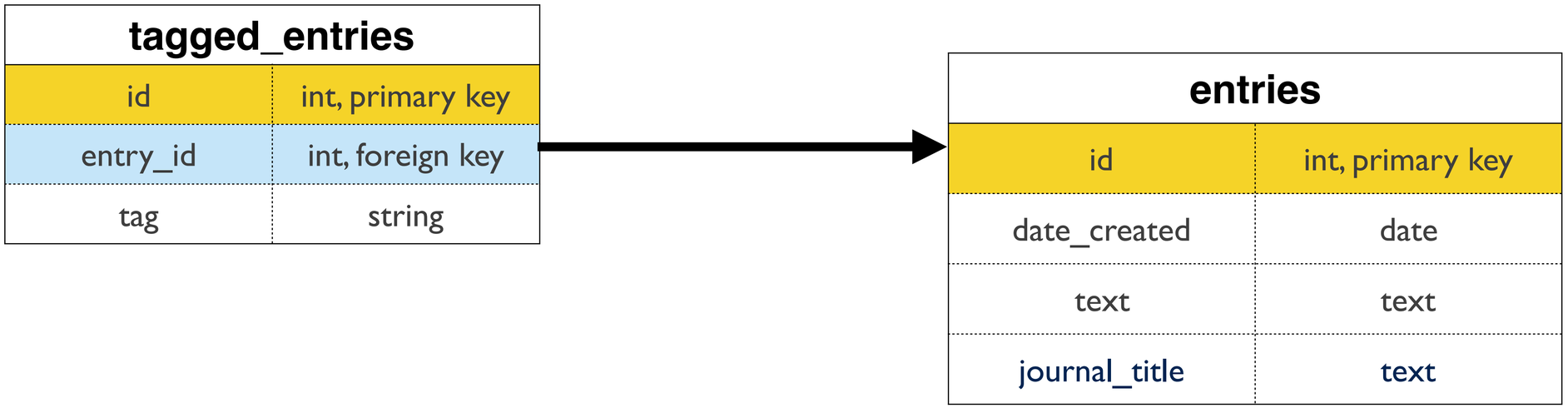
  - I want to be able to #tag entries and find all entries with a particular #tag
- **Take 2…**

Example: A Journal Conceptual Design, Take 2



Example: A Journal
Logical Design: Take 2



But Wait!!!
Normalization

- Organization that minimizes data redundancy and improves data integrity
- How do I change the name of “happy times” to “sadness”?

select * from entries;

id	date_created	text	journal_title
0	2016-04-01	I am happy	happy times
1	2016-04-02	I am very happy	happy times
2	2016-04-03	Despair fills me	happy times
3	2016-04-03	Sadness is my life	an anatomy of pain

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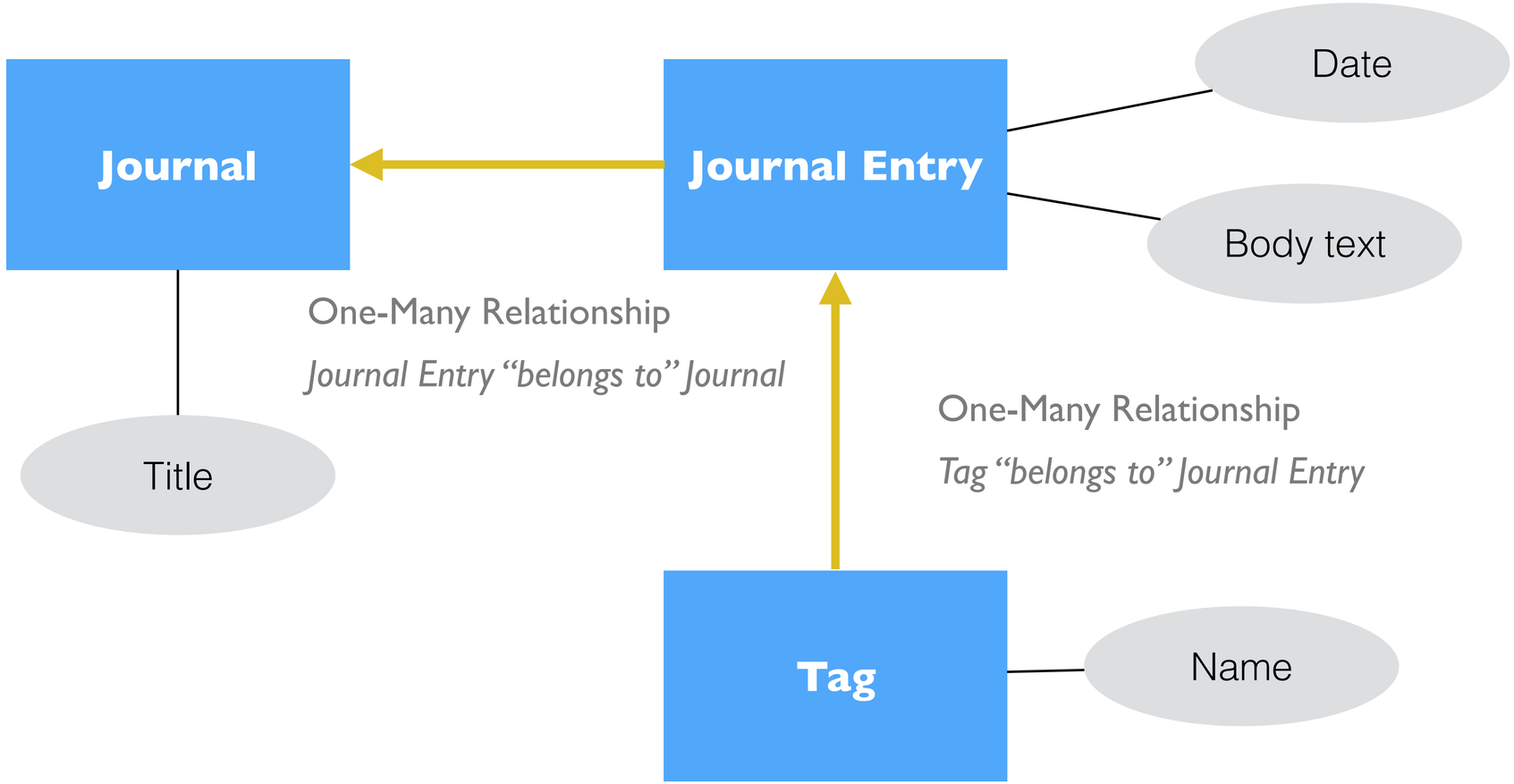
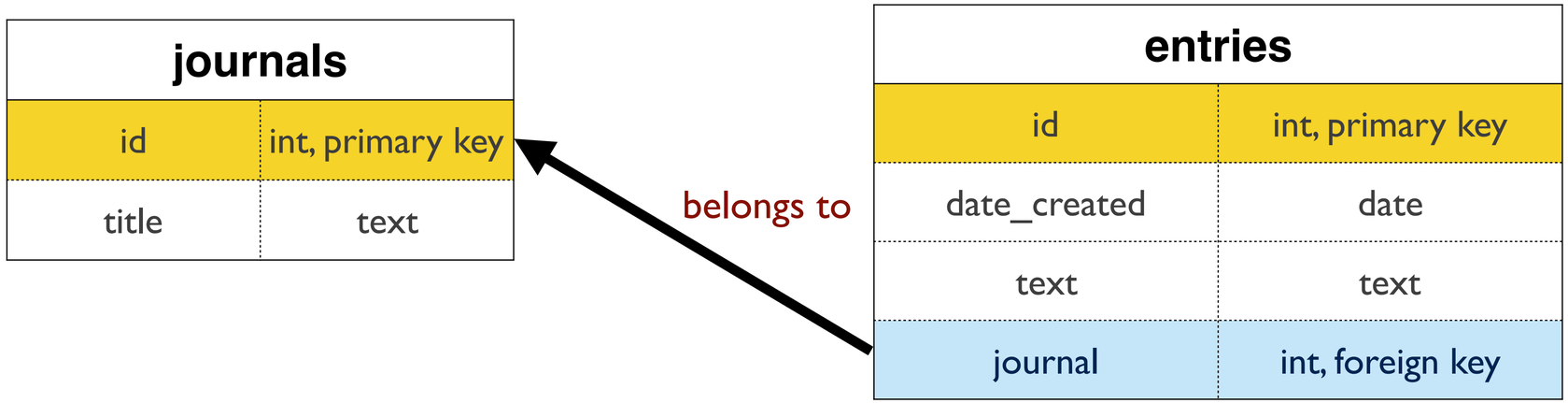
Conceptual Design, Take 3

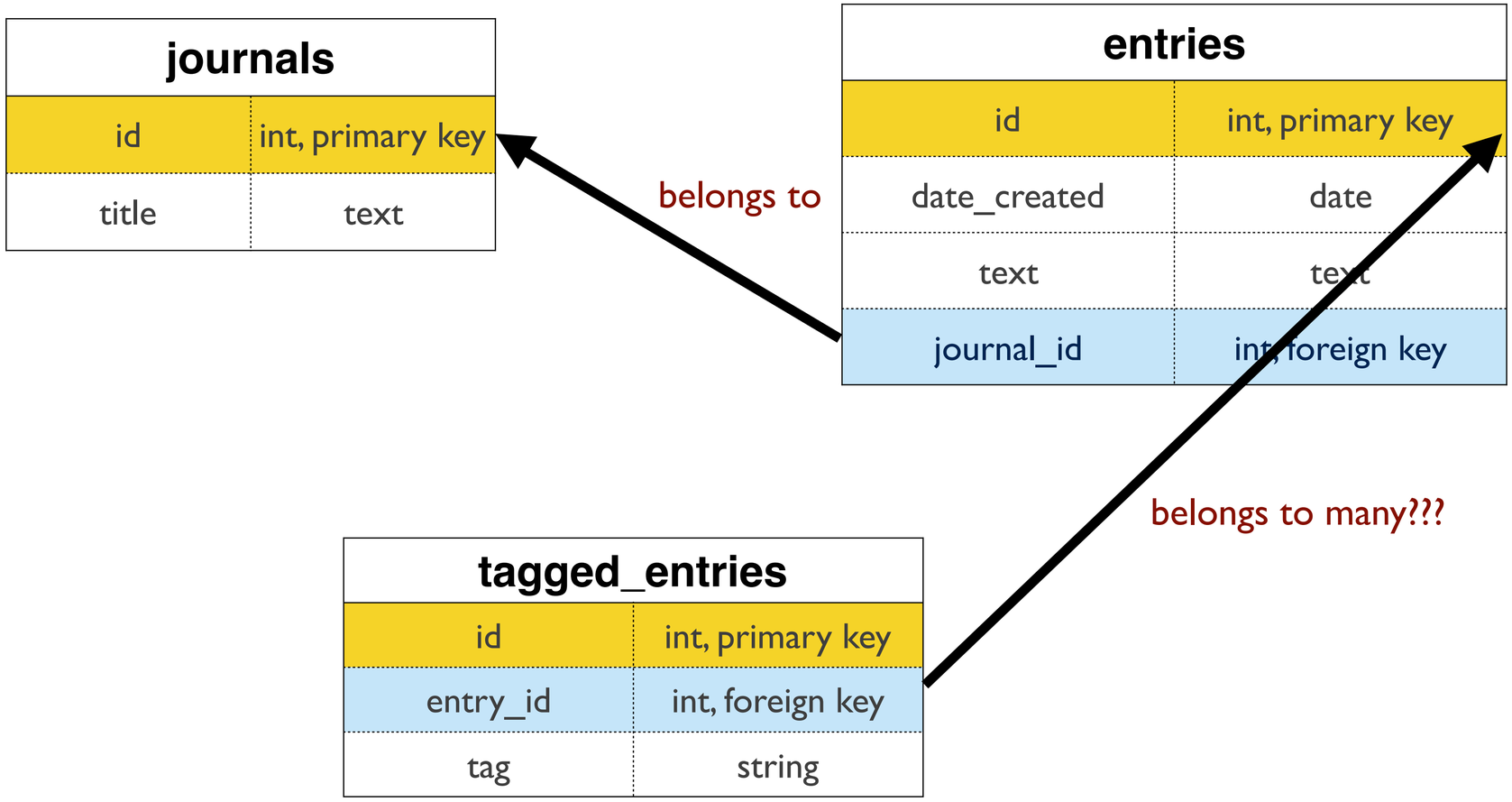


Logical Design, Take 3

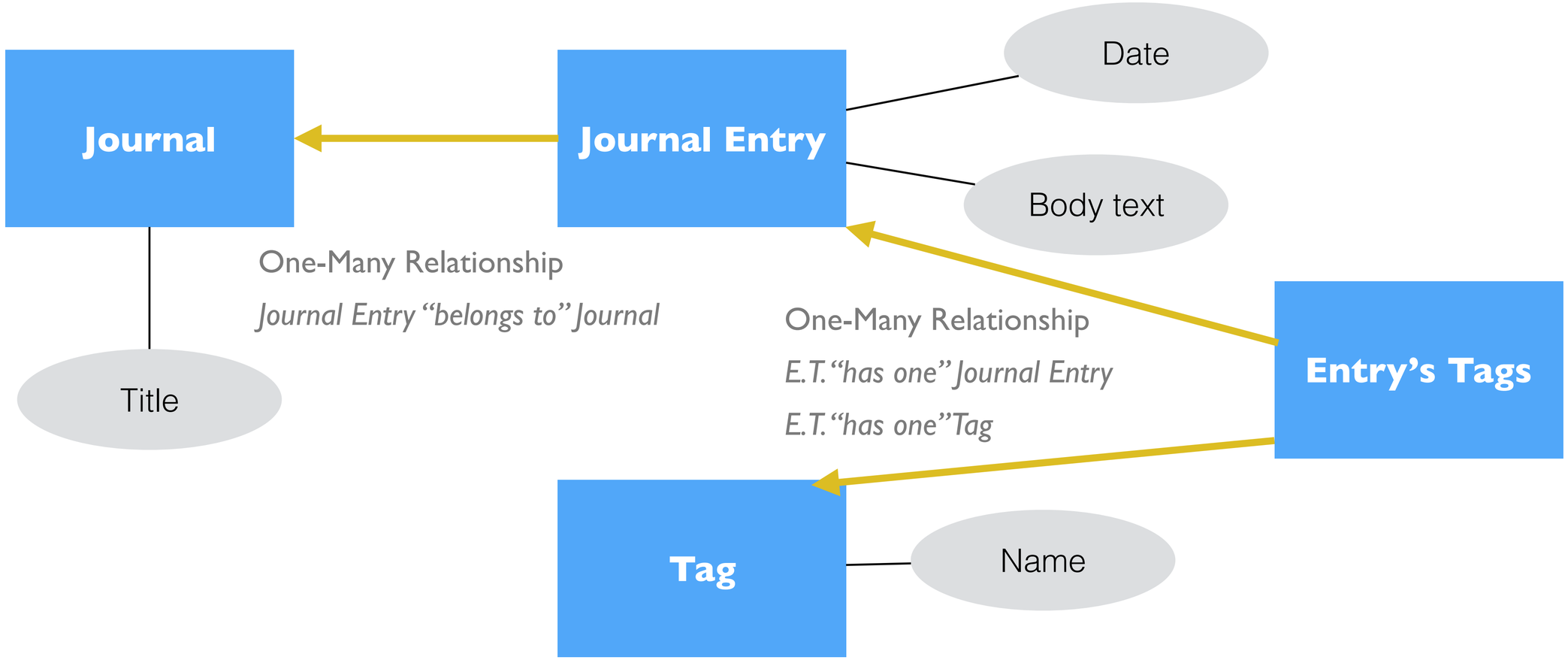
- Eliminate repeating groups in individual tables
- Create a separate table for each set of related data
- Identify each set of related data with a primary key



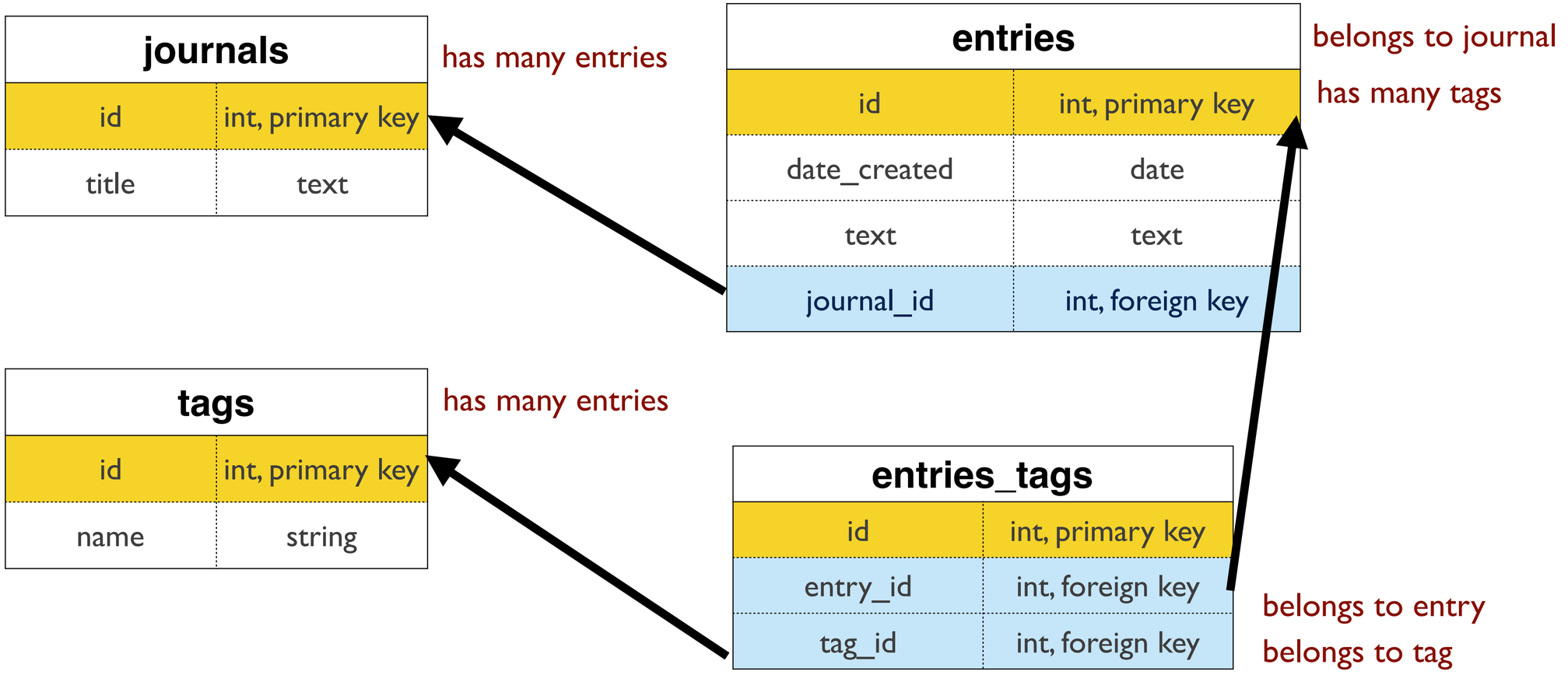
But what about tags?!?



Conceptual Design, Take 4



Logical Design, Take 4



Logical Design, Take 4

SELECT * FROM entries

id	date_created	Text	journal_id
0	2016-04-01	I am happy	0
1	2016-04-02	I am very happy	0
2	2016-04-03	Despair fills me	0
3	2016-04-03	Sadness is my life	1

SELECT * FROM journals

id	date_created	Title
0	2016-04-01	happy times
1	2016-04-02	an anatomy of pain

SELECT * FROM tags-entries

tag_id	entry_id
0	0
0	1
1	0

SELECT * FROM tags

id	date_created	Tag
0	2016-04-01	#YOLO
1	2016-04-02	#LOVELIFE

Has vs. Belongs To

- If rows in table A “belong to” rows in table B, that means A contains a foreign key for B
- If rows in table A “have” one or many rows in table B, that means table B is responsible for keeping track of the foreign key
- Think: the “owner” has less to worry about

Relationships

- **Has One/Belongs To**
  - Author has one Journal
  - Journal belongs to an Author
- **Has Many/Belongs To**
  - Entries belong to a Journal
  - A Journal has many Entries
- **Belongs To Many**
  - Tags and Journal Entries

Normalized Databases

- **Focus on optimal storage - often at odds with retrieval speed due to complex queries using complicated joins**
- **Work best when the application is write-intensive and write-load is more than read-load**
  - Tables are usually smaller as data is divided vertically (fast reads on single tables)
  - Updates and Inserts are fast because there are no duplicates to update
  - Data is not duplicated so there is less of a need for process intensive group by or distinct queries
- **Normalized tables mean join tables, which mean read operations on multiple tables suffer (indexing strategies don't work as well with joins)**

Denormalized

- **Works best when the application is read-intensive**
  - The data is present in the same table (no need for joins)
  - A single table with all required data allows for efficient index usage
- **Data is duplicated which means that updates and inserts become complex and costly**

What Do I Do?!

- Real world applications will most likely have both read-loads and write-loads
- Utilize both approaches depending on the situation!
- Befriend your local DBA

Steps for Developing your ERD

1. Identify Entities
2. Define Relationships
3. Draw Rough-Draft ERD
4. Fill in Cardinality/Modality (arrows with relationship type)
5. Define Primary Keys
6. Label Foreign Keys
7. Identify and Map Attributes

Design one!

- Twitter
- Gmail
- Facebook
- Instagram
- Wordpress
- Wikipedia
- AirBnB
- GitHub
- Youtube
- Spotify
- Slack
- Google (search)