Relational Schema Design Notes

Incentivize high fidelity—data that reflects their real-world meaning as closely as possible—and disincentivize errors—data that is inaccurate, contradictory, or needlessly missing

- It should be no surprise to state that we want our database to reflect our information accurately
- But to paraphrase the so-called "Rule of Repair," we also want to make attempts to insert bad data fail and <u>fail noisily and as soon as possible</u>:
  - Inconsistent data—pieces of information in the same database that contradict each other
  - Redundant data—pieces of information that always change together (meaning that, if you don't, you will then get inconsistent data)
  - Dangling data—information that references other information that doesn't exist

Relationships

- A key aspect of the "high fidelity" side is representing how different entities relate to each other
- An objective characteristic of such relationships is cardinality—i.e., how many of one side of the relationship can connect to the other side?
- For each type of cardinality, a fairly standard "recipe" exists for modeling each in a relational database—these recipes aren't absolute, but they represent a great starting point

- One-to-one: An instance of one side can connect to only one instance of the other side, and vice versa

e.g., A driver's license relating to its owner

- One-to-many: An instance of one side can connect to more than one instance of the other side, but not the other way around (a "many-to-one" relationship is essentially the same thing, but the other way around)

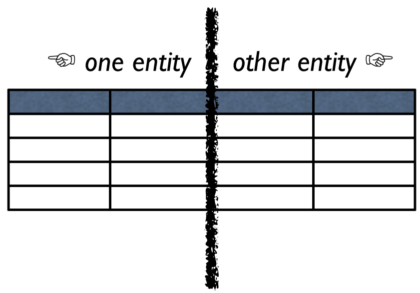
e.g., A parent relating to their biological children

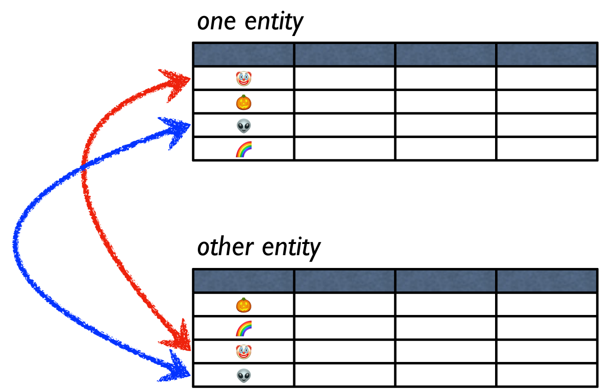
- Many-to-many: An instance from either side can connect to more than one instance of the other side

e.g., Classes relating to students that are taking them

One-to-One Recipe

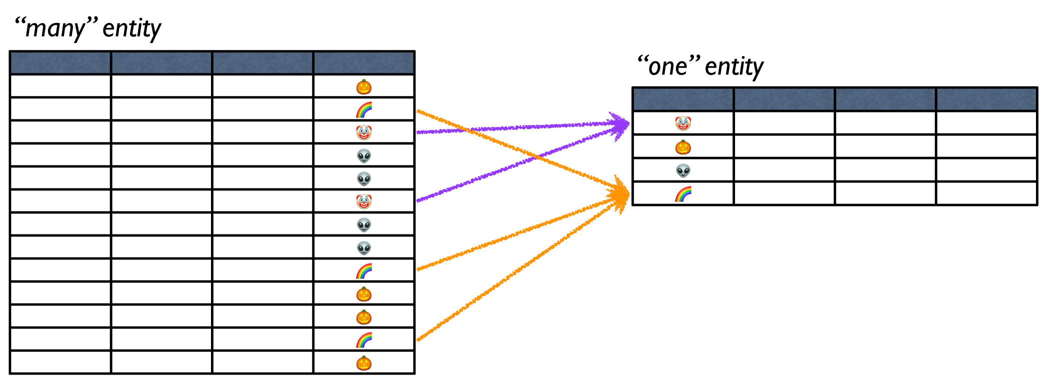
Put both entities in the same table -or- use the same primary key for each table





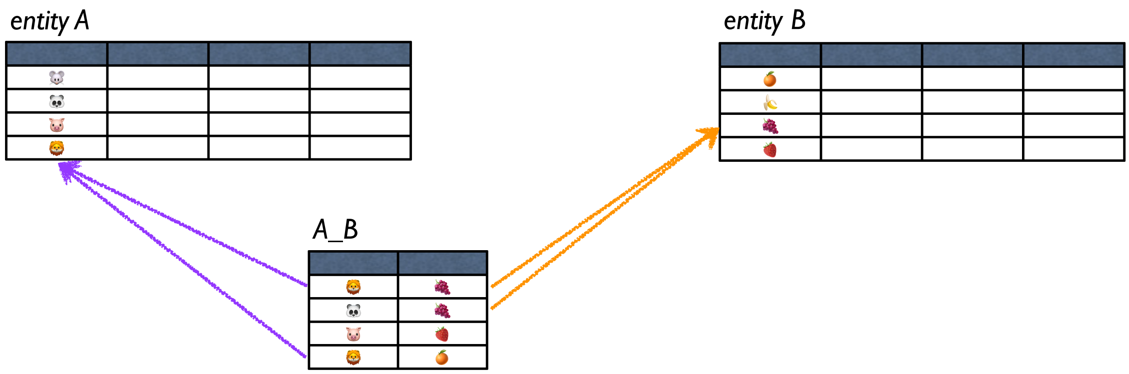
One-to-Many Recipe

Make the “many”-side entity have a non-primary-key reference to the primary key of the “one”-side entity



Many-to-Many Recipe

Define a third table with references to the primary keys of the related entities (the references can be the primary key to avoid relationship duplications)



"It's Complicated"

- Consider if either side of a relationship can be empty—this determines whether a reference can be null
- Relationships between the same entity types (e.g., friends; items assembled from other items [a.k.a. "bill of materials"]) follow similar recipes—but watch for directionality (i.e., A ☞ B is the same B ☞ A?)
- Recipes shown here are for relationships involving two groups of entities—relationships that involve more than two have different approaches

Minimizing Repetition

- Although not an absolute, relational databases seek to minimize the repetition of data—e.g., having a person's name appear in more than one table or in multiple rows of the same table
- Repetitions not only waste space, but make updates error-prone: if you update a repeated value, you need to update it <u>everywhere</u> in order to stay consistent
- If a value (except for a key) appears more than once, you may have a relationship—so model it that way

- The process of eliminating repetitions is typically called <u>normalization</u> because relational database theory has the concept of <u>normal forms</u>—formalized descriptions of how tables are defined
- Intuitively speaking, the theoretical <u>third normal form</u> denotes a relational database schema that has eliminated redundant attributes among its tables
- The single major factor <u>against</u> normalization is performance: normalization implies joins, and joins can be costly—thus, applications with specific performance needs may <u>denormalize</u> their data as long as they accept the consequence of doing extra work to keep the data self-consistent

What’s in a Name?

- This one is a bit of a soapbox—but if it isn’t pointed out now, how can we possibly seek change in the future: Many databases still model name fields in ways that hold overly-narrow assumptions
- Here’s something to read and bookmark, to share with anyone you encounter whose idea of names remains limited and oversimplified:

https://www.kalzumeus.com/2010/06/17/falsehoods-programmers-believe-about-names/

- Note how many of the things stated in that article are directly contradictory—highlighting the inherent challenge of how to approach them in a database
- The key here isn’t necessarily to find a “one true way” for modeling names, but simply to spread awareness that storing names isn’t as straightforward as some people [still] think
- Here’s a slightly newer take, this time more specific to data modeling and how they affect a user interface:

https://softwareforgood.com/why-you-should-stop-asking-for-first-and-last-names-on-forms/

- Spread the word! Call this out whenever you spot it

Structured Attributes

- The aforementioned practices were largely developed when relational database columns/attributes were always single-valued or scalar—i.e., they weren't allowed to have intrinsic structure, like the primitive data types of a programming language
- Things have gotten even more complicated with the emergence of structured attributes such as JSON or similar data types—all of a sudden, a column/attribute can have parts, can be a list, etc.

- This raises questions like: Can an array column replace a simple one-to-many relationship? Can a column hold an object to represent a one-to-one relationship? How does one avoid redundancy of values within a structured attribute? 😬😵🤯
- On the one hand, one can ignore this very feature—relational databases were without this for decades after all, and they did just fine (mostly)
- But that begs the question of why this feature emerged in the first place—something compels it, right?
- For these (and all future changes in database technology), keep first principles in mind: maximize fidelity to your data's meaning and minimize errors