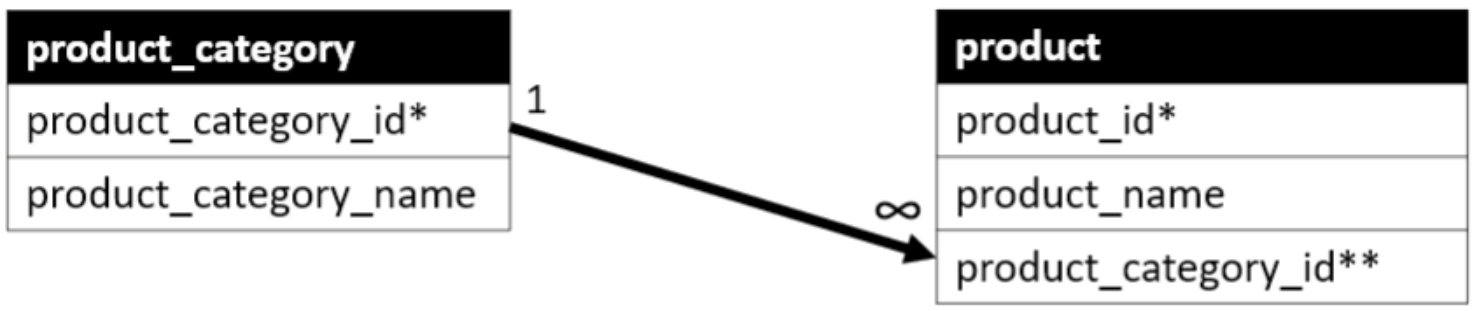
Database Relationships and SQL JOINs

- Relationships between tables and key fields help us combine them using a `JOIN` statement.
  - For example:
    - To list each product name with its product category name, we need to combine the `product` and `product_category` tables.
    - The `product` table has product name.
    - The `product_category` table has product category name.
- Figure 5.1 shows the one-to-many relationship between the `product` and `product_category` tables.
  - Each product belongs to one category.
  - Each category can contain many products.
  - The primary key in the `product_category` table is `product_category_id`. Primary keys are marked with an asterisk.
  - Each row in the `product` table has a `product_category_id` as a foreign key, identifying the category each product belongs to. Foreign keys are marked with a double asterisk.



product_category. product_category_id*	product_category. product_category_name
1	Fresh Fruits & Vegetables
3	Packaged Prepared Food
5	Plants & Flowers
6	Eggs & Meat

product. product_id	product. product_name	product. product_category_id**
2	Jalapeno Peppers - Organic	1
4	Banana Peppers - Jar	3
5	Whole Wheat Bread	3
6	Cut Zinnias Bouquet	5
7	Apple Pie	3
13	Baby Salad Lettuce Mix	1
99	Handmade Candle	NULL

- To combine these tables:
  - We need to determine which type of `JOIN` to use.
  - Some columns are removed to simplify.
  - The fields that connect the two tables are `product_category.product_category_id` and `product.product_category_id`.
- `LEFT JOIN`:
  - Retrieves all records from the left table.
  - Retrieves matching records from the right table.
  - Matches based on `JOIN` criteria.

```
SELECT [columns to return]
FROM [left table]
[JOIN TYPE] [right table]
ON [left table].[field in left table to match] = [right table].[field in right table to match]
```

- `LEFT JOIN` includes all `product` records and matching `product_category` records. Non-matching `product` records still appear, but non-matching `product_category` records do not.

```
SELECT * FROM product
    LEFT JOIN product_category
         ON product.product_category_id =  product_category.product_category_id
LIMIT 5
```

Table 5.1

product_id	product_name	product_size	product_category_id	product_qty_type	product_catego
1	Habanero Peppers - Organic	medium	1	lbs	1
2	Jalapeno Peppers - Organic	small	1	lbs	1
3	Poblano Peppers - Organic	large	1	unit	1
4	Banana Peppers - Jar	8 oz	3	unit	3
5	Whole Wheat Bread	1.5 lbs	3	unit	3

- Two `product_category_id` columns appear because we used the asterisk to select all fields from both tables.
    - To fix this, specify the fields to return and include `product_category_id` from only one table or alias the column names.
- To retrieve specific columns:
    - Specify which table each column is from.
    - Alias columns to differentiate them if they have the same name.

```
SELECT
    product.product_id, product.product_name,
    product.product_category_id AS product_prod_cat_id,
    product_category.product_category_id AS category_prod_cat_id,
    product_category.product_category_name
FROM product
    LEFT JOIN product_category
         ON product.product_category_id = product_category.product_category_id
LIMIT 5
```

Table 5.2

product_id	product_name	product_prod_cat_id	category_prod_cat_id	product_category_name
1	Habanero Peppers - Organic	1	1	Fresh Fruits & Vegetables
2	Jalapeno Peppers - Organic	1	1	Fresh Fruits & Vegetables
3	Poblano Peppers - Organic	1	1	Fresh Fruits & Vegetables
4	Banana Peppers - Jar	3	3	Packaged Prepared Food
5	Whole Wheat Bread	3	3	Packaged Prepared Food

- Table aliasing in SQL allows you to use short names for tables in the `FROM` clause.
  - Assign an alias to a table for convenience.
  - Use the alias throughout the query.

```sql
SELECT
    p.product_id, p.product_name,
    pc.product_category_id,
    pc.product_category_name
FROM product AS p
    LEFT JOIN product_category AS pc
        ON p.product_category_id = pc.product_category_id
ORDER BY pc.product_category_name, p.product_name
LIMIT 5
```

Table 5.3

product_id	product_name	product_category_id	product_category_name
10	Eggs	6	Eggs & Meat (Fresh or Frozen)
11	Pork Chops	6	Eggs & Meat (Fresh or Frozen)
13	Baby Salad Lettuce Mix	1	Fresh Fruits & Vegetables
12	Baby Salad Lettuce Mix - Bag	1	Fresh Fruits & Vegetables
17	Carrots	1	Fresh Fruits & Vegetables

- `RIGHT JOIN`:
  - `RIGHT JOIN` returns all `product_category` records and matching `product` records.
  - The last row has `NULL` values for `product` columns because there are no products with `product_category_id` 6.
- Use `RIGHT JOIN` to:
  - List all product categories and their products.
  - Ignore products not in a category.
- `INNER JOIN`:
  - Only rows with matching `product_category_id` are included.
- There is a FULL JOIN, which is not covered in the book.
  - `FULL JOIN` returns all rows with matches in either table, filling `NULL` for non-matching rows.

Illustration

- Practice `JOIN` types with `customer` and `customer_purchase` tables.
  - One-to-many relationship: each customer can have multiple purchases.
  - Tables are related via `customer_id`, the primary key in `customer` and foreign key in `customer_purchase`.
- Using a `LEFT JOIN`:

```sql
SELECT c.*
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
LIMIT 5
```

customer_id	customer_first_name	customer_last_name	customer_zip	product_id	vendor_id	market_date	customer_id	quantity	cost_to_cust	transacti
5	Abigail	Harris	22801	7	9	2019-03-09	5	1.00	16.00	10:41:00
6	Betty	Bullard	22801	NULL	NULL	NULL	NULL	NULL	NULL	NULL
7	Jessica	Armenta	22803	12	7	2019-03-09	7	2.00	3.00	11:40:00
8	Norma	Valenzuela	22803	NULL	NULL	NULL	NULL	NULL	NULL	NULL
9	Janet	Forbes	22801	NULL	NULL	NULL	NULL	NULL	NULL	NULL
10	Russell	Edwards	22801	4	8	2019-03-02	10	1.00	4.00	09:12:00
11	Richard	Paulson	22801	NULL	NULL	NULL	NULL	NULL	NULL	NULL
12	Jack	Wise	22803	4	8	2019-03-09	12	1.00	4.00	13:03:00
12	Jack	Wise	22803	8	9	2019-03-09	12	3.00	18.00	13:18:00
12	Jack	Wise	22803	11	1	2019-03-09	12	0.90	12.00	13:10:00
12	Jack	Wise	22803	12	7	2019-03-09	12	2.00	3.00	13:00:00
13	Jeremy	Gruber	22803	NULL	NULL	NULL	NULL	NULL	NULL	NULL
14	William	Lopes	22801	NULL	NULL	NULL	NULL	NULL	NULL	NULL

- Some customers might not have any purchases; they were added to the `customer` table when they signed up for the loyalty card.
  - `LEFT JOIN` lists all customers and their purchases, if any.
  - Customers with multiple purchases appear multiple times.
  - Customers without purchases have `NULL` values in `customer_purchases` fields.
  - Use the `WHERE` clause to filter only customers with no purchases.

```sql
SELECT c.*
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
WHERE cp.customer_id IS NULL
```

customer_id	customer_first_name	customer_last_name	customer_zip
6	Betty	Bullard	22801
8	Norma	Valenzuela	22803
9	Janet	Forbes	22801
11	Richard	Paulson	22801
13	Jeremy	Gruber	22803
14	William	Lopes	22801
15	Darrell	Messina	22801

- We selected columns from the `customer` table using `c.*`.
  - All `customer_purchases` columns will be `NULL`.
  - Every purchase is logged at checkout, and every customer uses their loyalty card.
- Using a `RIGHT JOIN`:
  - Use `RIGHT JOIN` to pull all `customer_purchases` records.
  - Only customers with purchases are included.

```sql
SELECT *
FROM customer AS c
    RIGHT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
```

customer_id	customer_first_name	customer_last_name	customer_zip	product_id	vendor_id	market_date	customer_id	quantity	cost_to_cust	transacti
4	Deanna	Washington	22801	4	8	2019-03-02	4	2.00	4.00	10:22:00
10	Russell	Edwards	22801	4	8	2019-03-02	10	1.00	4.00	09:12:00
12	Jack	Wise	22803	4	8	2019-03-09	12	1.00	4.00	13:03:00
5	Abigail	Harris	22801	7	9	2019-03-09	5	1.00	16.00	10:41:00
1	Jane	Connor	22801	8	9	2019-03-09	1	1.00	18.00	08:25:00
12	Jack	Wise	22803	8	9	2019-03-09	12	3.00	18.00	13:18:00
2	Manuel	Diaz	22803	9	4	2019-03-02	2	4.60	2.00	10:53:00
3	Bob	Wilson	22803	9	4	2019-03-02	3	8.40	2.00	11:39:00
4	Deanna	Washington	22801	9	4	2019-03-02	4	1.40	2.00	10:31:00
4	Deanna	Washington	22801	9	4	2019-03-09	4	9.90	2.00	13:02:00
1	Jane	Connor	22801	10	1	2019-03-02	1	1.00	5.50	08:59:00
1	Jane	Connor	22801	10	1	2019-03-02	1	3.00	5.00	09:31:00
1	Jane	Connor	22801	10	1	2019-03-09	1	2.00	5.50	08:30:00

- The output is truncated to save space:
  - No `NULL` values are in the `customer` table columns since every purchase has a `customer_id`.
  - `RIGHT JOIN` excludes customers without purchases.
- Use `INNER JOIN` for records with matches in both tables.
  - For `customer` and `customer_purchases`, `INNER JOIN` returns the same results as `RIGHT JOIN` because every purchase is linked to a customer.

A Common Pitfall when Filtering Joined Data

- 'LEFT JOIN' in the previous:

```sql
SELECT *
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
```

- Compared with this query?

```sql
SELECT *
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
WHERE cp.customer_id > 0
```

- All `customer_id` values are positive integers.
  - Adding this `WHERE` clause filters `customer_id` in `customer_purchases` (alias `cp`).
  - Customers without purchases are excluded.
  - The query behaves like a `RIGHT JOIN`, excluding `NULL` values in `customer_purchases`.
  - The output will look like Figure 5.14, not Figure 5.12.
- With `LEFT JOIN`, avoid filtering on fields from the "right" table without allowing `NULL` values; otherwise, you'll filter out intended rows.
- Let's write a query to list customers who didn't make a purchase on March 2, 2019.

```sql
SELECT c.*, cp.market_date
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
WHERE cp.market_date <> '2019-03-02' -- <> is !=
```

customer_id	customer_first_name	customer_last_name	customer_zip	market_date
1	Jane	Connor	22801	2019-03-09
1	Jane	Connor	22801	2019-03-09
1	Jane	Connor	22801	2019-03-09
2	Manuel	Diaz	22803	2019-03-13
2	Manuel	Diaz	22803	2019-03-13
3	Bob	Wilson	22803	2019-03-16
3	Bob	Wilson	22803	2019-03-16
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
5	Abigail	Harris	22801	2019-03-09
7	Jessica	Armenta	22803	2019-03-09
10	Russell	Edwards	22801	2019-03-16
12	Jack	Wise	22803	2019-03-09
12	Jack	Wise	22803	2019-03-09
12	Jack	Wise	22803	2019-03-16
12	Jack	Wise	22803	2019-03-09
12	Jack	Wise	22803	2019-03-09

- We're missing customers without purchases, like Betty Bullard in Figure 5.12, due to filtering on `market_date` from `customer_purchases`.
  - SQL comparisons with `NULL` values return FALSE.
  - Solution: adjust the `WHERE` clause to allow `NULL` values.

```sql
SELECT c.*, cp.market_date
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
WHERE (cp.market_date <> '2019-03-02' OR cp.market_date IS NULL)
```

customer_id	customer_first_name	customer_last_name	customer_zip	market_date
1	Jane	Connor	22801	2019-03-09
1	Jane	Connor	22801	2019-03-09
1	Jane	Connor	22801	2019-03-09
2	Manuel	Diaz	22803	2019-03-13
2	Manuel	Diaz	22803	2019-03-13
3	Bob	Wilson	22803	2019-03-16
3	Bob	Wilson	22803	2019-03-16
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
4	Deanna	Washington	22801	2019-03-09
5	Abigail	Harris	22801	2019-03-09
6	Betty	Bullard	22801	NULL
7	Jessica	Armenta	22803	2019-03-09
8	Norma	Valenzuela	22803	NULL
9	Janet	Forbes	22801	NULL
10	Russell	Edwards	22801	2019-03-16
11	Richard	Paulson	22801	NULL
12	Jack	Wise	22803	2019-03-09
12	Jack	Wise	22803	2019-03-09
12	Jack	Wise	22803	2019-03-16

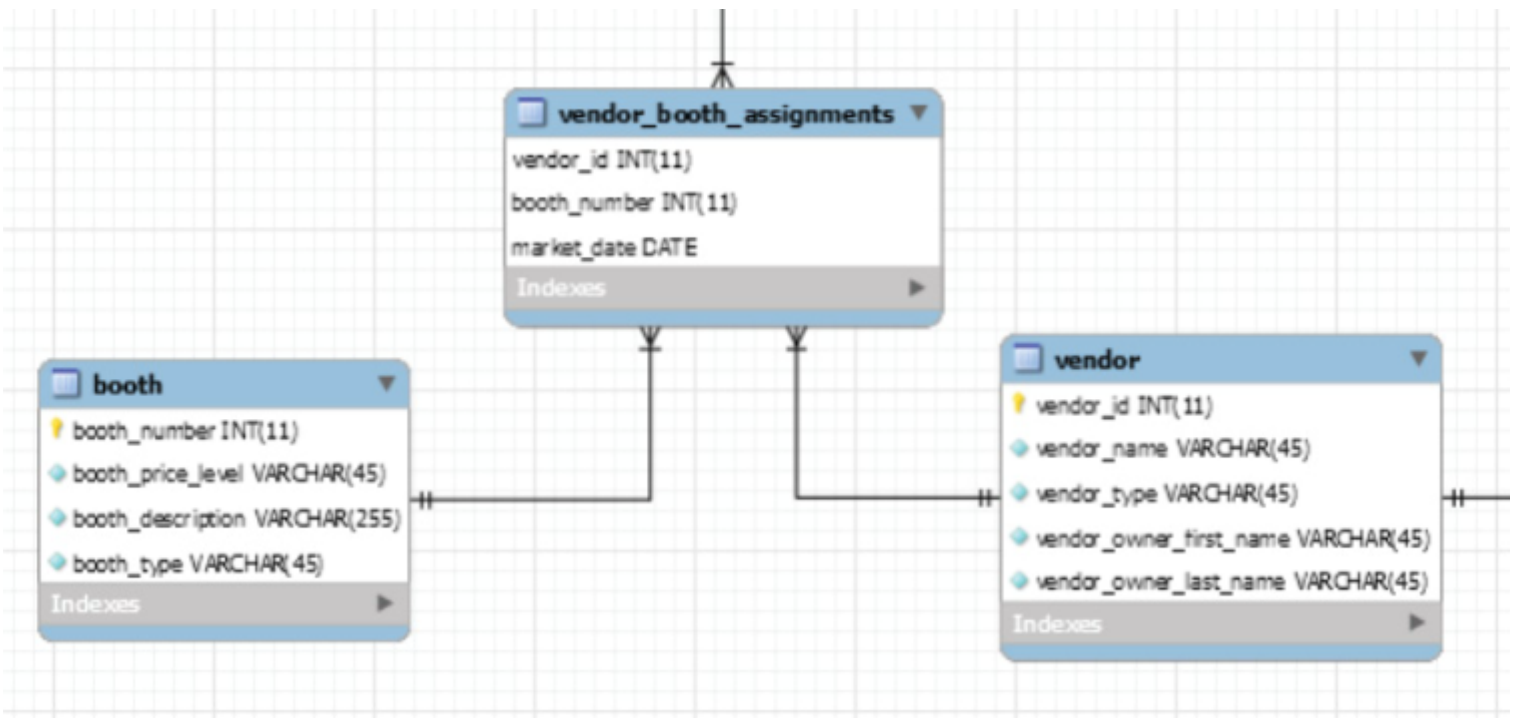
- Figure 5.16 shows customers without purchases, like Betty Bullard, and those with purchases on other dates.
  - The output has one row per customer per item purchased, but we only want a list of customers.
  - Remove the `market_date` field and use `DISTINCT` to eliminate duplicates.

```sql
SELECT DISTINCT c.*
FROM customer AS c
    LEFT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
WHERE (cp.market_date <> '2019-03-02' OR cp.market_date IS NULL)
```

customer_id	customer_first_name	customer_last_name	customer_zip
1	Jane	Connor	22801
2	Manuel	Diaz	22803
3	Bob	Wilson	22803
4	Deanna	Washington	22801
5	Abigail	Harris	22801
6	Betty	Bullard	22801
7	Jessica	Armenta	22803
8	Norma	Valenzuela	22803
9	Janet	Forbes	22801
10	Russell	Edwards	22801
11	Richard	Paulson	22801
12	Jack	Wise	22803
13	Jeremy	Gruber	22803
14	William	Lopes	22801
15	Darrell	Messina	22801

JOINs with More than Two Tables

- We want to get details of all booths and vendor assignments for every market date:
  - Join the three tables in Figure 5.18.



- What `JOIN`s could we use to ensure all booths are included, even if they aren t assigned to a vendor yet, and all vendors assigned to booths are included?
  - We can `LEFT JOIN` `vendor_booth_assignments` to `booth`, including all booths.
  - `LEFT JOIN` `vendor` to `vendor_booth_assignments`.
  - The query looks like this and results in Figure 5.19:
- We use `JOIN`s to include all booths, even unassigned ones, and all vendors:
  - `LEFT JOIN` `vendor_booth_assignments` with `booth`.
  - `LEFT JOIN` `vendor` with `vendor_booth_assignments`.

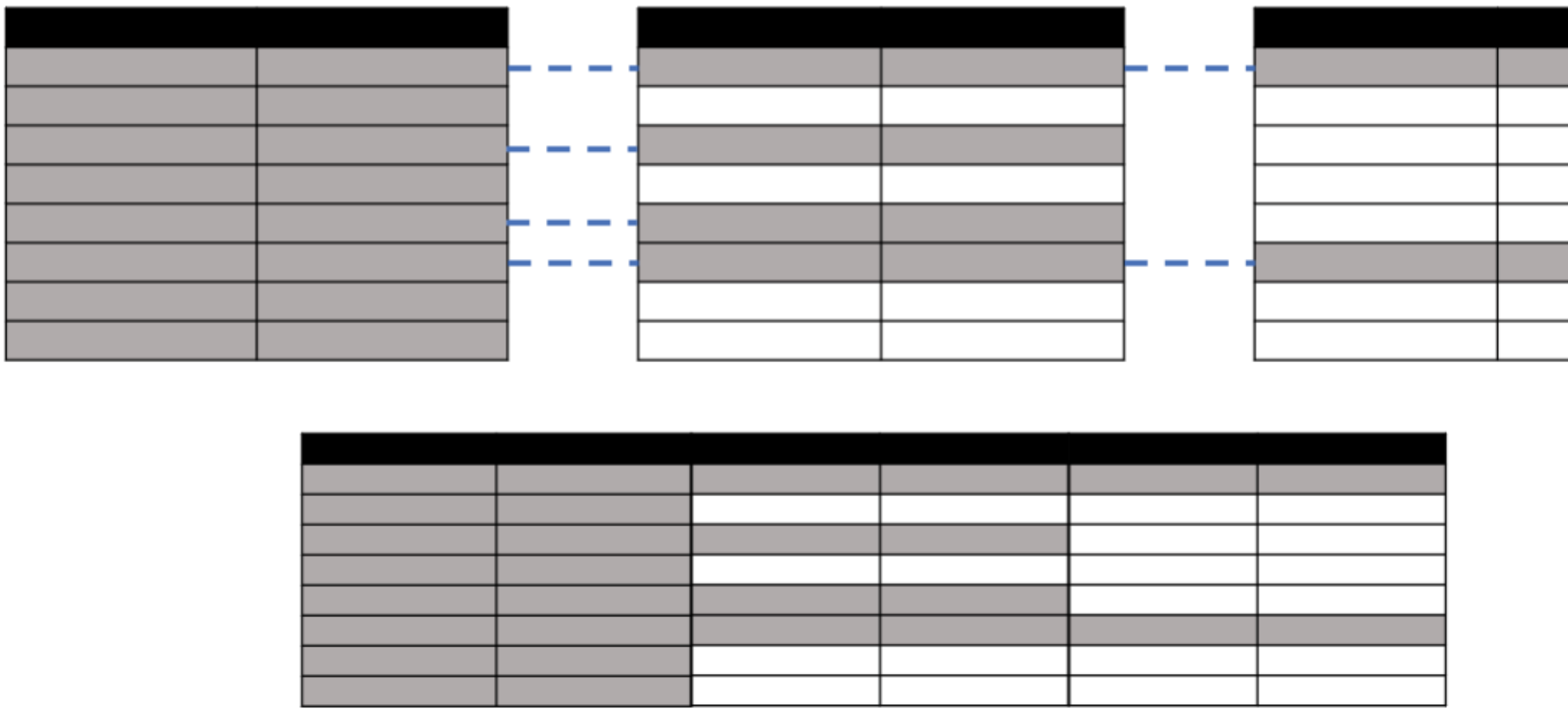
```sql
SELECT
    b.booth_number,
    b.booth_type,
    vba.market_date,
    v.vendor_id,
    v.vendor_name,
    v.vendor_type
FROM booth AS b
    LEFT JOIN vendor_booth_assignments AS vba ON b.booth_number = vba.
booth_number
    LEFT JOIN vendor AS v ON v.vendor_id = vba.vendor_id
ORDER BY b.booth_number, vba.market_date
```

booth_number	booth_type	market_date	vendor_id	vendor_name	vendor_type
1	Standard	2019-03-02	3	Hernández Salsa & Veggies	Fresh Variety: Veggies & More
1	Standard	2019-03-09	3	Hernández Salsa & Veggies	Fresh Variety: Veggies & More
1	Standard	2019-03-13	3	Hernández Salsa & Veggies	Fresh Variety: Veggies & More
2	Standard	2019-03-02	1	Chris's Sustainable Eggs & Meats	Eggs & Meats
2	Standard	2019-03-09	1	Chris's Sustainable Eggs & Meats	Eggs & Meats
2	Standard	2019-03-13	4	Mountain View Vegetables	Fresh Variety: Veggies & More
3	Small	NULL	NULL	NULL	NULL
4	Small	NULL	NULL	NULL	NULL
5	Small	NULL	NULL	NULL	NULL
6	Small	2019-03-02	8	Marco's Peppers	Fresh Focused
6	Small	2019-03-09	8	Marco's Peppers	Fresh Focused
6	Small	2019-03-13	8	Marco's Peppers	Fresh Focused
7	Standard	2019-03-02	4	Mountain View Vegetables	Fresh Variety: Veggies & More
7	Standard	2019-03-09	4	Mountain View Vegetables	Fresh Variety: Veggies & More
8	Small	2019-03-02	9	Annie's Pies	Prepared Foods
8	Small	2019-03-09	9	Annie's Pies	Prepared Foods
8	Small	2019-03-13	10	Mediterranean Bakery	Prepared Foods

- The second `JOIN` merges into the first `JOIN` result.
  - `vendor.vendor_id` joins `vendor_booth_assignments.vendor_id`.
  - Only vendors in `vendor_booth_assignments` are included.

Table LEFT JOINed to a table on the RIGHT side of an existing LEFT JOIN

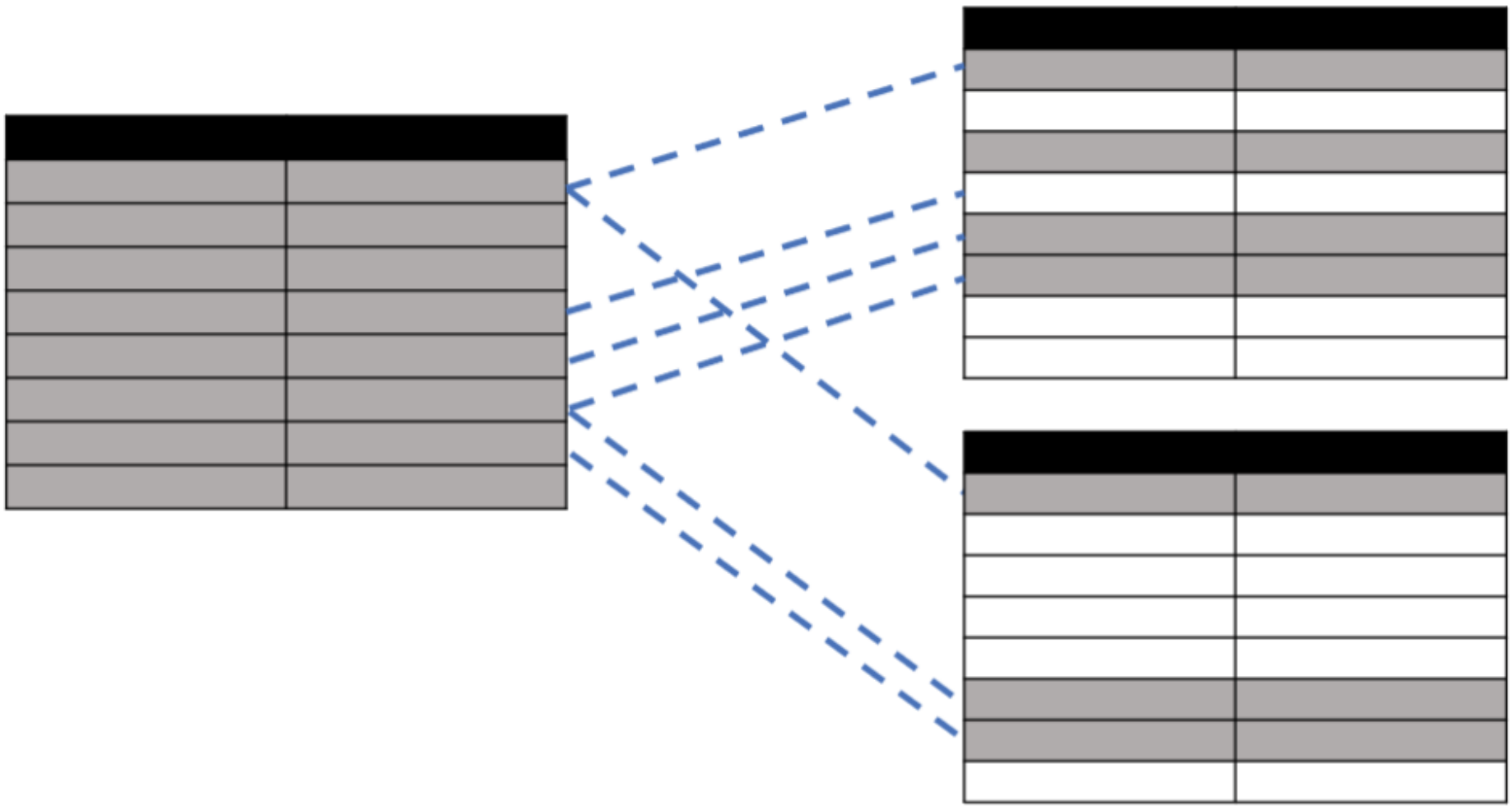
All rows from the “left table”, only rows from the “middle table” with matching values in the specified fields of the “left table”, and only rows from the “right table” with matching values in the specified fields of the “middle table”.

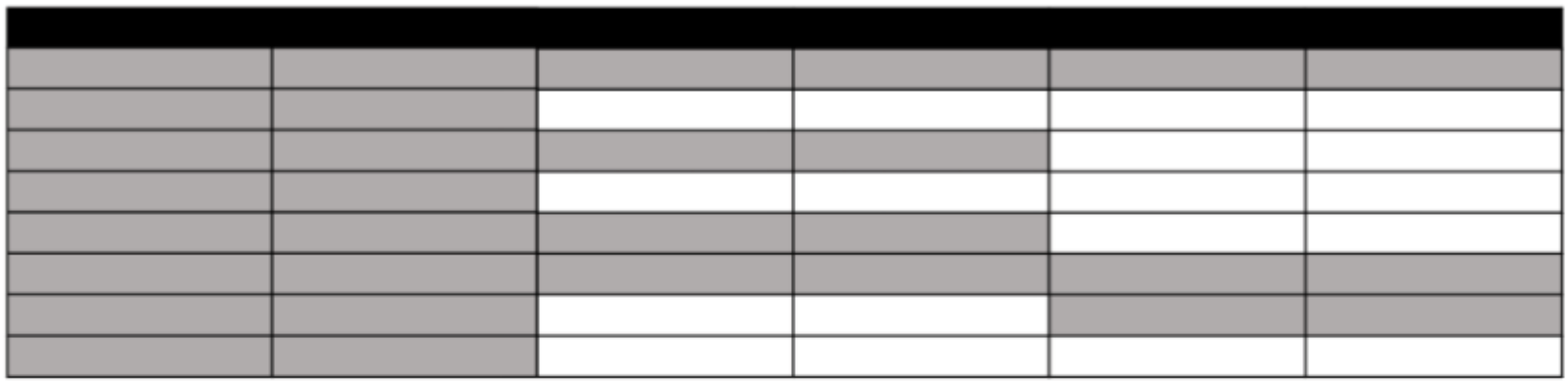


- This type of JOIN isn't possible in the Farmer's Market database because no other tables are joined to the `booth` table.

Two Tables LEFT JOINed to a Table

All rows from the “left table”, and only rows from each “right table” with matching values in the specified fields of the “left table”.





- In machine learning, multiple tables are often joined by `LEFT JOIN`ing other tables to a primary table with one row per entity. This adds summarized data (counts or sums) from other tables, keeping the dataset at one row per entity.

Exercises

1. Write a query that `INNER JOIN`s the `vendor` table to the `vendor_booth_assignments` table on the `vendor_id` field they have in common.
    - Sort the result by `vendor_name`, then `market_date`.
2. Write a query that produces the same output as the following query but uses a `LEFT JOIN` instead of a `RIGHT JOIN`:

```
SELECT *
FROM customer AS c
RIGHT JOIN customer_purchases AS cp
    ON c.customer_id = cp.customer_id
```

3. To answer the question "When is each type of fresh fruit or vegetable in season, locally?" we need data from:
    - The `product_category` table
    - The `product` table
    - The `vendor_inventory` table What type of `JOIN`s would be needed to combine these three tables