Databases

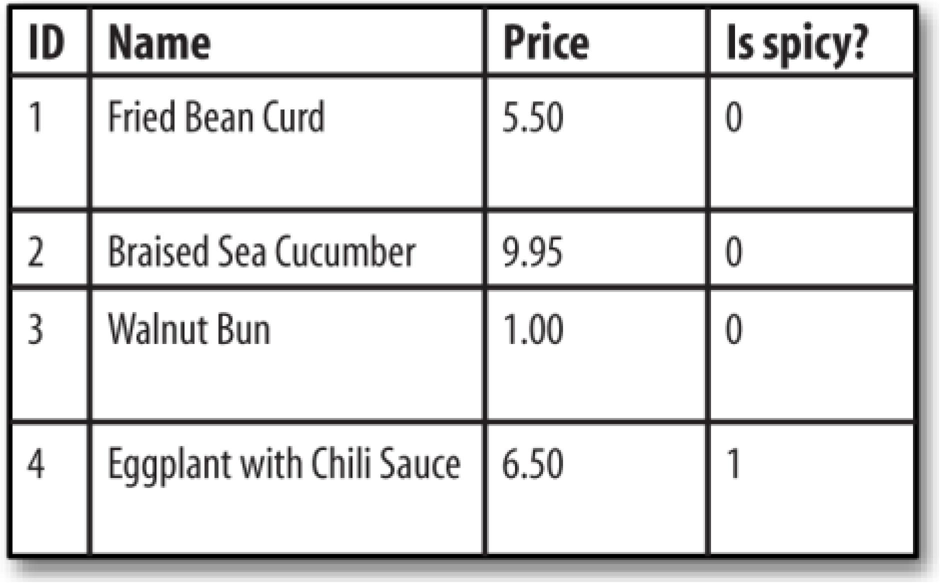
Chapter 8

Why Databases?

- Why not storing data in simple files? Why databases?
- There are three big reasons why using databases:
  - **Convenience**: if data is in a file, you must read, search to find data, change it and write back data!
  - **Simultaneous access:** if 2 users change same data at the same time, which change get the final effect?
  - **Security:** we cannot control access to part of a data file, but in the database we can

Organizing Data in a Database

- Data in your database is organized in tables
- Each table has rows and columns (fields)



ID	Name	Price	Is spicy?
1	Fried Bean Curd	5.50	0
2	Braised Sea Cucumber	9.95	0
3	Walnut Bun	1.00	0
4	Eggplant with Chili Sauce	6.50	1

- Structured Query Language (SQL) is a language used to ask questions of and give instructions to the database program.

- SQL is case-insensitive for its keywords
- But sensitive (by default) for the string values

Connecting to a Database Program

- To establish a connection to a database program, create a new PDO object.
- You pass the PDO constructor a string that describes the database you are connecting to
- It returns an object that you use in the rest of your program to exchange data with the database program.

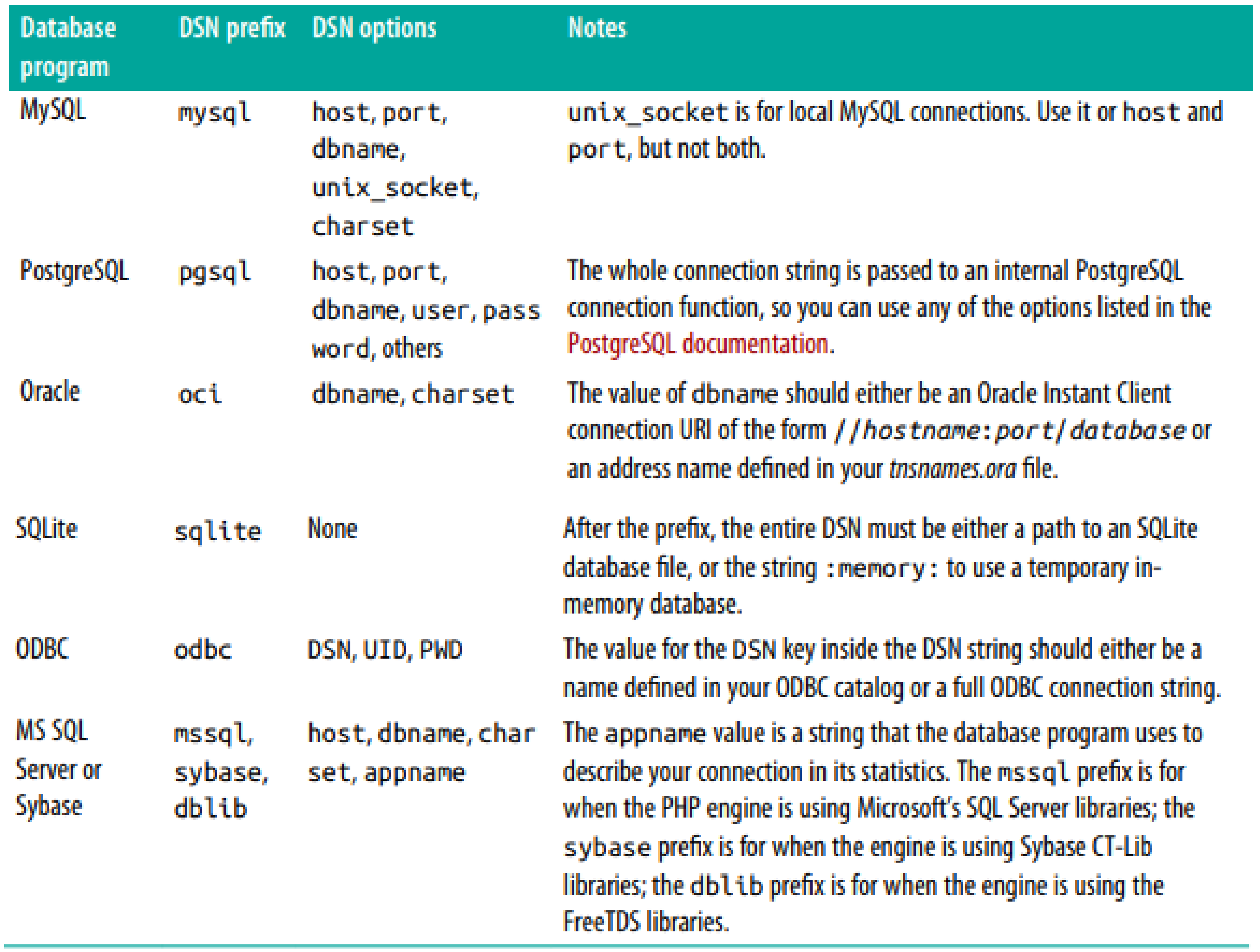
```
$db = new PDO('mysql:host=db.example.com;dbname=restaurant','penguin','top^hat');
```

- The first argument is called a data source name (DSN):
  - It begins with what kind of database program to connect to (e.g. mysql)
  - then has a colon :
  - then some key=value pairs separated by semicolon providing information about how to connect.
- If the database connection needs a username and password, these are passed as the second and third arguments

- PDO support many DBMSs but if it not, you will get could not find driver message when creating a PDO object

The charset option, available with some database programs, specifies how the database program should handle non-English characters.

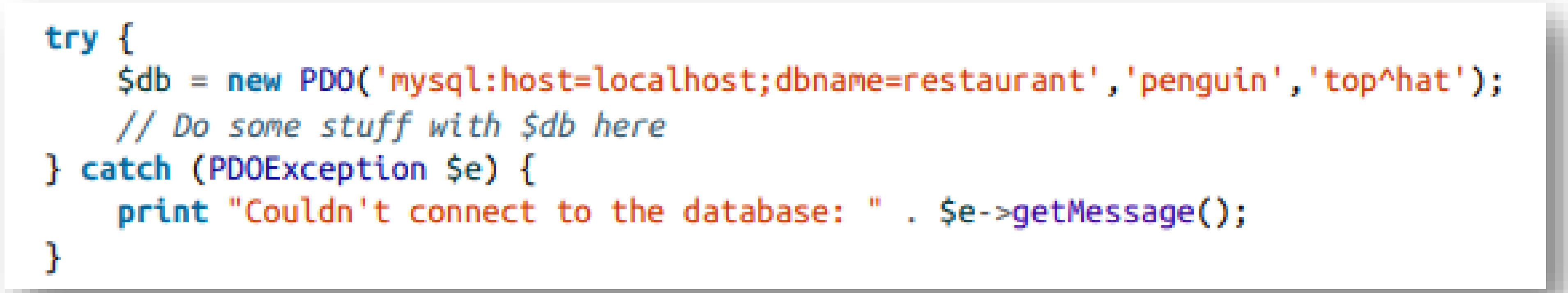
Table 8-1. PDO DSN prefixes and options



Database program	DSN prefix	DSN options	Notes
MySQL	`mysql`	`host`, `port`, `dbname`, `unix_socket`, `charset`	`unix_socket` is for local MySQL connections. Use it or `host` and `port`, but not both.
PostgreSQL	`pgsql`	`host`, `port`, `dbname`, `user`, `password`, others	The whole connection string is passed to an internal PostgreSQL connection function, so you can use any of the options listed in the PostgreSQL documentation.
Oracle	`oci`	`dbname`, `charset`	The value of `dbname` should either be an Oracle Instant Client connection URI of the form `//`*`hostname`*`:`*`port`*`/`*`database`* or an address name defined in your *tnsnames.ora* file.
SQLite	`sqlite`	None	After the prefix, the entire DSN must be either a path to an SQLite database file, or the string `:memory:` to use a temporary in-memory database.
ODBC	`odbc`	`DSN`, `UID`, `PWD`	The value for the `DSN` key inside the DSN string should either be a name defined in your ODBC catalog or a full ODBC connection string.
MS SQL Server or Sybase	`mssql`, `sybase`, `dblib`	`host`, `dbname`, `charset`, `appname`	The `appname` value is a string that the database program uses to describe your connection in its statistics. The `mssql` prefix is for when the PHP engine is using Microsoft's SQL Server libraries; the `sybase` prefix is for when the engine is using Sybase CT-Lib libraries; the `dblib` prefix is for when the engine is using the FreeTDS libraries.

PDO

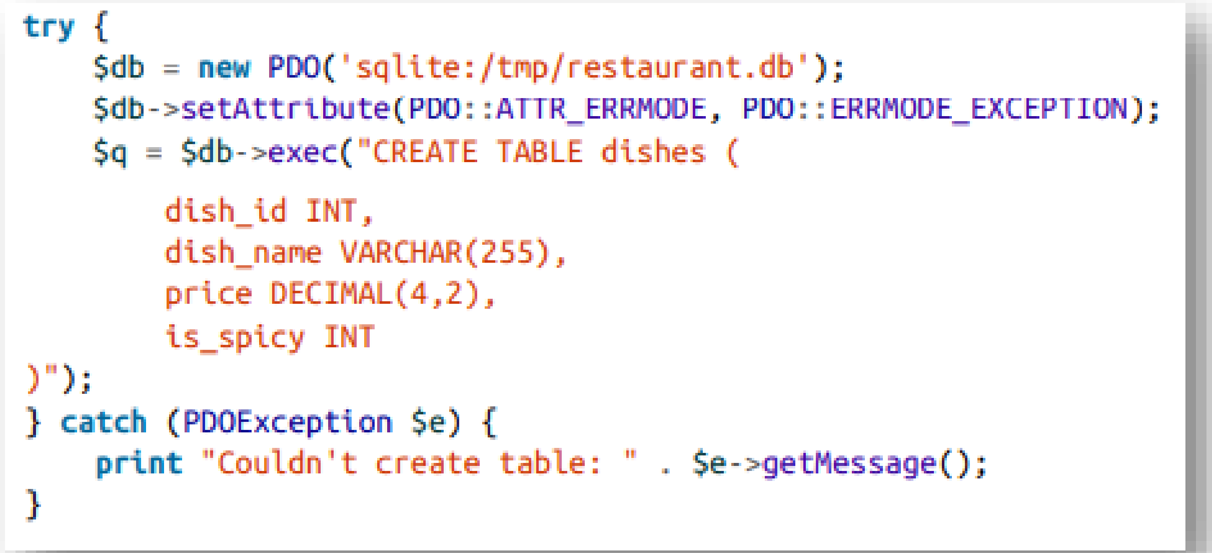
- If all goes well with new PDO(), it returns an object that you use to interact with the database.
- If there is a problem connecting, it throws a PDOException exception. Make sure to catch exceptions so you can verify that the connection succeeded before going forward in your program.



```
try {
    $db = new PDO('mysql:host=localhost;dbname=restaurant','penguin','top^hat');
    // Do some stuff with $db here
} catch (PDOException $e) {
    print "Couldn't connect to the database: " . $e->getMessage();
}
```

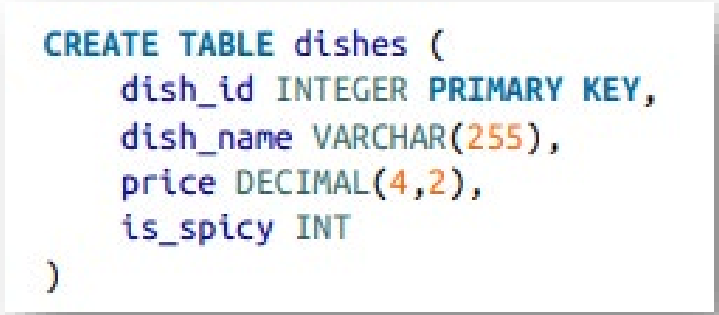
Creating a Table

- First you must create a table. This is usually a one-time operation.

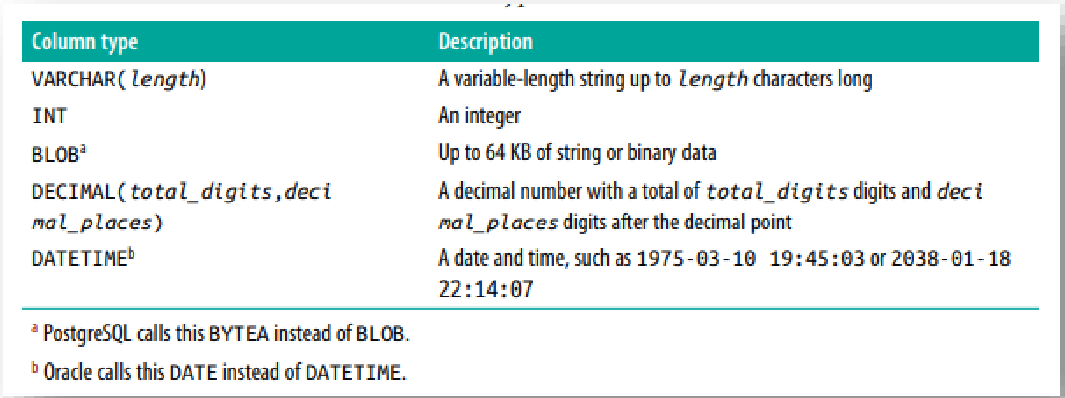


```
try {
    $db = new PDO('sqlite:/tmp/restaurant.db');
    $db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION);
    $q = $db->exec("CREATE TABLE dishes (

        dish_id INT,
        dish_name VARCHAR(255),
        price DECIMAL(4,2),
        is_spicy INT
)");
} catch (PDOException $e) {
    print "Couldn't create table: " . $e->getMessage();
}
```



```
CREATE TABLE dishes (
    dish_id INTEGER PRIMARY KEY,
    dish_name VARCHAR(255),
    price DECIMAL(4,2),
    is_spicy INT
)
```



Column type	Description
VARCHAR(*length*)	A variable-length string up to *length* characters long
INT	An integer
BLOB[a]	Up to 64 KB of string or binary data
DECIMAL(*total_digits*,*decimal_places*)	A decimal number with a total of *total_digits* digits and *decimal_places* digits after the decimal point
DATETIME[b]	A date and time, such as 1975-03-10 19:45:03 or 2038-01-18 22:14:07

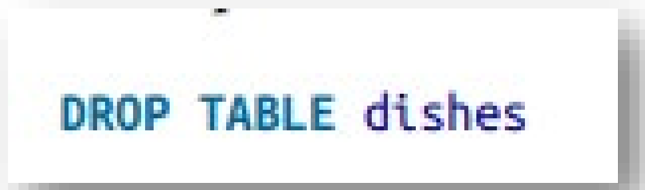
[a] PostgreSQL calls this BYTEA instead of BLOB.

[b] Oracle calls this DATE instead of DATETIME.

- setAttribute() ensures that PDO throws exceptions if there are problems with queries, not just a problem when connecting.

Dropping a table

- The opposite of CREATE TABLE is DROP TABLE.

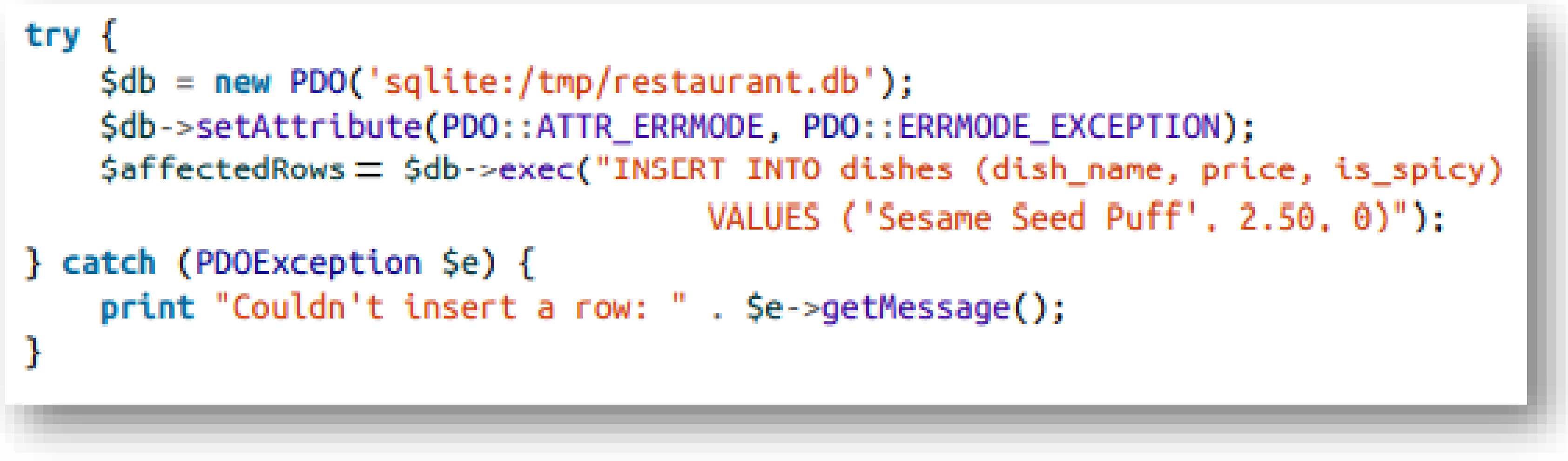


```
DROP TABLE dishes
```

- NOTE: It removes a table and the data in it from a database

Putting Data into the Database

- To put some data into the database, pass an INSERT statement to the object's exec() method



```
try {
    $db = new PDO('sqlite:/tmp/restaurant.db');
    $db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION);
    $affectedRows = $db->exec("INSERT INTO dishes (dish_name, price, is_spicy)
                               VALUES ('Sesame Seed Puff', 2.50, 0)");
} catch (PDOException $e) {
    print "Couldn't insert a row: " . $e->getMessage();
}
```

- The exec() method returns the number of rows affected by the SQL statement. In this case, it returns 1

- If something goes wrong with INSERT, an exception is thrown.

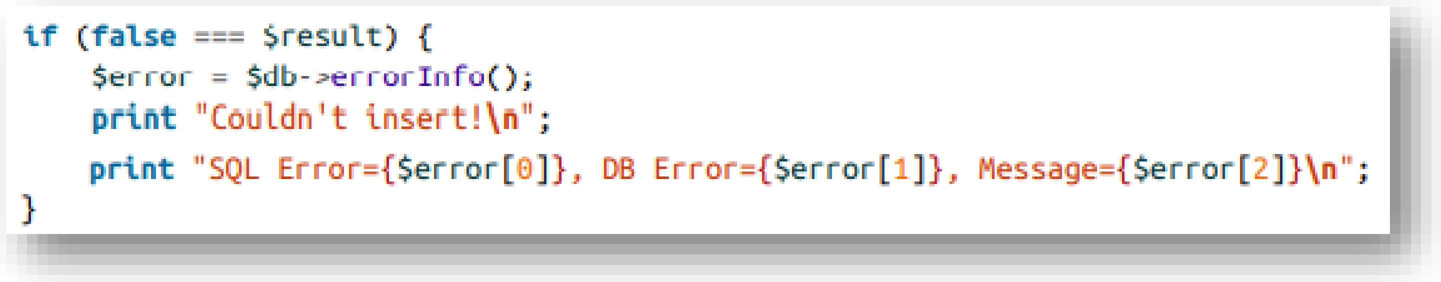
PDO error modes

- PDO has 3 error modes:
  - Silent
  - Warning
  - Exception
- The silent mode is the default.
- The exception error mode is activated by $db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION)
- The other two error modes require you to check the return values from your PDO function calls
  - If there is an error, use additional PDO methods to find information about the error.

- The warning mode is activated by setting the PDO::ATTR_ERRMODE attribute to PDO::ERRMODE_WARNING

errorinfo()

- Like other PDO methods, if exec() fails at its task, it returns false. (Question: why === instead of ==?)

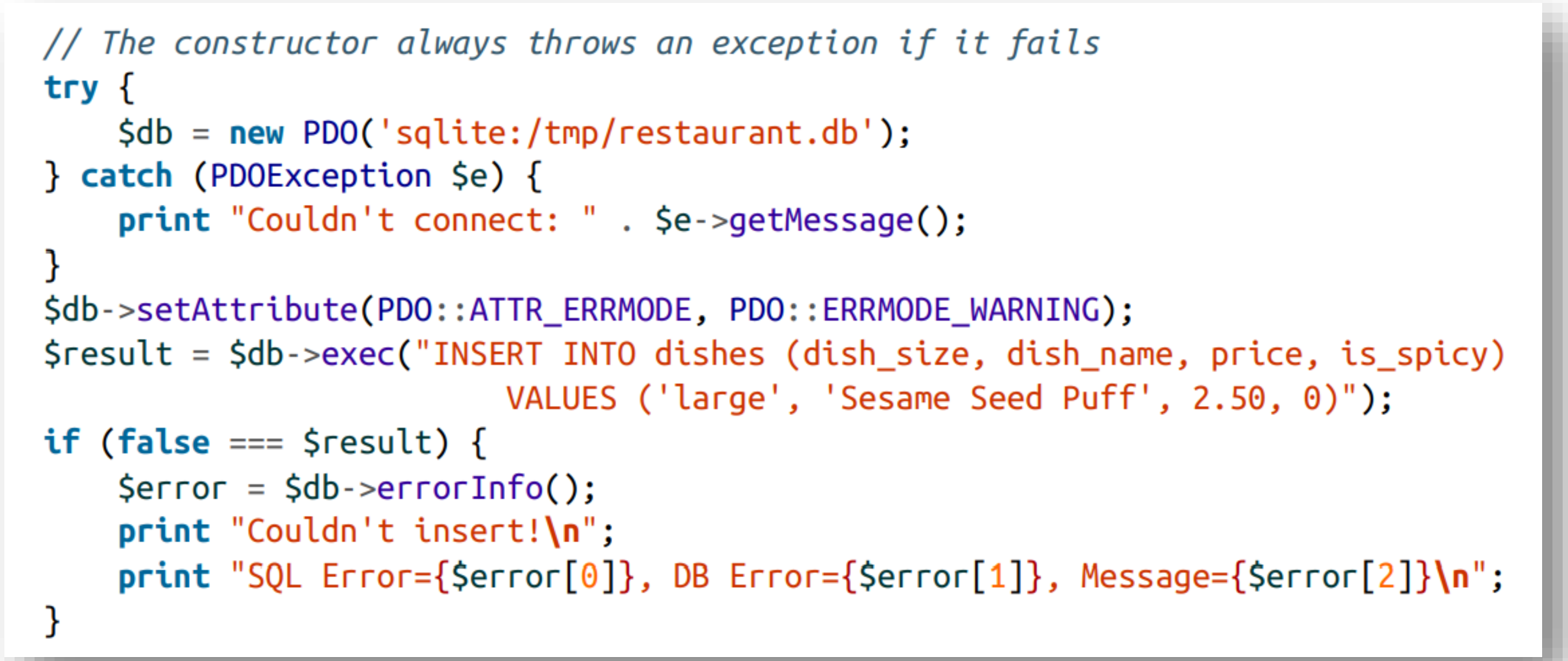


```
if (false === $result) {
    $error = $db->errorInfo();
    print "Couldn't insert!\n";
    print "SQL Error={$error[0]}, DB Error={$error[1]}, Message={$error[2]}\n";
}
```

- errorInfo() returns a three-element array with error information.
  - The **first** element is an SQLSTATE error code. These are error codes that are mostly standardized across different database programs. In this case, HY000 is a catch-all for general errors.
  - The **second** element is an error code specific to the particular database program in use.
  - The **third** element is a textual message describing the error.

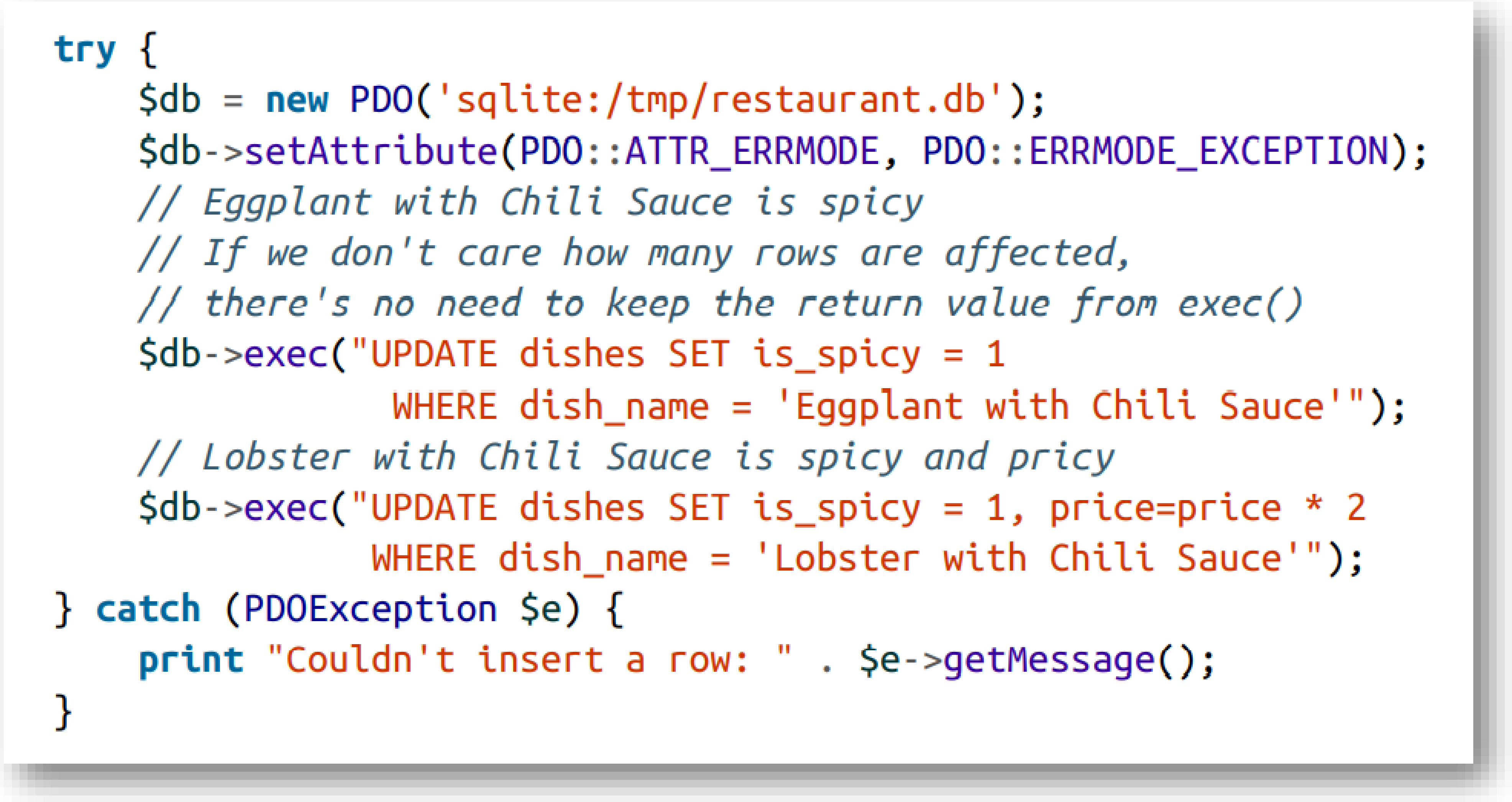
Warnign mode

- In this mode, functions behave as they do in silent mode—no exceptions, returning false on error—but the PHP engine also generates a warning-level error message.
- Depending on how you've configured error handling, this message may get displayed on screen or in a log file.



```php
// The constructor always throws an exception if it fails
try {
    $db = new PDO('sqlite:/tmp/restaurant.db');
} catch (PDOException $e) {
    print "Couldn't connect: " . $e->getMessage();
}
$db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_WARNING);
$result = $db->exec("INSERT INTO dishes (dish_size, dish_name, price, is_spicy)
                     VALUES ('large', 'Sesame Seed Puff', 2.50, 0)");
if (false === $result) {
    $error = $db->errorInfo();
    print "Couldn't insert!\n";
    print "SQL Error={$error[0]}, DB Error={$error[1]}, Message={$error[2]}\n";
}
```

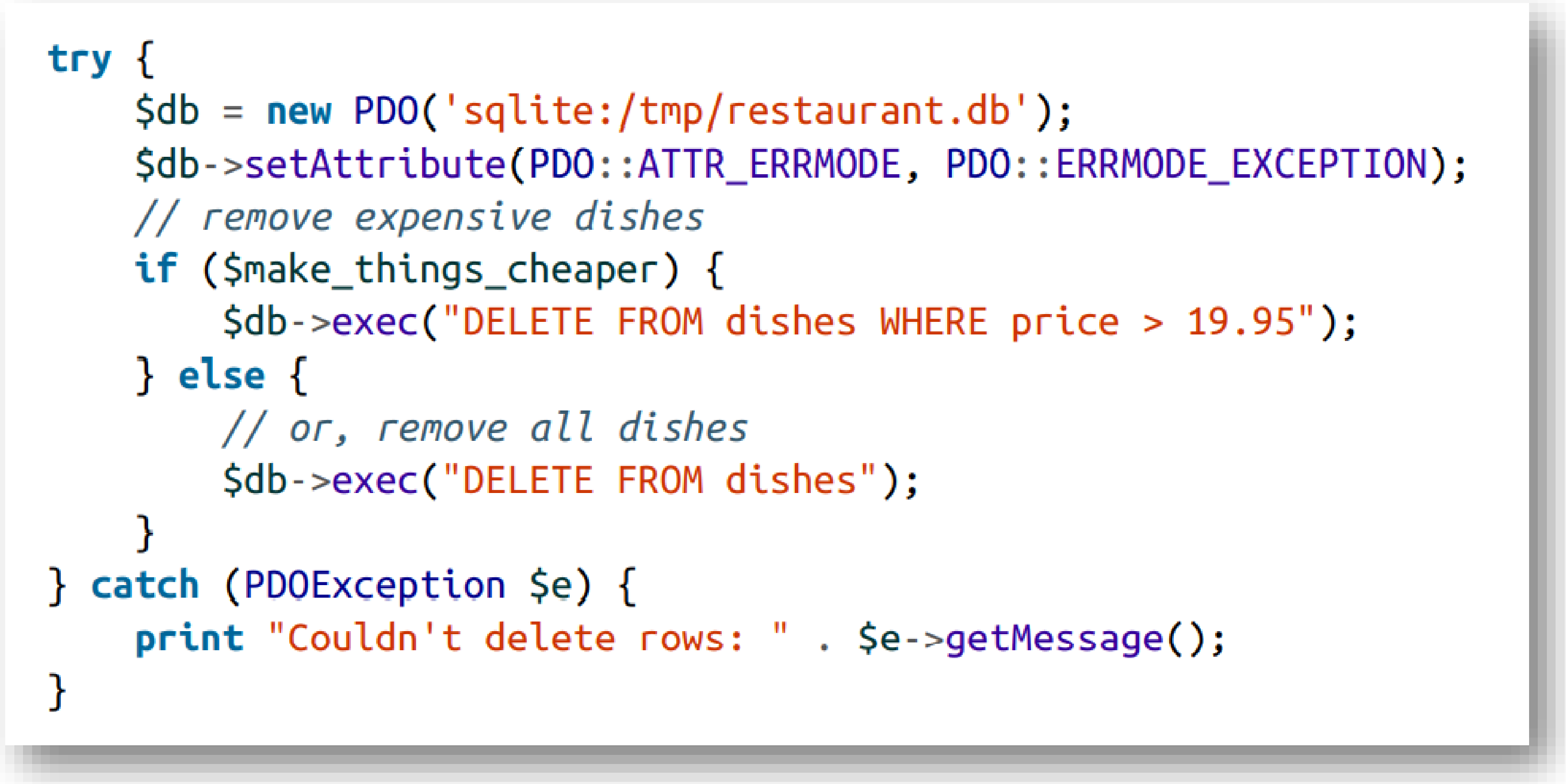
Update Data in a Table



```php
try {
    $db = new PDO('sqlite:/tmp/restaurant.db');
    $db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION);
    // Eggplant with Chili Sauce is spicy
    // If we don't care how many rows are affected,
    // there's no need to keep the return value from exec()
    $db->exec("UPDATE dishes SET is_spicy = 1
                WHERE dish_name = 'Eggplant with Chili Sauce'");
    // Lobster with Chili Sauce is spicy and pricy
    $db->exec("UPDATE dishes SET is_spicy = 1, price=price * 2
               WHERE dish_name = 'Lobster with Chili Sauce'");
} catch (PDOException $e) {
    print "Couldn't insert a row: " . $e->getMessage();
}
```

Delete Data From a Table

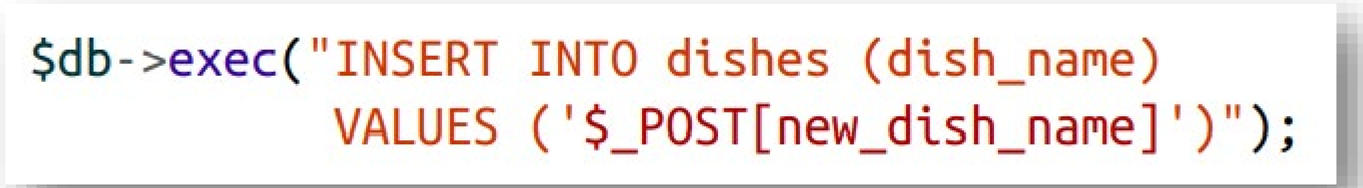
- emember that exec() returns the number of rows changed or removed by an UPDATE or DELETE statement.
- Use the return value to find out how many rows that query affected.



```
try {
    $db = new PDO('sqlite:/tmp/restaurant.db');
    $db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION);
    // remove expensive dishes
    if ($make_things_cheaper) {
        $db->exec("DELETE FROM dishes WHERE price > 19.95");
    } else {
        // or, remove all dishes
        $db->exec("DELETE FROM dishes");
    }
} catch (PDOException $e) {
    print "Couldn't delete rows: " . $e->getMessage();
}
```

Inserting Form Data Safely

- Using unsanitized form data in SQL queries can cause a problem, called an “SQL injection attack.”



```
$db->exec("INSERT INTO dishes (dish_name)
           VALUES ('$_POST[new_dish_name]')");
```

- If the submitted value for new_dish_name is reasonable, such as Fried Bean Curd, then the query succeeds.
- A query with an apostrophe in it causes a problem.
  - If the submitted value for new_dish_name is *General Tso's Chicken*, DBMS thinks that the apostrophe between Tso and s ends the string, so the s Chicken' after the second single quote is an unwanted syntax error.