Unit Test Your Database!

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PGX
POSTGRESQL
EXPERTS, INC.

Why?

Do these sound familiar?

“It takes too long to write tests.”

“Testing will just slow me down.”

“It takes too long to run tests.”

“We already write app-level unit tests.”

“I test stuff by running my app.”

"Tests never find

“This code is so simple it doesn’t need tests.”

“This function is too hard to test.”

“This is a private function.”

"Tests can't prove a program correct so why bother?"

"The behavior of the code changes a lot and rewriting the tests to match will just slow things down."

"If I imagined a problem to write tests for, I probably wrote code that doesn't have that problem."

"I can produce software that works even without focusing specifically on low-level unit tests."

“I’m lucky enough to only be dealing with really good developers.”

"AHHHHHHHH!!!! NOT TESTING! Anything but testing! Beat me, whip me, send me to Detroit, but don't make me write tests!"

—Michael Schwern, Test::Tutorial

Test Conceptions

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- For finding bugs

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- Difficult

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- Irrelevant

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- Prove nothing

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- App tests are sufficient
- For public interface only
- Prove nothing
- For stable code
- I really like Detroit

Let's Get Real

What does it take?

Test-Driven Development

Test-Driven Development

- Say you need a Fibonacci Calculator

Test-Driven Development

- Say you need a Fibonacci Calculator
- Start with a test

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- Say you need a Fibonacci Calculator
- Start with a test
- Write the simplest possible function

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- Say you need a Fibonacci Calculator
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- Write the simplest possible function
- Add more tests

Test-Driven Development

- Say you need a Fibonacci Calculator
- Start with a test
- Write the simplest possible function
- Add more tests
- Update the function

Test-Driven Development

- Say you need a Fibonacci Calculator
- Start with a test
- Write the simplest possible function
- Add more tests
- Update the function
- Wash, rinse, repeat...

Simple Test

Simple Test

Emacs

```
BEGIN;
SET search_path TO public, tap;
SELECT * FROM no_plan();

SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);

SELECT * FROM finish();
ROLLBACK;
```

--:-- try.sql All (SQL[ansi])

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ROLLBACK;
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--:-- try.sql All (SQL[ansi])

Simple Function

Simple Function

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
    RETURN 0;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Simple Function

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
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Run the Test

Terminal

%

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```
% psql -d try -f fib.sql
CREATE FUNCTION
%
```

Run the Test

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
1..2
ok
All tests successful.
Files=1, Tests=2, 0 secs (0.03 usr + 0.00 sys = 0.03 CPU)
Result: PASS
%
```

Run the Test

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
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All tests successful.
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1..2
ok
All tests successful.
Files=1, Tests=2, 0 secs (0.03 usr + 0.00 sys = 0.03 CPU)
Result: PASS
%
```

That was easy

Add Assertions

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
```

--:-- try.sql All (SQL[ansi])

Add Assertions

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
```

--:-- try.sql All (SQL[ansi])

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SELECT can('{fib}');
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SELECT can('{fib}');
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```

--:-- try.sql All (SQL[ansi])

Terminal

```
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```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
not ok 4 - fib(1) should be 1
# Failed test 4: "fib(1) should be 1"
#         have: 0
#         want: 1
1..4
# Looks like you failed 1 test of 4
Failed 1/4 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 4 Failed: 1)
  Failed test:  4
Files=1, Tests=4, 1 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
not ok 4 - fib(1) should be 1
# Failed test 4: "fib(1) should be 1"
#         have: 0
#         want: 1
1..4
# Looks like you failed 1 test of 4
Failed 1/4 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 4 Failed: 1)
  Failed test:  4
Files=1, Tests=4, 1 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Modify for the Test

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
    RETURN 0;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Modify for the Test

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```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
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BEGIN
    RETURN fib_for;
END;
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```

--:-- try.sql All (SQL[ansi])

Modify for the Test

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```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
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BEGIN
    RETURN fib_for;
END;
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```

Bare minimum

--:-- try.sql All (SQL[ansi])

Tests Pass!

Terminal

%

Tests Pass!

Terminal

```
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CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
ok 4 - fib(1) should be 1
1..4
ok
All tests successful.
Files=1, Tests=4, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
%
```

Add Another Assertion

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
```

--:-- try.sql All (SQL[ansi])

Add Another Assertion

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
```

--:-- try.sql All (SQL[ansi])----------

Terminal

```
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
ok 4 - fib(1) should be 1
not ok 5 - fib(2) should be 1
# Failed test 5: "fib(2) should be 1"
#         have: 2
#         want: 1
1..5
# Looks like you failed 1 test of 5
Failed 1/5 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 5 Failed: 1)
  Failed test:  5
Files=1, Tests=5, 1 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
ok 4 - fib(1) should be 1
not ok 5 - fib(2) should be 1
# Failed test 5: "fib(2) should be 1"
#         have: 2
#         want: 1
1..5
# Looks like you failed 1 test of 5
Failed 1/5 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 5 Failed: 1)
  Failed test:  5
Files=1, Tests=5, 1 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Modify to Pass

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
    RETURN fib_for;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Modify to Pass

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
    IF fib_for < 2 THEN
        RETURN fib_for;
    END IF;
    RETURN fib_for - 1;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

And...Pass!

Terminal

%

And...Pass!

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql ..
ok 1 - Schema pg_catalog or public or tap can
ok 2 - Function fib(integer) should exist
ok 3 - fib(0) should be 0
ok 4 - fib(1) should be 1
ok 5 - fib(2) should be 1
1..5
ok
All tests successful.
Files=1, Tests=5, 0 secs (0.02 usr + 0.00 sys = 0.02 CPU)
Result: PASS
%
```

Still More Assertions

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
```

--:-- try.sql All (SQL[ansi])

Still More Assertions

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```
SELECT can('{fib}');
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SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
```

--:-- try.sql All (SQL[ansi])

Terminal

```
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sq1 .. 1/?
not ok 8 - fib(5) should be 5
# Failed test 8: "fib(5) should be 5"
#         have: 4
#         want: 5
# Looks like you failed 1 test of 8
test_fib.sql .. Failed 1/8 subtests

Test Summary Report
-------------------
test_fib.sq1 (Wstat: 0 Tests: 8 Failed: 1)
  Failed test:  8
Files=1, Tests=8, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 .. 1/?
not ok 8 - fib(5) should be 5
# Failed test 8: "fib(5) should be 5"
#          have: 4
#          want: 5
# Looks like you failed 1 test of 8
test_fib.sql .. Failed 1/8 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 8 Failed: 1)
  Failed test:  8
Files=1, Tests=8, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 .. 1/?
not ok 8 - fib(5) should be 5
# Failed test 8: "fib(5) should be 5"
#          have: 4
#          want: 5
# Looks like you failed 1 test of 8
test_fib.sql .. Failed 1/8 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 8 Failed: 1)
  Failed test:  8
Files=1, Tests=8, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Fix The Function

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
   IF fib_for < 2 THEN
        RETURN fib_for;
   END IF;
   RETURN fib_for - 1;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

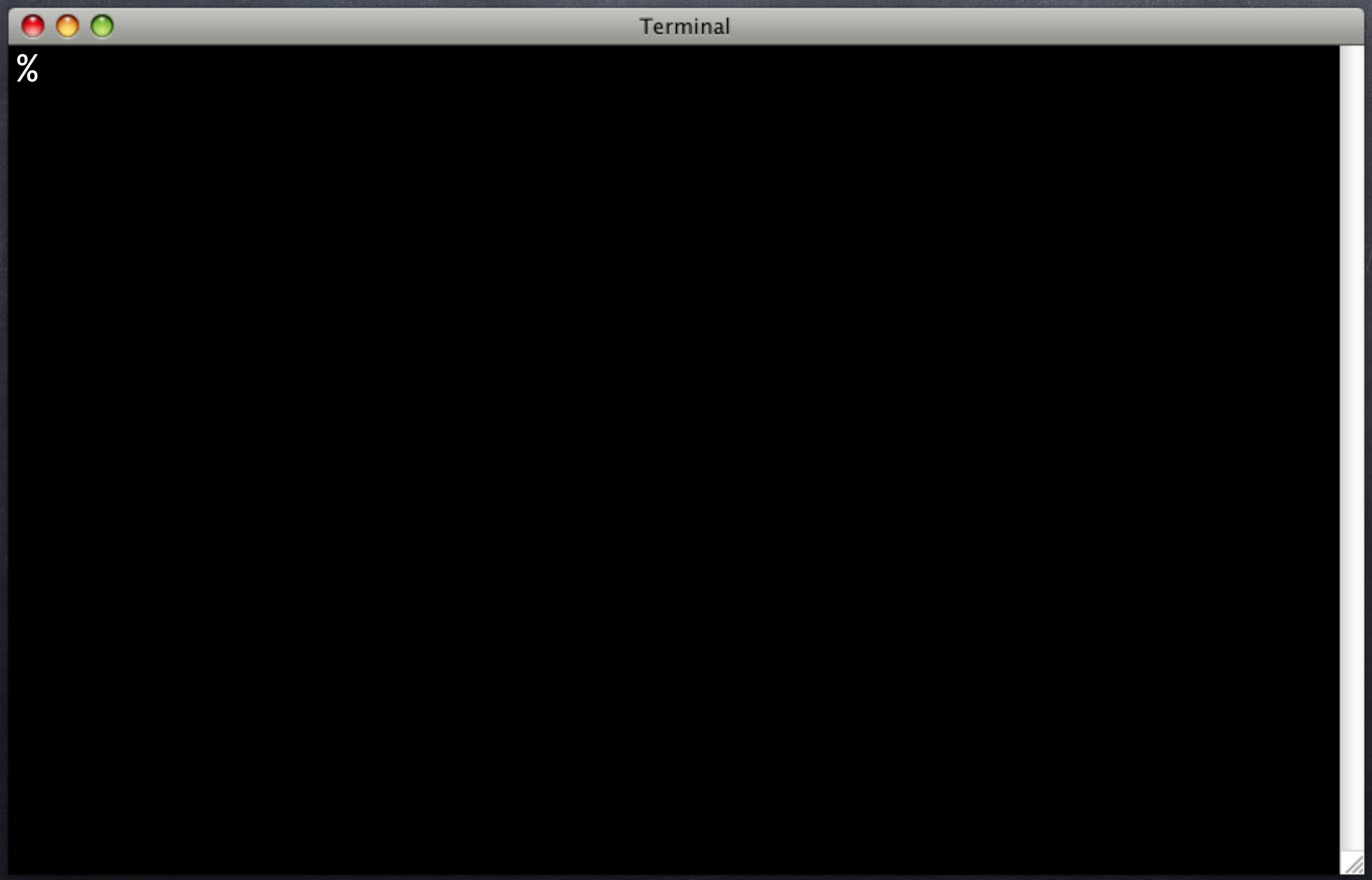
Fix The Function

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
   IF fib_for < 2 THEN
        RETURN fib_for;
   END IF;
   RETURN fib(fib_for - 2)
        + fib(fib_for - 1);
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

WOOT!



WOOT!

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. ok
All tests successful.
Files=1, Tests=8, 0 secs (0.02 usr + 0.00 sys = 0.02 CPU)
Result: PASS
%
```

A Few More Assertions

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
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--:-- try.sql All (SQL[ansi])

A Few More Assertions

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```
SELECT can('{fib}');
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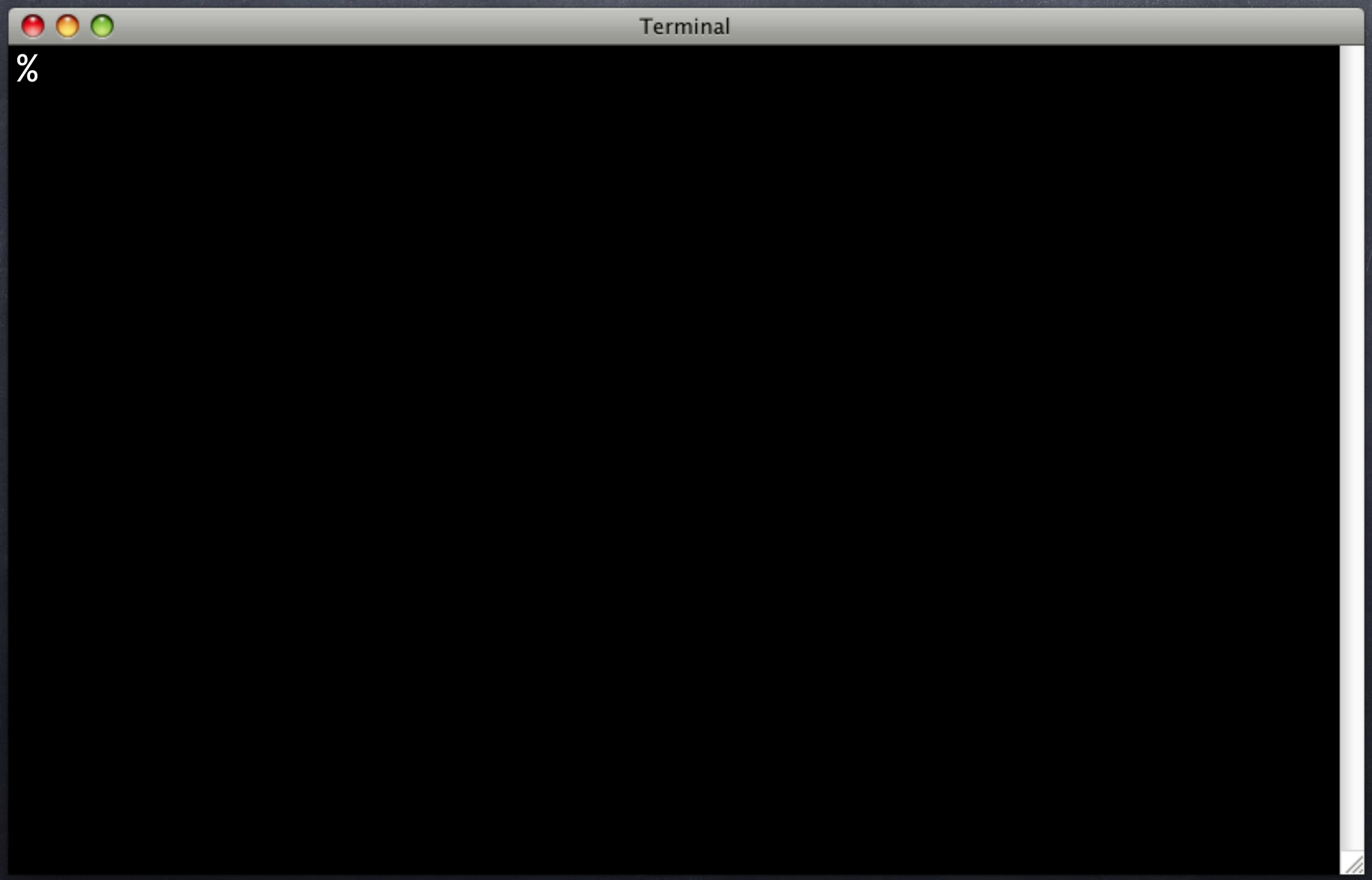
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
```

--:-- try.sql All (SQL[ansi])

We're Golden!



We're Golden!

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. ok
All tests successful.
Files=1, Tests=11, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
%
```

Make it so,
Number One.

OMG

WTF???

The server is hammered!

Debug,
debug,
debug...

Nailed it!

Detroit, we have a problem.

Terminal

```
try=#
```

Detroit, we have a problem.

Terminal

```
try=# \timing
Timing is on.
try=# select fib(30);

  fib
--------
 832040
(1 row)

Time: 6752.112 ms
try=#
```

Detroit, we have a problem.

Terminal

```
try=# \timing
Timing is on.
try=# select fib(30);

  fib
--------
 832040
(1 row)

Time: 6752.112 ms
try=#
```

Regression

Add a Regression Test

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
```

--:-- try.sql All (SQL[ansi])

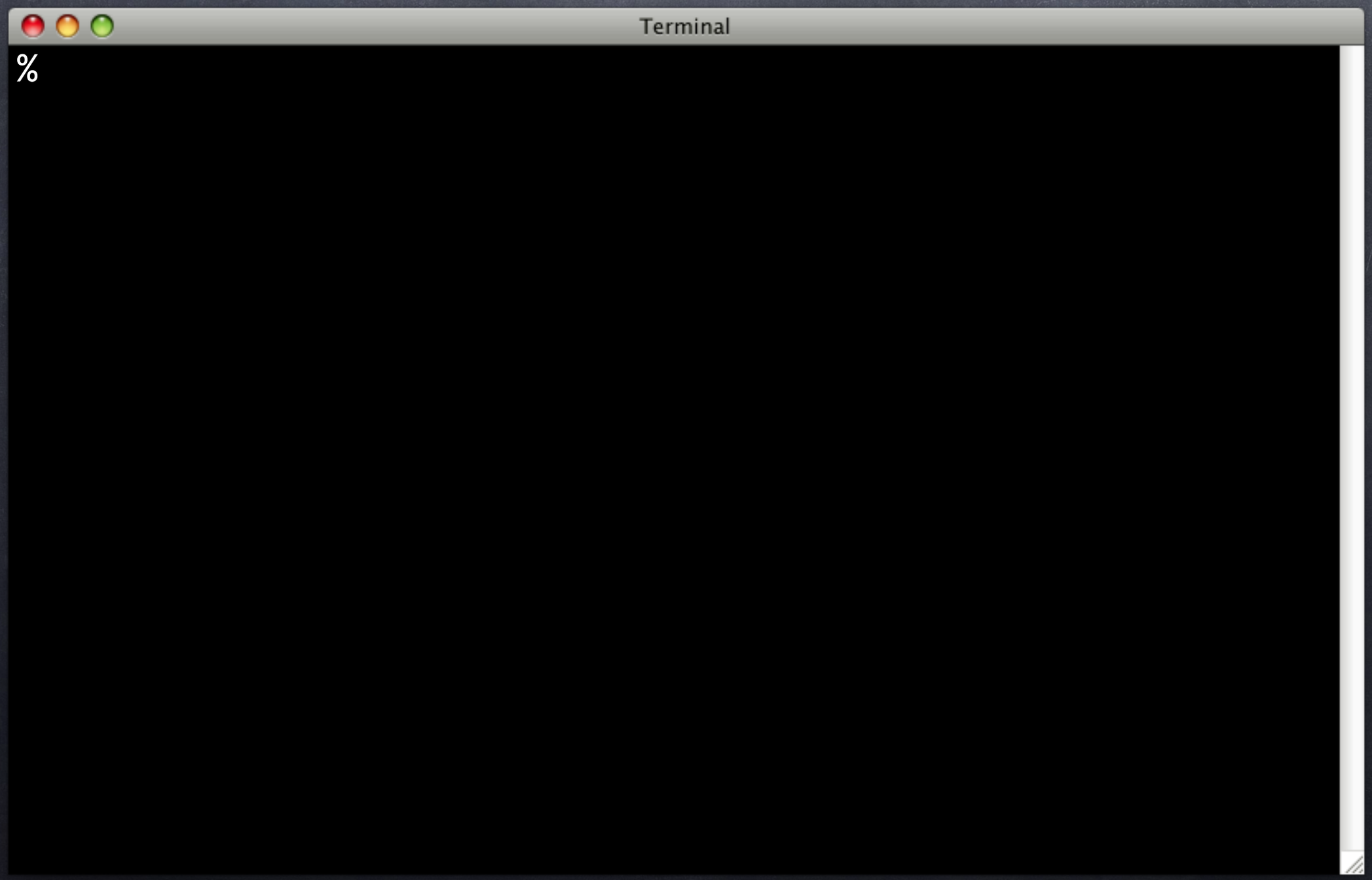
Add a Regression Test

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
SELECT performs_ok( 'SELECT fib(30)', 500 );
```

--:-- try.sql All (SQL[ansi])

What've We Got?



What've We Got?

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. 12/?
not ok 12 - Should run in less than 500 ms
# Failed test 12: "Should run in less than 500 ms"
#       runtime: 8418.816 ms
#       exceeds: 500 ms
# Looks like you failed 1 test of 12
test_fib.sql .. Failed 1/12 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 12 Failed: 1)
  Failed test:  12
Files=1, Tests=12, 8 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

What've We Got?

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. 12/?
not ok 12 - Should run in less than 500 ms
# Failed test 12: "Should run in less than 500 ms"
#       runtime: 8418.816 ms
#       exceeds: 500 ms
# Looks like you failed 1 test of 12
test_fib.sql .. Failed 1/12 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 12 Failed: 1)
  Failed test:  12
Files=1, Tests=12, 8 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL
%
```

Refactor

Emacs

```
--:--  try.sql        All  (SQL[ansi])----------------------------------------------------------------
```

Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
DECLARE
    ret integer := 0;
    nxt integer := 1;
    tmp integer;
BEGIN
    FOR num IN 0..fib_for LOOP
        tmp := ret;
        ret := nxt;
        nxt := tmp + nxt;
    END LOOP;

    RETURN ret;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Terminal

```
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 .. 1/?
not ok 3 - fib(0) should be 0
# Failed test 3: "fib(0) should be 0"
#         have: 1
#         want: 0
not ok 5 - fib(2) should be 1
# Failed test 5: "fib(2) should be 1"
#         have: 2
#         want: 1
not ok 6 - fib(3) should be 2
# Failed test 6: "fib(3) should be 2"
#         have: 3
#         want: 2
not ok 7 - fib(4) should be 3
# Failed test 7: "fib(4) should be 3"
#         have: 5
#         want: 3
not ok 8 - fib(5) should be 5
# Failed test 8: "fib(5) should be 5"
#         have: 8
#         want: 5
not ok 9 - fib(6) Should be 8
# Failed test 9: "fib(6) Should be 8"
#         have: 13
#         want: 8
not ok 10 - fib(7) Should be 13
# Failed test 10: "fib(7) Should be 13"
#         have: 21
#         want: 13
not ok 11 - fib(8) Should be 21
# Failed test 11: "fib(8) Should be 21"
#         have: 34
#         want: 21
# Looks like you failed 8 tests of 12
test_fib.sql .. Failed 8/12 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 12 Failed: 8)
  Failed tests:  3, 5-11
Files=1, Tests=12,  0 secs (0.03 usr + 0.01 sys = 0.04 CPU)
Result: FAIL
%
```

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql1 .. 1/?
not ok 3 - fib(0) should be 0
# Failed test 3: "fib(0) should be 0"
#         have: 1
#         want: 0
not ok 5 - fib(2) should be 1
# Failed test 5: "fib(2) should be 1"
#         have: 2
#         want: 1
not ok 6 - fib(3) should be 2
# Failed test 6: "fib(3) should be 2"
#         have: 3
#         want: 2
not ok 7 - fib(4) should be 3
# Failed test 7: "fib(4) should be 3"
#         have: 5
#         want: 3
not ok 8 - fib(5) should be 5
# Failed test 8: "fib(5) should be 5"
#         have: 8
#         want: 5
not ok 9 - fib(6) Should be 8
# Failed test 9: "fib(6) Should be 8"
#         have: 13
#         want: 8
not ok 10 - fib(7) Should be 13
# Failed test 10: "fib(7) Should be 13"
#         have: 21
#         want: 13
not ok 11 - fib(8) Should be 21
# Failed test 11: "fib(8) Should be 21"
#         have: 34
#         want: 21
# Looks like you failed 8 tests of 12
test_fib.sql .. Failed 8/12 subtests

Test Summary Report
-------------------
test_fib.sql (Wstat: 0 Tests: 12 Failed: 8)
  Failed tests:  3, 5-11
Files=1, Tests=12,  0 secs (0.03 usr + 0.01 sys = 0.04 CPU)
Result: FAIL
%
```

WTF?

Emacs

```sql
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
DECLARE
    ret integer := 0;
    nxt integer := 1;
    tmp integer;
BEGIN
    FOR num IN 0..fib_for LOOP
        tmp := ret;
        ret := nxt;
        nxt := tmp + nxt;
    END LOOP;

    RETURN ret;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

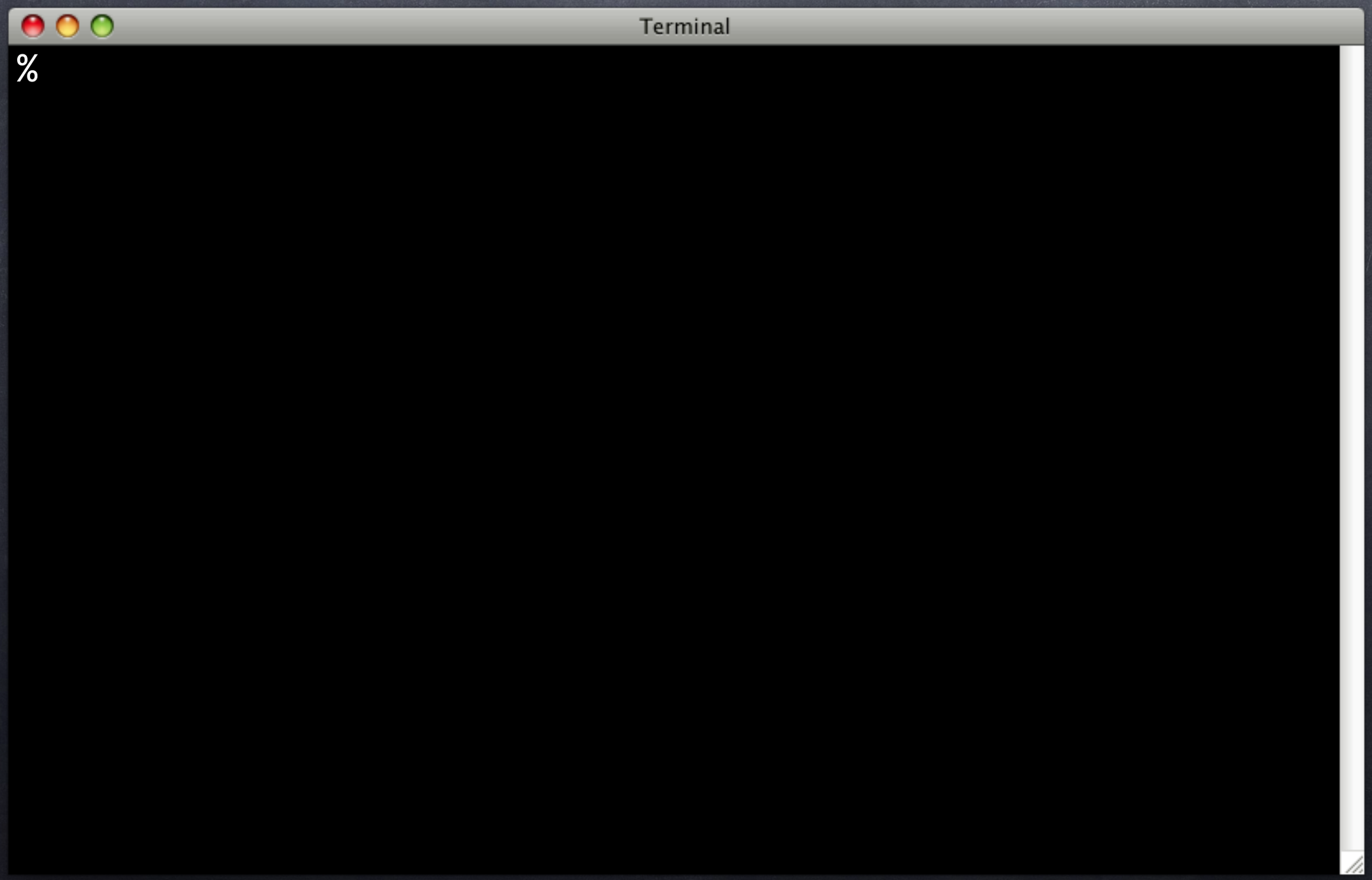
Emacs

```
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
DECLARE
    ret integer := 0;
    nxt integer := 1;
    tmp integer;
BEGIN
    FOR num IN 1..fib_for LOOP
        tmp := ret;
        ret := nxt;
        nxt := tmp + nxt;
    END LOOP;

    RETURN ret;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Back in Business



Back in Business

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. ok
All tests successful.
Files=1, Tests=12, 1 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
%
```

Just for the Hell of it...

Push It!

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
SELECT performs_ok( 'SELECT fib(30)', 500 );
```

--:-- try.sql All (SQL[ansi])

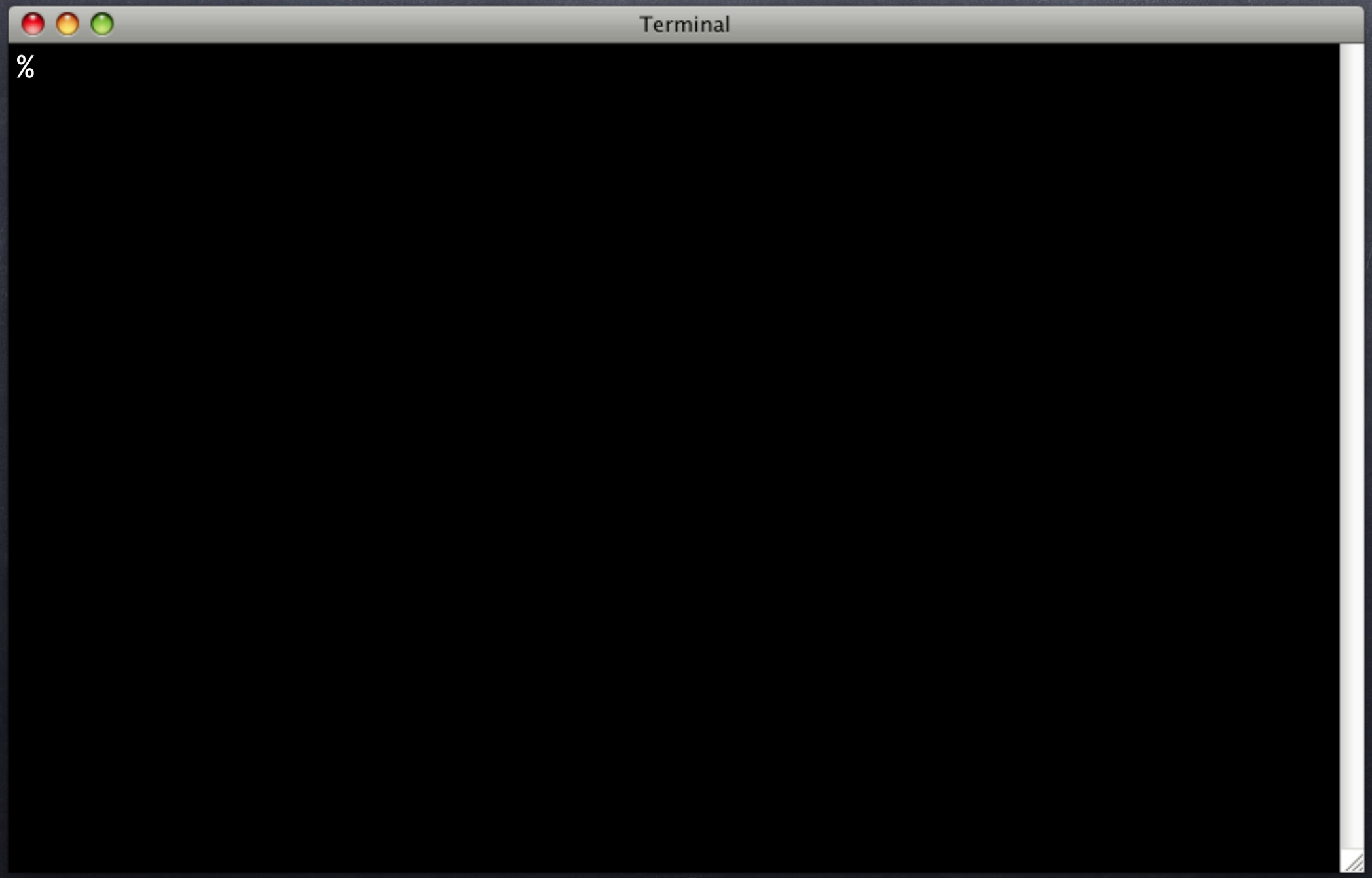
Push It!

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
SELECT performs_ok( 'SELECT fib(30)', 500 );
SELECT is( fib(32), 2178309, 'fib(32) is 2178309');
SELECT is( fib(64), 10610209857723, 'fib(64) is 10610209857723');
```

--:-- try.sql All (SQL[ansi])

No Fibbing.



No Fibbing.

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. 1/? psql:test_fib.sql:18: ERROR:  function is(integer,
bigint, unknown) does not exist
LINE 1: SELECT is( fib(64), 10610209857723, 'fib(64) Should be 10610...
               ^
HINT:  No function matches the given name and argument types. You might
need to add explicit type casts.
test_fib.sql .. Dubious, test returned 3 (wstat 768, 0x300)
All 13 subtests passed

Test Summary Report
-------------------
test_fib.sql (Wstat: 768 Tests: 13 Failed: 0)
  Non-zero exit status: 3
  Parse errors: No plan found in TAP output
Files=1, Tests=13, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL

%
```

No Fibbing.

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. 1/? psql:test_fib.sql:18: ERROR:  function is(integer,
bigint, unknown) does not exist
LINE 1: SELECT is( fib(64), 106102098577 23, 'fib(64) Should be 10610...
               ^
HINT:  No function matches the given name and argument types. You might
need to add explicit type casts.
test_fib.sql .. Dubious, test returned 3 (wstat 768, 0x300)
All 13 subtests passed

Test Summary Report
-------------------
test_fib.sql (Wstat: 768 Tests: 13 Failed: 0)
  Non-zero exit status: 3
  Parse errors: No plan found in TAP output
Files=1, Tests=13, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: FAIL

%
```

Hrm...

Emacs

```sql
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS integer AS $$
BEGIN
DECLARE
    ret integer := 0;
    nxt integer := 1;
    tmp integer;
BEGIN
    FOR num IN 1..fib_for LOOP
        tmp := ret;
        ret := nxt;
        nxt := tmp + nxt;
    END LOOP;

    RETURN ret;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Emacs

```sql
CREATE OR REPLACE FUNCTION fib (
    fib_for integer
) RETURNS bigint  AS $$
BEGIN
DECLARE
    ret bigint  := 0;
    nxt bigint  := 1;
    tmp bigint ;
BEGIN
    FOR num IN 1..fib_for LOOP
        tmp := ret;
        ret := nxt;
        nxt := tmp + nxt;
    END LOOP;

    RETURN ret;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Apples to Apples...

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0, 'fib(0) should be 0');
SELECT is( fib(1), 1, 'fib(1) should be 1');
SELECT is( fib(2), 1, 'fib(2) should be 1');
SELECT is( fib(3), 2, 'fib(3) should be 2');
SELECT is( fib(4), 3, 'fib(4) should be 3');
SELECT is( fib(5), 5, 'fib(5) should be 5');
SELECT is( fib(6), 8, 'fib(6) should be 8');
SELECT is( fib(7), 13, 'fib(7) should be 13');
SELECT is( fib(8), 21, 'fib(8) should be 21');
SELECT performs_ok( 'SELECT fib(30)', 500 );
SELECT is( fib(32), 2178309, 'fib(32) is 2178309');
SELECT is( fib(64), 10610209857723, 'fib(64) is 10610209857723');
```

--:-- try.sql All (SQL[ansi])

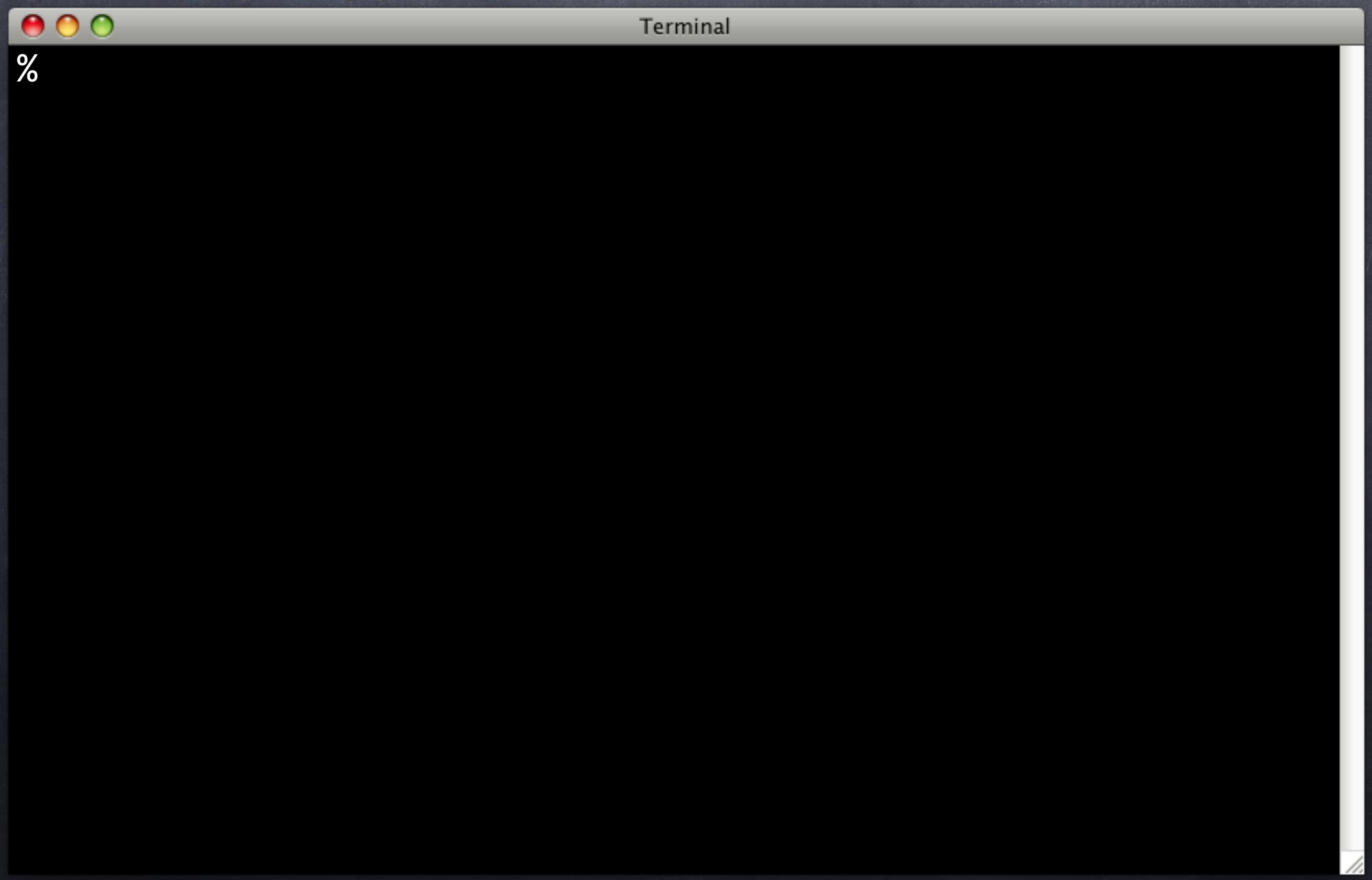
Apples to Apples...

Emacs

```
SELECT can('{fib}');
SELECT can_ok('fib', ARRAY['integer']);
SELECT is( fib(0), 0::int8, 'fib(0) should be 0');
SELECT is( fib(1), 1::int8, 'fib(1) should be 1');
SELECT is( fib(2), 1::int8, 'fib(2) should be 1');
SELECT is( fib(3), 2::int8, 'fib(3) should be 2');
SELECT is( fib(4), 3::int8, 'fib(4) should be 3');
SELECT is( fib(5), 5::int8, 'fib(5) should be 5');
SELECT is( fib(6), 8::int8, 'fib(6) should be 8');
SELECT is( fib(7), 13::int8, 'fib(7) should be 13');
SELECT is( fib(8), 21::int8, 'fib(8) should be 21');
SELECT performs_ok( 'SELECT fib(30)', 500 );
SELECT is( fib(32), 2178309::int8, 'fib(32) is 2178309');
SELECT is( fib(64), 10610209857723::int8, 'fib(64) is 10610209857723');
```

--:-- try.sql All (SQL[ansi])

And Now?



And Now?

Terminal

```
% psql -d try -f fib.sql
CREATE FUNCTION
% pg_prove -vd try test_fib.sql
test_fib.sql .. ok
All tests successful.
Files=1, Tests=14, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
%
```

TDD Means Consistency

What about Maintenance?

Emacs

```
--:--  try.sql        All  (SQL[ansi])----------------------------------------------------------------
```

Emacs

```
CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
RETURNS SETOF integer AS $$
DECLARE
    p_day    ALIAS FOR $1;
    p_mon    ALIAS FOR $2;
    p_offset ALIAS FOR $3;
    p_limit  ALIAS FOR $4;
    p_state  ALIAS FOR $5;
    v_qry    TEXT;
    v_output RECORD;
BEGIN
    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
    v_qry := v_qry || ' AND birth_mon ~ ''^0?' || p_mon::text || '$''';
    v_qry := v_qry || ' AND birth_day = ''' || p_day::text || '''';
    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
    RETURN;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Emacs

```
CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
RETURNS SETOF integer AS $$
DECLARE
    p_day    ALIAS FOR $1;
    p_mon    ALIAS FOR $2;
    p_offset ALIAS FOR $3;
    p_limit  ALIAS FOR $4;
    p_state  ALIAS FOR $5;
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    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
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    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
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END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Emacs

```
CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
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    p_offset ALIAS FOR $3;
    p_limit  ALIAS FOR $4;
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    v_qry    TEXT;
    v_output RECORD;
BEGIN
    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
    v_qry := v_qry || ' AND birth_mon ~ ''^0?' || p_mon::text || '$''';
    v_qry := v_qry || ' AND birth_day = ''' || p_day::text || '''';
    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
    RETURN;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Emacs

```
CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
RETURNS SETOF integer AS $$
DECLARE
    p_day    ALIAS FOR $1;
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    p_offset ALIAS FOR $3;
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    v_qry    TEXT;
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BEGIN
    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
    v_qry := v_qry || ' AND birth_mon ~ ''^0?' || p_mon::text || '$''';
    v_qry := v_qry || ' AND birth_day = ''' || p_day::text || '''';
    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
    RETURN;
END;
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```

--:-- try.sql All (SQL[ansi])

Emacs

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CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
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    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
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    v_qry := v_qry || ' AND birth_day = ''' || p_day::text || '''';
    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
    RETURN;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

Emacs

```
CREATE FUNCTION find_by_birthday(integer, integer, integer, integer, text)
RETURNS SETOF integer AS $$
DECLARE
    p_day    ALIAS FOR $1;
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    p_state  ALIAS FOR $5;
    v_qry    TEXT;
    v_output RECORD;
BEGIN
    v_qry := 'SELECT * FROM users WHERE state = ''' || p_state || '''';
    v_qry := v_qry || ' AND birth_mon ~ ''^0?' || p_mon::text || '$''';
    v_qry := v_qry || ' AND birth_day = ''' || p_day::text || '''';
    v_qry := v_qry || ' ORDER BY user_id';
    IF p_offset IS NOT NULL THEN
        v_qry := v_qry || ' OFFSET ' || p_offset;
    END IF;
    IF p_limit IS NOT NULL THEN
        v_qry := v_qry || ' LIMIT ' || p_limit;
    END IF;
    FOR v_output IN EXECUTE v_qry LOOP
        RETURN NEXT v_output.user_id;
    END LOOP;
    RETURN;
END;
$$ LANGUAGE plpgsql;
```

--:-- try.sql All (SQL[ansi])

What's on the Table?

Terminal

```
try=#
```

What's on the Table?

Terminal

```
try=# \d users
                          Table "public.users"
   Column   |         Type         |         Modifiers
------------+----------------------+----------------------------------------
 user_id    | integer              | not null default nextval(…)
 name       | text                 | not null default ''::text
 birthdate  | date                 |
 birth_mon  | character varying(2) |
 birth_day  | character varying(2) |
 birth_year | character varying(4) |
 state      | text                 | not null default 'active'::text
Indexes:
    "users_pkey" PRIMARY KEY, btree (user_id)
```

What's on the Table?

Terminal

```
try=# \d users
                          Table "public.users"
   Column   |          Type          |          Modifiers
------------+------------------------+-------------------------------------
 user_id    | integer                | not null default nextval(…)
 name       | text                   | not null default ''::text
 birthdate  | date                   |
 birth_mon  | character varying(2)   |
 birth_day  | character varying(2)   |
 birth_year | character varying(4)   |
 state      | text                   | not null default 'active'::text
Indexes:
    "users_pkey" PRIMARY KEY, btree (user_id)
```

What's on the Table?

Terminal

```
try=#
```

What's on the Table?

Terminal

```
try=# select * from users;
 user_id | name  | birthdate  | birth_mon | birth_day | birth_year | state
---------+-------+------------+-----------+-----------+------------+--------
       1 | David | 1968-12-19 | 12        | 19        | 1968       | active
       2 | Josh  | 1970-03-12 | 03        | 12        | 1970       | active
       3 | Dan   | 1972-06-03 | 6         | 3         | 1972       | active
(3 rows)
```

What's on the Table?

Terminal

```
try=# select * from users;
 user_id | name  | birthdate  | birth_mon | birth_day | birth_year | state
---------+-------+------------+-----------+-----------+------------+--------
       1 | David | 1968-12-19 | 12        | 19        | 1968       | active
       2 | Josh  | 1970-03-12 | 03        | 12        | 1970       | active
       3 | Dan   | 1972-06-03 | 6         | 3         | 1972       | active
(3 rows)
```

Must...
restrain...
fist...
of death...

The Situation

The Situation

- This is production code

The Situation

- This is production code
- Cannot afford downtime

The Situation

- This is production code
- Cannot afford downtime
- No room for mistakes

The Situation

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- Cannot afford downtime
- No room for mistakes
- Bugs must remain consistent

The Situation

- This is production code
- Cannot afford downtime
- No room for mistakes
- Bugs must remain consistent
- But...

Dear GOD it needs rewriting.

But first...

Test the existing implementation.

Emacs

```
--:--  try.sql        All  (SQL[ansi])----------------------------------------------------------------
```

Emacs

```sql
BEGIN;
SET search_path TO public, tap;
SELECT plan(13);

SELECT has_table( 'users' );
SELECT has_pk(    'users' );

SELECT has_column(   'users', 'user_id' );
SELECT col_type_is(  'users', 'user_id', 'integer' );
SELECT col_is_pk(    'users', 'user_id' );
SELECT col_not_null( 'users', 'user_id' );

SELECT has_column(   'users', 'birthdate' );
SELECT col_type_is(  'users', 'birthdate', 'date' );
SELECT col_is_null(  'users', 'birthdate' );

SELECT has_column(     'users', 'state' );
SELECT col_type_is(    'users', 'state', 'text' );
SELECT col_not_null(   'users', 'state' );
SELECT col_default_is( 'users', 'state', 'active' );

SELECT * FROM finish();
ROLLBACK;
```

--:-- try.sql All (SQL[ansi])

Emacs

```sql
BEGIN;
SET search_path TO public, tap;
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SELECT has_table( 'users' );
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SELECT col_is_pk(    'users', 'user_id' );
SELECT col_not_null( 'users', 'user_id' );

SELECT has_column(   'users', 'birthdate' );
SELECT col_type_is(  'users', 'birthdate', 'date' );
SELECT col_is_null(  'users', 'birthdate' );

SELECT has_column(     'users', 'state' );
SELECT col_type_is(    'users', 'state', 'text' );
SELECT col_not_null(   'users', 'state' );
SELECT col_default_is( 'users', 'state', 'active' );

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--:-- try.sql All (SQL[ansi])

Emacs

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SELECT col_not_null( 'users', 'user_id' );

SELECT has_column(   'users', 'birthdate' );
SELECT col_type_is(  'users', 'birthdate', 'date' );
SELECT col_is_null(  'users', 'birthdate' );

SELECT has_column(     'users', 'state' );
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```

--:-- try.sql All (SQL[ansi])

Emacs

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SELECT has_table( 'users' );
SELECT has_pk(    'users' );

SELECT has_column(   'users', 'user_id' );
SELECT col_type_is(  'users', 'user_id', 'integer' );
SELECT col_is_pk(    'users', 'user_id' );
SELECT col_not_null( 'users', 'user_id' );

SELECT has_column(   'users', 'birthdate' );
SELECT col_type_is(  'users', 'birthdate', 'date' );
SELECT col_is_null(  'users', 'birthdate' );

SELECT has_column(     'users', 'state' );
SELECT col_type_is(    'users', 'state', 'text' );
SELECT col_not_null(   'users', 'state' );
SELECT col_default_is( 'users', 'state', 'active' );

SELECT * FROM finish();
ROLLBACK;
```

--:-- try.sql All (SQL[ansi])

Emacs

```sql
BEGIN;
SET search_path TO public, tap;
SELECT plan(13);

SELECT has_table( 'users' );
SELECT has_pk(    'users' );

SELECT has_column(   'users', 'user_id' );
SELECT col_type_is(  'users', 'user_id', 'integer' );
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SELECT has_column(   'users', 'birthdate' );
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Schema Sanity

Terminal

%

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Terminal

```
% pg_prove -d try test_schema.sql
test_schema.sql .. ok
All tests successful.
Files=1, Tests=13,  0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
%
```

Emacs

```
--:--  try.sql        All  (SQL[ansi])----------------------------------------------------------------
```

Emacs

```sql
BEGIN;
SET search_path TO public, tap;
--SELECT plan(15);
SELECT * FROM no_plan();

SELECT can('{find_by_birthday}');
SELECT can_ok(
    'find_by_birthday',
    ARRAY['integer', 'integer', 'integer', 'integer', 'text']
);

-- Set up fixtures.
ALTER SEQUENCE users_user_id_seq RESTART 1;
INSERT INTO users (name, birthdate, birth_mon, birth_day, birth_year)
VALUES ('David', '1968-12-19', '12', '19', '1968'),
       ('Josh',  '1970-03-12', '03', '12', '1970'),
       ('Dan',   '1972-06-03', '6',  '3',  '1972'),
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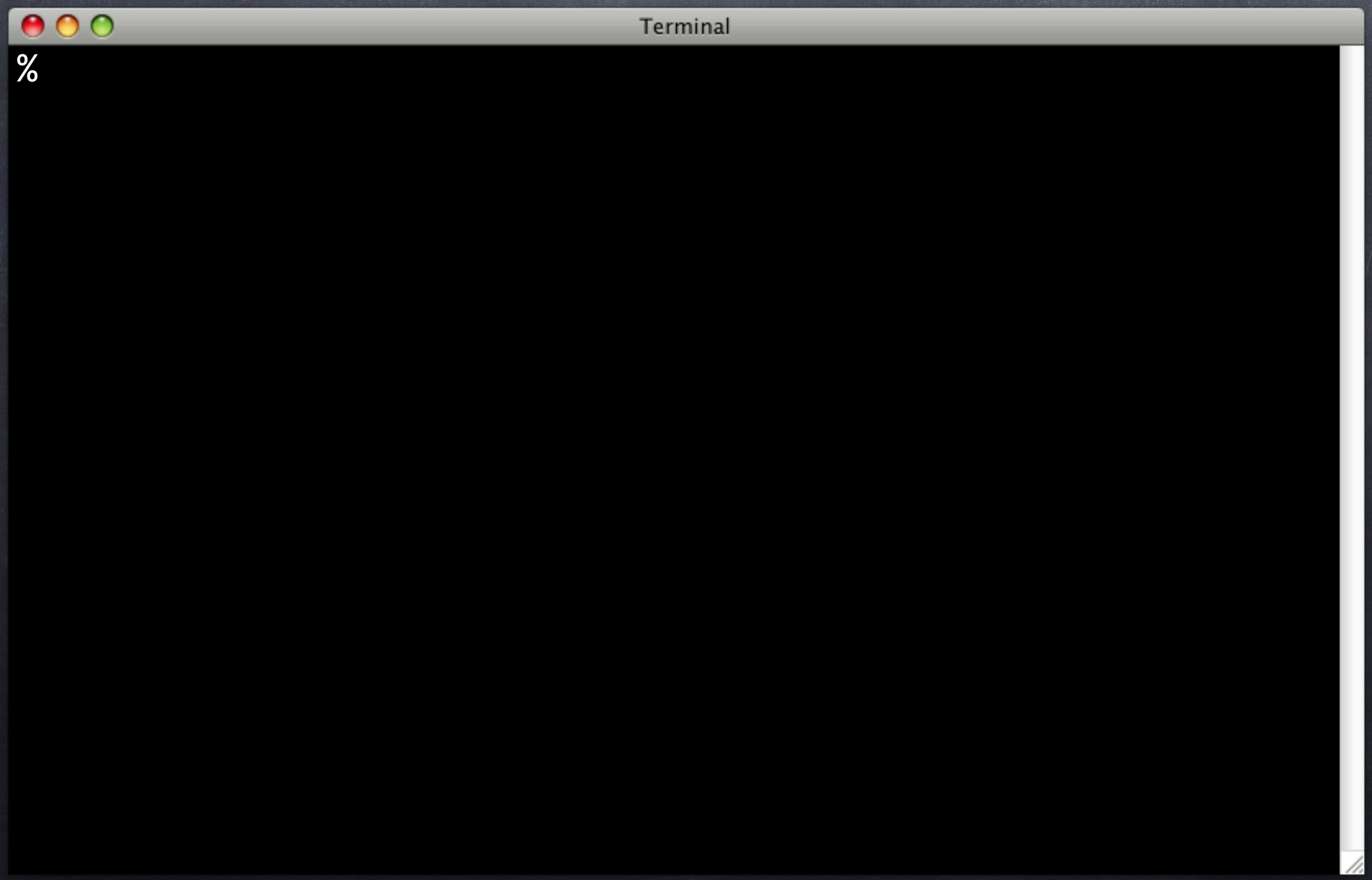
How We Doin'?



How We Doin'?

Terminal

```
% pg_prove -d try test_schema.sql
test_find_by_bday.sql .. ok
All tests successful.
Files=1, Tests=3, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
Result: PASS
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Emacs

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Emacs

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    ARRAY( SELECT * FROM find_by_birthday( 3, 6, NULL, 1, 'active' ) ),
    ARRAY[3],
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);
UPDATE users SET state = 'inactive' WHERE user_id = 3;
SELECT is(
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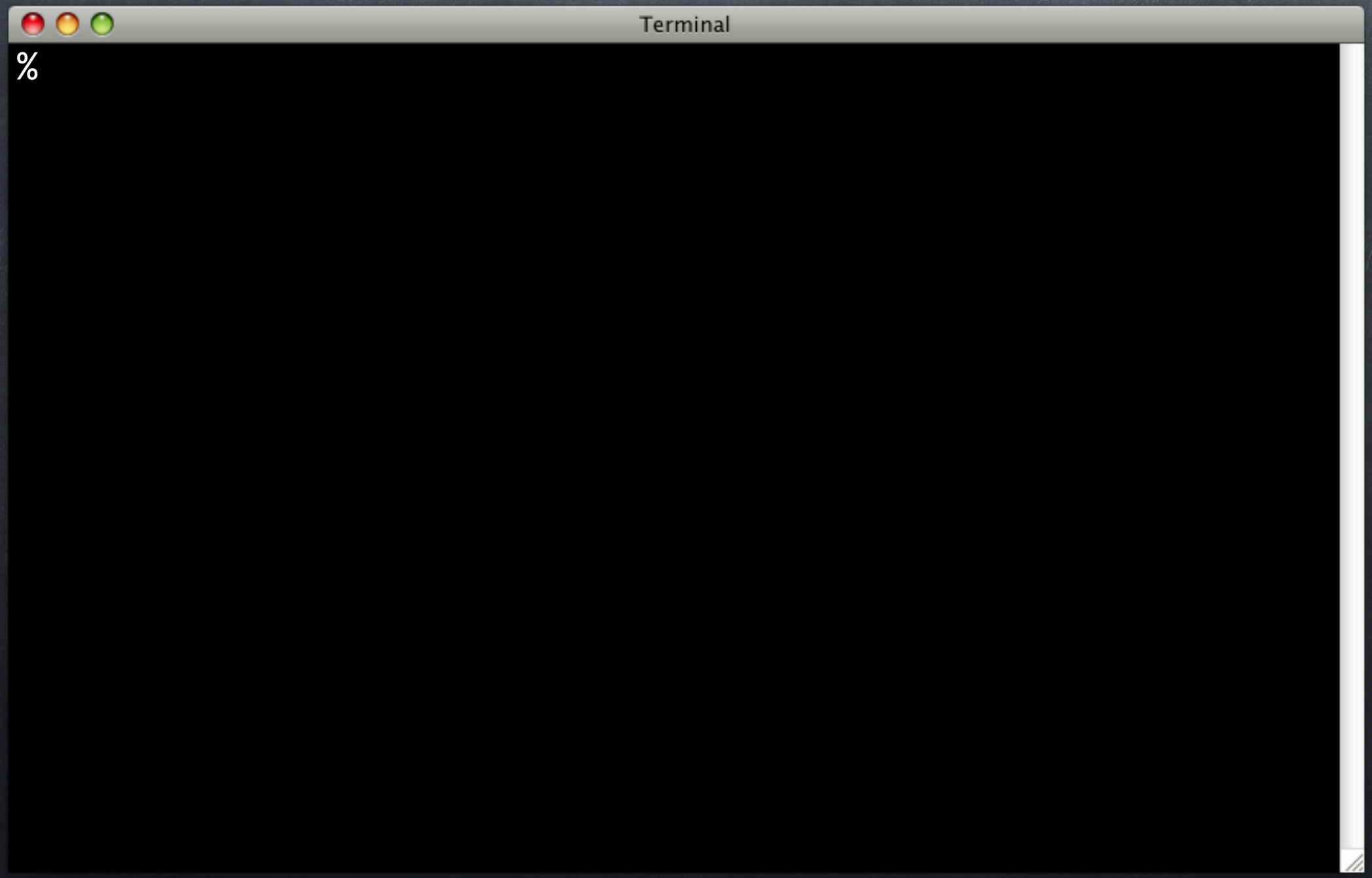
Still Good...



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test_find_by_bday.sql .. ok
All tests successful.
Files=1, Tests=8, 0 secs (0.02 usr + 0.01 sys = 0.03 CPU)
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NOW We Can Refactor

Let's Go with SQL

Let's Go with SQL

Emacs

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CREATE OR REPLACE FUNCTION find_by_birthday(
    p_day    integer,
    p_mon    integer,
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       AND EXTRACT(day   FROM birthdate) = $1
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$$ LANGUAGE sql;
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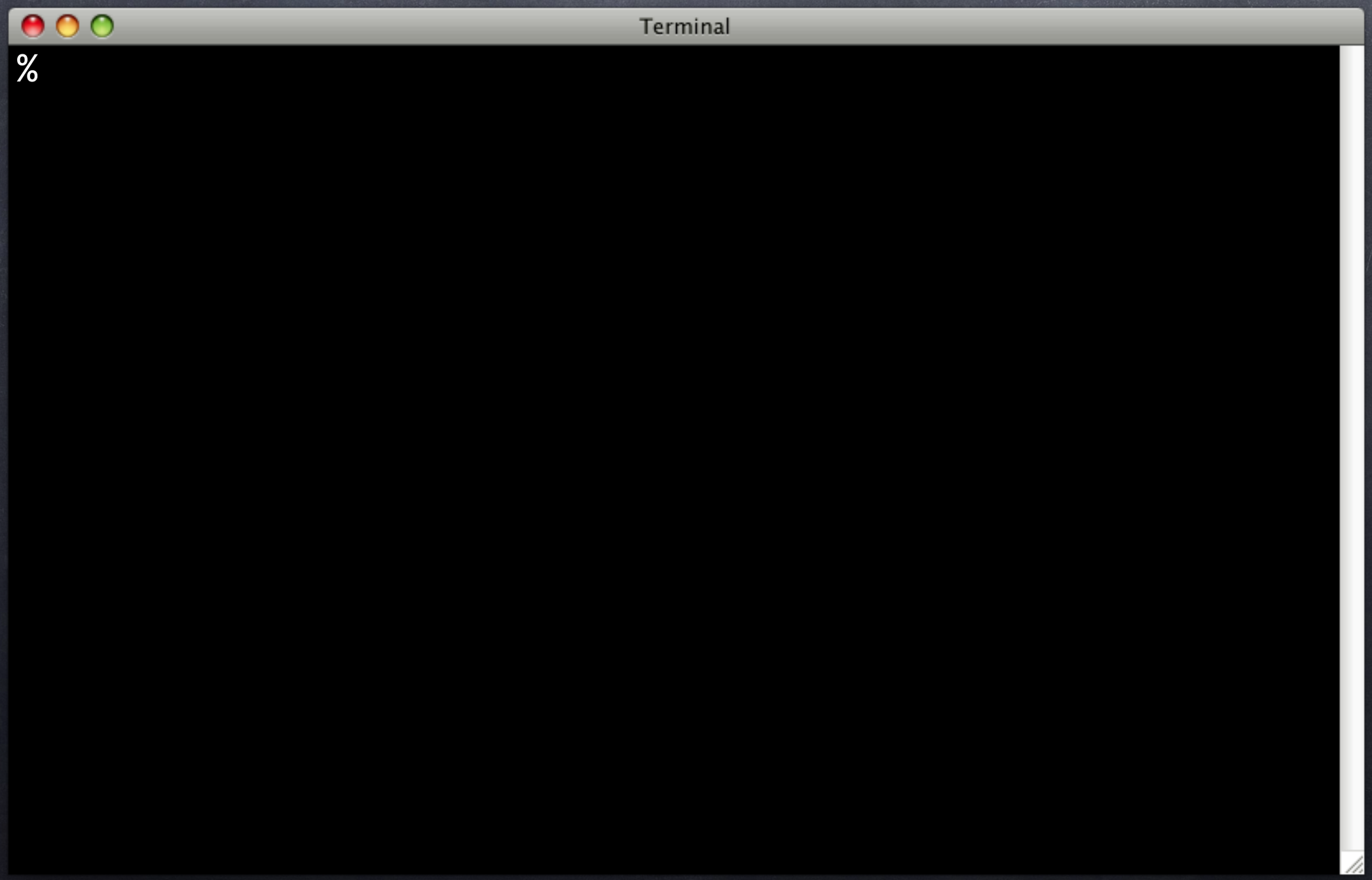
And That's That



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```

Hell Yes!

Let's Review

Tests are for Finding Bugs

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- TDD not for finding bugs

Tests are for Finding Bugs

- TDD not for finding bugs
- TDD for sanity and consistency

Tests are for Finding Bugs

- TDD not for finding bugs
- TDD for sanity and consistency
- Tests prevent future bugs

Tests are Hard

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- Good frameworks easy

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Tests are Hard

- Good frameworks easy
- pgTAP provides lots of assertions
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  - If it's hard to test...
  - It's hard to use

Never Find Relevant Bugs

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- Tests don't find bugs

Never Find Relevant Bugs

- Tests don't find bugs
- Test **PREVENT** bugs

Never Find Relevant Bugs

- Tests don't find bugs
- Test **PREVENT** bugs
- If your code doesn't work...

Never Find Relevant Bugs

- Tests don't find bugs
- Test **PREVENT** bugs
- If your code doesn't work...
- That failure is **RELEVANT**, no?

Time-Consuming

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Time-Consuming

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- Iterating between tests and code is natural
- Tests are as fast as your code
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- When no tests, bugs repeat themselves

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- Good frameworks easy to use
- Iterating between tests and code is natural
- Tests are as fast as your code
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- Talk about a time sink!

Running Tests is Slow

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Running Tests is Slow

- Test what you're working on
- Set up automated testing for everything else
- Pay attention to automated test failures

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- Tests represent **FREEDOM** from the tyranny of fragility and inconsistency

Unnecessary for Simple Code

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- And it was still wrong
- Tests keep even the simplest code working

Best for Fragile Code

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  - Your users

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- QA departments are disappearing
- Users don't want to see bugs
- Find ways to test your code
- Users avoid fragile applications

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- It still needs to always work

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- It still needs to always work
- Don't reject glass box testing
- Make sure that ALL interfaces work

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- TDD help with working through issues
- TDD helps thinking through interfaces
- Tests encourage experimentation

I Really Like Detroit

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- I can't help you

What're You Waiting For?

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- pg_regress

Start writing tests

Increase consistency

Improve stability

Save time

Free yourself

and...

Kick ass.

Thank You

Unit Test Your Database!

David E. Wheeler
PostgreSQL Experts, Inc.

PGCon, May 21, 2009

PGX
POSTGRESQL
EXPERTS, INC.