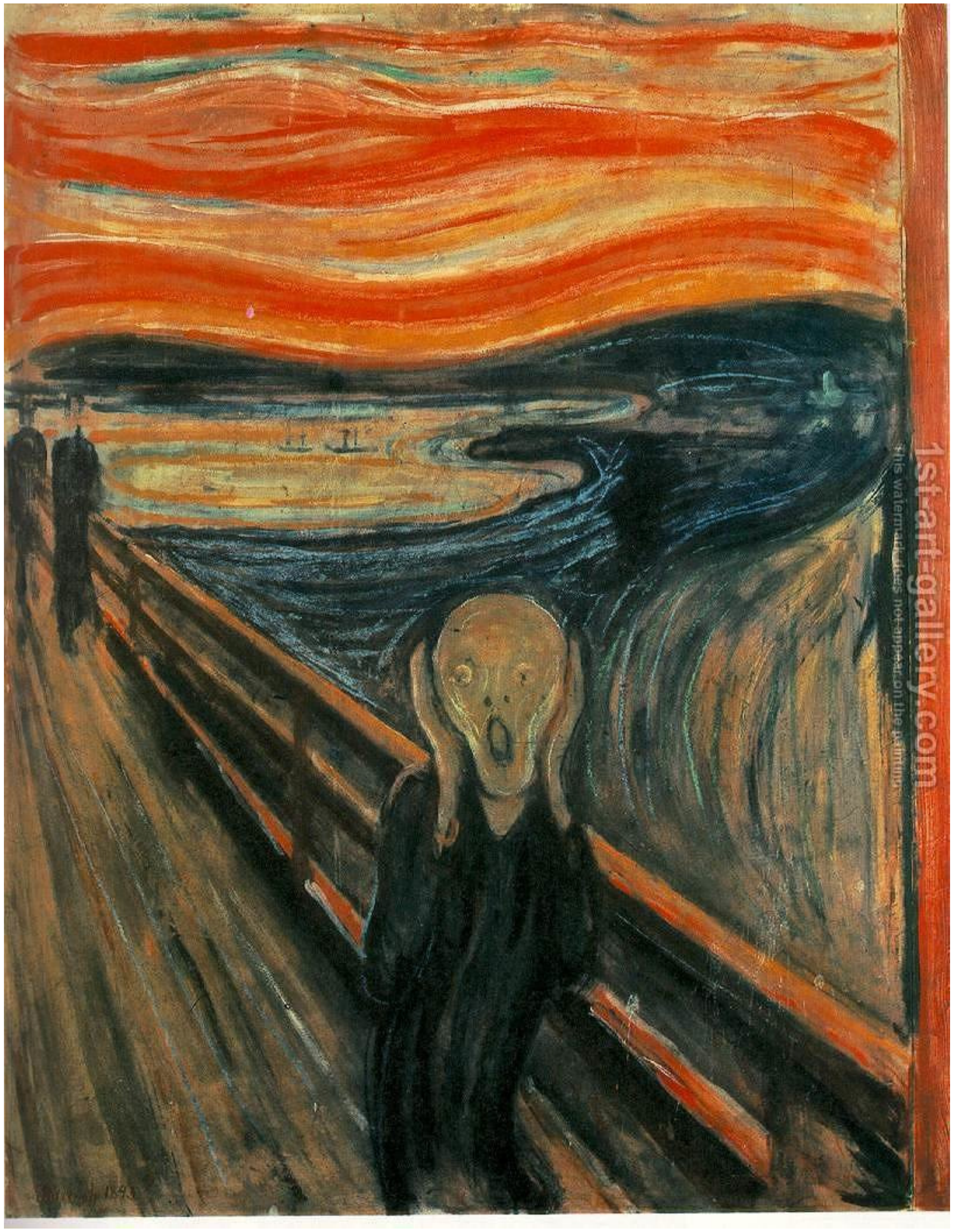
How to Test Terraform Code

DevOps World is Full of Fear



The Plan

- Manual tests
  - Manual testing basics
  - Cleaning up after tests
- Automated tests
  - Unit tests
  - Integration tests
  - End-to-end tests
  - Other testing approaches

Manual Tests

- What does manual testing mean in Terraform?
  - How much is it like manual testing in a programming language?
- With terraform, there is no quick and dirty test environment like *localhost* for web apps
  - True of most IaC tools
  - Deployment needs to be a real environment
  - Testing should *never* be done in a production environment
- It is essential to have examples which can be manually tested in a real AWS environment

Test Frameworks

- A test harness or drive automates the running of the tests
  - Involves some appropriate client to validate the result of the test
- For web apps, 'curl' or some other tool can be used to check the output at a specific address or URL
- If possible, the checking of the results should be automated and not require manual inspections
- Best practice is to set up a test sandbox
  - There will be a lot a building and tearing down of code
  - Each developer should have their own sandbox
  - The Gold standard would be separate AWS accounts

Cleaning Up After Testing

- Regularly clean up the testing sandbox environments
  - Running deployments cost money
  - It's easy to overlook infrastructure so that it sort of just hangs around
- At a minimum, use *terraform destroy* after completing the testing
  - Also consider a regular "scrubbing" of the workspace using a cron job
- Some useful tools to do an account resource "purge"
  - **cloud-nuke** : An open source tool that can delete all the resources in your cloud environment
  - **Janitor Monkey** : An open source tool that cleans up AWS resources on a configurable schedule
  - **aws-nuke** : An open source tool dedicated to deleting everything in an AWS account

Automated Testing

- There are three kinds of automated tests:
- Unit tests
  - Unit tests verify the functionality of a single, small unit of code
  - External dependencies are replaced with test mocks, also called "stubs"
- Integration tests
  - Integration tests verify that multiple units work together correctly
  - Other parts of the system not being tested are mocked out
- End to end testing
  - End-to-end tests involve exercising the entire architecture from the end-user’s perspective
  - E2E testing runs with no mocks in an architecture that mirrors production

Unit Testing

- The first step is to identify what a terraform “unit” is
  - A unit would be a single generic module like those developed in a previous module
  - The idea of unit testing traditionally assumes a procedural programming language
  - The idea of unit testing has to be tweaked to work with declarative languages
- The unit under test is being deployed into a real AWS environment
  - Unit tests in terraform have to involve some integration with AWS resources
  - Carefully controlling the AWS environment set up can the thought of as a way to *mock*

Unit Testing Strategy

- A basic strategy for writing unit tests for Terraform is:
  - Create a generic, standalone module
  - Create an easy-to-deploy example for that module
  - Run *terraform apply* to deploy the example into a real environment
  - Validate that what you just deployed works as expected
  - Run *terraform destroy* at the end of the test to clean up.
- For automated testing, first write the manual test, then automate
  - Remember to try the automated tests on code that has no errors to ensure the tests are being automated correctly

Rethinking Unit Testing in Terraform

- Unit testing has traditionally been functional testing
  - The correctness of the code is inferred from:
    - Specifying expected outputs for each test case
    - Running the unit under test with the test case inputs
    - Recording the actual outputs
    - Comparing actual outputs against expected outputs
- Exactly the same approach can be used in terraform
- Given a terraform module, a description of what is expected can be written
- Using *outputs* , the actual result can be documented
- The difference between the actual and expected can be computed
- For terraform, unit tests should verify:
  - Was the right resource created?
  - Does it have the correct expected attributes?
  - Are the right associations in place

Automated Testing Pointers

- Manual testing should be done in a sandbox account
  - For automated testing, this is even more important
  - A totally separate account is recommended.
- As an automated test suite grows, hundreds or thousands of resources may be created in every test suite, so keeping them isolated from everything else is essential
  - Teams should consider a completely separate environment just for automated testing
  - This is separate even from the sandbox environments you use for manual testing.

Testing Accuracy

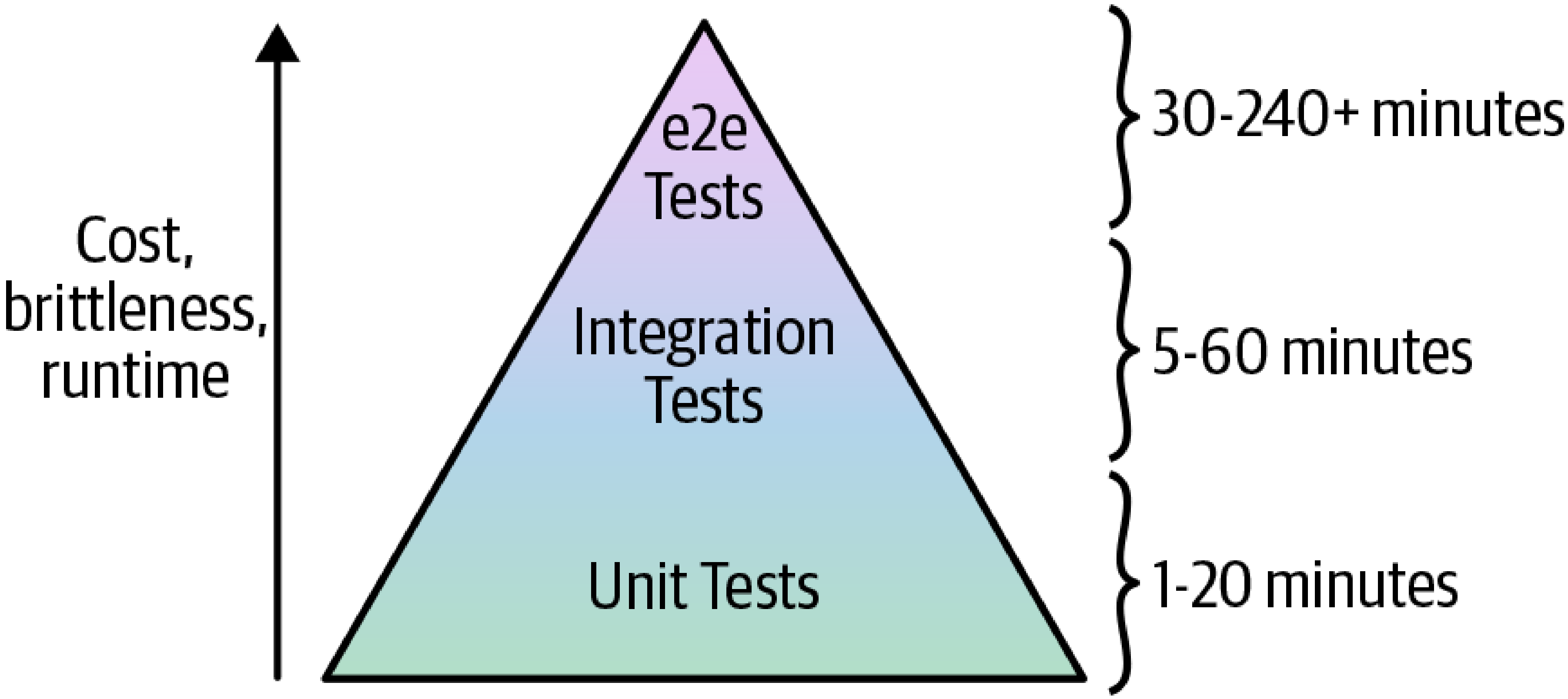
- When testing, two types of testing errors can occur *False Positives* : The test fails but it should have passed because there is no underlying fault *False Negatives* : The test passes but it should have failed because if didn't detech an underlying fault
- When automatic tests, errors can occur in the code being tested or the test automation code
- Before running any automated tests
  - Have a terraform benchmark configuration with no errors
  - Have a set of error-benchmark modules with deliberate errors, if possible
  - Run any test automation scripts against the benchmark to identify possible false positives
  - Run the scripts against specific error modules to identify possible false negative

High Quality Testing

- Testing should never be ad hoc
- A third source of testing errors are poor-quality tests
- Test need to satisfy certain criteria:
  - *Validity* : The tests actual test what we *think* they test
  - *Accuracty* : Discussed on the previous slide
  - *Reliability* : Results of the tests are not affected by extraneous factor, like the AWS account the tests are being run in
  - *Comprehensive* : Nothing can "fall through the cracks" during testing
  - *Economical* : The set of tests is minimal without compromising any of the above
- A software tester or QA team member should be part of any testing effort

End to End Tests

- As our tests include more and more code, they become longer to execute and more costly to set up and run
- We should plan for a large number of unit tests, smaller number of integration tests and and even smaller number of end-to-end tests



End to End Setup

- With larger and more complicated infrastructure, setting up a stable infrastructure (test environments, namespaces et) becomes increasingly difficult
  - Do as much of your testing as low in the pyramid as possible
  - The bottom of the pyramid offers the fastest, most reliable feedback loop
- Deploying a complicated architecture from scratch is untenable for several reasons
- Too slow:
  - The more complex the infrastructure, longer it takes to set up
  - Limits the amount of testing that can be done which means slow feedback
- Too brittle:
  - Constantly redeploying a complex setup increases the likelihood of transient errors
  - This means constant retries which inhibit the whole testing effort

End to End Strategy

- A common end-to-end strategy is:
  - A persistent, production-like environment called “test” is deployed which is left running
  - Every time a change is made to the infrastructure, the end-to-end test does the following:
  - Applies the infrastructure change to the test environment
  - Runs validations against the test environment (e.g., use Selenium to test your code from the end-user’s perspective) to make sure everything is working
- More closely mimics how changes will be deployed in production
  - Also confirms the deployment process also works - for example, the change can be made with zero downtime

End to End Testing

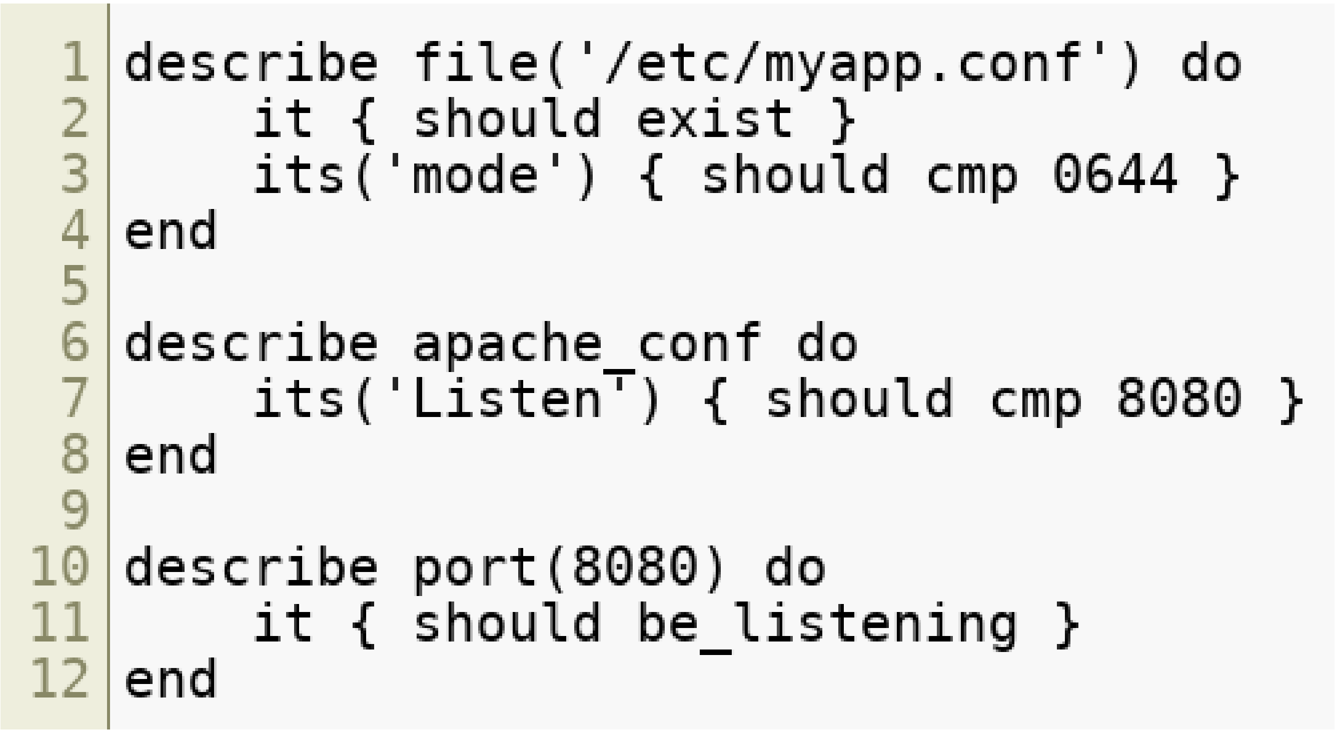
- E2E testing treats the AWS environment as a black box
- Scenarios are selected and developed that:
  - Represent all the functionality required from the client perspective
  - Are executable through the application interfaces
  - This allows regression testing after changes to the internal structure of the AWS environment
- Testing can be done with standard E2E tools like Functional Tester and Selenium

Static Analysis

- Static analysis involves running tools that examine the structure of the code without executing it
- Common tools are:
  - *terraform validate* : a command built into Terraform that you can use to check your Terraform syntax and types
  - *tflint* : A “lint” tool for Terraform that can scan Terraform code and catch common errors and potential bugs based on a set of built-in rules
  - *HashiCorp Sentinel* : A “policy as code” framework that allows you to enforce rules across various HashiCorp tools

Property Testing

- These are testing tools like `rspec-terraform` that use Domain Specific Languages to confirm that the infrastructure conforms to a specification
- For example:



```
describe file('/etc/myapp.conf') do
    it { should exist }
    its('mode') { should cmp 0644 }
end

describe apache_conf do
    its('Listen') { should cmp 8080 }
end

describe port(8080) do
    it { should be_listening }
end
```

Key Takeaways

- When testing Terraform code, testing is done in a real environment
  - All manual testing is done by deploying real resources into one or more isolated sandbox environments
- Sandbox environments *must* be purged after testing
  - Otherwise, the environments will become unmanageable, and costs will spiral out of control
- Unit testing for terraform involves automatically or manually checking deployed configurations for correctness
  - All automated testing is done by writing code that deploys real resources into one or more isolated sandbox environments
- Smaller modules are easier and faster to test
  - Smaller modules are easier to create, maintain, use, and test.
- End-to-end testing is done using a long-lasting near production environment

Lab

- Please do Lab 7-1