Ansible for SRE Teams

Presented by James Meickle
Velocity New York 2018
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1.1 Introduction & Overview

(5 minute lecture)

- About the instructor
- About the course
- Introduction to Ansible
- Overview of course goals and outline

About the Instructor

- Daily user of Ansible for >2 years
- Site Reliability Engineer at Quantopian
  - Crowd-sourced quant finance
  - Infrastructure and ops work
  - Python, Ansible, Vault, AWS
- Organizer at DevOpsDays Boston
- Formerly:
  - Site Reliability Engineer, Harvard
  - Developer Evangelist, AppNeta
  - Release Engineer, Romney 2012

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About the Course

- Online version: Two three hour sessions on two adjacent days
- Today: **Three hours** (with a half hour of breaks)
- Mixture of lectures, demos, and hands-on exercises in AWS
- **Slides are available online!**
  - **Don't try to read them all now, they're text-heavy and include links so you can come back later.**

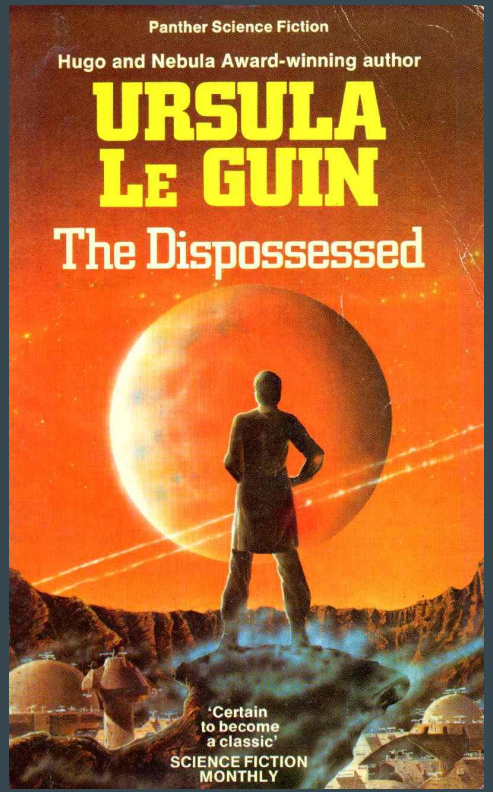
What Is Ansible?

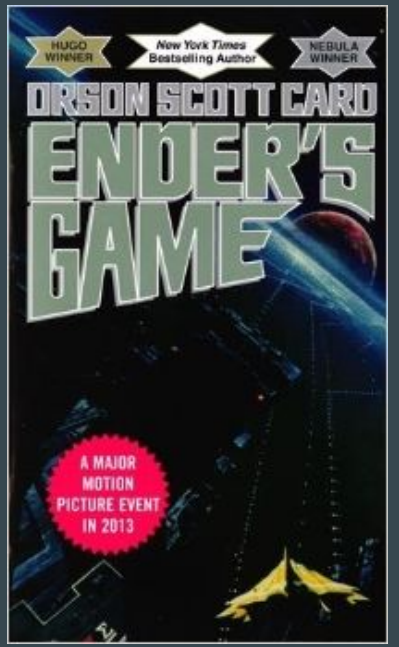
- Software library, tools, and ecosystem for:
  - Automation
  - Configuration management
  - Orchestration
- Open source
- Highly extensible (roles, modules, plugins)

Where Did Ansible Come From?

"It win be a device that will permit communication without any time interval between two points in space. The device will not transmit messages, of course; simultaneity is identity. But to our perceptions, that simultaneity will function as a transmission, a sending. So we will be able to use it to talk between worlds, without the long waiting for the message to go and the reply to return that electromagnetic impulses require. It is really a very simple matter. Like a kind of telephone."

The Dispossessed, Ursula K. Le Guin





Where Did Ansible Come From?

- Created by Michael DeHaan (February 2012)
  - Originally AnsibleWorks; later Ansible, Inc.
- Acquired by Red Hat around v1.9.4 (October 2015)
- Major internal rework in v2.0 (January 2016)
- Recently released 2.6 "Heartbreaker" (July 2018)
- Recent focus on enterprise features:
  - Clouds
  - Windows
  - Network devices
  - Containers
  - Ansible Tower

What Do People Use Ansible For?

Docker, git, S3, Django, Azure, Cisco, Datadog, Homebrew, apt, Pingdom, SELinux, Composer, OpenStack, pip, Pagerduty, yum, Mercurial, CloudFormation, dnf, Vmware, Puppet, DigitalOcean, cron, Windows, New Relic, rabbitMQ, svn, CloudStack, EC2, iptables, Rackspace, npm, Sensu...

What Do I Use Ansible For?

- Ansible Tower for deploys
- Local Ansible runs for Kubernetes node provisioning
- Building AMIs with Packer
- Provisioning Vagrant VMs
- One-off orchestration tasks

- Managing a lot of “pets” (no cattle)
- Additional configuration within someone else’s Puppet environment
- Ansible-based CI system
  - Deployed with Ansible!
- Building and managing legacy web apps
- Building Docker containers without Dockerfiles

Course Goals

During this course, you'll learn...

- Why companies are adopting Ansible over other tools
- Key Ansible concepts: variables, modules, playbooks, roles, and more
- Best practices for writing reusable, maintainable code in Ansible

After the course, you'll be able to...

- Write Ansible roles and playbooks to automate routine operations tasks
- Orchestrate deployments of multi-tier applications
- Manage your infrastructure as code, whether in the cloud or the data center
- Drive adoption of Ansible within your team through incremental adoption

Course Outline

Part One:

- Introduce Ansible and its history
- Connect to training environment
- Cover Ansible concepts:
  - Modules
  - Playbooks
  - Roles
- Practice writing playbooks and roles

Part Two:

- Explore cloud-focused features
- Deploy a multi-tier, multi-instance application in AWS
- Discuss code quality for Ansible
- Try out Ansible Tower
- Learn about the Ansible ecosystem

1.2
Installing Ansible

5 minute lecture
5 minute exercise

- Learn how Ansible is installed, and try to do it locally
- Run your first ad hoc (non-playbook) Ansible command

Installing Ansible locally is not required for this training!

Python

This course uses Ansible v2.4 - remember that there can be breaking changes. Check the matching documentation!

- Ansible is (mostly) written in Python
  - The control machine (your computer) requires Python 2.6+
- Most Ansible functionality is Python code executed remotely
  - The managed node (the server you connect to) requires Python 2.6+
- No unusual dependencies
  - Can be pip installed like other Python packages
- Works out of the box almost anywhere!
  - Except on Windows...

Environment Conflicts

- “Infrastructure as code” implies consistency and reproducibility
- Ansible’s behavior is affected by runtime environment
  - Variables loading differently or failing to load
  - Playbooks suddenly not finding or connecting to hosts
  - Includes or file references no longer found
- Ansible development is “move fast and break things”
  - Occasionally, breaking changes aren't in release notes

Common Sources of Environment Conflicts

Affects the control machine:

- Ansible config file
  - Don't use global Ansible config files
  - Commit a config file per repo
- Ansible version
  - Repo-level: pip requirements.txt
  - Playbook-level: assert on Ansible version

Watch out! Ansible roles allow you to specify a "minimum Ansible version", but it isn't checked at runtime.

Affects both control and managed nodes:

- Python 2 vs. Python 3
- Python minor version
- Python module versions
  - pip freeze > requirements.txt
- OpenSSH version
- SSH configuration options
  - Especially ~/.ssh/config

Maintainable Ansible Installations

Don't try these at home:

- `yum install ansible`
- `apt-get install ansible`
  - `apt-add-repository ppa:ansible/ansible`
- `brew install ansible`
- `sudo pip install ansible`

These commands **will** install Ansible, but at the cost of...

- Less control over version
- Less recent versions
- Version conflicts
- Difficulty reproducing your Ansible installation

Maintainable Ansible code starts with maintainable Ansible installations!

Installing Ansible on Linux

```
# Install pyenv/ pyenv-virtualenv:
https://github.com/pyenv/pyenv-installer

pyenv install 2.7.10
pyenv global 2.7.10
pyenv virtualenv ansible
pyenv activate ansible

# Even better: specify an ansible
# version in a requirements.txt
# file in the repo!
pip install ansible==2.4
ansible --version
```

pyenv installs multiple versions of Python side by side without touching your system Python

virtualenv creates isolated Python package environments with known versions of Python as well as independent, non-root pip installs

pyenv-virtualenv uses pyenv to manage virtualenvs stored in your home directory and loaded by name from anywhere

Installing Ansible on OSX

```
# Install pyenv/pyenv-virtualenv:
https://github.com/pyenv/pyenv#homebrew-on-mac-os-x
https://github.com/pyenv/pyenv-virtualenv#installing-with-homebrew-for-os-x-users

pyenv install 2.7.10
pyenv global 2.7.10
pyenv virtualenv ansible
pyenv activate ansible

pip install ansible==2.4
ansible --version
```

pyenv installs multiple versions of Python side by side without touching your system Python

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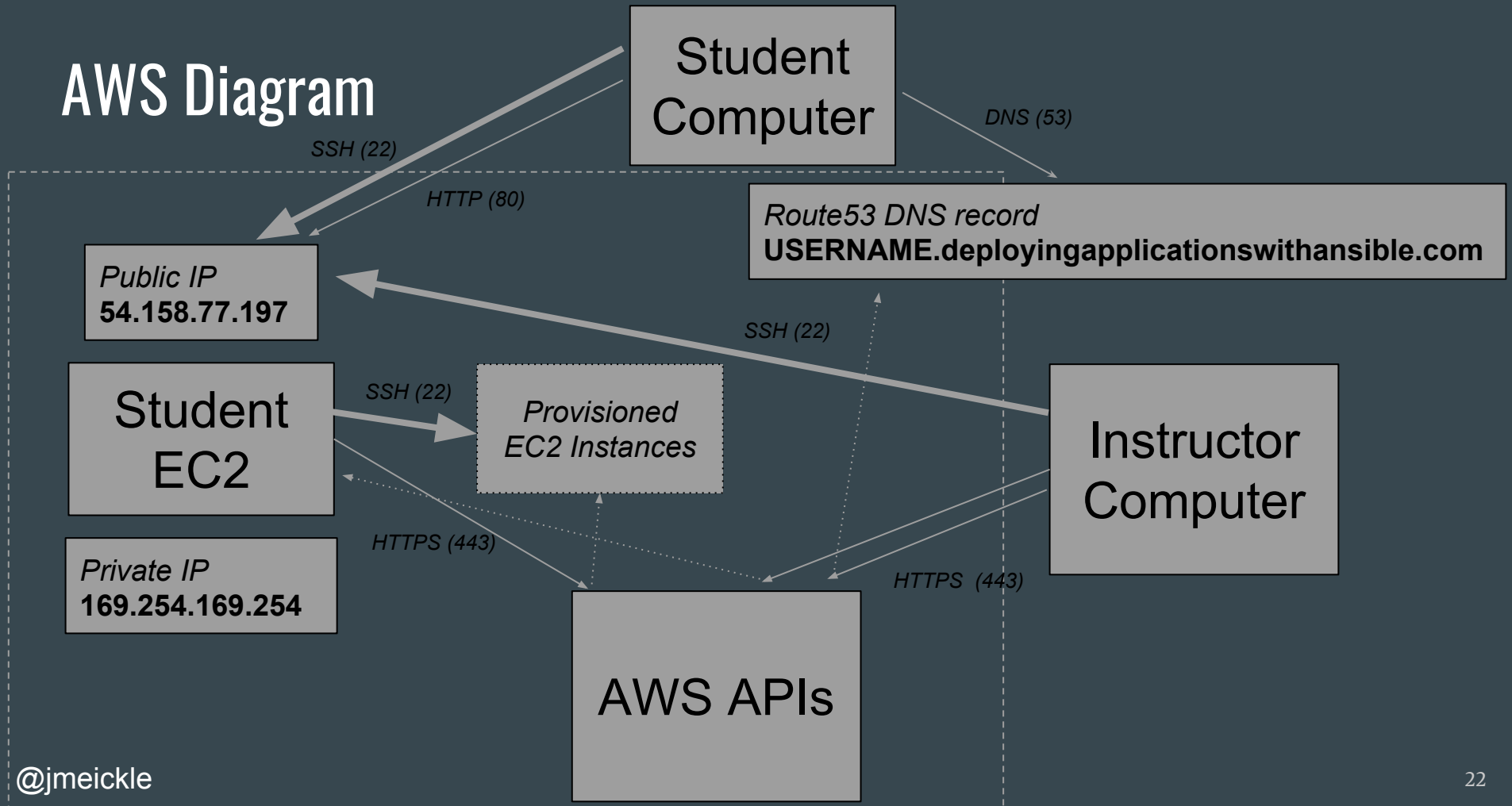
pyenv-virtualenv uses pyenv to manage virtualenvs stored in your home directory and loaded by name from anywhere

Installing Ansible on Windows

- You can use Ansible to manage Windows hosts: http://docs.ansible.com/ansible/list_of_windows_modules.html
  - Shell commands
  - Windows Update
  - IIS
- *Windows is **NOT** fully supported as a control machine.*
  - There is experimental support here: http://docs.ansible.com/ansible/intro_windows.html
- **If you are running Windows, consider installing Ansible on a Linux VM.**

Let's use EC2 instead!

AWS Diagram


Student Computer
SSH (22)
HTTP (80)
DNS (53)
Route53 DNS record
USERNAME.deployingapplicationswithansible.com
Public IP
54.158.77.197
SSH (22)
Student EC2
SSH (22)
Provisioned EC2 Instances
Instructor Computer
HTTPS (443)
Private IP
169.254.169.254
HTTPS (443)
AWS APIs

Exercise:

Retrieve your SSH username and password, and SSH to:

USERNAME@USERNAME.deployingapplicationswithansible.com

Then: cd ~/ansible && pyenv activate ansible

Logged in? 'cd ~/ansible' and check out 'ONELINERS.md'!

1.3
Tasks and Modules

5 minute lecture
5 minute exercise

- Introduce Ansible modules
- Describe how Ansible discovers and connects to servers
- Try running module commands

Modules

- Extend Ansible to perform new tasks
- “Batteries included” - ships with a huge number of common OS tasks, plus many third party modules
- Core Ansible modules written in Python
  - We’ll talk about other languages later
- Modules typically generate a script, push it to the remote node, and execute it

The “-m” in ‘ansible -m ping all’ stands for ‘module’. Any module can be run this way, but it’s only recommended for the simplest modules.

Amazon

- aws_kms - Perform various KMS management tasks.
- cloudformation - Create or delete an AWS CloudFormation stack
- cloudformation_facts - Obtain facts about an AWS CloudFormation stack
- cloudfront_facts - Obtain facts about an AWS CloudFront distribution
- cloudtrail - manage CloudTrail create, delete, update
- cloudwatchevent_rule - Manage CloudWatch Event rules and targets
- dynamodb_table - Create, update or delete AWS Dynamo DB tables.
- ec2 - create, terminate, start or stop an instance in ec2
- ec2_ami - create or destroy an image in ec2
- ec2_ami_copy - copies AMI between AWS regions, return new image id
- ec2_ami_find - Searches for AMIs to obtain the AMI ID and other information
- ec2_ami_search (D) - Retrieve AWS AMI information for a given operating system.
- ec2_asg - Create or delete AWS Autoscaling Groups
- ec2_asg_facts - Gather facts about ec2 Auto Scaling Groups (ASGs) in AWS
- ec2_customer_gateway - Manage an AWS customer gateway
- ec2_eip - manages EC2 elastic IP (EIP) addresses.
- ec2_elb - De-registers or registers instances from EC2 ELBs
- ec2_elb_facts - Gather facts about EC2 Elastic Load Balancers in AWS
- ec2_elb_lb - Creates or destroys Amazon ELB.
- ec2_eni - Create and optionally attach an Elastic Network Interface (ENI) to an instance
- ec2_eni_facts - Gather facts about ec2 ENI interfaces in AWS
- ec2_facts - Gathers facts about remote hosts within ec2 (aws)

ansible

- 'ansible' is the most basic Ansible command
- Runs an Ansible 'module' as an isolated command
  - Restart a service
  - Get current disk use
  - Count active SSH sessions
- Can run in parallel and has structured output, so already mor features than SSH commands

```
(ansible) vagrant@vagrant:~/ansible$ ansible -m ping localhost
localhost | SUCCESS => {
    "changed": false,
    "ping": "pong"
}
(ansible) vagrant@vagrant:~/ansible$ ansible -m setup localhost
localhost | SUCCESS => {
    "ansible_facts": {
        "ansible_all_ipv4_addresses": [
            "10.0.2.15",
            "192.168.33.10"
        ],
        "ansible_all_ipv6_addresses": [
            "fe80::a00:27ff:fee8:89c6",
            "fe80::a00:27ff:fe51:4661"
        ],
        "ansible_apparmor": {
            "status": "enabled"
        },
        "ansible_architecture": "x86_64",
        "ansible_bios_date": "12/01/2006",
        "ansible_bios_version": "VirtualBox",
        "ansible_cmdline": {
            "BOOT_IMAGE": "/vmlinuz-4.4.0-75-generic",
            "quiet": true,
            "ro": true,
            "root": "/dev/mapper/vagrant--vg-root"
        },
        "ansible_date_time": {
            "date": "2017-05-14",
            "day": "14",
            "epoch": "1494781895",
            "hour": "17",
            "iso8601": "2017-05-14T17:11:35Z",
            "iso8601_basic": "20170514T171135756412",
            "iso8601_basic_short": "20170514T171135",
```

SSH

- Ansible's default "transport" is SSH (sftp or scp)
- Uses your user's ~/.ssh/config AND Ansible-specific configuration overrides
  - Pro: Supports any topology (e.g. bastion hosts) the same way you would SSH into them
  - Con: This is a common source of inconsistency between users executing playbooks locally!
- SSH keys are strongly recommended
- OpenSSH is strongly recommended
  - Use a recent OpenSSH!
  - Paramiko (limited-functionality Python SSH client) is available otherwise
- ControlPersist and connection pipelining are strongly recommended
  - ControlPersist is enabled by default, but can catastrophically fail and block plays
  - Pipelining is **disabled** by default

Try it out on your instance!

- ansible -m ping localhost
- ansible -m setup localhost
- ansible -a "df -h" localhost

5 Minute Q&A / Tech Support

1.4
Key Ansible Modules

10 minute lecture

- Cover the modules pointed to with individual documentation readings

- Point out some important quirks/gotchas for these common modules

- Module gotchas in general

file

- Name is misleading:
  - Delete files
  - Create directories or symlinks
  - 'touch' files
  - Change file permissions or owner
- You can 'become' a user and create files as them, or you can 'become' root and pass 'owner:' and 'group:'
  - Pro: Will respect existing permissions, can be run without root
  - Con: Can fail if the user doesn't exist

copy

- Transfers local files to the remote node
  - 'fetch' does the reverse
- For quick tasks, you can set 'content:' and provide a string (or variable) instead
- Look into 'synchronize' (rsync wrapper) if you have more complex needs

template

- Same execution environment as inside of Ansible playbooks (e.g. custom filters)
- But unlike in Ansible playbooks, Jinja macros can be used in template files
- Path will default to looking for templates relative to the current role, or otherwise the current playbook

Package, apt, yum, & pip

- `package` is a general package manager module...
  - But they usually have different package names anyways
  - you may need multiple package manager calls and conditionals

- If you're using pip, make sure to account for virtualenvs
- Package manager modules "flatten" calls to "with_items:" so that they get condensed into a single package manager call

command & shell

- Don't do this if there's a useful module for what you want to do...
- But if there isn't, run an arbitrary command
- 'command:' doesn't provide a shell, so you won't have: pipes, redirects, etc.
  - But in some contexts it can be safer than shell. Know what you're doing!
- 'shell' provides these
  - But it's /bin/sh by default, so e.g. 'source' won't work
  - Won't load a .bashrc even if you set the shell to bash

lineinfile & replace

- Templating is not always desired; sometimes you want to tweak an existing file without replacing it
  - appending to .bashrc
  - modifying a non-Ansible-managed service
- 'replace' is simpler, but more limited
- 'lineinfile' (and 'blockinfile') are incredibly dangerous, but very powerful
  - Think 'chainsaw'

Safe Templating In Ansible

- This is a great way to render your machine broken!
  - c.f. visudo
- 'validate' argument to replace/lineinfile/template module that:
  - Templates the file to a temporary location
  - Runs an arbitrary command to validate it
  - Replaces the existing file if it validates
  - Optionally, backs up the original file
- Consider adding an 'Ansible Managed' header:
  - {{ansible_managed}}

command & shell

- Run arbitrary commands
- Ansible can't tell whether command modules are idempotent, so make sure to include 'changed_when:'
- 'register:' saves the output, which includes the RC. If that isn't enough, you might need: *"changed_when: 'no changes' not in output.stderr"*
  - Remember, *output.stdout* and *output.stderr* are different streams!
- Remember to use nohup if you're launching persistent processes!
  - Or just deploy it as a service or with supervisord...

service & systemd

- Restart, reload, or otherwise manage services
- "service" will work on systemd systems, but it will be missing a few systemd-specific features
- These tasks are commonly used to implement handlers
- Remember that this will typically require 'become' on these tasks!

meta

- Meta modules are a catchall for anything allow you to control the Ansible execution flow
  - - meta: end play
  - - meta: flush handlers
  - - meta: refresh inventory
- **Not recommended, especially not in roles!** They can be very confusing. Use sparingly.

block

- Technically not a module, but can be used in most places you can use a module
- Works like a try/except statement in Python
  - block: Try some tasks
  - rescue: Run some other tasks, only if there is a failure in the above tasks
  - always: Do any cleanup steps regardless of success or failure
- Settings for the block are passed down to the tasks inside the block

http://docs.ansible.com/ansible/latest/playbooks_blocks.html

```
tasks:
  - name: Attempt and gracefull roll back demo
    block:
      - debug: msg='I execute normally'
      - command: /bin/false
      - debug: msg='I never execute, due to the above task failing'
    rescue:
      - debug: msg='I caught an error'
      - command: /bin/false
      - debug: msg='I also never execute :-('
    always:
      - debug: msg="this always executes"
```

Quick break!
Stretch your legs, hydrate!

1.5
Ansible Playbooks: Concepts

10 minute lecture
5 minute demo

- Cover YAML and Jinja syntax
- Introduce tasks, plays, and playbooks
- Demonstrate higher complexity modules

YAML

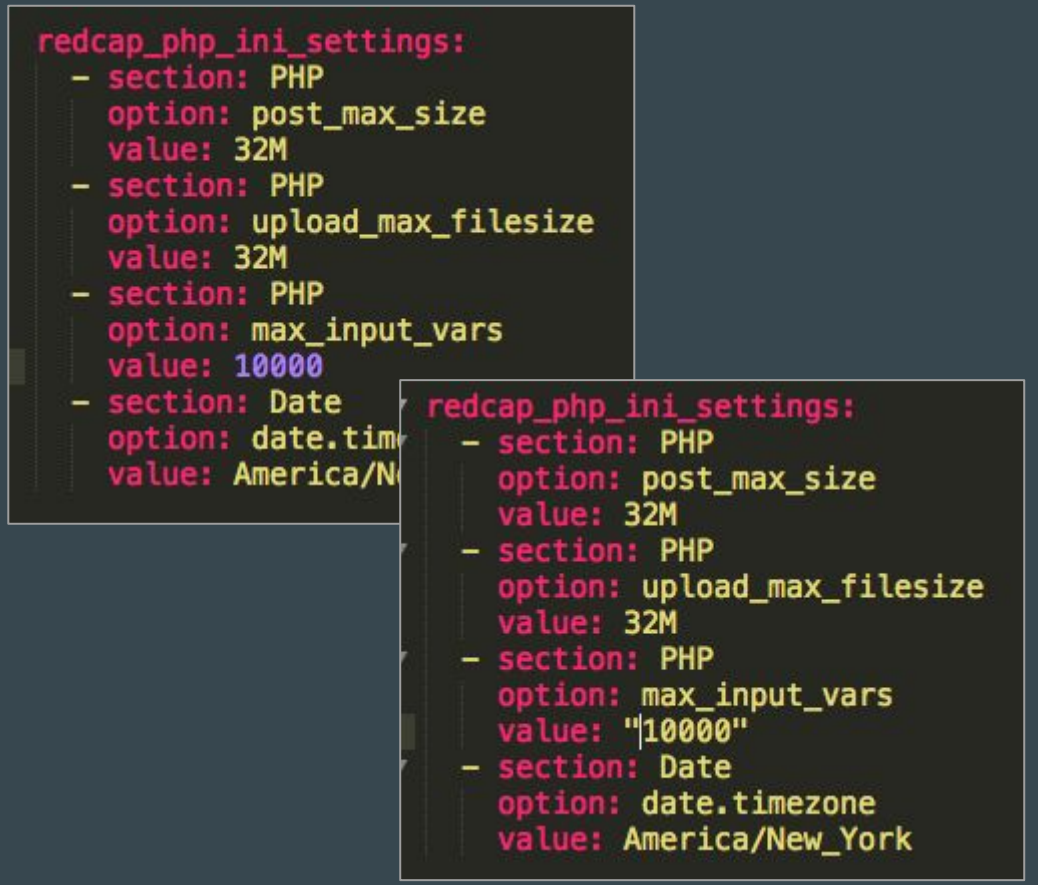
- Markup language for describing data
- Used for both Ansible playbooks ("code") and variable files ("data")
- YAML is a superset of JSON
  - Supports comments!
- Data types:
  - int: 123
  - float: 123.0
  - string: "123"
  - bool: y|Y|yes|Yes|YES|n|N|no|No|NO|true|True|TRUE|false|False|FALSE|on|On|ON|off|Off|OFF
  - lists: ['foo', 'bar'] or indent + '-'
  - dicts/hashes: {'foo': 'bar'} or indent + 'foo:'

```
logstash_forwarder_logstash_server_port: 5000
logstash_forwarder_ssl_src_dir: '{{inventory_dir}}/files/ssl'
logstash_forwarder_ssl_certificate_file: logstash.crt

logstash_forwarder_files:
  # CentOS syslog paths
  - paths:
      # Syslog
      - /var/log/messages
      # User logins
      - /var/log/secure
    fields:
      type: syslog
```

YAML Typing

- YAML is aggressive about type inference, so use syntax highlighting!
  - "{{ foo }}" - templated variable
  - {{ foo }} - invalid
- Quote values that confuse the parser:
  - [] = empty list, “[]” = two square brackets
  - “” = empty string, ““” = two double quotes
  - {test} = invalid, “{test}” = string
- Or cast values with Jinja filters:
  - {{1|float}}
  - {{“10000”|int}}
  - {{character_string|list}}
  - {{ some_variable | from_json }}
- Or YAML tags:
  - !!str 5
  - !!python/complex 1+2j



Jinja2

- Python templating language
  - Similar to handlebars, jade, haml, etc.
  - Often used for building HTML
- Used in Ansible for:
  - templating files (config, html, etc.)
  - variable definition
  - playbook logic
- Supports:
  - Tests
  - Filters
  - Loops
  - Nested templates/inheritance
  - Extension with Python code
- Syntax
  - {{ }} - evaluate and print in place
  - {% %} - evaluate without printing
  - {# #} - comment

```
include /etc/nginx/conf.d/*.{{item.name}}.upstream;

server {
    listen      80;
    server_name {{item.host}};
    rewrite     ^   https://$server_name$request_uri? permanent;
}

server {
  listen                443;

  {% if item.ssl_cert is defined or item.ssl_key is defined %}
  ssl    on;
  ssl_certificate       {{nginx_ssl_dest}}/{{item.ssl_cert}};
  ssl_certificate_key   {{nginx_ssl_dest}}/{{item.ssl_key}};
  {% endif %}

  server_name           {{item.host}};
  access_log            {{item.log}};

  include /etc/nginx/conf.d/*.{{item.name}}.location;
}
```

Defining Tasks

- YAML dictionary containing:
  - a module (like an ansible 'function')
  - parameters (like function arguments)
  - control flow (loops, sudo, etc.)
  - metadata (name, tags for selecting/excluding tasks, etc.)
- Stored within a linear list of tasks

```
# System level installation of buildb

# We install GCC to compile Twisted b
- name: Install buildbot dependencies
  tags: buildbot
  yum: name={{ item }} state=present
  sudo: yes
  with_items:
    - python-devel
    - python-pip
    - git
    -
    -

- nam
  tag
  pip
  suc
```

```
- name: Install nginx dependencies
  sudo: yes
  yum: name={{item}}
  with_items:
    - pam-devel
    - pcre
    - pcre-devel

- name: Configure nginx makefile
  shell: >
    cd {{nginx_workdir}}/nginx-{{nginx_version}}
    && ./configure
    --prefix=/usr/share/nginx
    --sbin-path=/usr/sbin/nginx
    --conf-path=/etc/nginx/nginx.conf
```

Executing Tasks

- Shares an execution context with other tasks:
  - Register task output as a variable
  - Conditional execution based on variables
  - Failure of a task stops host from running subsequent tasks
- Executed directly via `ansible` or `ansible-console` on command line

```
# System level installation of buildb

# We install GCC to compile Twisted b
- name: Install buildbot dependencies
  tags: buildbot
  yum: name={{ item }} state=present
  sudo: yes
  with_items:
    - python-devel
    - python-pip
    - git
```

```
- name: Install nginx dependencies
  sudo: yes
  yum: name={{item}}
  with_items:
    - pam-devel
    - pcre
    - pcre-devel

- name: Configure nginx makefile
  shell: >
    cd {{nginx_workdir}}/nginx-{{nginx_version}}
    && ./configure
    --prefix=/usr/share/nginx
    --sbin-path=/usr/sbin/nginx
    --conf-path=/etc/nginx/nginx.conf
```

Ansible Execution Order

Task List

A YAML list of tasks with no additional metadata

Task

A YAML dictionary of metadata and arguments around module

Defining Plays

- Task: parameters + control flow + metadata for a module
- Play: parameters + control flow + metadata for lists of tasks
- Unlike task lists, plays also have a variable scope

```
# PLAY 1: Set up Cachet
- hosts: cachet
  tags: [cachet, docker]
  tasks:
    - name: Run the Cachet app container
      docker_container:
        name: '{{cachet_app_docker_name}}'
        image: '{{cachet_app_docker_image}}:{{cachet_app
        command: /var/www/html/entrypoint.sh
        state: started
        expose: 9000
        memory_swappiness: 0
        ports:
          - '{{cachet_app_http_port}}:9000'
        env:
          APP_DEBUG: true
          APP_URL: '{{cachet_app_url}}'
          DB_HOST: '{{cachet_db_host}}'
          DB_DATABASE: '{{cachet_db_database}}'
          DB_DRIVER: '{{cachet_db_type}}'
          DB_USERNAME: '{{cachet_db_username}}'
          DB_PASSWORD: '{{cachet_db_password}}'
          MAIL_HOST: '{{cachet_smtp_host}}'
          MAIL_PORT: '{{cachet_smtp_port}}'
          MAIL_ADDRESS: '{{cachet_smtp_address}}'
          MAIL_NAME: '{{cachet_smtp_name}}'
          MAIL_ENCRYPTION: '{{cachet_smtp_encryption}}'
          QUEUE_DRIVER: '{{cachet_queue_driver}}'
      register: cachet_app_container

    # WHY DOES THIS KEEP FAILING ON THE FIRST RUN AAAA
    - name: Run database migrations
```

Executing Plays

- Execution order is still strictly linear, but includes multiple stages:
  - vars_*
  - pre_tasks
  - roles
  - tasks
  - post_tasks
  - (plus handlers!)
- Plays are never executed directly

```yaml
# PLAY 1: Set up Cachet
- hosts: cachet
  tags: [cachet, docker]
  tasks:
    - name: Run the Cachet app container
      docker_container:
        name: '{{cachet_app_docker_name}}'
        image: '{{cachet_app_docker_image}}:{{cachet_app
        command: /var/www/html/entrypoint.sh
        state: started
        expose: 9000
        memory_swappiness: 0
        ports:
          - '{{cachet_app_http_port}}:9000'
        env:
          APP_DEBUG: true
          APP_URL: '{{cachet_app_url}}'
          DB_HOST: '{{cachet_db_host}}'
          DB_DATABASE: '{{cachet_db_database}}'
          DB_DRIVER: '{{cachet_db_type}}'
          DB_USERNAME: '{{cachet_db_username}}'
          DB_PASSWORD: '{{cachet_db_password}}'
          MAIL_HOST: '{{cachet_smtp_host}}'
          MAIL_PORT: '{{cachet_smtp_port}}'
          MAIL_ADDRESS: '{{cachet_smtp_address}}'
          MAIL_NAME: '{{cachet_smtp_name}}'
          MAIL_ENCRYPTION: '{{cachet_smtp_encryption}}'
          QUEUE_DRIVER: '{{cachet_queue_driver}}'
      register: cachet_app_container

    # WHY DOES THIS KEEP FAILING ON THE FIRST RUN AAAA
    - name: Run database migrations
```

Ansible Execution Order

Play — A YAML dictionary of tasks, arguments, and metadata

Task List — A YAML list of tasks with no additional metadata

Task — A YAML dictionary of metadata and execution arguments

Defining Playbooks

- A playbook is a file containing a YAML list of plays
  - ...but most playbooks are just one play!
- No parameters or metadata, but shared runtime scope
- Playbooks can include each other:
  - ansible-playbook my_website.yml
    - include: provision_servers.yml
    - include: install_web_tier.yml
    - include: Install_database.yml

Executing Playbooks

- Execution order is still strictly linear, forming a nested loop
- ansible-playbook command runs playbooks, not plays/roles/task_lists/tasks

Ansible Execution Order

Playbook — A YAML file containing only plays and/or playbook includes

Play — A YAML dictionary of tasks, arguments, and metadata

Task List — A YAML list of tasks with no additional metadata

Task — A YAML dictionary of metadata and execution arguments

Demo:

ansible-playbook playbooks/1.4_cron.yml

1.6
Ansible Playbooks: Structure

15 minute lecture

- Cover key play and playbook concepts:
  - Hosts
  - Variables
  - Tasks
  - Handlers
- Multiple plays and variable scoping

Play Hosts

- 'hosts': is the host, or groups of hosts, that the play is executed across
- 'remote_user:' changes the user (default: your current user) used to *connect to* each host executing the play
- 'become: yes' and 'become_user:' (default: root) switch to a different user to *run commands on* each host executing the play
    - This used to be 'sudo', but that syntax is now deprecated.

```
- name: apply common configuration to all nodes
  hosts: all
  remote_user: root

  roles:
    - common

- name: configure and deploy the webservers and application code
  hosts: webservers
  remote_user: root

  roles:
    - web

- name: deploy MySQL and configure the databases
  hosts: dbservers
  remote_user: root

  roles:
    - db
```

Play Variables

- Scoped to last through a play
  - *Not* a playbook! Important difference
- Three common sources:
  - Provided in playbook directly via ‘vars:’
  - Collected from user at runtime via ‘vars_prompt:’
  - Included from YAML files at runtime via ‘vars_files:’

```yaml
- hosts: control_machine
  become: yes

  vars:
    # Default to a dev environment
    env: dev
    # Default to yum as a package manager
    package_manager: yum

  vars_prompt:
    name: distro
    prompt: Choose which distro to install
    default: ubuntu

  vars_files:
    - "../vars/{{distro}}-{{env}}.yml"

  tasks:
    - apt:
        name: git
      when: package_manager == 'apt'
```

ubuntu-dev.yml

```yaml
# Override package manager
package_manager: apt
```

Defining Tasks in Plays

- Each play has three task lists:
  - pre_tasks (before roles)
  - tasks (after roles*)
  - post_tasks (after roles)
- Task lists can include YAML files:
  - Lists of tasks
  - Variables (via vars_files)
  - Roles (include/import role)
  - NOT playbooks!
- Tasks support 'become:' syntax, which will override the play-level 'become:'
  - Useful for running some tasks as root, and some tasks as a specific user

Extra Parameters for Tasks

- Change task outputs:
  - 'register:' (save variable)
  - 'changed_when' (define changed state)
  - 'failed_when:' (define failed state)
  - 'ignore_errors:' (failures don't stop execution)
- Change execution flow:
  - 'when:' (if)
  - 'with_*:' (loops)
  - notify (trigger handlers)
  - tags (can be used to skip tasks)

Ansible Execution Order

Playbook — A YAML file containing only plays and/or playbook includes

Play — A YAML dictionary of tasks, arguments, and metadata

Task List — A YAML list of tasks with no additional metadata

Task — A YAML dictionary of metadata and execution arguments

Defining Handlers

```
- name: write the apache config file
  template: src=/srv/httpd.j2 dest=/etc/httpd.conf
  notify:
  - restart apache

handlers:
  - name: restart apache
    service: name=httpd state=restarted
```

- Defined in 'handlers:' list of a play
- Handlers listen to their 'name:'
- They can set 'listen:' to a string or list of strings to additionally listen to those names
  - e.g. "restart web services" -> 3 other handlers
- If a 'changed' task has a 'notify:' argument, it will notify any associated handlers
  - Changed config file -> restart service
  - Installed package -> recompile code

Notifying Handlers

- Notified handlers run...
  - At the end of the current section (pre_tasks, post_tasks, etc.)
  - Only once per section, regardless of how many times they were notified
  - Only on the hosts that notified them
  - In the order they were **defined**, *not the order they were notified!*

```
- name: write the apache config file
  template: src=/srv/httpd.j2 dest=/etc/httpd.conf
  notify:
  - restart apache

handlers:
  - name: restart apache
    service: name=httpd state=restarted
```

Multiple Plays

- Playbooks can contain more than one play
- Each play can have different hosts and variables
- All hosts will finish executing a play before the next play starts.

Variable Scope

- Beware of different variable scopes when using multiple plays!
  - Global: config variables, environment variables, command line extra vars
  - Play: each play and contained structures, vars entries (vars; vars_files; vars_prompt). **These variables are 'global' but don't persist across plays.**
  - Role: variables that only exist during a role execution
  - Host: variables directly associated to a host, like inventory, include_vars, facts or registered task outputs. **Persists on a per-host basis across any plays the host is included in.**

1.7
Ansible Playbooks: Hands-On

15 minute exercise

- Point out the pre-provided playbooks repository on the instance
- Extend a provided demo playbook with additional tasks to deploy a basic web application

Exercise:

Fill in incomplete tasks and get this playbook to complete:

ansible-playbook playbooks/1.6_webapp.yml

1.8
Ansible's Strengths & Weaknesses

10 minute discussion

- Summarize what we've learned so far
- Present some perceived strengths/weaknesses of Ansible
- Encourage learners to discuss and tie it to what they've learned so far in their hands-on work

Strengths and Weaknesses

- About the simplest approach that could possibly work
- Requires no agent and minimal configuration
- Runs almost anywhere
- Trivially extensible

- High flexibility means it's not always obvious the best way to do something
- Not a complete system out of the box
- It's a huge toolkit with hundreds of modules you will never use

Ansible: a toolkit, not a system!

How Does Ansible Compare?

- Chef & Puppet: expect complete control of your system, require more buy-in
- Terraform: all-encompassing declarative system, limited orchestration
- CloudFormation: declarative configuration language, can't perform tasks
- Fabric: older, just orchestration, much less support for config management
- Salt: most similar, but not as widely adopted

Want to keep learning?
Come back after the break!

2.1
Ansible Roles: Concepts

10 minute lecture

- Introduce roles, Ansible's primary unit of reusable functionality
- Show a more typical, role-heavy playbook

Introduction to Roles

- Roles are packages of reusable Ansible tasks that promote code reuse and composability
  - ansible-galaxy package manager
- They can be:
  - Ansible Galaxy public roles
  - Forks of public roles
  - Custom "in-house" roles
- Roles are never executed directly; they are only executed during plays

Roles can bundle:

- Tasks
- Files
- Templates
- Handlers
- Variables
- Modules (rare)
- Plugins (rare)

Ansible Execution Order

Playbook	A YAML file containing only a list of plays and/or includes of other playbooks
Play	A YAML dictionary containing metadata, connection info, and roles/tasks
Task List	A YAML list of tasks with no additional metadata
Task	A YAML dictionary of metadata and execution arguments wrapping a module

Roles in Playbooks: Classic

- Execution order:
  - pre_tasks
  - roles
  - tasks
  - post_tasks
- Roles have access to variables in the current play's and the global scope
- Plays can pass named variables and/or tags into a role
- Plays can execute the same role multiple times

```
- hosts: xnat_proxies
  remote_user: "{{root_user}}"
  environment: '{{default_env}}'

  pre_tasks: []

  roles:
    # Install nginx with SSL and PAM
    - {role: nginx, tags: nginx}
    - role: nginx_ssl
      tags: [nginx, nginx_ssl]
      nginx_servers: '{{xnat_proxy_servers}}'
    - {role: nginx_pam, tags: [nginx, nginx_pam]}
    - {role: xnat_proxy, tags: xnat_proxy}
    # - {role: logstash-forwarder, tags: logstash-forwarder}

  tasks: []

- hosts: xnat_servers
  remote_user: "{{root_user}}"
  environment: '{{default_env}}'

  roles:
    # - {role: common, tags: common}
    - {role: xnat_app, tags: xnat_app}
    - {role: rsnapshot, tags: rsnapshot}
    # - {role: logstash-forwarder, tags: logstash-forwarder}
```

Ansible Execution Order

- **Playbook** — A YAML file containing only a list of plays and/or includes of other playbooks
- **Play** — A YAML dictionary containing metadata, connection info, and roles/tasks
- **Role** — A folder containing tasks, handlers, metadata, variables, etc.
- **Task List** — A YAML list of tasks with no additional metadata
- **Task** — A YAML dictionary of metadata and execution arguments wrapping a module
- **Task List** — A YAML list of tasks with no additional metadata
- **Task** — A YAML dictionary of metadata and execution arguments wrapping a module

Classic Role Handler Execution Order

- Handlers notified from (not defined in!) 'roles:' execute *slightly* differently
- Don't use 'pre_tasks:', 'tasks:', 'roles:', and 'post_tasks:' in a playbook if you can avoid doing so!
- **Never** flush handlers in your role. It can lead to unpredictable and/or dangerous behaviors.

Handler order:

1. Each task defined in 'pre_tasks:'
2. Handlers notified in 'pre_tasks:'
3. Each task from each role defined in 'roles:'
4. Each task defined in 'tasks:
5. **Handlers notified in 'roles:'**
6. **Handlers defined in 'tasks:'**
7. Each task defined in 'post_tasks:'
8. Handlers notified in 'post_tasks:'

(Repeat this process for each play!)

Roles in Playbooks: import_role/include_role

- import_role and include_role are a newer addition to Ansible
- Allow including an entire role, instead of just including a YAML list of tasks
- Allow roles to be included in any task list (e.g. run roles in pre_tasks)
- Improves abstraction and ability of roles to be containers for Ansible tasks
- **Recommended for future development**

- import_role is static:
  - role contents evaluated on playbook run
  - cannot be looped
  - registers handlers into scope
  - allows use of --start-task-at
  - can't import dynamically based on runtime variables
- include_role is dynamic:
  - not evaluated until runtime
  - can be looped
  - can't register handlers
  - no --start-task-at
  - can include roles based on host variables (e.g. include 'myrole_{{ansible_os_version}}'

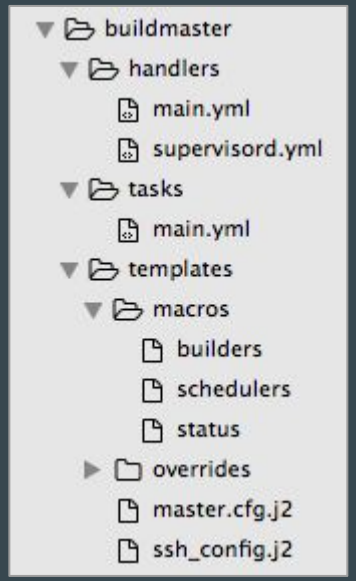
http://docs.ansible.com/ansible/latest/playbooks_reuse.html#dynamic-vs-static

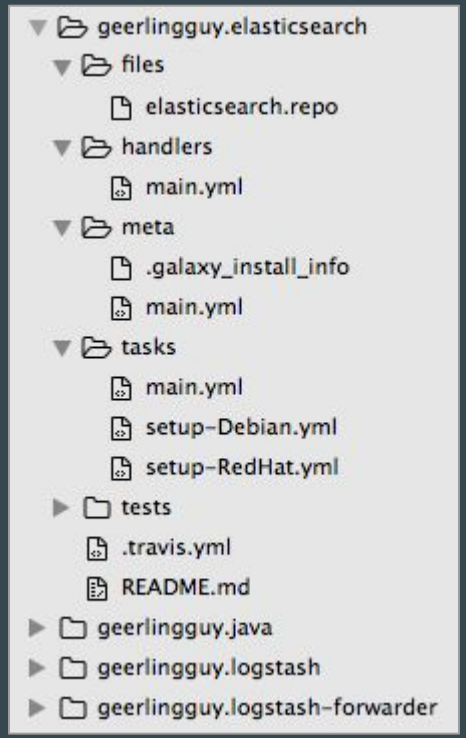
Ansible Execution Order

Playbook	A YAML file containing only a list of plays and/or includes of other playbooks
Play	A YAML dictionary containing metadata, connection info, and roles/tasks
Task List	A YAML list of tasks with no additional metadata
Role	A folder containing tasks, handlers, metadata, variables, etc.
Task List	A YAML dictionary of metadata and execution arguments wrapping a module
Task	A YAML list of tasks with no additional metadata
Task	A YAML dictionary of metadata and execution arguments wrapping a module

Role Structure

- Typically, each role is its own repository
  - Git repos can be installed directly as roles via *ansible-galaxy*
- Well defined directory structure that can be generated automatically with *ansible-galaxy*
- Roles package Ansible code along with:
  - README.md
  - meta/main.yml (for Ansible Galaxy)
  - tests (hopefully!)
  - possibly a Vagrantfile, travis.yml, etc.





Role Tasks

- Stored in "tasks" folder
- Defaults to executing "main.yml"
- Common pattern:
  - main.yml only has include statements for other .task ymls, and logic for when to include them
  - Other .ymls are for clearly defined steps: compile, install, configure, etc.
  - Environment specific includes are split out with conditionals: compile-Debian.yml vs. compile-RedHat.yml
  - Include statements in main.yml are tagged to permit running or excluding steps

```
- include: dependencies.yml
  tags: ['dependencies', 'internet']

- include: install.yml
  tags: ['install']

- include: run-aws.yml
  tags: ['aws']

- include: run-gcp.yml
  tags: ['gcp']

- include: run-vagrant.yml
  tags: ['vagrant']
```

Role Files and Templates

- Roles often ship with configuration files of the templates that they manage
- 'template' tasks will first look for files in 'templates':
  - src: config.ini.j2
- Other tasks that load files will first look for files in 'files':
  - src: python_script.py
- Rarely, you may need to access files via relative paths, starting from the playbook:
  - src: ../roles/a_different_role/files/my_file

Ansible documentation:

Any copy, script, template or include tasks (in the role) can reference files in roles/x/{files,templates,tasks}/ (dir depends on task) without having to path them relatively or absolutely

Role Variables

- Role “defaults” (defaults/main.yml or defaults/vars.yml) are always included, but are the lowest precedence of all variables
- Roles often also include a *vars* folder that can be explicitly included at runtime, often based on a condition:
  - Environment (Staging, Production)
  - OS
  - Cloud provider
- **Make sure to use prefixes, because there is no namespacing for Ansible variables**

```
logstash_forwarder_ssl_src_dir: '{{inventory_dir}}/files/ssl
logstash_forwarder_ssl_certificate_file: logstash.crt

logstash_forwarder_files:
  # CentOS syslog paths
  - paths:
      # Syslog
      - /var/log/messages
      # User logins
      - /var/log/secure
    fields:
      type: syslog
```

```
nginx_ssl_key: docker.key
nginx_ssl_cert: docker.crt

nginx_servers:
  - name: xnat_proxy_docker
    host: nrg-buildmaster.rc.fas.harvard.edu
    log: /var/log/nginx/access.log timed_combined
    ssl_key: xnat_docker.key
    ssl_cert: xnat_docker.crt

xnat_proxy_servers:
  - name: docker
    host: nrg-buildmaster.rc.fas.harvard.edu
    port: XNAT_DOCKER_HTTP_PORT
    ssl_port: XNAT_DOCKER_HTTPS_PORT
    ssl_cert: xnat_docker.crt
```

Role Handlers

- Same functionality as play handlers
- Role handlers get registered when the role is **imported**
  - Remember that handler execution order is the same as the handler registration order!
- Well designed roles support this pattern for cooperation with custom tasks:
  - Role defines all service handlers, even ones it doesn't use itself
  - Play imports role to perform basic configuration and make handlers available
  - In 'tasks:', modify a config file that impacts the service managed by that role
  - Notify handlers defined by the role

```yaml
- name: start nginx
  become: yes
  service:
    name: nginx
    state: started

- name: stop nginx
  become: yes
  service:
    name: nginx
    state: stopped

- name: restart nginx
  become: yes
  service:
    name: nginx
    state: restarted

- name: reload nginx
  become: yes
  service:
    name: nginx
    state: reloaded
```

2.2
Ansible at Scale

5 minute lecture
5 minute demo

- Inventories and groups
- Dynamic inventories
- Working with multiple hosts
  - Parallelism
  - Rolling updates
  - Delegation

Inventory

- Named list of remote nodes
- Groups can be defined with ':children'
- Groups can be nested in other groups
- Nodes and/or groups can be combined via 'pattern matching':
  - OR: webservers:dbservers
  - AND: webservers:&staging
  - NOT: webservers:!phoenix
- Host definitions can include:
  - SSH connection information
  - User to run commands as
  - Python executable path
  - Variables **(not recommended!)**

```
[atlanta]
host1
host2

[raleigh]
host2
host3

[southeast:children]
atlanta
raleigh

[southeast:vars]
some_server=foo.southeast.example.c
halon_system_timeout=30
self_destruct_countdown=60
escape_pods=2

[usa:children]
southeast
northeast
southwest
northwest
```

```
# MGH infrastructure
[mgh]
embarc
nexuscentral
gspcentral
simons
gspstaging
launchpad

# RC-managed infrastructure

# Specific RC nodes
[rc]
cbscentral
cbsstaging
contecentral
nrgcentral

# Groups that fall under RC
[rc:children]
ncf
workstations
nrg
```

Dynamic Inventories

- Dynamic inventories replace a static list of hosts with a data-driven one
- Implemented as a script in the inventory directory that calls APIs, reads CSVs, ...
- There are existing dynamic inventories for EC2, Google Compute Engine, Linode, OpenStack, and others
- EC2 inventory: lists each host, but also creates groups for each EC2 tag

@jmeickle

```
#!/usr/bin/env python

'''
EC2 external inventory script
=================================

Generates inventory that Ansible can understand by making API request to
AWS EC2 using the Boto library.

NOTE: This script assumes Ansible is being executed where the environment
variables needed for Boto have already been set:
    export AWS_ACCESS_KEY_ID='AK123'
    export AWS_SECRET_ACCESS_KEY='abc123'

optional region environement variable if region is 'auto'

This script also assumes there is an ec2.ini file alongside it.  To specify a
different path to ec2.ini, define the EC2_INI_PATH environment variable:

    export EC2_INI_PATH=/path/to/my_ec2.ini

If you're using eucalyptus you need to set the above variables and
you need to define:

    export EC2_URL=http://hostname_of_your_cc:port/services/Eucalyptus

If you're using boto profiles (requires boto>=2.24.0) you can choose a profile
using the --boto-profile command line argument (e.g. ec2.py --boto-profile prod) or using
the AWS_PROFILE variable:

    AWS_PROFILE=prod ansible-playbook -i ec2.py myplaybook.yml

For more details, see: http://docs.pythonboto.org/en/latest/boto_config_tut.html

When run against a specific host, this script returns the following variables:
 - ec2_ami_launch_index
 - ec2_architecture
 - ec2_association
 - ec2_attachTime
 - ec2_attachment
 - ec2_attachmentId
 - ec2_block_devices
 - ec2_client_token
 - ec2_deleteOnTermination
 - ec2_description
 - ec2_deviceIndex
 - ec2_dns_name
 - ec2_eventsSet
 - ec2_group_name
 - ec2_hypervisor
 - ec2_id
```

Using inventories

- Default inventory only has 'localhost'
- You can select an inventory with -i on the command line with Ansible commands
- You can point to:
  - a static inventory (.ini file)
  - a dynamic inventory (an executable script)
  - a folder containing some mix of the above
- As of 2.4, -i can be specified multiple times, for multiple inventories in use at once

Parallelism

- Ansible connects to multiple nodes and runs tasks simultaneously
- All nodes must complete (or fail) a task before the next task starts
  - You can bypass this by using 'strategy: free' to allow hosts to complete each *play* as fast as they can
- Ansible defaults to 5 forks - very low! Can usually be increased to 50 or more
  - Even more on a non-laptop
  - Remember, most of the work is on the remote host

Demo:
ansible-playbook playbooks/2.4_parallel.yml

Rolling Updates

- You may not want to run a play on all hosts at the same time
  - You have a rate limit on an API
  - You don't want to overload the database while it's still spinning up
  - You want special treatment, like making every n-th node a leader
- Set to 'serial: 1' to finish the whole play on each host before starting the next
- Set to 'serial: 20%' to run the play in five batches
- Include 'max_fail_percentage:' to bail out of the play early

Demo:
ansible-playbook playbooks/2.4_rolling.yml

Delegation

- Tasks usually run:
  - once per host
  - with that host's variables
  - on that host
- 'delegate_to:' allows tasks to run:
  - once per host
  - with that host's variables
  - *on a different host*
- Not commonly used, but very convenient!
  - Get values from each host, delegate to localhost, and write each to disk
  - Delegate to a leader node and send an instruction to each follower
- There is also a 'delegate_facts:', for using another host's facts

Demo:
ansible-playbook playbooks/2.4_delegate.yml

2.3
Ansible in the Cloud

10m exercise

- Introduce cloud management modules
- Provision additional instances with Ansible
- Use dynamic inventory to request data from instances

ec2

- Built in module to provision, manage, and terminate EC2 instances: http://docs.ansible.com/ansible/ec2_module.html
- Other relevant EC2 modules:
  - ec2_facts: Get info about EC2 instances
  - ec2_tag: Just tagging, not provisioning
  - ec2_vol_facts: Get volume information

```
# Basic provisioning example
- ec2:
    key_name: mykey
    instance_type: t2.micro
    image: ami-123456
    wait: yes
    group: webserver
    count: 3
    vpc_subnet_id: subnet-29e63245
    assign_public_ip: yes

# Advanced example with tagging and CloudWatch
- ec2:
    key_name: mykey
    group: databases
    instance_type: t2.micro
    image: ami-123456
    wait: yes
    wait_timeout: 500
    count: 5
    instance_tags:
       db: postgres
    monitoring: yes
    vpc_subnet_id: subnet-29e63245
    assign_public_ip: yes
```

Make sure to edit your ~/ansible/ansible.cfg inventory before this!

Exercise:

Provision a new instance with *playbooks/2.5_provision.yml*

Connect to your new instance with *playbooks/2.5_hello.yml*

Take a quick break while you provision - next section is 20 minutes!

2.4: Cloud Orchestration

20 minute exercise

- Deploy a multi-tier application in AWS
- Successfully serve traffic

Demo:

ansible-galaxy init test -p roles

Exercise:

Let's extend *playbooks/1.6_webapp.yml* with new functionality:

- Install nginx, Redis, and supervisord
- Recommended: use roles instead of tasks!
  - (either third party or included examples: 1.8_webapp.yml)
- Write a custom role to manage Flask with supervisord
- Persist number of visits in Redis
- Increment and display visits to user

Exercise:

Provision a multi-tier app, with services on both your control machine and the instance you provisioned from *2.5_provision.yml*. Start from this playbook:

ansible-playbook playbooks/2.6_cloud.yml

2.5: Ansible for Cloud Architectures

10 minute lecture

User management and access control

- Ansible has no access controls
- Ansible has no audit trail
- Developers run Ansible with their local credentials
- Often requires root on instances to do anything interesting
  - Consider minimizing scope by revoking root after a brief provisioning period
- (Ansible Tower provides all of this!)

Secret management

- Ansible has a secret management system, "Vault": https://docs.ansible.com/ansible/2.4/vault.html
- Commit encrypted secrets into your git repo
  - *...no thanks*, personally
- Suggested approach: use Hashicorp Vault and retrieve secrets
  - Ask me about this after the course

Scheduled jobs

- Ansible has no scheduled job capability
- It also has no agent
- Recommended "naive" approach is to schedule it with cron
- Ansible Tower provides periodic and dependency-based scheduling

Provisioning callbacks

- Ansible does not have provisioning callbacks
- You'd have to build these for cloud "frying" deployments
  - Autoscaling Lifecycle Hooks
- You can run in "local mode" on the same instance but this is often insecure
- Local mode is better for "baking" with Packer/Docker
  - We also use local mode for Kubernetes provisioning which has multiple orchestration steps

Remember, it's a toolkit,
not a complete system!

2.6: Ansible Tower

5 minute lecture
10 minute exercise

Ansible Tower

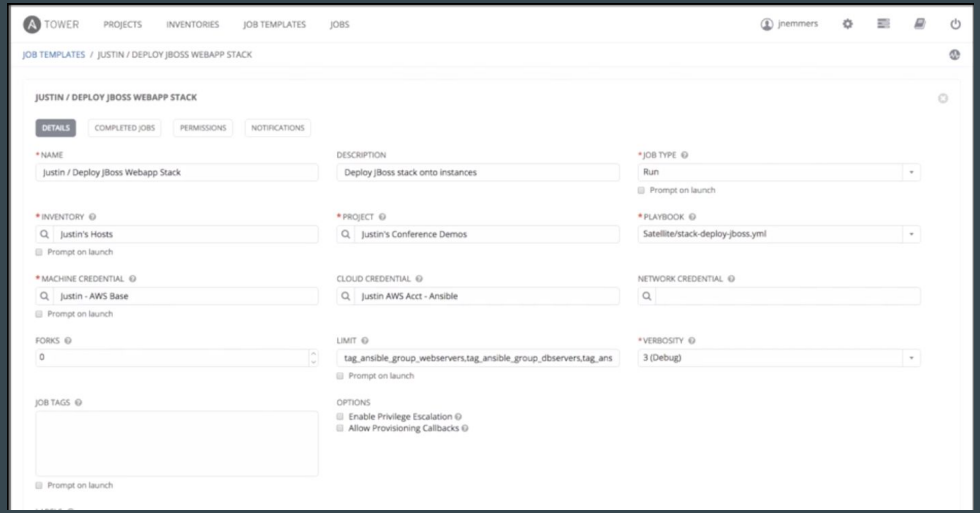
- Paid product offered by Red Hat
- Automatic updates to inventory and code to keep in sync with cloud and VCS
- ACLs on who can run jobs or view their output
- Provisioning callbacks for new cloud servers to request that Tower run Ansible playbooks on them
- On-run prompts for credentials and variables
- Paid support offerings!

AWX

- Underlying project for Ansible Tower
- Open sourced by Red Hat, official project
- Has the same feature set
- Moves faster, but no official support
- https://github.com/ansible/awx
- https://www.ansible.com/products/awx-project/faq

Downsides of Ansible Tower

- User interface is complex, clunky, and has actually brought down our instance
- New releases can break a lot of playbooks/configs
- Lack of control over per-job Ansible settings and versions
- Tower API callback issues are difficult to debug
- Overall, still a great project for its age
  - Was rocky for a while but they've fixed most of our prior issues



5 Minute Q&A about Tower (or last break)

2.7
Writing Maintainable Ansible Code

15 minute lecture

- Discuss tips and tricks for making Ansible code more maintainable

What Is Maintainable Code?

- Dependency managed
  - Well-known
  - Version pinned
  - In code
- Documented
  - Conceptual/"why" (high-level, code-light documents kept up to date)
  - Practical/"how" (focused, concise comments)
- Only as complex as necessary
  - Standards-oriented
  - Minimize "clever tricks"
  - Principle of least surprise!
- Tested *and* regularly used
  - unit tests
  - integration tests
  - continuous integration
  - continuous deployment
- Production-ready
  - Monitoring
  - Alerting
  - Logging
  - Well-understood deployment process
- Human friendly
  - Easily readable and modifiable
  - More than one person understands it
  - Can be run either automated or manually

Structure Your Repository

http://docs.ansible.com/ansible/playbooks_best_practices.html#content-organization

```
production                # inventory file for production servers
staging                   # inventory file for staging environment

group_vars/
   group1                 # here we assign variables to particular groups
   group2                 # ""
host_vars/
   hostname1              # if systems need specific variables, put them here
   hostname2              # ""

library/                  # if any custom modules, put them here (optional)
filter_plugins/           # if any custom filter plugins, put them here (optic

site.yml                  # master playbook
webservers.yml            # playbook for webserver tier
dbservers.yml             # playbook for dbserver tier
```

```
roles/
    common/               # this hierarchy represents a "role"
        tasks/            #
            main.yml      #  <-- tasks file can include smaller files if warranted
        handlers/         #
            main.yml      #  <-- handlers file
        templates/        #  <-- files for use with the template resource
            ntp.conf.j2   #  <------- templates end in .j2
        files/            #
            bar.txt       #  <-- files for use with the copy resource
            foo.sh        #  <-- script files for use with the script resource
        vars/             #
            main.yml      #  <-- variables associated with this role
        defaults/         #
            main.yml      #  <-- default lower priority variables for this role
        meta/             #
            main.yml      #  <-- role dependencies

    webtier/              # same kind of structure as "common" was above, done for the webtier role
    monitoring/           # ""
    fooapp/               # ""
```

Structure Your Repository

- For small teams I prefer a slight variant on the Ansible recommendations
- Overall structure is a single repo - possible to share structure with others
- Each environment gets its own folder with independent inventories, group_vars, etc.:
  - environments/vagrant, environments/staging, environments/production
- Roles can be placed directly in the main repo (convenient), or split out into their own repo (better for open source releases)
- Playbooks folder can be placed in the main repo, or split into their own repo and versioned independently, depending on project complexity

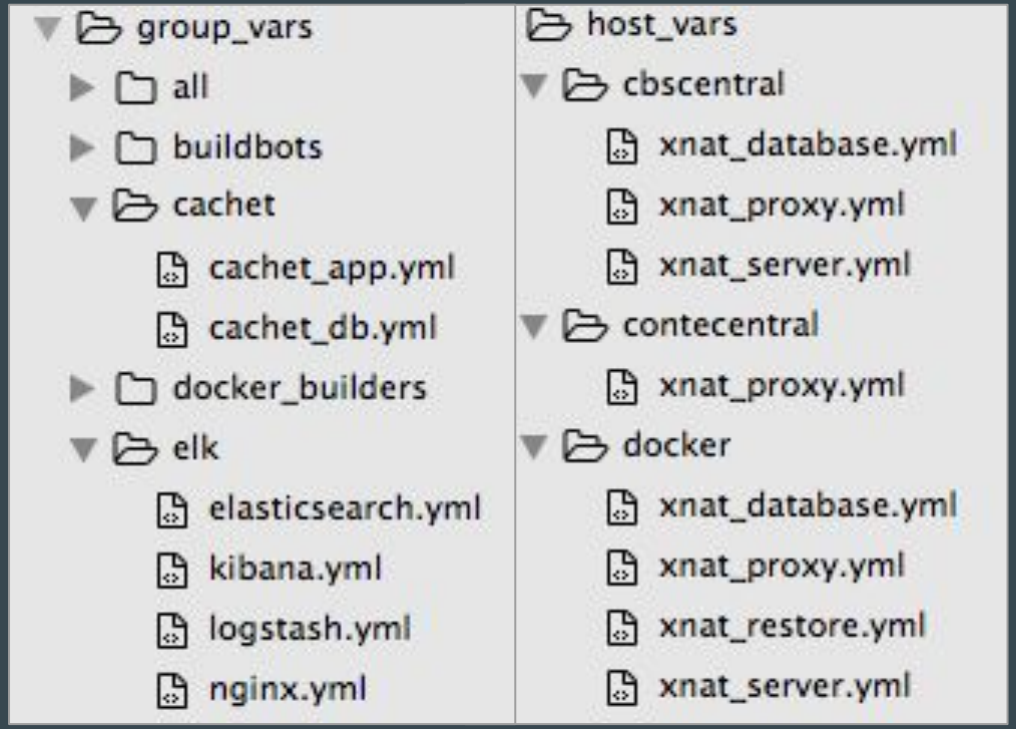
Structure Your Variables

- Probably the single most common source of Ansible maintainability problems
- Ansible variables can come from **more than 16 different sources**, and many of those sources have within-source precedence rules too
- There is no effective debugging tool for figuring out what source set which variable
- Minimize complexity as much as possible:
  - Decide which sources you'll use, and when
  - Develop standards to use cross-project
  - Be disciplined, even when it's inconvenient

role defaults (lowest!)
inventory vars
inventory group_vars
inventory host_vars
playbook group_vars
playbook host_vars
host facts
play vars
play vars_prompt
play vars_files
registered vars
set_facts
role and include vars
block vars (only for tasks in block)
task vars (only for the task)
extra vars (highest!)

Structure Your Variables

- host_vars and group_vars are a good starting point for most organizations
- host_vars has precedence over group_vars on a per-variable basis
  - Keep most configuration general
  - Selectively override specific variables
- Instead of single configuration files, store host or group config as folders of logically separated concerns
  - All .yml files in a subfolder get included



Variables for large teams

- Problems with this approach for large teams:
  - Single repo for config is a bottleneck
  - Error in any group file can result in issues in your unrelated Ansible code
  - Inheritance can be very surprising for complex group structures

- Alternative: per-role variables
  - Ship roles with their own variable files for different environments
  - Single-purpose playbooks in same repo as the config-containing roles they use
  - Keep roles closer to "microservices"
  - Shared roles are used across multiple projects, with well-known APIs
  - **Downside: lots of deploy branches**

Structure Your Playbooks

- Play-level settings should be variables, but with sensible defaults provided:
  - hosts: {{play_hosts|default('all')}}
- Avoid using pre_tasks for anything that doesn't *need* to be run before roles.
- Avoid using 'pre_tasks:', 'roles:', 'tasks:' *and* 'post_tasks:' in the same playbook. There are few cases where this level of complexity is necessary.
- **Avoid using 'roles:' in favor of 'import_role:'**
- If you think you'll want to run a play by itself, put it in its own playbook file. You can always include it from other playbooks.

Structure Your Roles

- Provide a sensible but general vars/main.yml.
- Consider providing contingent override files in in vars/ specific to environments, OSes, cloud providers, etc.
- Define a full set of handlers (start, stop, restart, reload) for services managed by your role. Even if you aren't using them, other developers might try to later, and their code won't fail until runtime.
- ***Roles should never flush handlers or start/restart services without providing a way to override this behavior.*** You could cause security or stability issues in an unrelated role!

Avoid Nested Variables

- Ansible's control structures are very limited
- Writing more complex structures in Jinja is almost unreadable
- Loops are almost impossible after more than two levels of nesting
- Consider implementing complex loops inside of custom modules
- Jinja template files *can* still have arbitrary nesting! (Loops, subtemplates)

Write Idempotent Playbooks

- Most Ansible modules are idempotent:
  - "Modules are ‘idempotent’, meaning if you run them again, they will make only the changes they must in order to bring the system to the desired state. This makes it very safe to rerun the same playbook multiple times. They won’t change things unless they have to change things."
- “command” and “shell” modules are not inherently idempotent!
- A playbook of idempotent modules is idempotent... sort of
  - Using handlers breaks idempotency guarantee in the case of failures
  - Registering output or checking for 'changed:' can break idempotency
  - Changing variables between runs can break idempotency in surprising ways (orphans)
- Idempotency is hard to achieve in practice, but it’s a valuable goal.

Avoid Orphaned Files In Tasks

- Ansible has no knowledge of files generated on previous runs
- The naive approach will result in ‘orphaned’ configuration files, SSH keys, etc.
  - Define ‘app_name: blue’
  - Playbook templates out ‘blue.conf’
  - Change app_name to ‘green’
  - Playbook templates out ‘green.conf’, *ignoring* ‘blue.conf’
  - Webserver loads ‘blue.conf’ *and* ‘green.conf’
- Instead, remove and recreate files with variable-based names
- Can be challenging to implement pattern across roles or playbooks

Write Tests

- At a basic level, use a YAML linter
- Ansible Lint: https://github.com/willthames/ansible-lint
  - Pro: more Ansible-specific, more configurable to team standards
  - Con: not much out of the box, new rules hard to set up
- Testing infra code has traditionally been hard
- Ansible comes with a "check mode"
  - Not much better than syntax checking
  - Fails spuriously for almost any multi-step install process
- Molecule seems really promising!

2.8
Community Resources

(10 minute lecture)

- Community resources
- Paid tools and support
- Online learning

Ansible Documentation

- http://docs.ansible.com/
- Very detailed module references - check there first!
- Ansible moves fast, so don't trust code samples from Google
  - *Make sure you're using the right documentation version!*
- Missing more in-depth use cases and real world examples

Official Example Playbooks

- https://github.com/ansible/ansible-examples
- More realistic than www.ansible.com snippets
- Still lacking in complexity - if you need better examples, consider looking at popular roles on Ansible Galaxy.

Ansible On Github

- Developed on GitHub: https://github.com/ansible/ansible
- “Releases are named after Led Zeppelin songs.”
  - “(Releases prior to 2.0 were named after Van Halen songs.)”
- It’s possible to run an Ansible git checkout, including local modifications
- Comes with a set of shell scripts to configure dependencies properly: https://github.com/ansible/ansible/blob/devel/hacking/README.md
- Great for custom module development!

Mailing Lists

- Announcements: https://groups.google.com/forum/#!forum/ansible-announce
- General discussion: https://groups.google.com/forum/#!forum/ansible-project
- Dev discussion: https://groups.google.com/forum/#!forum/ansible-devel

Ansible IRC

- All on irc.freenode.net:
  - #ansible: general discussion, support
  - #ansible-devel: developer discussion
  - #ansible-meeting: community meetings
- "Don't ask if you can ask!"

Conferences and Meetups

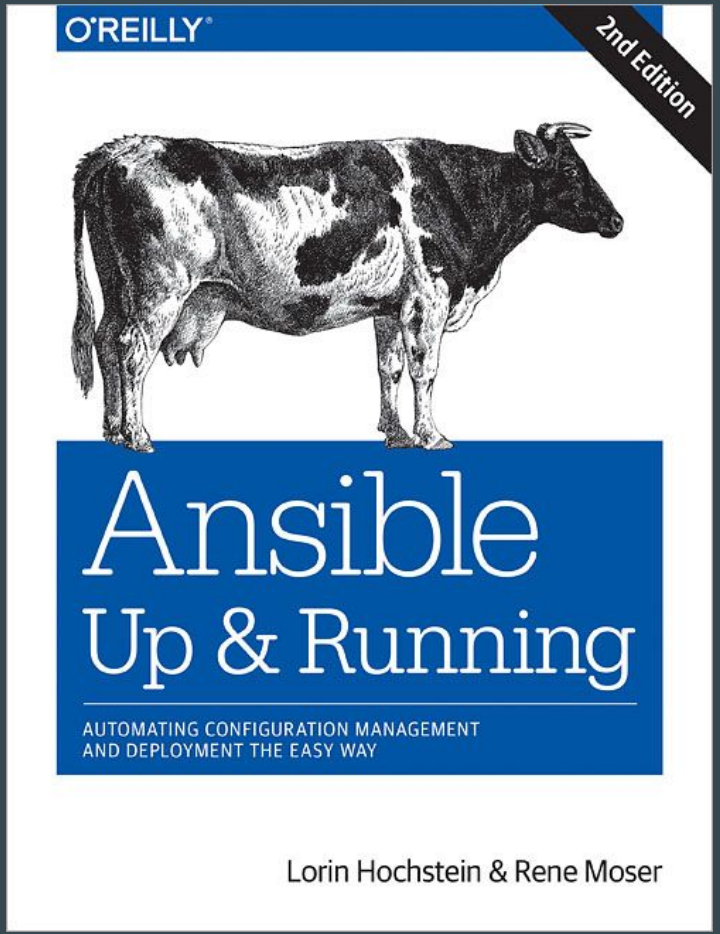
- AnsibleFest: https://www.ansible.com/ansiblefest
  - If you're here, you're missing it, oops!
- Local meetups: https://www.meetup.com/topics/ansible/
  - Or check out your local DevOps, Infrastructure Coders, etc. meetup!

Red Hat

- Offers paid certifications in Ansible: https://www.ansible.com/training-certification
- Runs in person and online trainings: https://www.ansible.com/webinars-training
- Currently, no enterprise support offering
- But they do have paid Ansible consulting: https://www.ansible.com/consulting

O'Reilly Media

- Ansible: Up & Running is available for purchase, with several chapters free: http://www.ansiblebook.com/
- Network Automation With Ansible: http://www.oreilly.com/webops-perf/free/network-automation-with-ansible.csp



2.9 Conclusion

(5 minute lecture)

Best Practices

- Use appropriate Ansible modules rather than shell commands
- Structure your code as composable roles and playbooks
- Emphasize code quality for infrastructure code
- Understand when *not* to use Ansible's flexibility
- Treat Ansible as a toolkit, not a system

Ansible Tower Demo

Course Playbook Demo

Interested in Ansible consulting or advice?

Nothing formal, but come get my card!

Questions?

I'll be around after! Or find me at @jmeickle or eronarn@gmail.com or permadeath.com!

Thank you!

Feel free to connect!

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And to all of you for attending! <3