Transforming Science through Data-Driven Discovery

CACAO Templates

Edwin Skidmore
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Today's webinar

- What & Why of CACAO
- What is a template?
- Syntax of a template
- Using the CLI

- Demo
  - Importing a basic Terraform template
  - Updating your template
  - Updating the metadata
  - Deleting a template

- Future Work
Cloud Automation Continuous Analysis Orchestration
Doing collaborative, data-driven team science in the cloud is challenging.

Effective science in the cloud requires deep technical understanding of each cloud provider's capabilities and cost.

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CACAO is an **open-source, multi-cloud software platform** that enables **researchers, educators, research software professionals (RSPs)** to create, use, and share their **data-driven workflows, infrastructure, and software stacks**, while allowing them to **minimize costs by leveraging cloud frameworks**.

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Researcher
Educator
RSP*

* RSP is a Research Software Professional, including RSEs, RS Devops, etc.
What are templates and why use them?

Think "recipes"...
3 types of recipe roles

1. Recipe producers
2. Recipe reproducer / transformer
3. Feasters (recipe consumers)

Characteristics of recipes

• Sharable
• Portable
• Customizable

Salted Brown Butter Crispy Treats

What’s different about these? Oh, just a bit more (cough double) butter which you toast until it’s brown and nutty and help along with some coarse salt, just minor things. But it changes everything.

Makes 16 2-inch squares or 32 1 x 2-inch small bars

4 ounces (1/4 pound or 1 stick) unsalted butter, plus extra for the pan
1 10-ounce bag marshmallows
Heaping 1/4 teaspoon coarse sea salt
6 cups Rice Krispies cereal (about half a 12-ounce box)

Butter (or coat with non-stick spray) an 8-inch square cake pan with 2-inch sides.

In a large pot, melt butter over medium-low heat. It will melt, then foam, then turn clear golden and finally start to turn brown and smell nutty. Stir frequently, scraping up any bits from the bottom as you do. Don’t take your eyes off the pot as while you may be impatient for it to start browning, the period between the time the butter begins to take on color and the point where it burns is often less than a minute.

As soon as the butter takes on a nutty color, turn the heat off and stir in the marshmallows. The residual heat from the melted butter should be enough to melt them, but if it is not, turn it back on low until the marshmallows are smooth.

Remove the pot from the stove and stir in the salt and cereal together. Quickly spread into prepared pan. I liked to use a piece of waxed or parchment paper that I’ve sprayed with oil to press it firmly and evenly into the edges and corners, though a silicon spatula works almost as well.

Let cool, cut into squares and get ready to make new friends.
What are templates? Think: recipes

**Salted Brown Butter Crispy Treats**

What’s different about these? Oh, just a bit more (cough *double*) butter which you toast until it’s brown and nutty and help along with some coarse salt, just minor things. But it changes *everything*.

Makes 16 2-inch squares or 32 1- x 2-inch small bars

- 4 ounces (1/4 pound or 1 stick) unsalted butter, plus extra for the pan
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In a large pot, melt butter over medium-low heat. It will melt, then foam, then turn clear golden and finally start to turn brown and smell nutty. Stir frequently, scraping up any bits from the bottom as you do. Don’t take your eyes off the pot as while you may be impatient for it to start browning, the period between the time it begins browning and becomes *very* nutty is short. You want to see *very* nutty. In the end, the best brown butter you can get will be from 3-4 minutes. Simply put your pan on the stove, get the brown butter and wait until the brown is right, then stir constantly and let it cook for 1 minute. Mix well into the other ingredients.
What are templates? Think recipes

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What are templates? Think recipes

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Other metadata:

Author(s)
Dependencies
Equipment
Customization (configurable parameters)
Scaling up your recipe

What is not metadata?

Provenance
Time and cost of experimentation
Blood, sweat, tears that went into a recipe
Accidents, mishaps, lessons learned
jupyterhub
Created by: Edwin Skidmore

Launch a multi-vm zero-to-jupyterhub

openstack_compute
openstack_terraform

Purpose/Yield
Ingredients
Scaling
Customization
Types
- Infrastructure as Code (IaC) [Terraform, OpenTofu]
- Declarative [Kubernetes]
- Domain-specific language (DSLs) [Nextflow]

Target specific clouds

CACAO
- OpenStack: Terraform + provisioners (e.g., Ansible)
- Kubernetes: Kubernetes native
- AWS: Terraform + provisioners
The core technology revolves around cloud frameworks, IaC, DSLs.

We require these to be currently stored in a git repo.

We don’t require any other changes to the templates, other than a couple of metadata files located in .cacao folder.
Template syntax: metadata.json

```
{
  "schema_version": "3",
  "name": "single image openstack instances",
  "author": "Edwin Skidmore",
  "author_email": "edwin@cyverse.org",
  "description": "single launch of one or more vms",
  "template_type": "openstack_terraform",
  "purpose": "openstack_compute",
  "cacao_pre_tasks": [],
  "cacao_post_tasks": [
    {
      "type": "ansible",
      "location": "cacao_atmosphere.legacy"
    }
  ],
  "parameters": [
    {
      "name": "username",
      "type": "cacao_username",
      "default": "username",
      "description": "CACA username"
    },
    {
      "name": "region",
      "type": "cacao_provider_region",
      "default": "IU",
      "description": "Openstack region"
    },
    {
      "name": "instance_name",
      "type": "string",
      "description": "Instance name"
    }
  ]
}
```

-.cacao/metadata.json

- Informative metadata
- Semantic information
- Configurable parameters

Additional information: [https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/](https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/)
Template syntax: ui.json

```
{
  "schema_url": "https://gitlab.com/cyverse/cacao-common/-/raw/master/template/ui-sc
  "schema_version": "1",
  "author": "Sean Davey",
  "author_email": "sdaevey@arizona.edu",
  "steps": [
    {
      "title": "Parameters",
      "items": [
        {
          "name": "region",
          "ui_label": "Choose Region"
        },
        {
          "name": "instance_name",
          "ui_label": "Instance name"
        },
        {
          "name": "power_state",
          "ui_label": "Power state"
        },
        {
          "name": "image_name",
          "ui_label": "Boot image name",
          "parameters": [
            { "key": "windows_disclaimer", "value": true }
          ]
        },
        {
          "type": "row",
          "items": ["name": "instance_count",
            { "ui_label": "# of Instances" }
          ]
        }
      ]
    }
  ]
}
```

- Additional informative metadata
- Layout
- UI-specific labels
- UI-specific data types
- Help text

Additional information: [https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/](https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/)
Using the CACAO CLI to manage templates

How to login: [https://docs.jetstream-cloud.org/ui/cacao/advanced_cacao_cli/](https://docs.jetstream-cloud.org/ui/cacao/advanced_cacao_cli/)

How to manage: [https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/](https://docs.jetstream-cloud.org/ui/cacao/import_terraform_template/)

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>cacao template get</code></td>
<td>Lists all templates</td>
</tr>
<tr>
<td><code>cacao template create</code></td>
<td>Create (imports) a template into CACAO</td>
</tr>
<tr>
<td><code>cacao template update</code></td>
<td>Updates CACAO’s internal metadata or settings for a template, like visibility, tags, git branch, etc.</td>
</tr>
<tr>
<td><code>cacao template sync</code></td>
<td>Syncs (retrieves) the template metadata from git</td>
</tr>
<tr>
<td><code>cacao template delete</code></td>
<td>Deletes template</td>
</tr>
</tbody>
</table>
DEMO
Future work on templates

• Using the web interface to import templates
• Being able to share templates by user or group
• Adding AWS and Kubernetes cloud providers and Kubernetes-native templates
• Additional fields, such as secret and character encoding fields, password generation fields
## CyVerse-curated Templates (on Jetstream2)

<table>
<thead>
<tr>
<th>Name</th>
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<th>Git repo</th>
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<tbody>
<tr>
<td>single-image</td>
<td>Deploy one or more instances</td>
<td><a href="https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image">https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image</a></td>
</tr>
<tr>
<td>single-image-k3s</td>
<td>Deploy a k3s cluster with multiple nodes</td>
<td><a href="https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image-k3s">https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image-k3s</a></td>
</tr>
<tr>
<td>vms4workshop</td>
<td>Deploy a set of instances with instructor and separate student instances, with a desktop and ssh</td>
<td><a href="https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/vms4workshop">https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/vms4workshop</a></td>
</tr>
<tr>
<td>single-image-docker</td>
<td>Deploy one or more instances configured as a docker stacks</td>
<td><a href="https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image-docker">https://gitlab.com/cyverse/cacao-tf-os-ops/-/tree/main/single-image-docker</a></td>
</tr>
<tr>
<td>cacao-tf-jupyterhub</td>
<td>Deploy a Zero to Jupyterhub with multiple nodes configurable GPUs, Shared Storage, and other configurable options; Dask Gateway as an option</td>
<td><a href="https://gitlab.com/stack0/cacao-tf-jupyterhub">https://gitlab.com/stack0/cacao-tf-jupyterhub</a></td>
</tr>
<tr>
<td>magic-castle</td>
<td>Deploy a virtual HPC/Slurm cluster</td>
<td><a href="https://github.com/edwins/magic_castle">https://github.com/edwins/magic_castle</a></td>
</tr>
<tr>
<td>terraform-mlflow-basics</td>
<td>Mlflow for workshops</td>
<td><a href="https://gitlab.com/stack0/terraform-mlflow-basics">https://gitlab.com/stack0/terraform-mlflow-basics</a></td>
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Thank you!

Questions?