



Developing Applications with Cloud Foundry

Lab Instructions

Application Deployment using Pivotal Cloud
Foundry

Pivotal

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Chapter 1. Lab Setup

1.1. About this Lab

Goals

Prepare your computer for the lab exercises

- Install the Cloud Foundry Command Line Interface
- Copy Lab projects to your computer
- Setup a trial account on Pivotal Web Services (or use a private PCF installation)
- Install an IDE: Eclipse, STS, or IntelliJ
- Install the Cloud Foundry Plugin for Eclipse
- Establish a GitHub Account (optional)

Prerequisites

To complete these steps, you will need:

- An Internet connection.

Estimated time to complete: 30 minutes

1.2. Steps

1. Obtain a Cloud Foundry account. Two options:

- a. If you are running Pivotal CF on-premise you may already have an account so there may nothing more to do. If not, ask an organization manager to "invite" you to become a member of a Cloud Foundry organization. Your organization may have established an alternate process for you to follow to obtain an account. (Typically, an "organization manager" must send you an "invitation" to join an existing organization.)

- b. Alternatively, use Pivotal Web Services (PWS). Go to <https://console.run.pivotal.io/register> and go through the registration process for a trial account. If you already have a PWS account you can skip this step.

2. Install Cloud Foundry Command Line Interface (CLI)

Go to <https://github.com/cloudfoundry/cli/releases> or <https://console.run.pivotal.io/tools> and download the installer for your platform. Run the installer.

3. Copy lab files from GitHub

- a. Go to <https://github.com/S2EDU/CloudFoundryStudentFiles>. Click the “Download Zip” button to download the project files we will use in this course.
- b. Unzip the files to an easy-to-find location on your local file system (for simplicity we suggest C:\ on a Windows system). For the remainder of this course, we will simply refer to the projects by name, so you should remember this location.

4. Install an IDE (Eclipse, Spring Tool Suite or IntelliJ)

Some of the exercises work best when run from an IDE, such as Eclipse, Spring Tool Suite (STS) or IntelliJ, but again if you are not familiar with these tools, you may prefer to simply use the CLI and your favorite editor (such as Wordpad, Notepad++, JEdit, TextWrangler, XCode, gEdit or even `vi` or `emacs`). If so you are done, please ignore the rest of these instructions.

- a. For Eclipse, Go to <https://www.eclipse.org/downloads/> and download Eclipse. Select the latest version, download it, and install it. If you already have Eclipse 4.3 or higher, you can skip this step.
- b. For STS Go to <http://spring.io/tools/sts> and download STS. Select the latest version. If you already have STS version 3.6.0 or higher, you can skip this step.
- c. IntelliJ also includes integration with Cloud Foundry. You may use it if you prefer, although the instructions in this course will only refer to Eclipse. If you already have IntelliJ Ultimate Edition V13 or later, skip this step. Otherwise download the Ultimate Edition for your platform from <http://www.jetbrains.com/idea/download/>. This comes with a free 30 day trial license and Cloud Foundry integration built-in. The free Community Edition *does not* support Cloud Foundry deployment.

5. Install IDE Support for Cloud Foundry

- a. Eclipse / STS: Install Cloud Foundry Integration
 - i. If using Eclipse or STS, select Eclipse Marketplace from the Help menu.

- ii. In the marketplace dialog, enter “Cloud Foundry” in the Find field, and click Go.
- iii. Find the entry for "Cloud Foundry Integration for Eclipse" in the search results. The most recent versions of STS have Cloud Foundry installed by default. There are three possibilities:
 - A. The Cloud Foundry plugin is not installed, click the Install button now.
 - B. If Cloud Foundry is already installed there will be two buttons Update and Uninstall. If the Update button is disabled there is nothing more to do. Go to the next section "Add a “Cloud Foundry” Server" below.
 - C. If the Update button is enabled, you may wish to update now. Click Update to continue. If you *do not* wish to update, go to the next section "Add a “Cloud Foundry” Server" below.
- iv. In the next dialog just click Confirm
- v. Finally, accept the license agreement and click Finish. The install/update process will take a bit of time, and you will be prompted to restart Eclipse to make the changes take effect.
- vi. Full details: [Install to Eclipse](#)

b. IntelliJ: Enable Cloud Foundry Plugin

You may have enabled Cloud Foundry when you ran IntelliJ the first time. If not, or not sure, go to Preferences / Plugins (under IDE Settings) now and enable it.

6. Add a “Cloud Foundry” Server

a. Eclipse or STS

- i. Within Eclipse or STS, Select the “Servers” view; this is typically located in the lower left corner of the workspace. (If it is not present, go to Window / Show View / Other / Server / Servers.)
- ii. Within the Servers view, right click, select New / Server and browse to Pivotal / Cloud Foundry. Enter the email and password for your account.
- iii. By default the URL specifies PWS (run.pivotal.io). If using a different installation, click on “Manage Cloud”, then “Add” and then specify a name for your CF instance (call it whatever you want) and its API URL. If you are not sure of the API URL, you will need to obtain it from an administrator familiar with your CF setup.
- iv. If prompted, it is fine to take the default values for Organization / Space or make a selection from the choices offered. If unsure, accept the defaults. We will explain "organization" and "space" more fully

later in the course.

v. Click Finish. We now have a 'server' in Eclipse/STS that points to a Cloud Foundry environment.

b. IntelliJ

i. Open the Preferences/settings dialog and go to Cloud (under IDE Settings) to configure your Cloud Foundry setup.

ii. Click the + to add a new cloud and select Cloud Foundry. Specify your Cloud Foundry username, password, organization and preferred space. Be sure to leave Version V2 selected.

iii. The Provider defaults to PWS. If you are using your own CF instance you will need to supply its API URL (you were asked for this during step 3).

iv. Click "Test connection" to see if all the details are correct. Fix them if necessary.

v. Click OK to finish.

7. Import projects into your IDE

a. Eclipse or STS

i. From the project explorer, right click, import, Maven, existing maven projects

ii. Navigate to the folder where you extracted the student files (step 2) and Finish.

iii. The projects will be imported.

iv. Note that depending on the version of Eclipse / STS, your version of Java, and other factors, you may encounter errors. These will need to be fixed on a case-by-case basis before proceeding.

b. IntelliJ

i. From File menu select "Import Project" and navigate to wherever the course labs were installed during the previous step.

ii. Click "Import project from external model" and import as Maven projects.

iii. After clicking Next, select the "Search for projects recursively" tick-box.

iv. Click Next again and several projects should be listed.

v. Click Next and select a suitable SDK (Java 7 or 8 is required).

vi. Click Next one last time. You can leave the project name and location. Click Finish.

vii. Repeat the procedure, but this time explicitly select the spring-music project within CloudFoundryStudentFiles. IntelliJ should know automatically it is a gradle project so just click Next and then Finish. Import may take a while. When prompted, ask for the project to be added to a New Window.

8. Register a GitHub account (optional, recommended).

Go to <https://github.com> and signup for a free account. If you already have a GitHub account, you can skip this step. If you are not familiar with git, this step can be ignored.

Congratulations! You have setup everything you will need for the rest of the course. The hard part is over!

Chapter 2. Treasure Hunt

2.1. Introduction

In this lab you will look at various aspects of Cloud Foundry by using the *online documentation*. There is no coding required and you will not actually be using Cloud Foundry. This is just a "treasure hunt" to become familiar with the documentation.

Goals

What you will learn:

- Explore Cloud Foundry and Pivotal CF documentation sites

Estimated time to complete: 25 minutes

2.2. Resources

Open the following URLs in a browser:

- <http://docs.cloudfoundry.org/>
- <http://docs.pivotal.io/pivotalcf>
- <http://docs.run.pivotal.io>

Create bookmarks / favorites in your browser for each one of these.

2.3. Steps

Answer the following questions based on <http://docs.cloudfoundry.org> - note that most of these concepts have not yet been discussed in class:

1. What languages / frameworks does Cloud Foundry appear to support (see “buildpacks”)?
2. What kinds of things can be specified in a “Manifest”?

3. When designing applications for the cloud, what are some practices to avoid? (Hint: see section on "App design for the cloud")
4. What are the names of some of the architectural components within Cloud Foundry?
5. What are some of the “log types” that you can expect to find in Cloud Foundry logs?

Answer the following questions based on <http://docs.pivotal.io/pivotalcf/> - note that many of these concepts have not yet been discussed in class:

6. What kinds of things can be defined in the “Apps Manager”?
7. What is the purpose of a “Buildpack”?

Answer the following questions based on <http://docs.run.pivotal.io> - note that many of these concepts have not yet been discussed in class:

8. What kind of services are presently available in the services marketplace?
9. BONUS When building a custom buildpack, what is the purpose of the “DETECT” script?
- 10.BONUS: If you were to “push” a new web application named “weeble” to Pivotal web services, what URL could you use to access it?

(Answers are in the appendix)

Chapter 3. Deploy an Application Using the CLI

3.1. About this Lab

Goals

What you will learn:

1. Push a simple Java/Spring application to Cloud Foundry
2. Observe and scale a running application
3. You need to know the three URLs for either your Cloud Foundry installation or for PWS. Refer back to the presentation for details on the *System Domain*, *Apps Domain* and *Apps Manager* URLs.

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or Pivotal Web Services)
- The Cloud Foundry student files
- The CCloud Foundry CLI installed

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 30 minutes

3.2. Steps

3.2.1. Connect

Check setup and login to your Cloud Foundry instance.

1. Open a command prompt on your system. Run the `cf` command. If you do not see a detailed output of Cloud Foundry commands, return to the prerequisites.

2. Use `cf login` to connect to Cloud Foundry

- a. Use the `-a` option to specify the “api” of the Cloud Foundry instance you wish to connect to. For Pivotal Web Services, this is api.run.pivotal.io. For a private CF installation you will need to find out what the System Domain URL is - this is installation dependent. Once you know the System Domain, then the API URI is `api.<system-domain>`.
- b. Do NOT use the `-p` option for password. Instead, let the interface prompt you for your password.

3.2.2. Push

Push the Spring Music application.

3. Change folders to the location where you downloaded the `CloudFoundryStudentFiles` and go into the `spring-music` folder.
4. Run the `cf push` command to push this application to Cloud Foundry
 - a. Use any value you like for the application name. We suggest something brief and easy to type.
 - b. Use the `-n` option to specify the host. This value must be unique within the domain used by Cloud Foundry.
 - c. Use the `-p` option to specify the package to upload. This is a Java application, and a WAR file has already been built for you. It is located in “pre-built/spring-music.war”.
5. Observe the push log output. Can you identify the different stages of the process?

3.2.3. Observe

4. When the process is complete, identify the URL of the application. Open a browser and connect to this URL to make sure that the application comes up.
5. Run the `cf logs` command for your app.
6. Return to the browser, click the links, make changes to the data, then return to the command line and observe the generated log activity.

3.2.4. Scale

7. Open the Apps Manager associated with your Pivotal CF instance. For Pivotal Web Services, this is at <http://run.pivotal.io>. For a private CF installation you will need to find out what the System Domain URL is - this is installation dependent. Once you know the System Domain, then the Apps Manager URI is `console.<system-domain>`.
8. Login and navigate to the organization and space that your application was pushed to.
9. Open the details page associated with your application. Change the number of instances to 4 and save your changes. From the browser, refresh the application's web page repeatedly and notice that the application does not go down while it is being scaled. Return to the command prompt and observe the activity that occurs as Cloud Foundry scales your application horizontally.
10. Back on the Apps Manager, scroll down to the "instances" section to observe the running instances.
11. Scale back to 1 instance.
12. Unless you have time to do the bonus below, stop the app.

Congratulations, you have completed this exercise! If you have time, look at the bonus.

3.2.5. Bonus

There are other application properties we can modify. Change the memory settings, and experiment with adding / removing routes.

When you are done, stop the application.

Chapter 4. Deploy an Application Using Eclipse or STS

4.1. About this Lab

Goals

What you will learn:

- Use an IDE to deploy an application
- Push a simple Java/Spring application to Cloud Foundry
- Observe a running application

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- An IDE installed (with Cloud Foundry support) - Eclipse or STS may be used.



Note

If you wish to use IntelliJ, you may, but the instructions below are all Eclipse specific.

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 30 minutes

4.2. Steps

4.2.1. Check IDE

Open your IDE. Make sure that you have a “Cloud Foundry” Server and that you have imported all of the lab projects, specifically the `spring-mvc-demo` project. If you are missing either of these, please return to the Setup lab and make sure you complete the later steps on "Add a “Cloud Foundry” Server" and "Import projects into your IDE".

4.2.2. Deploy

Deploy the `spring-mvc-demo` project on Cloud Foundry.

1. Select the `spring-mvc-demo` project (there may be an outer folder, if so open the folder to find the project within it).
2. Drag the `spring-mvc-demo` project and drop on the “Pivotal Cloud Foundry” server. (Or, right-click on the project, select Run As / Run on Server, and select the Cloud Foundry server)
3. When prompted, enter a name. We recommend you choose a short name that is easy to type when working with CF’s command line interface. Leave “buildpack” empty, and check “Save to Manifest”. Next.
4. Alter the value of subdomain. The default value (based on application name) is unlikely to be unique within the `cfapps.io` domain, so create a longer name by prefixing/suffixing `spring-mvc-demo` with another value, such as your initials or name, such as `keyser.soze.spring-mvc-demo` - the goal is to make Deployed URL unique across the entire `cfapps.io` domain. Click Next.
5. Click “next” through the remaining screens. You won’t need to change any values, but note the type of things that can be controlled during deployment.



Note

A 400 error encountered at this stage typically indicates a non-unique application name. Remove your application and try to create a unique name.

4.2.3. Observe the running application

1. Double click on the “Pivotal Cloud Foundry” server. Go to the “Applications and Services” tab. Click on your `spring-mvc-demo` application.
2. Click on the “Mapped URLs” link to see your application. If desired open your app in another browser.
3. Note the Apps Manager is updated with the application’s activity.

If you have reached this point, congratulations, you have completed the lab!

4.3. Bonus

If you have time, see if you can complete the following:

1. Scale the application:
 - a. In the console view, use the “close console” button to close all consoles that may be open. There may be several open, so click this button several times.
 - b. Change the number of instances from 1 to 2. Click Restart.
 - c. Note the “Instances” section is updated with two running instances (it may take a moment for both instances to restart).
 - d. Right click on one instance and select “Show Recent Logs”
 - e. In the console view, you will see the logs for the instance you selected. Now right-click on the other instance. The console will refresh with its logs.
 - f. Unfortunately you cannot view the logs for more than one instance at a time. In the browser, refresh the web page. By fetching the logs for each instance in turn, see if you can determine which instance handled the request
 - g. Change instances back to 1. You should see a message in the console telling you an instance is stopping. After a while only one instance should remain in the Instances table.
2. Explore the manifest.
 - a. Find the “Manifest” prompt and click the “Save” button. Click “OK” if prompted about merging.
 - b. Right-click the spring-mvc-demo project and select Refresh. Notice that a “manifest.yml” file is now present within the project.
 - c. Open manifest.yml. Explore the settings and format of this file.
3. Alter memory setting.
 - a. Within Your IDE, alter the memory allocation for spring-mvc-demo to 128 MB. Note that this will not be enough memory to run the application.
 - b. Click Update and Restart. Observe the console to see what kinds of problems will be reported. Does the

application ever start? Do you get a clear message about memory?

Chapter 5. Logging and Troubleshooting

5.1. About This Lab

Goals

What you will learn:

- Become familiar with accessing / reading logs
- Diagnose application problems using CF tools

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The Cloud Foundry CLI installed
- Optionally: an IDE installed (with Cloud Foundry support)

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 20 minutes

5.2. Steps

In this section you will push an application to Cloud Foundry that has a fatal flaw. By accessing logs you will attempt to diagnose the issue, repair the application, and re-push.



Warning

If you have trouble viewing logs and events using `cf` commands, view the logs in the Apps Manager console instead. This is usually due to proxy or firewall restrictions on the websocket port 4443. The typical errors are:

```
Error dialing loggregator server: dial tcp 1.2.3.4:4443: connection timed out.
```

```
websocket.Dial wss://loggregator.run.pivotal.io:4443/tail/?... connection timed out.
```

5.2.1. Debugging Push Problems - IDE Users

If you prefer to use an IDE, continue with this section. If you prefer to use the `cf` command-line interface, skip to the [next section](#).

1. If you have not done so already, import the `cf-spring-mvc-trouble` project into your IDE.
If you have any other projects open, you might like to close them all so you don't work with the wrong project by mistake.
2. Deploy the `cf-spring-mvc-trouble` application on Cloud Foundry
 - a. Be sure to alter the value of subdomain to produce a unique route.
 - b. Watch the console / log output carefully during the deployment. Note that the application appears to be having difficulty starting. Run the following commands to see if you can diagnose the issue (replace “[app]” with your application’s name):

```
i. cf events [app]
```

```
ii. cf logs [app] --recent
```

```
iii. cf logs [app]
```

If you are having problems with `cf logs` - see warning at start of section.

3. Once you have a general feeling for the problem, return to the IDE and examine this Java class: `gopivotal.cf.workshop.Config` - an easy way to do this is to use Ctrl-T or Cmd-T to popup the Open Type dialog and enter `Config` - pick the `Config` class in the current project. Find the lines of code marked with the “BAD CODE” comment.

This is a Spring application and the `@PostConstruct` method is automatically called on startup. Do you see why it is failing?

4. Comment out the code that is causing the problem. (Java comments are lines starting with the “//” characters.) Save your work (File / Save), return to the “Pivotal Cloud Foundry” tab, and use “Update and Restart” to repush and restart the application.



Note

When using an IDE (Eclipse/STS/IntelliJ) there is no need to ‘build’ the application. Saving causes an automatic build on any modified files.

5. The application should now start successfully. Run the `cf events` and `cf logs` commands again and note the differences in the logged output.

Congratulations, you have finished this exercise.

5.2.2. Debugging Push Problems - Using `cf`

In this section we will do the lab using the `cf` utility.

1. In your terminal or command window, make sure that `CloudFoundryStudentFiles/cf-spring-mvc-trouble` is the current directory.
2. Deploy the `cf-spring-mvc-trouble` application on Cloud Foundry. There is no manifest so you will need to specify the `-i`, `-m`, `-n` and `-p` flags. The application you need to deploy is `pre-built/cf-spring-mvc-trouble-0.0.1-SNAPSHOT.war`.
 - a. Be sure to specify the value of subdomain (`-n` option) to produce a unique route.
 - b. Watch the console / log output carefully during the deployment. Note that the application appears to be having difficulty starting. Run the following commands to see if you can diagnose the issue (replace “[app]” with your application’s name):

i. `cf events [app]`

ii. `cf logs [app] --recent`

iii. `cf logs [app]`

If you are having problems with `cf logs` - see warning at start of section.

3. Once you have a general feeling for the problem, examine the Java code in the following file:
`gopivotal.cf.workshop.Config.java`. An easy way to do this is to enter
 - `more src/main/java/com/gopivotal/cf/workshop/Config.java` (Linux/MacOS)
 - `more src\main\java\com\gopivotal\cf\workshop\Config.java` (Windows)

in your command/terminal window to view the file. Use the tab key auto-complete feature to avoid typing the path in full. Or feel free to use the editor of your choice.

Note the lines of code marked with the “BAD CODE” comment:

```
@PostConstruct
public void consumeAllMemory() {

    //      TODO: LOOK HERE!  LOOK HERE!  LOOK HERE!
    //      BAD CODE!    BAD CODE!    BAD CODE!
    //      The code you see here will consume all available memory allocated
    //      to the application instance. Comment out this code and re-push

    List<Double> list = new ArrayList<Double>();
    while (true) {
        list.add(Math.random());
    }
    //      End of bad code.
}
```

This program has been deliberately setup to fail - the `consumeAllMemory` method sits in an infinite loop until all memory is consumed and the application fails to start.

4. Lets assume you contacted a developer colleague and got them to remove the offending code. The new application is `pre-built/fixed-cf-spring-mvc-trouble-0.0.1-SNAPSHOT.war`.

Rerun your `cf push` command but specify this file instead (using the `-p` option).

5. The application should now start successfully. Run the `cf events` and `cf logs` commands again and note the differences in the logged output.

Congratulations, you have finished this exercise.

Chapter 6. Manifests and Environment Variables

6.1. About This Lab

Goals

What you will learn:

- Set application behavior via manifest and CLI options
- Gain experience pushing and debugging applications

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The Cloud Foundry CLI installed
- An IDE installed (with Cloud Foundry support)

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 20 minutes

6.2. Steps

6.2.1. Setting Environment Variables

In this section you will set environment variables via the manifest and observe how they are accessed in (Java) code.

1. Open the `cf-spring-mvc-demo` folder and locate the manifest.



Note

STS does not use manifests when pushing so *you can only use the CLI to do the next few steps*.

2. Add an environment variable to the manifest using your favorite editor. Name the variable `EVTEST` and give it the value `FromManifest`. Save your work.
3. Push the `cf-spring-mvc-demo` application to Cloud Foundry *using the cf CLI*.
4. If you understand Java code and Spring MVC Controllers, while the application is being pushed, examine the logic in the `CloudFoundryWorkshopController` Java class. Specifically look at the `environment()` method to see how `System.getenv()` is used to obtain the variables.

Also open the `env.html` page (under `src/main/resources/templates`) and see how the `environmentVariables` are accessed and put in the page using Thymeleaf markup.

5. Once the application has started, access the main page, then select the `Environment Variables` menu. The `EVTEST` variable should be present and set to `literal>FromManifest`.

6.2.2. Optional - Scaling Application Instances

In this section you will scale the application to multiple instances and note the effect.

1. Using either your IDE, CLI, or Apps Manager, alter the number of instances to 2.
2. When scaling is complete, access the main page of the web app. Note the value of the application's port. Use the browser's refresh button several times. Does the port value remain the same?
3. Using the CLI or STS, tail the logs for this app. Refresh the home page several times. Do you see entries for both `App/0` and `App/1`?



Note

If you are unable to run `cf logs` due to proxy or firewall restrictions, view logs in Apps Manager instead.

4. Scale instances back to 1. (You will find this is much quicker using the CLI or Apps Manager)

5. Stop the application.

Congratulations, you have finished this exercise.

Chapter 7. CloudFoundry Services

7.1. About this Lab

In this lab, you'll practice creating, binding and managing services using both the CLI and Apps Manager.

Goals

What you will learn:

- Bind a service to an application

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The CCloud Foundry CLI installed
- Optional: An IDE installed (with Cloud Foundry support). This lab can be done using the CF utility only.
- Additionally, the "Spring Music" application should have already been pushed to Cloud Foundry. Push it now if needed. See the earlier lab "Deploy an Application Using the CLI" if you need guidance.
- Finally, you will need some database client software to connect to the new database that you will provision. Many JDBC compatible tools are suitable. Some suggestions are DBVisualizer (<http://www.dbvis.com/>), SquirrelSQL (<http://squirrel-sql.sourceforge.net>), HeidiSQL(<http://www.heidisql.com/>), JackDB (<https://www.jackdb.com>). JackDB is especially useful if your firewall prevents you from making connections to databases in the public cloud. Install / use the tool of your choice.

Estimated time to complete: 30 minutes

7.2. Steps

1. Obtain a listing of all of the services / plans available in the marketplace. This listing can vary depending on the Cloud Foundry environment you are connected to:

```

kkrueger-mbp15:~ kkrueger$ cf marketplace
Getting services from marketplace in org kkrueger-net / space development as kkrueger@gopivotal.com...
OK

```

service	plans	description
blazemeter	free-tier, basic1kmr, pro5kmr, pp10kmr, hv40kmr	The JMeter Load Testing Cloud
cleardb	spark, boost, amp, shock	Highly available MySQL for your Apps.
cloudamqp	lemur, tiger, bunny, rabbit, panda	Managed HA RabbitMQ servers in the cloud
cloudforge	free, standard, pro	Development Tools In The Cloud
elephantsql	turtle, panda, hippo, elephant	PostgreSQL as a Service
ironmq	pro_platinum, pro_gold, large, medium, small, pro_silver	Powerful Durable Message Queueing Service
ironworker	large, pro_gold, pro_platinum, pro_silver, small, medium	Scalable Background and Async Processing
loadimpact	lifree, li100, li500, li1000	Automated and on-demand performance testing
memcachedcloud	25mb, 100mb, 250mb, 500mb, 1gb, 2-5gb, 5gb	Enterprise-Class Memcached for Developers
mongolab	sandbox	Fully-managed MongoDB-as-a-Service
newrelic	standard	Manage and monitor your apps
rediscloud	25mb, 100mb, 250mb, 500mb, 1gb, 2-5gb, 5gb, 10gb, 50gb	Enterprise-Class Redis for Developers
searchify	small, plus, pro	Custom search you control
searchly	small, micro, professional, advanced, starter, business, enterprise	Search Made Simple. Powered-by Elasticsearch
sendgrid	free, bronze, silver, gold, platinum	Email Delivery. Simplified.

Figure 7.1.

2. Provision a new MySQL service instance. On PWS this service is known as “cleardb”.
 - a. Use the “spark” plan since our storage requirements are modest.
 - b. Give the service any name you like, but remember the name for later.

```

kkrueger-mbp15:~ kkrueger$ cf create-service cleardb spark mydb
Creating service mydb in org kkrueger-net / space development as kkrueger@gopivotal.com...
OK

```

Figure 7.2.

3. Bind spring-music to the service you have just provisioned. If you don't know where to get "Spring Music" ask your Instructor.

```

kkrueger-mbp15:~ kkrueger$ cf bind-service smkk mydb
Binding service mydb to app smkk in org kkrueger-net / space development as kkrueger@gopivotal.com...
OK
TIP: Use 'cf push' to ensure your env variable changes take effect

```

Figure 7.3.

4. Restage the app to make sure it uses the new service instance.
5. Use a browser to open the application’s URL. Navigate through the application and see there is data there. (Note that this application has an ‘embedded’ database that is used when no other DB is available, this is why it worked before the service was bound. So how can we tell if it is using the ‘bound’ database or the

‘embedded’ database? Next step...)

6. Obtain the DB credentials. You can do this via the Apps Manager: Find the details of your application, go to Bound Services, click on credentials.
7. Open your database client, create a MySQL connection and point it to the MySQL you just provisioned. Examine the table data containing the music albums.



Note

To do this step, the default MySQL port 3306 must be accessible. Your company firewall may block access to this port.

8. Alter the music data using your database client. Refresh the web page and notice the changes are present. Alternatively, alter the album data using the web application and use the database client to observe the changes.

Congratulations, you have finished this exercise.

Chapter 8. Using a Buildpack

8.1. About this Lab

In this lab you will learn how to deploy a Static HTML site by using an external buildpack.

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The Cloud Foundry CLI installed

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 15 minutes

8.2. Steps

Pushing a Static HTML Application

In this section you will push an existing static HTML application to Cloud Foundry. CF does not have a built-in buildpack for static HTML sites, so you will need to specify an external buildpack that utilizes Nginx.

1. Locate the `cf-static-demo` folder in `CloudFoundryStudentFiles` on your file system.
2. Edit the `manifest.yml`. Give your application a unique host, and specify `https://github.com/cloudfoundry-community/staticfile-buildpack.git` as the buildpack.
3. Use CLI `cf push` to push the application to your Cloud Foundry environment.



Note

Some administrators may choose to disallow external buildpacks, in which case you cannot specify an alternate selection. If this is the case in your environment, you may simply use Pivotal Web Services for this exercise.

4. When the push is complete, use a browser to access your running application. If it is not running, attempt to debug using `cf logs <app>--recent` and other techniques.

Congratulations, you have finished this exercise.

Chapter 9. Customizing a Buildpack

9.1. About this Lab

Goals

What you will learn:

- Fork the Java buildpack to make a minor change.

Prerequisites

To complete these steps you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- Either the Cloud Foundry CLI or an IDE installed (with Cloud Foundry support)
- Most importantly: a GitHub account. *Unlike other labs, a github account is **mandatory** for this lab.*

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 30 minutes

9.2. Steps

Forking the Java Buildpack

In this section you will fork the Java buildpack, make a minor change to the desired Java version, then use your modified buildpack to push an application to Cloud Foundry, and observe the results

1. Push the spring-mvc-demo application to Cloud Foundry (if needed)
 - a. Use either the CLI or Eclipse/STS, whichever you find most convenient. If you use Eclipse/STS it would be best to save a manifest file for the later steps.

- b. Observe the console output during the push process. Note the version of Java being used. Our goal in this lab will be to specify a different Java version.
2. Fork the Java Buildpack.
 - a. Using a browser, go to <https://github.com/cloudfoundry/java-buildpack> (if you are not signed into GitHub, do so now).
 - b. Click the “Fork” button to create a fork of this repository under your own GitHub account. (You may clone a copy of this repository locally, though it is not necessary for the steps here)
3. Alter the Java version
 - a. While still in the browser viewing your forked copy of the Java buildpack, drill-down to `config/open_jdk_jre.yml`. Click the edit button to modify this file in place.
 - b. Find the line (near line 20) that indicates the Java version: `version: 1.8.0_+`
 - c. Alter this line to deliberately specify an older Java version: `version: 1.8.0_31`
 - d. Save your work using the ‘Commit’ button.
4. Re-push the application using the altered Buildpack
 - a. This step is performed differently depending on whether you have an existing manifest file or not. Assuming you do:
 - i. Alter the manifest file. Add a line to indicate you new buildpack (change “yourGitId” and “java-buildpack” as needed to match). Be sure your indentation is correct:

```
buildpack: https://github.com/[yourGitId]/[java-buildpack]
```
 - ii. Re-push the application. If using Eclipse ensure that it is picking up the values you specified in the manifest.
 - b. If you did not have a manifest file, and you used the CLI, repush using the `-b` option to specify the buildpack (alter “yourGitId” and “java-buildpack” as needed):

```
-b https://github.com/[yourGitId]/[java-buildpack]
```
 - c. Observe the console output during the push process. Note the version of Java being used. It should be the version you specified above.

Congratulations, you have finished this exercise.

Chapter 10. Integrating with 3rd Party Log Management Tools

10.1. About this Lab

Setup a Syslog drain to a PaperTrail, third-party log management solution.

10.2. Prerequisites

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 25 minutes

10.3. Setup PaperTrail

1. Go to <https://papertrailapp.com> and establish a free trial account.
2. Once logged in, use "Add a Project" to create a new project. Give the project any name you like, such as "PWSLogDrain". Follow the instructions at <http://docs.cloudfoundry.org/devguide/services/log-management-thirdparty-svc.html#papertrail> to setup your project with the correct IP addresses.

10.4. Create and Bind User-Provided Service

1. Create a user-provided service using the command `cf cups log-drain -l syslog://<URL-FROM-PAPERTRAIL>`, replacing `<URL-FROM-PAPERTRAIL>` with the value provided by Papertrail. You may name the service whatever you like.
2. Bind the service to any of your existing applications used in prior labs.
3. Restart the application.
4. Access the URL of your application and generate logging activity. This varies depending on the application you are using; click on available links, refresh the web page, etc.

10.5. View Log Output

1. Return to Papertrail. Use the "Dashboard" button to find the main log output. Experiment with the search feature at the bottom of the page, look for terms such as "GET" or "hibernate".

Chapter 11. Integrating with APM tools

11.1. About this Lab

Integrate multiple instances of a running application with a third-party Application Performance Monitoring tool.

11.2. Prerequisites

To complete these steps you will need a Pivotal Web Services account. Another Cloud Foundry environment may or may not work depending on the existence of the New Relic service in the marketplace. Typically, Pivotal CF does not include such a marketplace service. See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 15 minutes

11.3. Configure New Relic APM Service

1. From the PWS Apps Manager, go to the marketplace and provision a new New Relic service instance. Name the instance anything you like (suggestion: "new-relic").
2. Determine if you already have the spring-music app deployed on Cloud Foundry from an earlier lab. If not, push it now. Bind it to the "new-relic" service you just provisioned. Restage the application. Scale it to 2 instances.
3. Once the application starts, open it's URL in a browser. Refresh it several times. Notice that the instance index, id, and port changes depending on which of the 4 instances you are hitting.
4. Return to the PWS Apps Manager. From the list of services in your application's space, locate the new-relic service and click on the "Manage" link.



Note

New Relic will use OAuth for authentication, so you will be prompted with a login screen from Pivotal Web Services. Essentially, it is verifying with PWS the account information.

5. Agree to the New Relic terms of service, or temporarily defer.

6. You should now see a page that lists your Cloud Foundry applications (only one should be in the list at the moment, the spring-music). Click on this entry to obtain detailed monitoring information. (Note that it may take several moments for detailed logging information to appear.)
7. If you have reached this point, congratulations! You have successfully bound your application to an APM via a Cloud Foundry service. If you have time, investigate the APM's capabilities. (Note that the specific capabilities of the New Relic APM is outside the scope of this course.)

Chapter 12. Blue/Green Deployment

12.1. About this Lab

Goals

What you will learn:

- Practice performing a zero-downtime deployment

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The CCloud Foundry CLI installed

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for setup details. Note that the instructions are written from the perspective of Pivotal Web Services, but will function with on any CF instance with minor adjustment.

Estimated time to complete: 20 minutes

12.2. Steps

12.2.1. Push "Blue"

Push the cf_bluegreen application to Cloud Foundry using the CLI (do not use an IDE for this first step).

1. Give your app the name "blue" for the application's name. 512M should be sufficient.
2. Give your app a host name of "XXX-always-available", except replace "XXX" with some value to ensure a unique route. Remember this host for later steps.

3. For the path, specify the "pre-built/blue.war". (This WAR file has been built for you using Maven and the project's source files.)
4. After the application starts, open a browser and access the app: `http://xxx-always-available.cfapps.io` (except using the URL based on your host name). Notice the large blue box on the screen. Leave this browser window open.

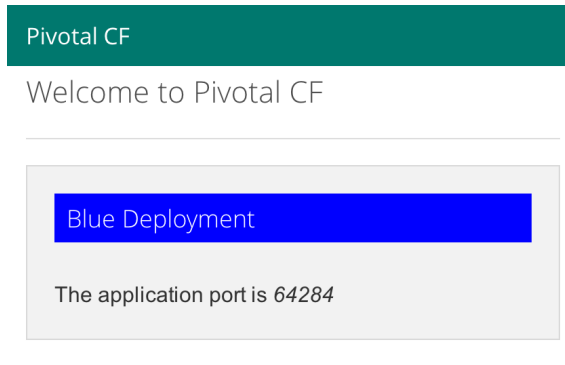


Figure 12.1.

12.2.2. Alter the application

1. Using your IDE, open the `src/main/resources/templates/index.html` page.
2. Find the tag containing "Blue Deployment". Comment this tag out using XML comment `<!-- -->` tags.
3. Notice the tag containing "Green Deployment" that is presently commented out. Remove the comments. Save your work.
4. If using Eclipse, the application will be built for you automatically and you are ready for the next step.

12.2.3. Push "Green"

Push a separate copy of the `cf_bluegreen` application to Cloud Foundry

1. For this step, we recommend you use an IDE to avoid the need to build the Java application. If you prefer to

use the CLI, you will need to build the application using Maven, which you may not have installed ("mvn clean install" is the command). If for any reason you cannot build the application, an existing WAR "green.war" is available for you in the pre-built sub folder.

2. Push the app using "green" for the application's name. 512M should be sufficient. As always, make sure your deployed URL is unique by customizing the host.
3. After the application starts, open a separate browser window/tab and access the green app via its route. Notice the large green box on the screen.

12.2.4. Alter Routes

1. Return to the original browser window/tab. Refresh it multiple times, notice it is still pointing to the old 'blue' deployment.
2. Using either the CLI, IDE, or Apps Manager, map the same "XXX-always-available" to the "green" app. IF using the CLI you may receive a warning that the route is already in use; this is expected.
3. Return to the original browser window/tab. Refresh this page several times. Notice that the same route alternates randomly between the 'blue' and 'green' apps; this is expected since the route is temporarily mapped to both applications.
4. Alter the blue app by removing its route.
5. Refresh the browser. The browser is now pointing to the new green instance with no downtime.

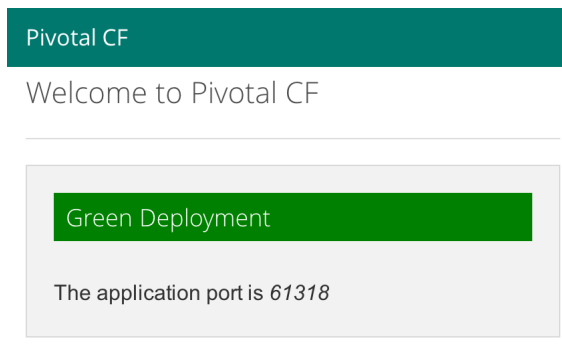


Figure 12.2.

The conclusion: no downtime would be experienced by any user of the `cf_bluegreen` application when accessed via its "always-reliable" route. Congratulations! You have conducted a zero-downtime deployment! You can stop and/or delete both applications now.

Chapter 13. Continuous Delivery

13.1. About this Lab

Setup and run a basic Continuous Delivery pipeline with Git, CloudBees, and Cloud Foundry.

13.2. Prerequisites

To complete these steps you will need a Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services) and a GitHub account. See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions. Unlike other labs, a github account is *mandatory* for this lab.

13.3. Setup Git Project

In this section you will fork an existing Java/Maven project into your personal GitHub repository. We will then use this project as something to deploy to CF via a Continuous Delivery pipeline.

1. Locate the “Cloud Foundry Environment Demo” example project on GitHub: <https://github.com/S2EDU/CloudFoundry-EnvironmentDemo.git>
2. Use the “Fork” button to make your own private copy of the project on your own GitHub repository.

13.4. Establish CloudBees Account

In this section you will setup a free trial account on CloudBees. Note that the trial is just for this course, courtesy of CloudBees Inc.

1. Signup for access to CloudBees: <https://grandcentral.cloudbees.com/login>. Setup your account using one of the options available.

After signing in, you should be taken to your new home page (see figure [below](#)). We are going to ignore the options on the page.

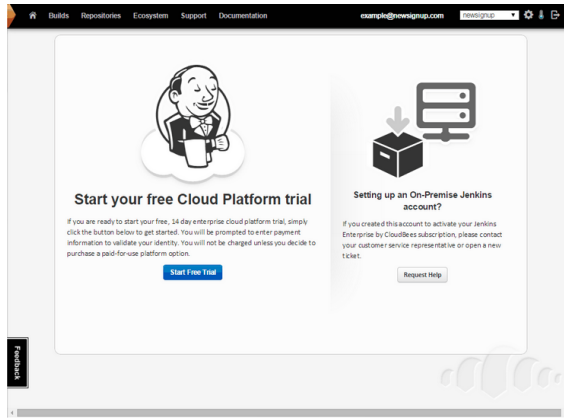


Figure 13.1. Initial CloudBees Home Page

2. In your browser, append `?trial_code=pivotal-edu` to the end of the URL. So for example, your home page URL will be something like `https://console.cloudbees.com/a/XXX/home` (where XXX is your organisation name)

Your modified URL will be `https://console.cloudbees.com/a/XXX/home?trial_code=pivotal-edu`. Hit enter to submit the new URL.

3. At this point a blue progress bar appears on the page and you should eventually be taken to the "real" home page looking like the figure below.



Warning

Registering for the trial often takes longer than the time to refresh the page. If the previous home page appears, wait a short while and click the house icon at top left of the page. Eventually it should say your trial has been accepted and take you to the home page like the figure below.

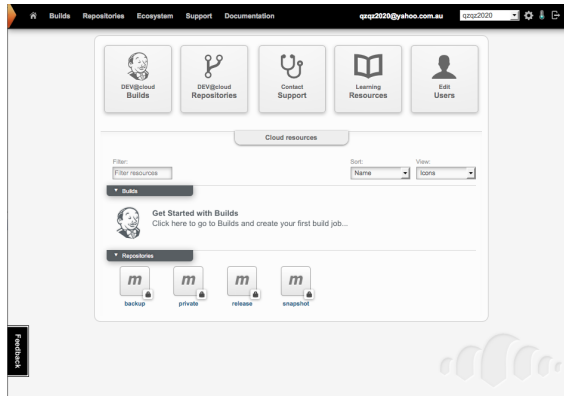


Figure 13.2. CloudBees Home Page

13.5. Integrate CloudBees with Cloud Foundry

Go to this URL: <https://cloudfoundry.cloudbees.com/index.html>. When requested, login using your Cloud Foundry account username and password. You will be prompted to allow this site to access your applications on Cloud Foundry - click **Accept**.

On the "Activate Your CloudBees Subscription" page there is a link at the bottom that reads *wait, I have an account, let me log in...*. Click it now and enter your username and password for the Cloud Bees account you just activated.

13.6. Establish CloudBees Account

In this section you will configure your CloudBees account to run the Continuous Delivery pipeline for your application.

1. Click the “Get Started with Builds” button. It will take CloudBees a bit of time to provision your account to do automated builds (don't worry if your browser takes several minutes to generate the next page). While it is running, you can read-ahead to familiarize yourself with the next few steps.
2. Within the CloudBees console, select “New Item” (at the top on the left hand side).

Give your build process a name. Indicate the “Build with Maven” option and click OK.

3. Under “Source Code Management”, select “Git”. Supply the “Repository URL”; this is found in GitHub on the main page of the project you just forked, look for the “HTTPS clone URL”. The syntax is typically “https://github.com/REPOSITORY/PROJECT.git”, where repository and project refer to your repository and the project.
4. Under “Build Triggers”, select “Poll SCM” and enter a schedule such as `H/5 * * * *`.
5. Add a “Post Build Action”.
 - a. Be sure to choose “Post Build Action”, not “Post Build Steps”!
 - b. In the drop-down select “Deploy Application”.
 - c. If there is a Host Service called “CloudBees RUN@cloud service”, remove it.
 - d. Under the Cloud Foundry section, indicate “Target API end-point”. For PWS this is `https://api.run.pivotal.io`
 - e. Enter the credentials for your account, typically this is an email address.
 - f. Select the org and space in which you want to run.
6. Within the Cloud Foundry section, specify a New Application.
 - a. Give your app a name and deployment URL. The name is synonymous with the app name specified in the CLI or manifest. The deployment URL should be the app name suffixed with the domain, for example “cfapps.io” when using PWS. Keep uniqueness in mind when choosing a deployment URL.
 - b. Indicate 1 instance, 512 memory reservation.
 - c. No services or environment variables will be needed.
 - d. Select “start application on deployment”
7. Click “Save”

13.7. Launch a build manually

In this section you will have CloudBees run your build.

1. From your builds main page, click the “Build Now” link. This will launch a build immediately without waiting for an SCM change.
 - a. The build can take a while to launch and run as we are using the free plan.
2. When the build is complete, access the build console output. In Jenkins/Cloudbees you can access this by clicking on the link for the build, then “Console Output”.
 - a. If there was a problem with the build this output should help you determine the cause.
 - b. If the build was successful CloudBees should report the URL of the deployed application at the bottom of the console output. Access this link to see your application running on Cloud Foundry.
3. If you have time, move onto the optional step below. Otherwise, to save resources, you may wish to:
 - a. Use the “Disable Project” in CloudBees to prevent unnecessary polling of your repository.
 - b. Access the Apps Manager and stop the application. You can delete it if you wish.

13.8. Trigger a Build via SCM (optional)

In this section we will see how Cloudbees can monitor our SCM repository and implement the Continuous Delivery pipeline automatically.

1. Return to your project’s location in GitHub. Commit a small change to cause a build to occur:
 - a. Access one of the web pages such as `src/main/resources/templates/index.html` .
 - b. Edit the page. You can do this from within GitHub itself, look for the small pencil icon.
 - c. Make a small change such as adding “hi there!” somewhere within the HTML body. Commit your change
2. Switch back to CloudBees. Monitor you project’s main page. Once enough time has elapsed, CloudBees will launch a new build. Based on the “schedule” entered earlier, this can take up to 5 minutes.
3. When the build is finished and the redeployment has occurred, you should see your change in the application.
4. Congratulations, you have finished this exercise! Disable your CloudBees build and stop your application as described in the earlier step.

Chapter 14. Session Management

14.1. About this Lab

In this lab you will learn how to enable an HTTP Session to survive instance failure

Prerequisites

To complete these steps, you will need a Cloud Foundry account, the Cloud Foundry student files, the Cloud Foundry CLI installed, and an IDE installed (with Cloud Foundry support). If you are missing any of these return to the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 20 minutes

14.2. Steps

You will be given an application that uses the `HttpSession` which will lose information if restarted. Then you will fix it in Cloud Foundry by adding a Redis session replication service.

14.2.1. Push

Locate the `cf-session-management` application and push it to Cloud Foundry. You may use CLI or Eclipse.

1. If using the CLI, edit the `manifest.yml` and specify a unique `host` (add your name or initials).
2. Once its running, go to its URL in the browser to see it working. The application is very simple. Enter a name and description (anything you like) and click "Submit". The name and description are displayed in the results page.
3. Refresh the page several times. Notice that the values are retained. You can examine the code if your are curious how the session is used.

14.2.2. Restart Application

1. Click on the "Stop!" link to kill the application (the code behind this actually kills the JVM, simulating a real application crash).

2. Go back to the previous page in the browser and refresh that page. You will get a CF error:

```
404 Not Found: Requested route ('cf-session-demo2.cfapps.io') does not exist.
```

3. Wait a moment for Cloud Foundry's Health Manager to notice the missing instance and cause it to be restarted. You can monitor the restart via the CLI, Eclipse plugin, or Apps Manager if you like.
4. Refresh the page again, note that the previously submitted data has been lost. This is expected since the session data is stored in memory; it is lost when the application instance stops. In the next steps we will use a service to cause the session data to be persisted external to the instance.

14.2.3. Bind the Redis session-replication Service

1. Using either the CLI, Apps Manager, or Eclipse, provision a new Redis service instance `session-replication`. You must use this name for the service instance to obtain the desired session behavior.

If you are running on PWS the service is called `rediscloud`. Select the 25Mb plan (its free!).

2. Bind the service to the application. You can do this via CLI, Apps Manager, or Eclipse.
3. Push the application to Cloud Foundry again. Though the application code did not change, we need to force the application to be restaged. (If using Eclipse you can use the "Update and Restart" button as a shortcut).



Note

You must run `cf push` again or the new service will not be used.

14.2.4. Retry Killing the Application

1. Return to your browser and check the application is working again. Go to the Home page and re-enter some name and description data.
2. Redo all the steps in [Section 14.2.2, "Restart Application"](#). However, this time the name and description should be retained by the Redis-backed session even after the application instance has been stopped.

14.2.5. Examine the Application

1. If you have time, take a few minutes to examine the application code. This is a Spring Boot application using

Spring MVC Controllers. You might like to look at the code to see how it works. In particular: `FormController` and `DisplayController`. The `FormController` loads values into the session and the `DisplayController` pulls them out.

The Spring Boot initialization class is `ConfigApplication` defines `main()` and `WebApplication` allows this application to also run as a WAR.

Congratulations, you have finished this exercise.

Chapter 15. Services and Environment in Java Applications

15.1. About this Lab

Goals

What you will learn:

1. Access Cloud specific application data

Prerequisites

To complete these steps, you will need:

- A Cloud Foundry account (either on your company's CF installation or on Pivotal Web Services)
- The Cloud Foundry student files
- The CCloud Foundry CLI installed
- An IDE installed (with Cloud Foundry support)

See the "Lab Setup" in the "Welcome, Agenda, and Setup" module for instructions.

Estimated time to complete: 20 minutes

15.2. Steps

In this lab you will implement a simple one-page web-site that displays information about the execution environment. By using Spring Profiles, the application should run both locally and on Cloud Foundry.

1. Import the `cf-cloud-info` application into your IDE as an existing Maven project (if you have not done so already). You will find it in the `CloudFoundryStudentFiles` folder.
2. There is no Cloud meta-data when running locally and no profile defined either. The profile "default" is activated automatically if no other profile is explicitly specified.

Look in `io.pivotal.cf.ConfigDefault` and you will see three Java Config `@Bean` methods defined. These return empty objects containing 'null' information when no cloud environment is detected. (TODO 01).

3. Run the application locally as a Spring Boot application - in Eclipse/STS right-click on the project and select `Run As ... -> Spring Boot App`. Then go to <http://localhost:8080>. You should see a page containing environment information, but the rest of the page below is empty. (TODO 02)



Note

If you are interested in the Spring Boot setup, look in `io.pivotal.cf.Application`. It's as simple as that!

4. Let's make this application cloud aware!

You need to modify the `io.pivotal.cf.CloudConfig` to return Cloud related information (TODO 03-06). This class should define the same beans `io.pivotal.cf.ConfigDefault` but use the `cloud` instance to get the data - invoke `cloud()` to get it.

5. Now look at the `io.pivotal.cf.web.InfoController` to see how this data is being used. (TODO 07). Thanks to the use of profiles, it has no knowledge of Cloud or otherwise.
6. Rerun the application locally as a Spring Boot application and check that it still works. If you have got your profile setup wrong you might get null-pointer errors because `cloud()` returns null.
7. If it works, deploy to Cloud Foundry and open the application URL in the browser. Make sure you specify a unique sub-domain (use your name, initials, anything). You should get a lot more information now. (TODO-08) Only Services is empty (we haven't bound any).
8. **BONUS:** Bind a service (any service, it won't be used) to the application and redeploy. Refresh the web-page in your browser and you should see some service information too. (TODO-09)
9. A worked solution is provided by the `cf-cloud-info-solution` project.

Congratulations, you have finished this exercise.

Chapter 16. Appendix: Treasure Hunt Solution

16.1. Answers

Here are the answers to the questions in the Treasure Hunt (documentation) lab:

1. Java, Node.js, Ruby, Go, PHP, Python.
2. Application name, buildpack, command, domain, instances, memory, host, timeout, anything described in: <http://docs.cloudfoundry.org/devguide/deploy-apps/manifest.html>
3. Avoid local file system, avoid Http session, avoid non-standard ports, avoid pushing unneeded files.
4. Router, Cloud Controller, DEA, health manager, ... See: <http://docs.cloudfoundry.org/concepts/architecture>
5. API, STG, DEA, RTR, LGR, APP, all defined here: <http://docs.cloudfoundry.org/devguide/deploy-apps/streaming-logs.html>
6. Orgs, spaces, users, ...
7. Allows you to extend CF to handle other languages and/or frameworks.
8. See: <http://docs.run.pivotal.io/marketplace/services> - cleardb, cloudamqp, elephantsql, mongolab, newrelic, sendgrid, etc.
9. Detects whether or not a buildpack can be applied to a given application.
10. `weeble.cfapps.io`