DEVOPS

Build, Test and Deploy a REST API with Azure DevOps

LES JACKSON 10TH MAR '19 2

Intro

Use Azure Devops pipelines with Github to continuously integrate and deploy a .Net Core REST API to Microsoft Azure.

What You'll Learn

By the end of this article you'll understand:

- What is “Azure DevOps”?
- Alternatives to Azure DevOps, (and Github and Azure!)
- How to connect Github and Azure to Azure DevOps
- How to configure the Azure DevOps Pipelines
- How to continuously integrate and deploy to a production Azure site

Ingredients

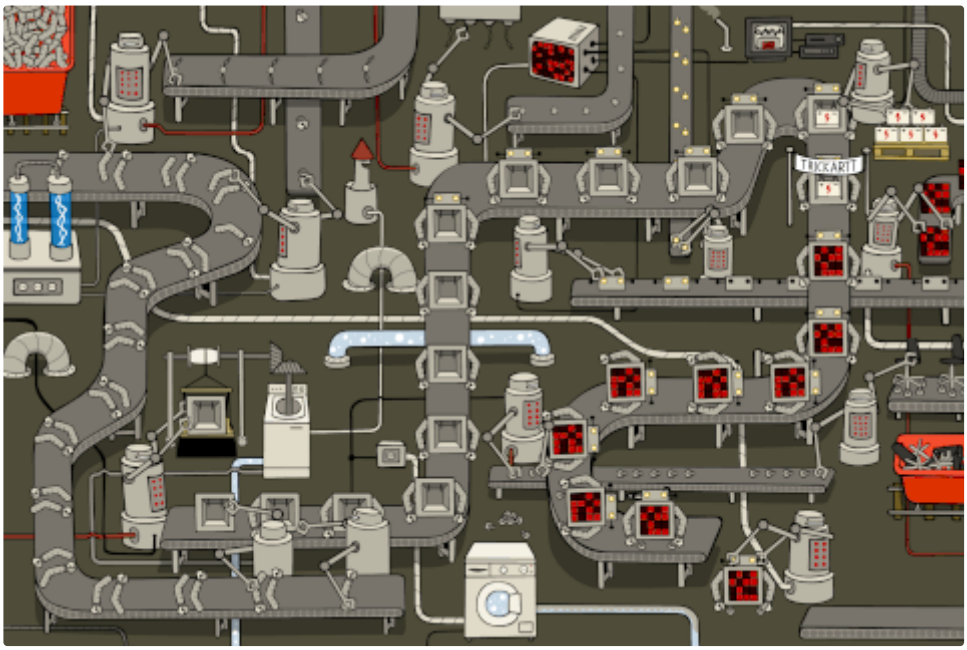
If you want to follow along with the examples in this tutorial you’ll need the following, (note everything is free unless stated otherwise):

- **Visual Studio Code**
- **.Net Core SDK**
- **Postman** (Optional you can just use a web browser)
- **Azure Subscription** (Free sign up. Mix of free and paid services)
- **Azure DevOps Account** (Free for individuals)

What is CI/CD?

Before we talk about specific technologies, (in this case Azure DevOps), we should take a minute to understand CI/CD concepts in general...

To talk about CI/CD, (don’t worry we’ll come onto what it stands for in a minute), is to talk about a pipeline of work”, or if you prefer another analogy: a production line, where



Clearly, this process will include a number of steps, most, (if not all), we will want to *automate*.

It's essentially about the faster realization of *business value* and is a central foundational idea of *agile software development*. (Don't worry I'm not going to bang that drum too much).

> *You could argue, (and in fact I would!), that the *business requirements* are the starting point of the software "build" process. For the purposes of this article though, we'll use code as the start point of the journey.

Enough! What IS CI/CD?

merging those changes back into the main code “branch” by building and testing that code. As the name would suggest this process is continuous, triggered usually when developers “check-in” code changes to the *code repository*.

The whole point of CI is to ensure that the main, (or master), code branch remains healthy throughout the build activity, and that any new changes introduced by the multiple developers working on the code don’t conflict and break the build.

CD can be a little bit more confusing... Why? We’ll you’ll hear people using the both the following terms in reference to CD: *Continuous **Deployment***, and *Continuous **Delivery***.

What’s the difference?

Well, if you think of Continuous Delivery as an extension of Continuous Integration it’s the process of automating the *release process.* It ensures that you can deploy software changes frequently and at the press of a button. Continuous Delivery stops just short of automatically pushing changes into production though, that’s where Continuous Deployment comes in...

Continuous deployment goes further than Continuous Delivery, in that code changes will make their way through to production without any *human intervention*, (assuming there are no failures in the CI/CD pipeline, e.g. failing tests).

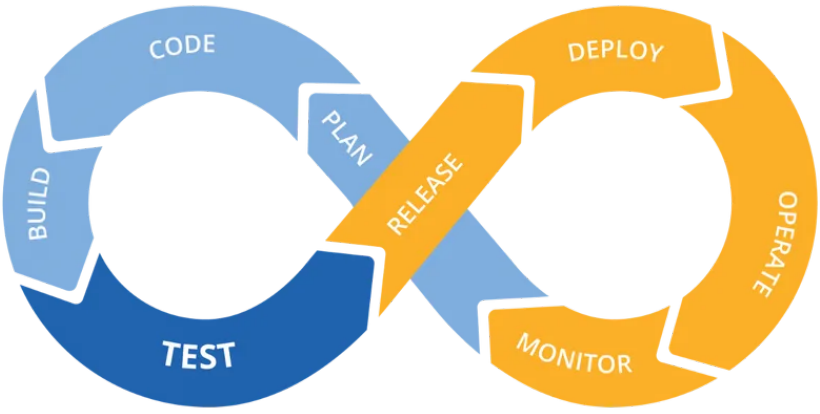
So which is it?

deploy software into production is a business decision, so the idea of Continuous Deployment is still overwhelming for most organizations....

The Pipeline

Google “CI/CD pipeline” and you will come up with a multitude of examples, I however like this one:

You may also see it depicted as an “infinite loop”, which kind of breaks the pipeline concept, but is none the less useful when it comes to understand “DevOps”:



The DevOps Infinite Loop

Coming back to the whole point of this article, (which if you haven’t forgotten is to detail how to use Azure DevOps), we are going to focus on the following elements of the pipeline:

Pipeline Stages we'll focus on

What is "Azure DevOps"?

Azure DevOps is cloud-based collection of tools that allow development teams to build and release software. It was previously called "Visual Studio Online", and if you are familiar with the on-premise "Team Foundation Server Solution", it's basically that, but in the cloud... (an over-simplification – I know!)

For this article we are going to be focusing exclusively on "pipeline" features it has to offer, and leave the other aspects untouched, (for now).

Alternatives

There are various on-premise and cloud based alternatives: Jenkins is possibly the most "famous" of the on-premise solutions available, but you also have things like:

- Bamboo
- Team City
- Werker
- Circle CI

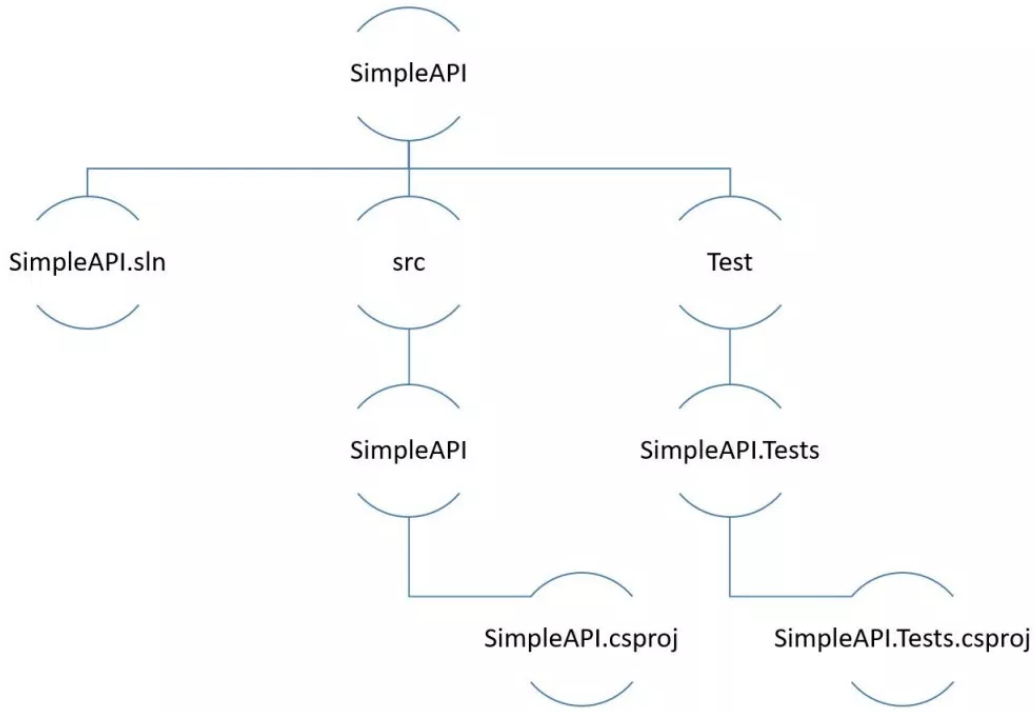
That list is by no means exhaustive, but for now, we'll leave these behind and focus on Azure DevOps!

Our API Solution

perfectly decent in proving out the concepts we need to.

Additionally we're going to create an XUnit Project to contain our unit tests, again these will be trivial, (this is not an article on unit testing), but again will be fully functional and demonstrate the core concept of automated testing in a CI/CD pipeline.

We'll "wrap" these 2 projects in a "solution", the folder structure of which is shown below:



Project Directory Structure

Create Our Solution Components

Note: it is assumed that you have the .Net Core SDK already installed, (if not refer back the **Developing a REST API with ASP.Net Core** article for more detail on this and other set up requirements).

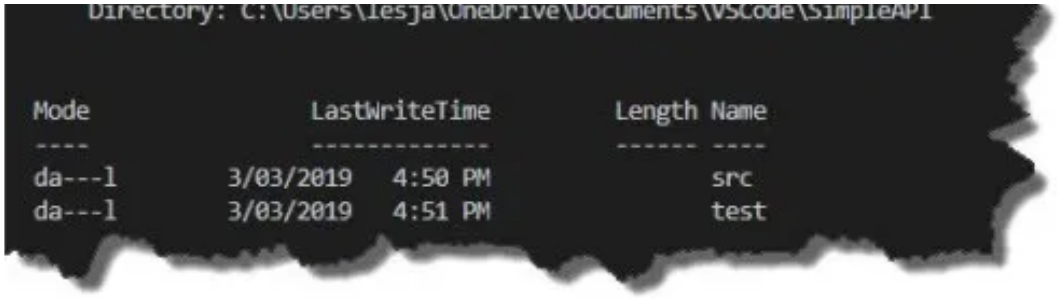
- Create 2 sub directories in here, named “src” and “test”
- Open a command prompt and change into the “src” directory
- Issue the following command

```
dotnet new webapi -n SimpleAPI
```

- This should create a sub folder, (SimpleAPI) in “src” containing our template API project
- Change into the “test” directory created above and issue the following command:

```
dotnet new xunit -n SimpleAPI.Tests
```

- This should create a sub folder, (SimpleAPI.Tests) in “test” containing our template Test project
- In the command window, change back into the main solution folder, (perform a directory listing to be sure) – you should see:



Note: I'm using the terminal within VSCode that will respond to the "ls" command, the standard Windows Command Prompt will not- you'll need to use "dir". (Linux / Max users you'll be fine though!)

- Now issue the following command to create a solution file, (this is not strictly necessary but I like to have one for various reasons)

```
dotnet new sln --name SimpleAPI
```

- This should create a solution file called SimpleAPI.sln

We now want to associate both our "child" projects to our solution, to do so, issue the following command:

```
npleAPI.sln add src/SimpleAPI/SimpleAPI.csproj test/SimpleAPI.Tests/Simp
```

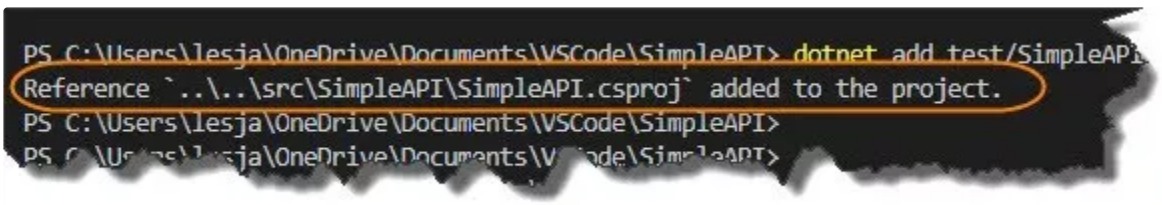
You should see output similar to the following

For more information on the **dotnet sln command** visit msdn.

Ok one last thing to do to is to place a “reference” to our SimpleAPI project in our SimpleAPI.Tests project, this will enable us to reference the SimpleAPI project and “test” it from our SimpleAPI.Tests project. You can either manually edit the SimpleAPI.Tests.csproj file, or type the following command:

```
dotnet add test/SimpleAPI.Tests/SimpleAPI.Tests.csproj reference sr
```

Where the 1st project path is the “host” project and the 2nd project is the referenced project, if done successfully you should see something similar to that below:



You should also check the contents of the SimpleAPI.Tests .csproj file to ensure the reference is there.

```
    <IsPackable>false</IsPackable>
  </PropertyGroup>

  <ItemGroup>
    <PackageReference Include="Microsoft.NET.Test.Sdk" Version="15.9.0" />
    <PackageReference Include="xunit" Version="2.4.0" />
    <PackageReference Include="xunit.runner.visualstudio" Version="2.4.0" />
  </ItemGroup>

  <ItemGroup>
    <ProjectReference Include="..\..\src\SimpleAPI\SimpleAPI.csproj" />
  </ItemGroup>

</Project>
```

You'll also notice the package references to xunit etc.

You can now build both projects, (ensure you are still in the root solution folder), by issuing:

```
dotnet build
```

Note: This is one of the advantages of using a solution file, (you can build both projects from here). Assuming all is well we have finished our initial projects set up!

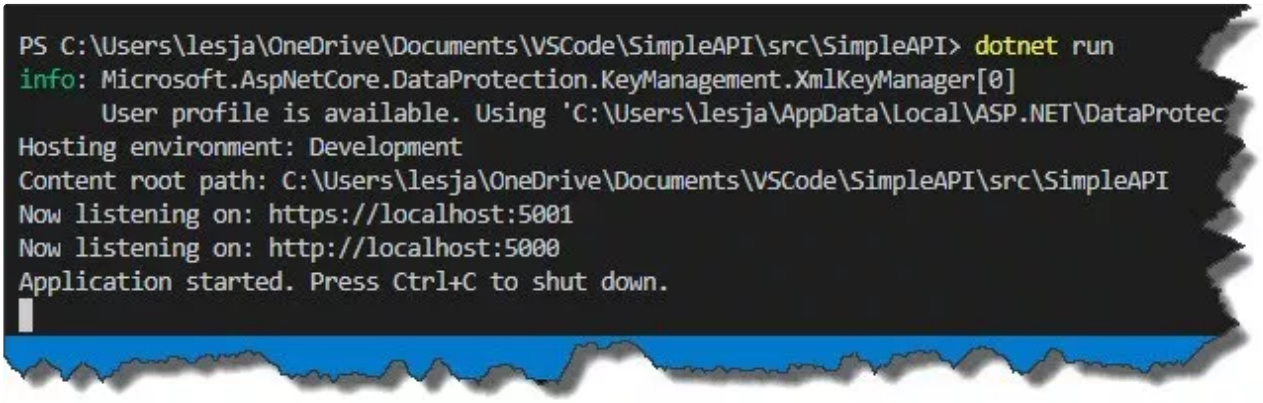
Run Our API and Unit Test

Run Our API

If you've not done so already start VSCode and open the "solution" **folder**, this will open the solution and the child projects. You can use Visual Studio too, in that case you'd open the solution **file**.

```
dotnet run
```

This will start the API project, you should see something like:



To see the api responding, open a web browser, (or use something like Postman), and browse to:

```
https://localhost:5001/api/values
```

Some points to note:

- Ensure the address your using matches what is being “listened on”
- The /api/values postfix is calling one of our controller actions in our “ValuesController”

OK, in the terminal window, use Ctrl + C to shutdown the server.

Unit Testing Our API

Ok, so I want to write 1 simple Unit test to test the response from one of our controller actions. It's super simple and rudimentary, but will illustrate the core concept of testing in CI/CD pipelines... The use-case I mention is also a valid one.

Again, just as this is not a tutorial in REST APIs, nor is this a tutorial in Unit Testing, so I won't go into it in depth. However if you've never heard of Unit Testing, these are tests that developers themselves write in order to test the low level units or functions of their code.

They are:

- Relatively small (or they should be)
- Quick to write
- Cheap
- Are executed first (see pyramid below)
- Abundant

You may also have heard about the "testing pyramid", we'll a picture paints a thousand, words so here you go:

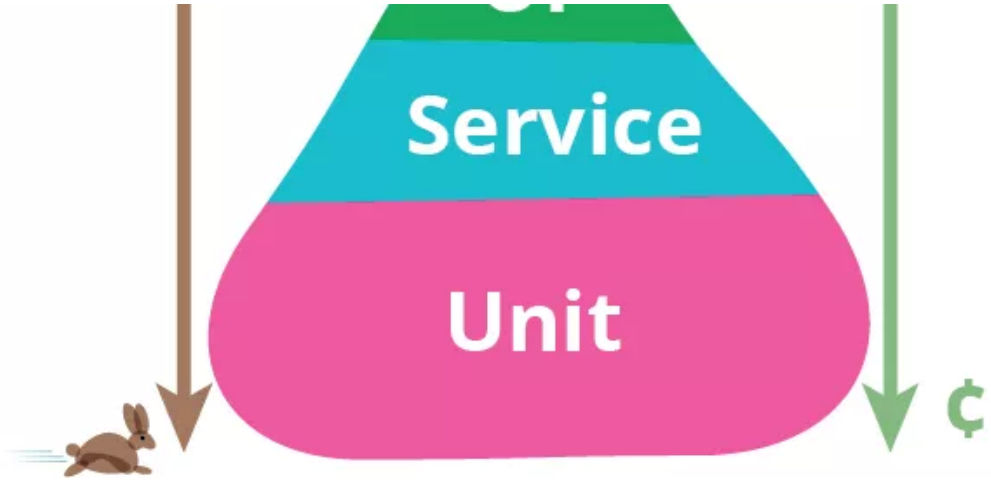


Image Copyright Marin Fowler

For more information visit **Martin Fowlers** site.

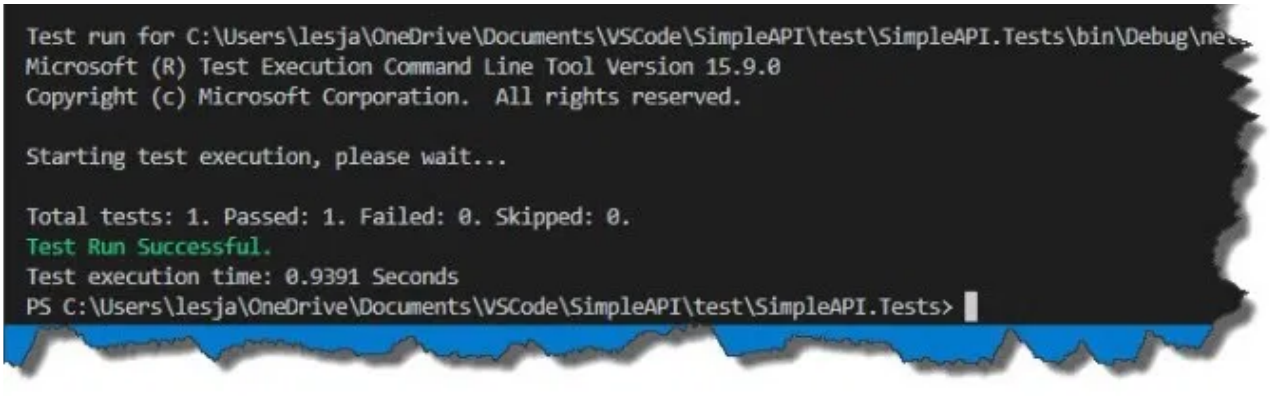
So, in your terminal, navigate not into our Test Project folder:

SimpleAPI/test/SimpleAPI.Tests

And issue the following command:

```
dotnet test
```

You should see something like:



We haven't even done anything yet, and still a test is passing? Well yes as part of the template project we have a UnitTest1 class with a single shell unit test that doesn't really test anything, so it passes.

We'll leave that there for now.

Open the the UnitTest1.cs file in VSCode, and add a new test underneath the existing empty test method, "Test1":

```
ValuesController controller = new ValuesController();
[Fact]
public void GetReturnsCorrectNumber()
{
  var returnValue = controller.Get(1);
  Assert.Equal("Les Jackson", returnValue.Value);
}
```

You'll also need to add an additional "using" directive at the top of the file:

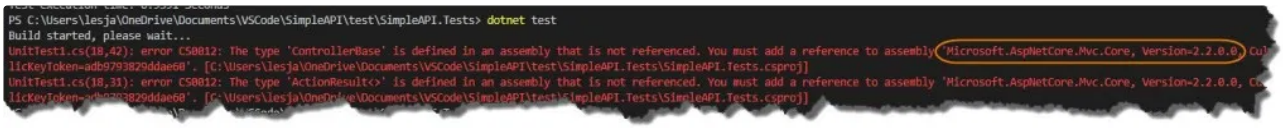
Note this directive would not resolve had we not placed a reference to API project in the SimpleAPI.Tests.csproj file...

The UnitTests1.cs file should look like this now:

```
using System;
using Xunit;
using SimpleAPI.Controllers;

namespace SimpleAPI.Tests
{
    public class UnitTest1
    {
        [Fact]
        public void Test1()
        {

        }

        ValuesController controller = new ValuesController();[Fact]
        public void GetReturnsCorrectNumber()
        {
            var returnValue = controller.Get(1);
            Assert.Equal("Les Jackson", returnValue.Value);
        }
    }
}
```

Save the file and let's execute our 2 tests now:

```
dotnet test
```

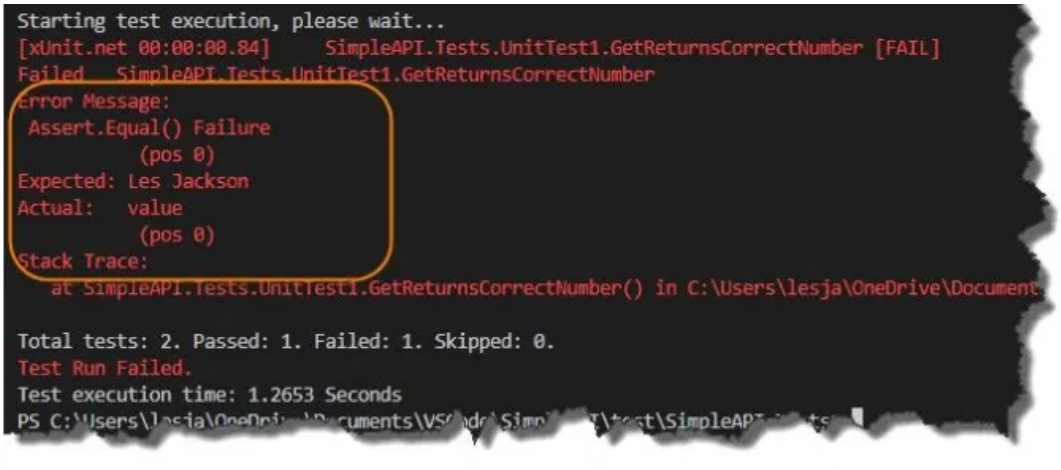


This can simply be resolved by adding the necessary assembly reference to the SimpleAPI.Tests .csproj file, as shown below:

```
<Project Sdk="Microsoft.NET.Sdk">

  <PropertyGroup>
    <TargetFramework>netcoreapp2.2</TargetFramework>

    <IsPackable>false</IsPackable>
  </PropertyGroup>

  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.App" />
    <PackageReference Include="Microsoft.NET.Test.Sdk" Version="15.9.0" />
    <PackageReference Include="xunit" Version="2.4.0" />
    <PackageReference Include="xunit.runner.visualstudio" Version="2.4.0" />
  </ItemGroup>

  <ItemGroup>
    <ProjectReference Include="..\..\src\SimpleAPI\SimpleAPI.csproj" />
  </ItemGroup>

</Project>
```

Note: After you save the file VSCode may ask to resolve dependencies – of course say yes!

Now run your tests again, (you should know how to do this now), you should see something like:



Yes using my name in the unit test is highly narcissistic!

What we have here is a failing unit test! Can you guess the reason why?

It's quite simple, our test is calling the Get(int id) method in our controller, (we pass in an arbitrary value of "1" but this could be any integer in this instance and would make no difference). It then "Asserts" that the value returned by the API should be "Les Jackson", when in fact it's passing back the value: "value" – hence it fails.

In order to get the test to pass we need to edit our controller method to look like that listed below:

```
// GET api/values/5
[HttpGet("{id}")]
public ActionResult<string> Get(int id)
{
  return "Les Jackson";
}
```

Save the file and re-run your tests, you should have success!

```
Test run for C:\Users\lesja\OneDrive\Documents\VSCode\SimpleAPI\test\SimpleAPI.Tests\bin\De
Microsoft (R) Test Execution Command Line Tool Version 15.9.0
Copyright (c) Microsoft Corporation.  All rights reserved.

Starting test execution, please wait...

Total tests: 2. Passed: 2. Failed: 0. Skipped: 0.
Test Run Successful.
Test execution time: 1.1273 Seconds
PS C:\Users\lesja\OneDrive\Documents\VSCode\SimpleAPI\test\SimpleAPI.Tests>
```

What you have, (kind of), done here is a form of development called: Test Driven Development, where developers will write the Unit Tests ***first***, to test as yet un-written functionality they have yet to write. As they start to write the functions, the tests start to pass.

(Technically our method did already exit – but you get the point!)

With our API working and our vast suite of unit tests passing, it's time we placed everything under source control!

Place Under Source Control

If we look back at the build pipeline components we're focusing on, the first stage is "code":

Now as well as this referring to the obvious, (basically what we've just covered in the last section), it also refers to the code "repository" that developers will submit or

In order for the build process to start, it has to fetch the code from somewhere – that somewhere is the code repository!

Source Control (Git & Github)

Now there are various code repository solutions out there, but by far the most common is Git, (and those based around Git), to such an extent that “source control” and Git are almost synonyms. Think about “vacuum cleaners” and “Hoover”, (or perhaps now Dyson), and you’ll get the picture.

Again, as with REST APIs and Unit Testing before, this is not a tutorial on Git, (there are plenty of those on the internet already!), so to looking to our friend Wikipedia it describes Git as:

> A distributed version-control system for tracking changes in source code during software development. It is designed for coordinating work among programmers, but it can be used to track changes in any set of files.

Think about it as the “central source of truth” in relation to your code base.

While you can use Git in a distributed team environment, there are a number of companies that have taken it further placed “Git in the Cloud”, with such examples as:

- Github, (probably the most well recognised – and recently aquired by Microsoft)

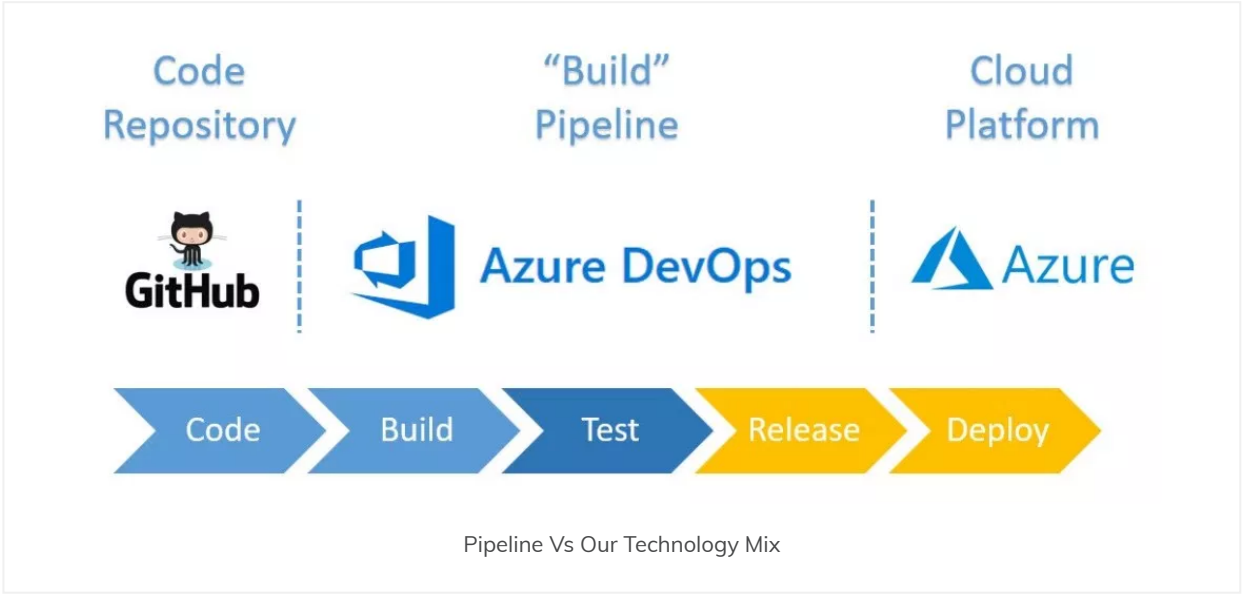
- Gitlabs

We're actually going to use both Git, (locally on our machine), and Github as part of this tutorial.

The Technology In Context

Now just before we move onto using Git and Github, I just wanted to say a few things on the technology, specifically the almost infinite choice and configuration options you have.

For this tutorial we're using the following mix:

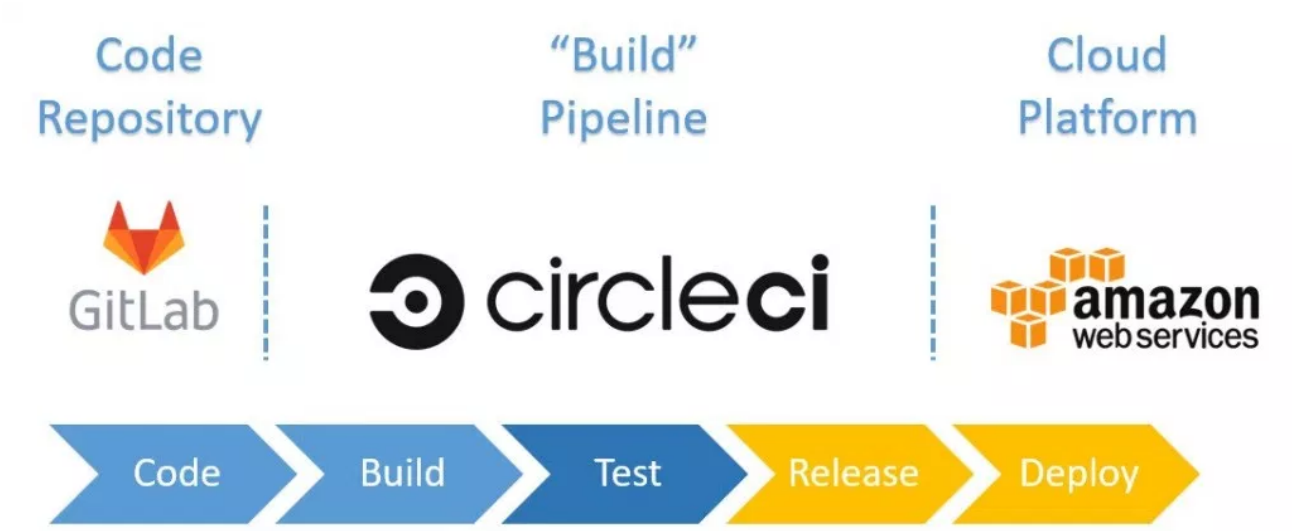


Pipeline Vs Our Technology Mix

Indeed, Azure DevOps actually comes with its own "code repository" feature, (Azure Repos), which means we could do away with Github...

So our mix could look like:

Or if you want to take Microsoft technologies out of the picture:



Going further, you can even break down the Build -> Test -> Release -> Deploy etc. components into specific technologies... I'm not going to do that here.

The takeaway points I wanted to make were:

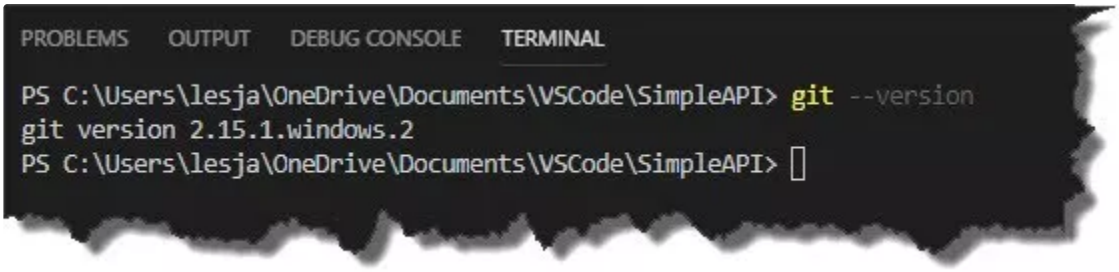
1. The relevant sequencing of technologies in our example
2. Make sure you understand the importance of the code repository
3. Be aware of the almost limitless choice of tech

Set Up Your Git Repo

Again in a terminal / command line in the ***main solution directory***, type:

```
git --version
```

You should see something like:



If you don't, and get an error you probably don't have git installed, (Google "Install git on <insert os here>" and you should be ok).

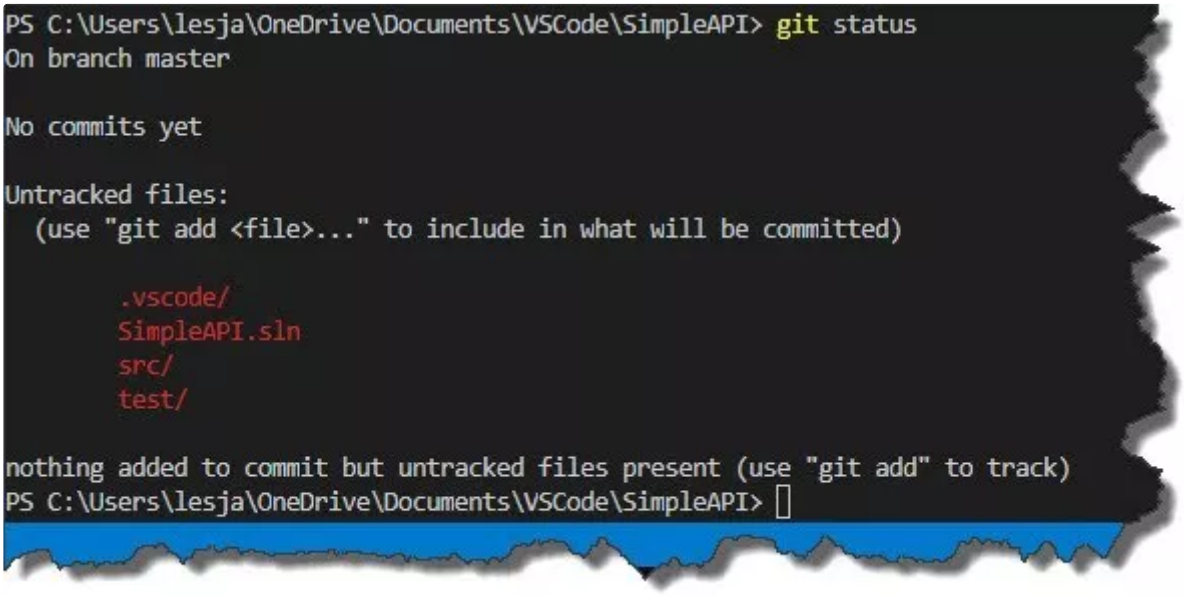
Assuming you get something similar to the above, (i.e. a version number!), we want to set up our ***local*** *git repository* by typing:

```
git init
```

This should initialize a local git repository in the solution directory that will track the code changes in a hidden folder called: *.git*

```
git status
```

This will show you all the “un-tracked” files in your directory, (basically files that are not under source control), at this stage that is everything:



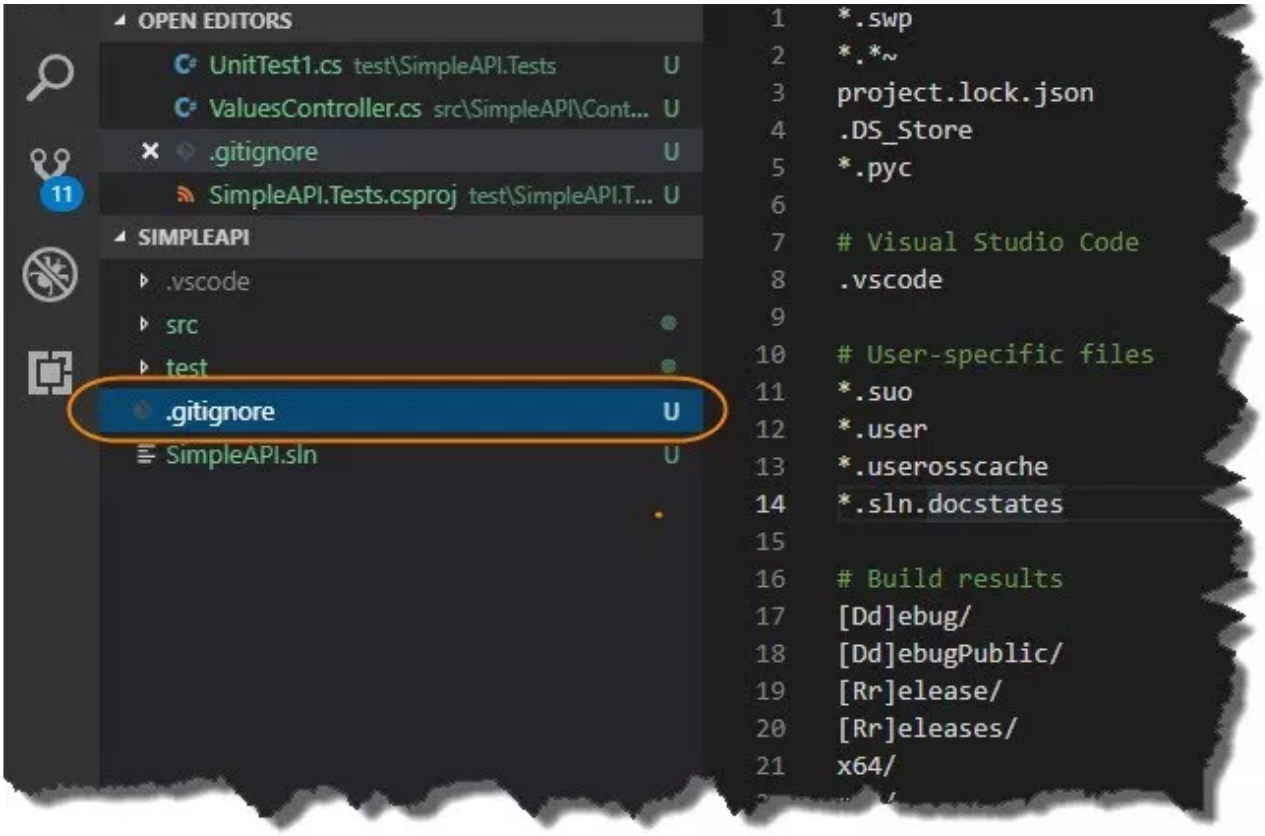
.gitignore File

Before we start to track our solution files, (and bring them under source control), there are certain files that you shouldn’t bring under source control, in particular files that are “generated” as the result of a build, primarily as they are surplus to requirements… (and they’re not “source” files’!)

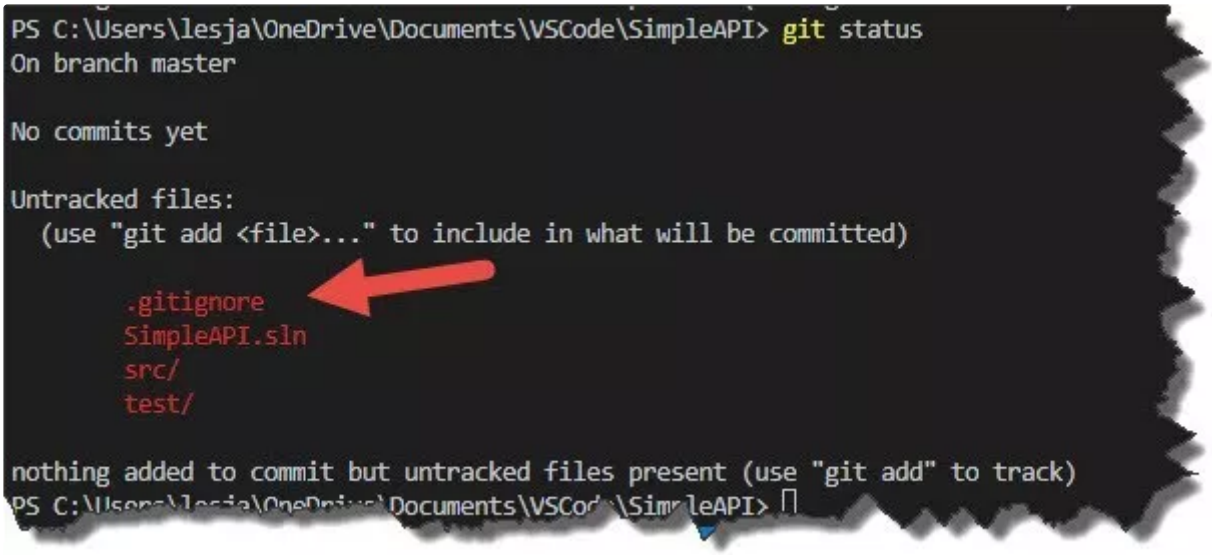
In order to “ignore” these file types you create a file in your “root” solution directory called: .gitignore, (note the period ‘.’ at the beginning). Now this can become quite a personal choice on what you want to include or not, but I have provided an example that you can use, (or ignore altogether – excuse the pun!):

```
*.*~
project.lock.json
.DS_Store
*.pyc

# Visual Studio Code
.vscode

# User-specific files
*.suo
*.user
*.userosscache
*.sln.docstates

# Build results
[Dd]ebug/
[Dd]ebugPublic/
[Rr]elease/
[Rr]eleases/
x64/
x86/
build/
bld/
[Bb]in/
[Oo]bj/
msbuild.log
msbuild.err
msbuild.wrn

# Visual Studio 2015
.vs/
```

So if you want to use a .gitignore file, create one, and pop it in your solution directory, as I've done below, (this shows the file in VSCode):



Type “git status” again, and you should see this file now as one of the “un-tracked” files:



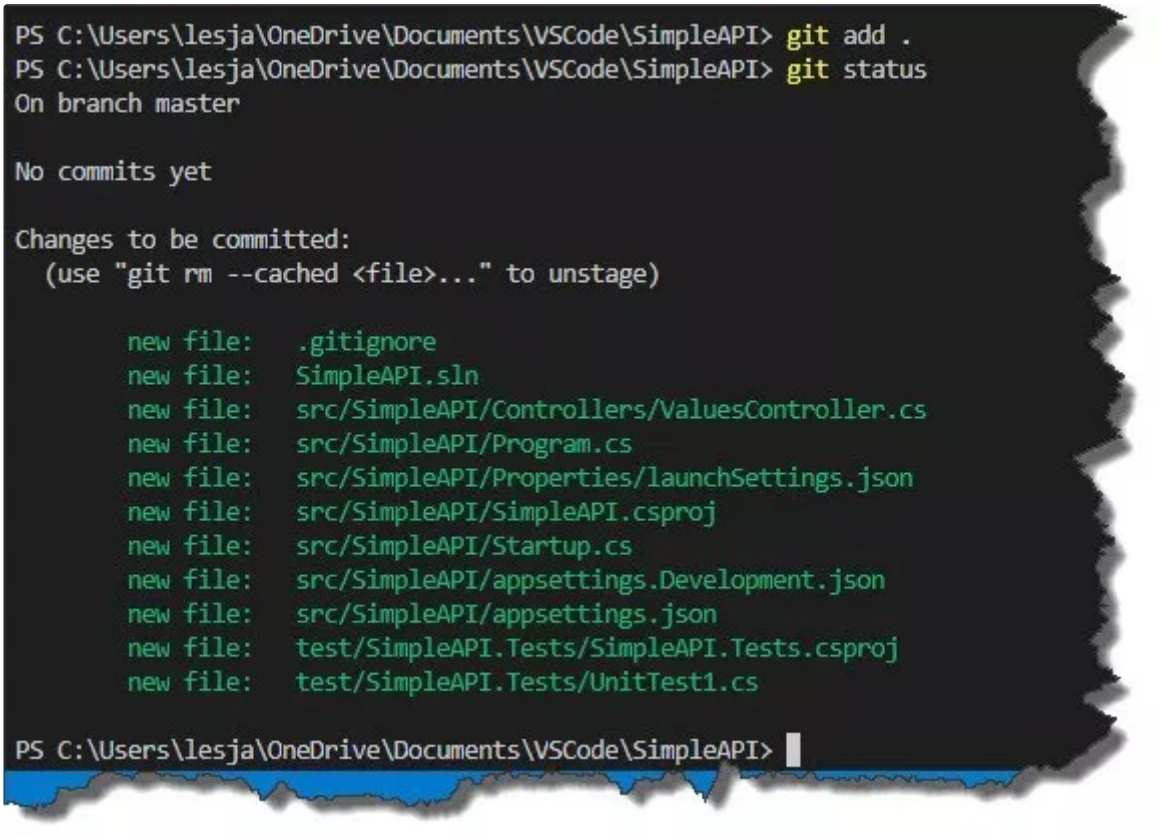
Track and Commit Your Files

Ok we want to track “everything”, (except those files ignored!), to so type:

Followed by:

```
git status
```

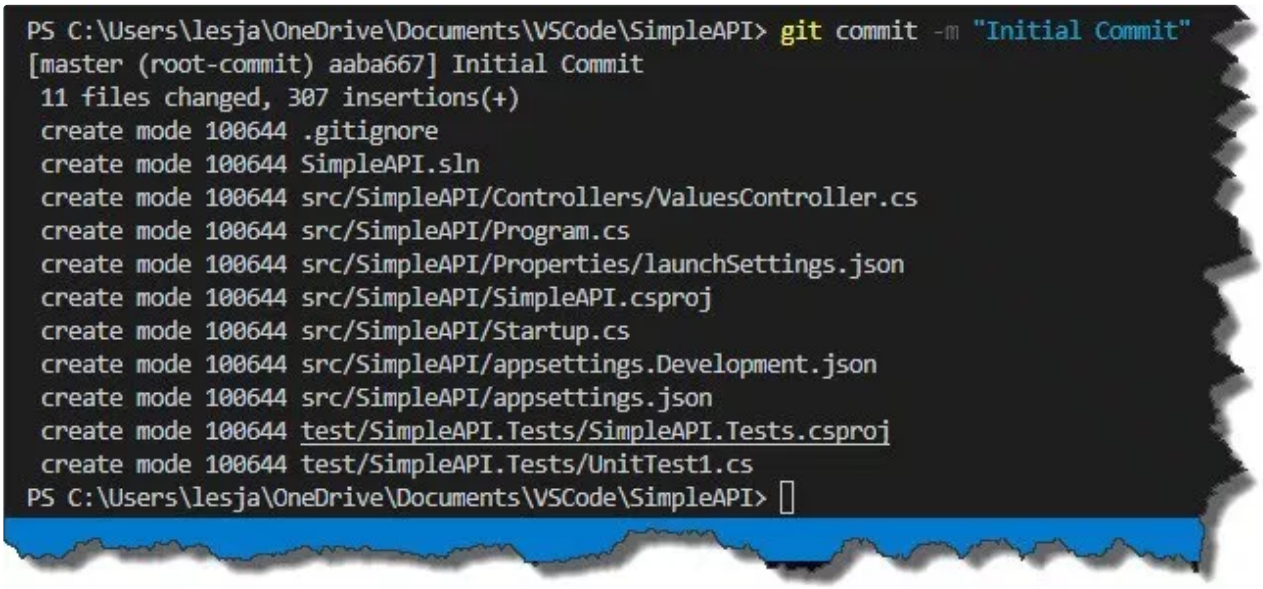
You should see:



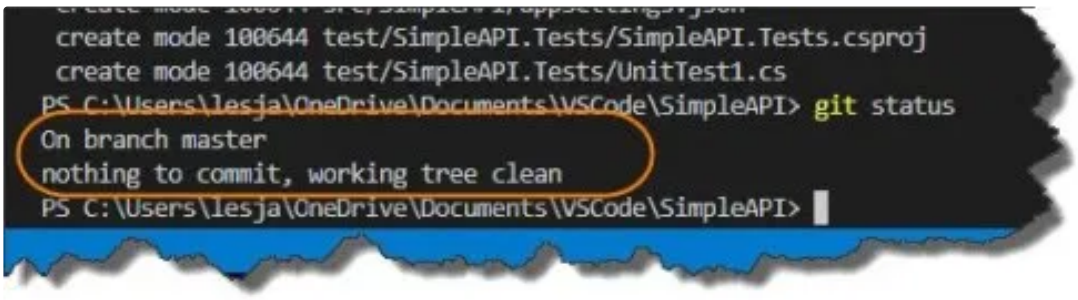
These files are being tracked and are “staged” for commit.

Finally, we want to “commit” the changes, (essentially lock them in), by typing:

This is commits the code with a note, (or “message”, hence the -m switch), about that particular commit. You typically use this to describe the changes or additions you have made to the code, (more about this later), you should see:



A quick additional “git status” and you should see:



We have basically placed our solution under ***local*** source control and have committed all our “changes” to our master branch in our 1st commit.

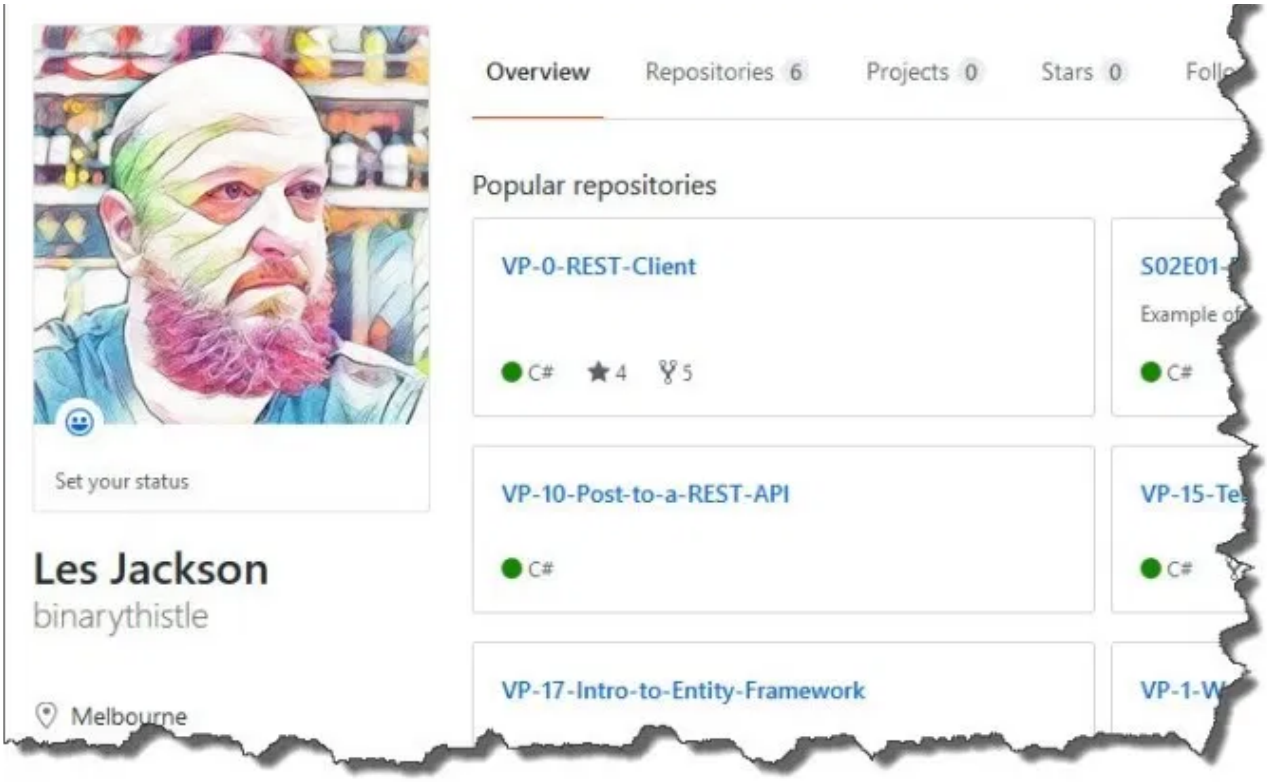
> pause this tutorial here, and do a bit of Googling to find some additional resources. It's a fairly big subject on its own – I just don't have the time to cover it more here.

Set Up Your Github Repo

Ok so the last section took you through the creation of a local Git repository, and that's fine for tracking code changes on your local machine. However if you're working as part of a larger team, or even as an individual programmer and want to make use of Azure DevOps, (as we do!), we need to configure a "remote Git repository" that we will:

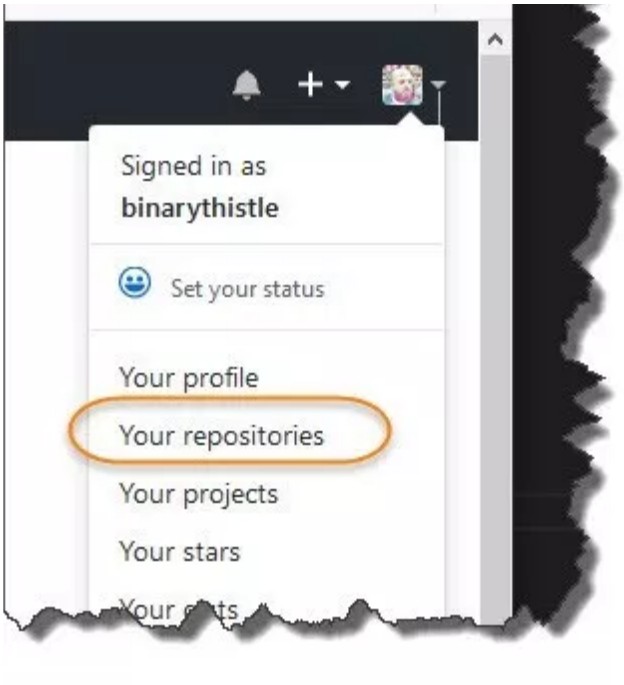
- Push to from our local machine
- Link to an Azure DevOps Build Pipeline to kick off the build process

Jump over to: https://github.com, (and if you haven't already – sign up for an account), you should see your own landing page once you've created an account / logged in, here's mine:

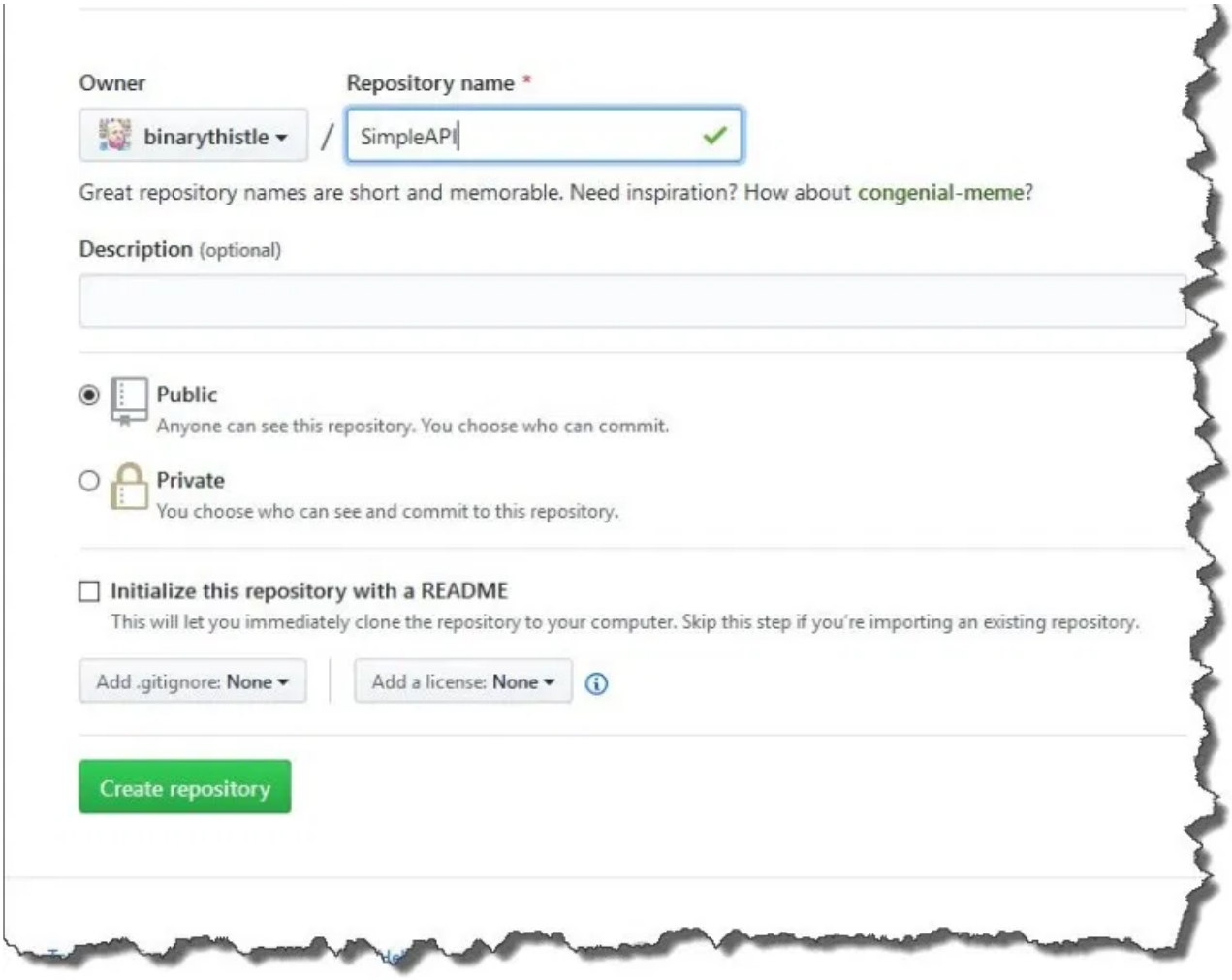


Create a GitHub repository

In the top right hand of the site click on your face, (or whatever the default is if you're not a narcissist), and select "Your repositories":



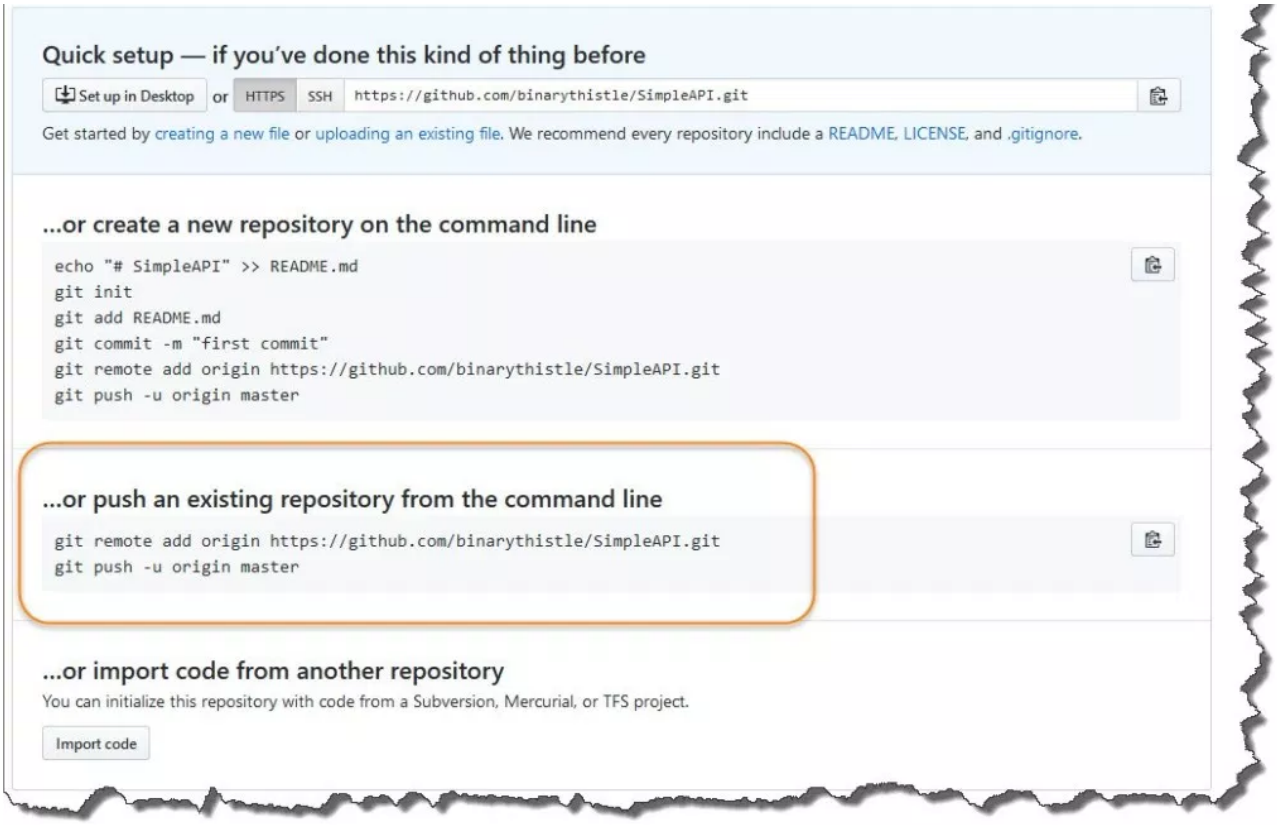
The Click “New” and you should see the “Create a new repository” screen:



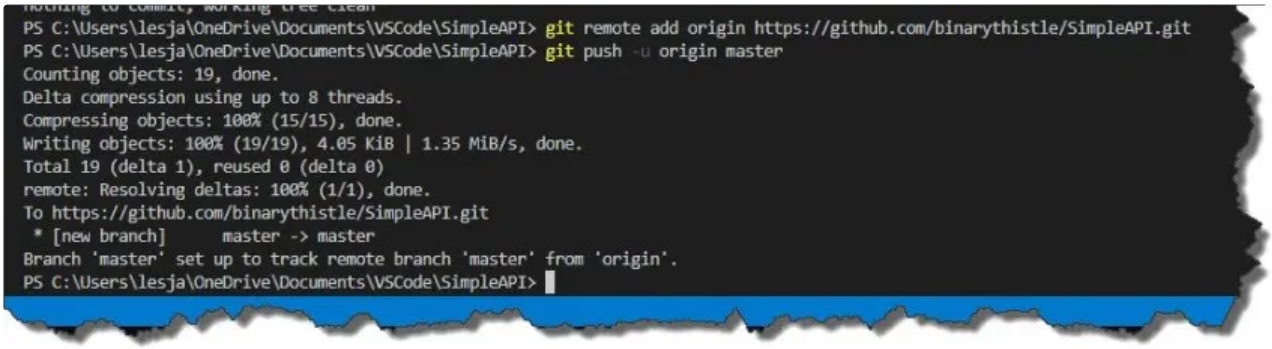
Give the repository a name, (I just named mine after the API Solution, but you can call it anything you like), and select either Public or Private. It doesn't matter which you select but remember your choice as this is important later.

Tip: If you want may advice, for projects like these – I'd just leave public.

Then click "Create Repository", you should see:



This page details how you can now link and push your local repository to this remote one, (the section I've circled in orange). So copy that text and paste it into your terminal window, (you need to make sure you're still in the root solution folder we were working in above):



IMPORTANT: You may get asked to authenticate to Github when you issue the 2nd command:

I've had some issues with this on Windows until I updated the "Git Credential Manager for Windows", after I updated it was all smooth sailing. Google "Git Credential Manager for Windows" if you're having authentication issues and install the latest version.

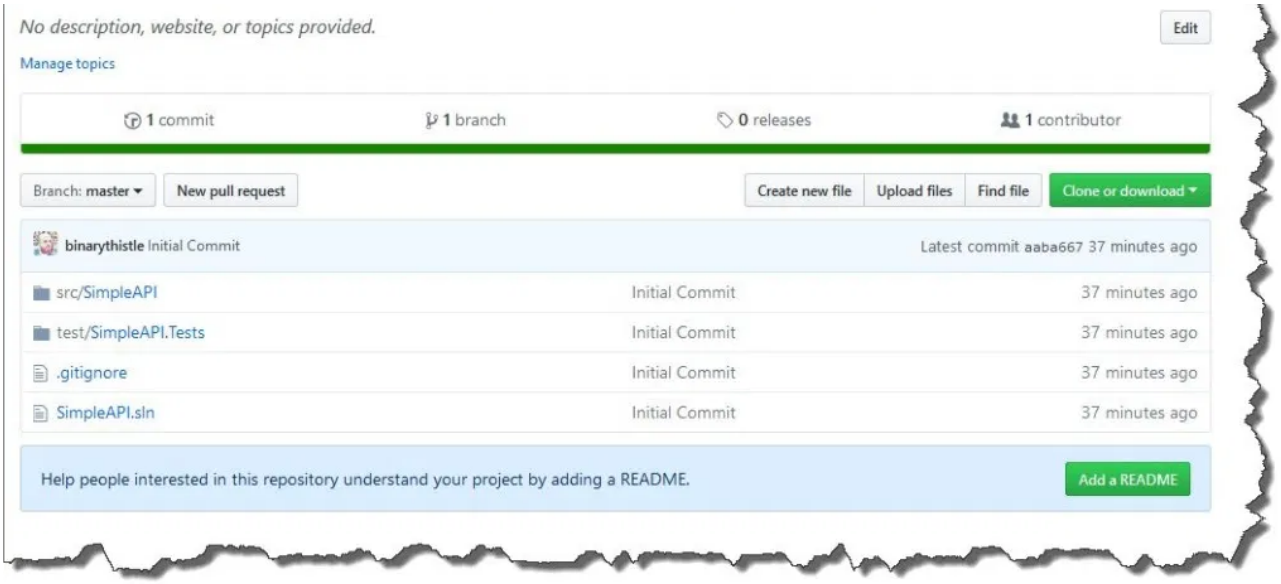
What Just Happened?

Well in short:

- We "registered" our remote Github repo with our local repo (1st command)
- We then pushed our local repo up to Github (2nd command)

Note: the 1st command line only needs to be issued once, the 2nd one we'll be using more throughout the rest of the tutorial.

If you refresh your Github repository page, instead of seeing the instructions you just issued, you should see our solution!



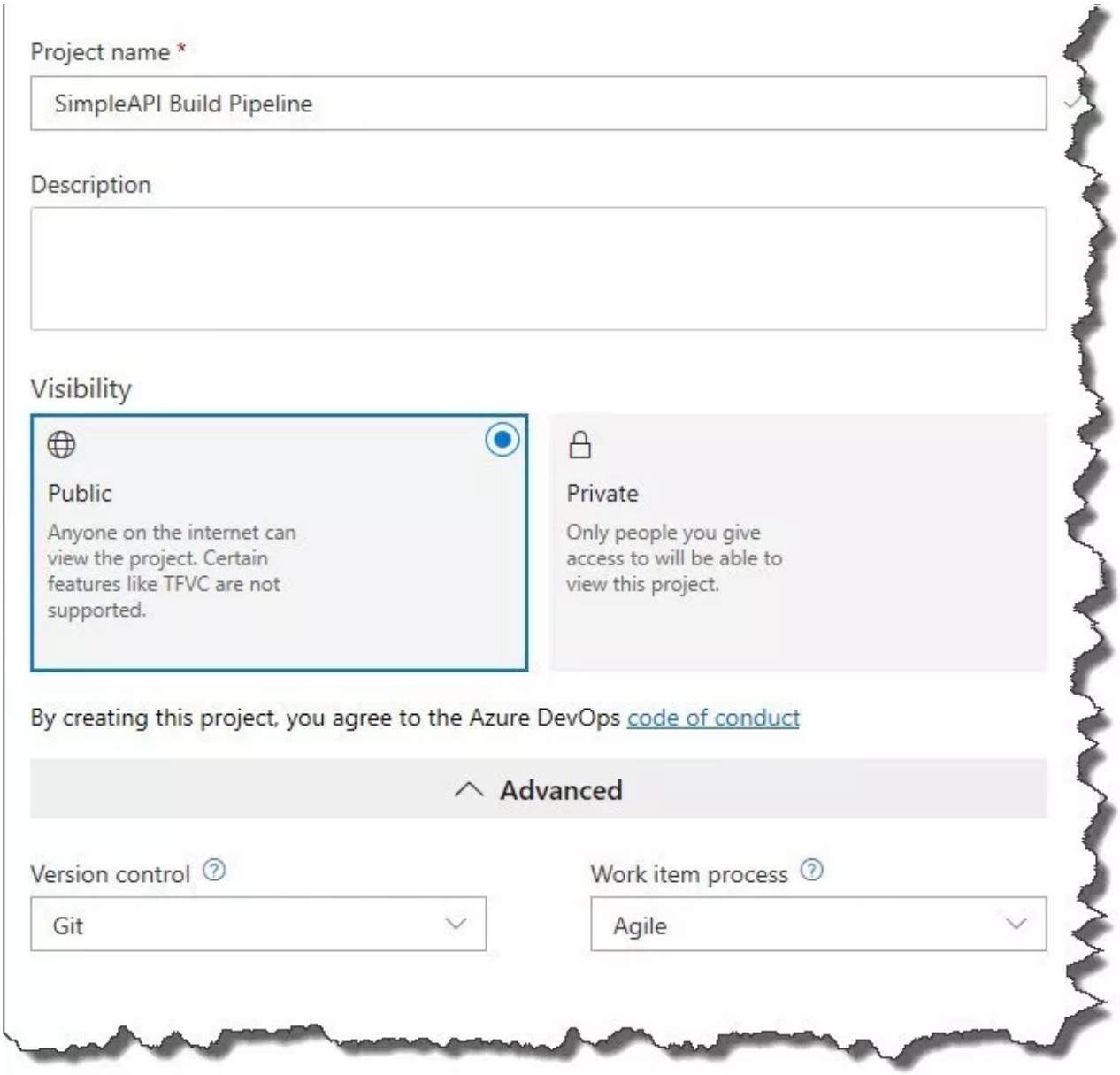
You'll notice "Initial Commit" as a comment against every file and folder – seem familiar?

Create a Build Pipeline

Finally we get to Azure DevOps!!

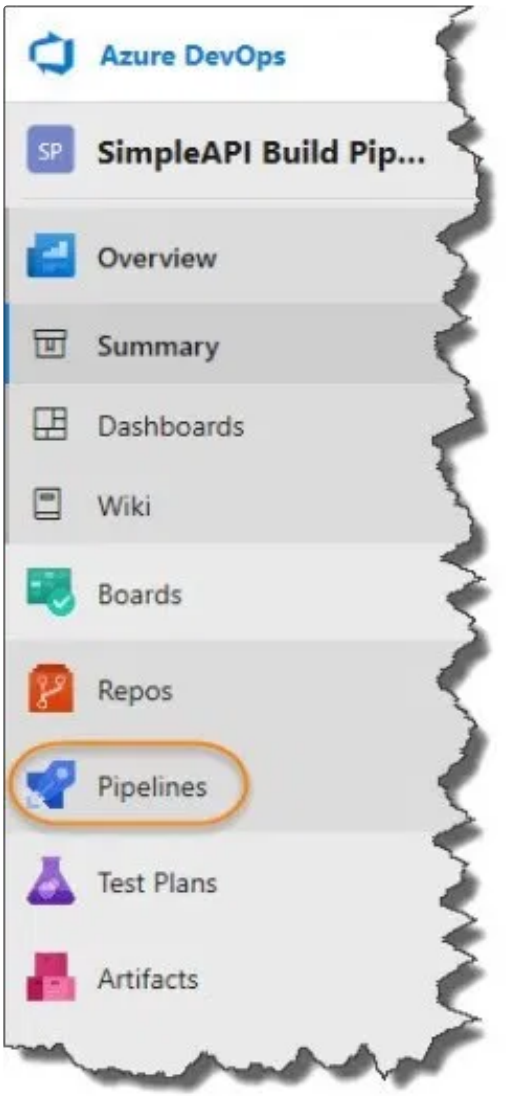
Ok, as with GitHub, jump over to: https://dev.azure.com and create an account if you don't have one – they're free so no excuses!

Once you have signed in / signed up, click on the "Create project" button to, surprise-surprise, create a project, (this project will contain all our build pipeline stuff)!



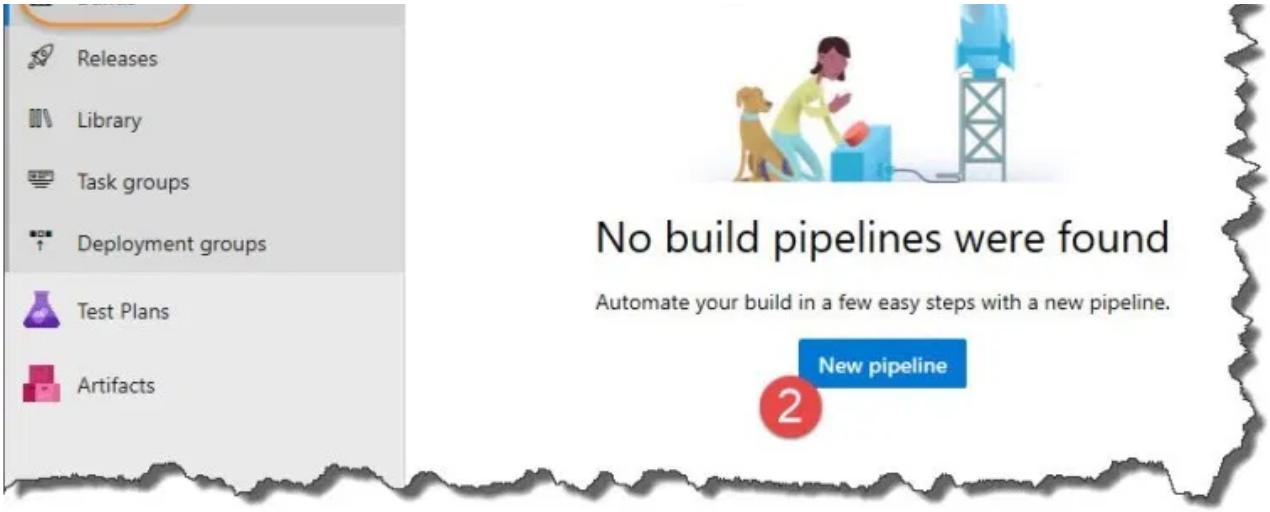
Make sure:

- You give it a name, (something meaningful)
- Select the same “visibility” that your Github repo has – remember?
    - It will complain if the 2 are different
- Version control set to Git



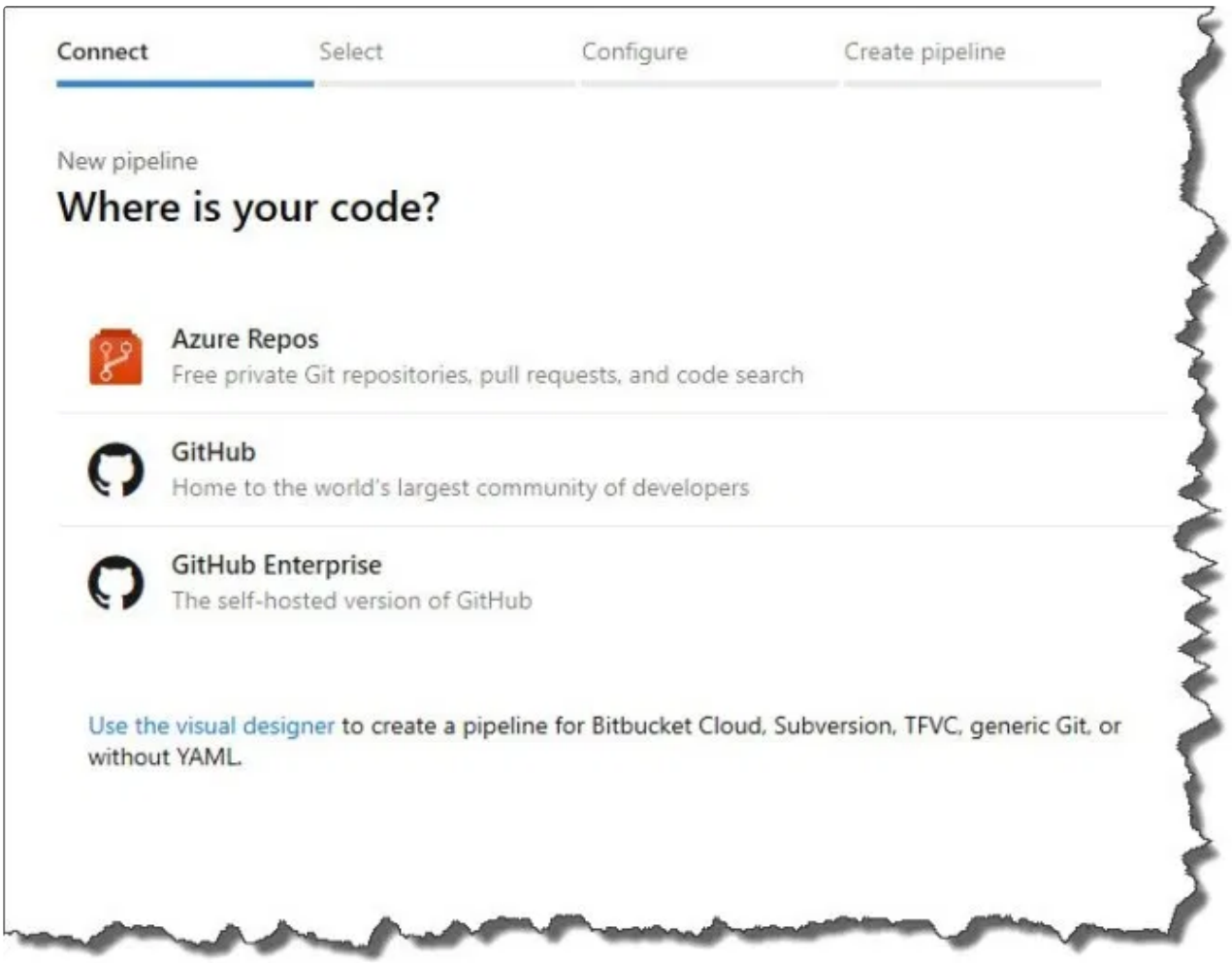
Azure DevOps has many features, but we'll just be using the "Pipelines" for now...

Select Pipelines, then Builds and then New pipeline:



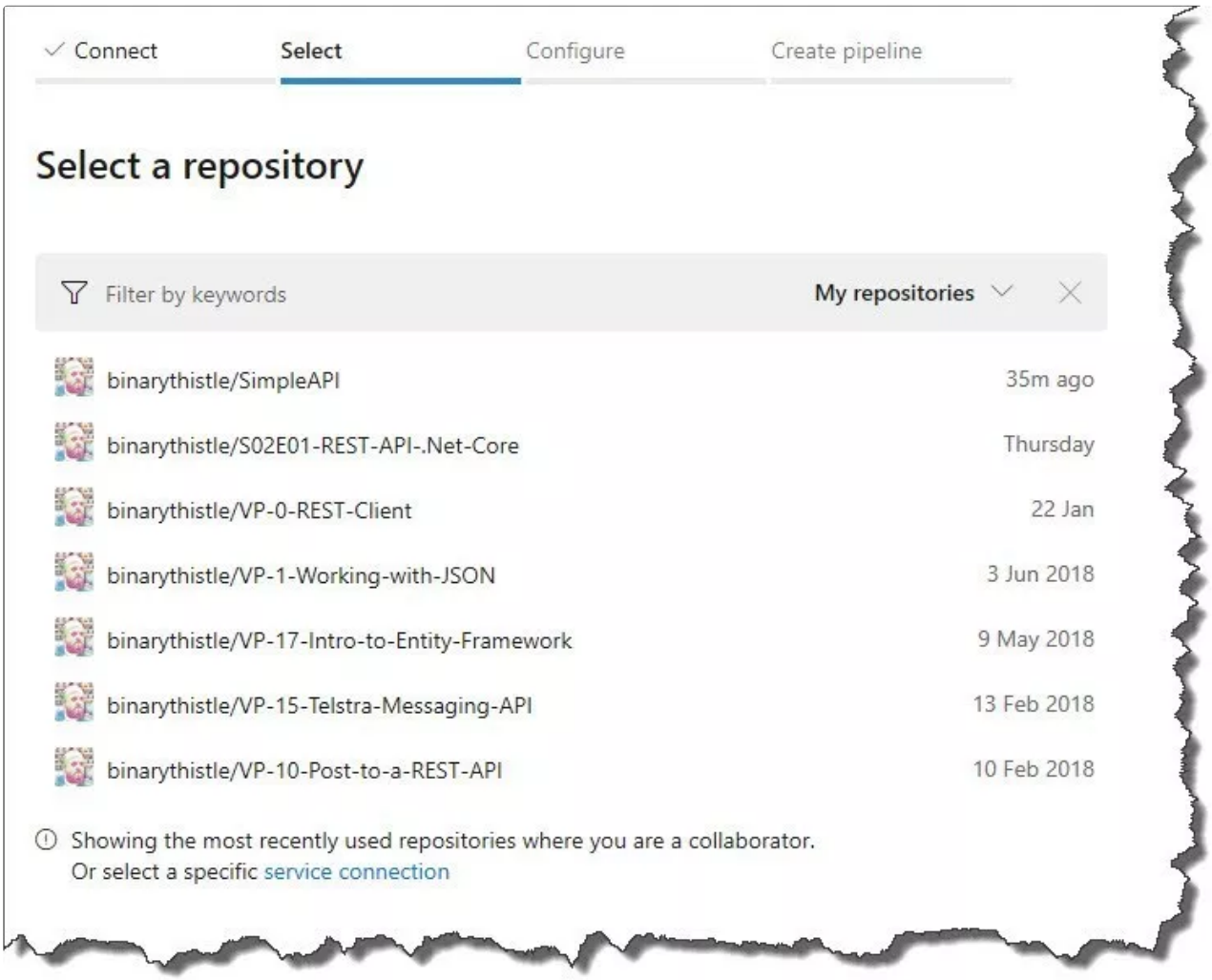
The first thing that it asks us is: “Where is your code?”

Well, where do you think? Yeah – that’s right – in Github!

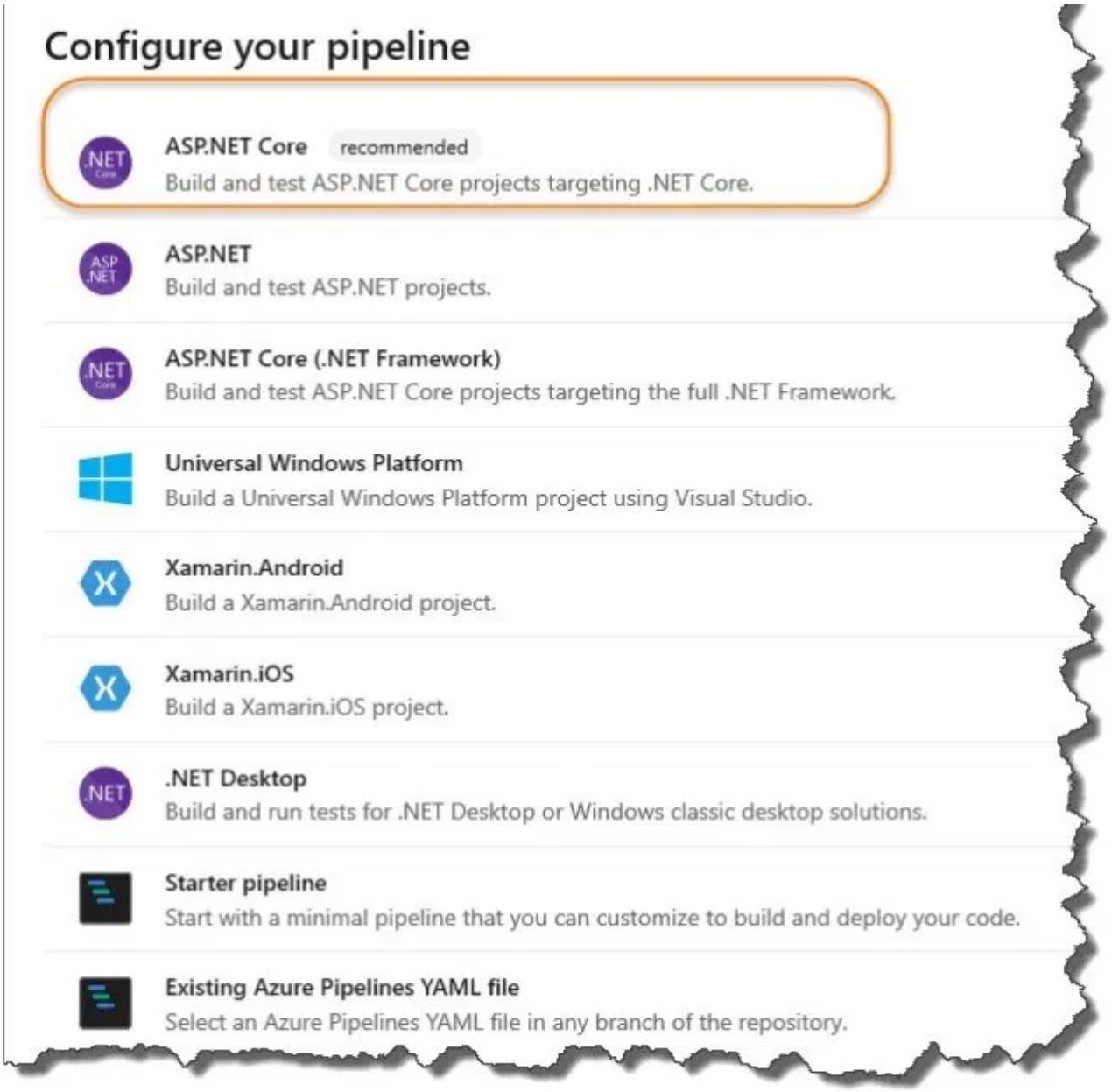


IMPORTANT: If this is the 1st time you're doing this, you'll need to give Azure DevOps permission to view your Github account- this is relatively painless and straightforward...

Once you've given Azure DevOps permission to connect to Github, you'll be presented with all your repositories:



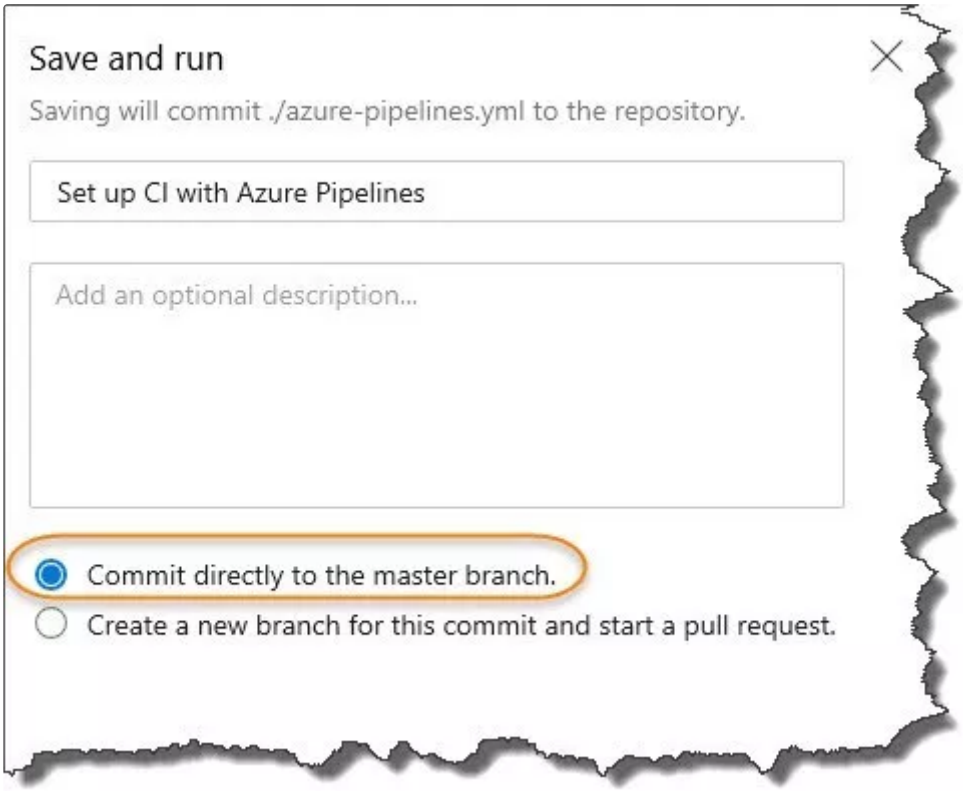
Pick your repository, (in my case it's "SimpleAPI"), once you click it, Azure DevOps will go off and analyse it to suggest some common pipeline templates, you'll see something like:



In this case go with the recommended pipeline template: ASP.NET Core, click it and you'll be presented with your pipeline yaml file:

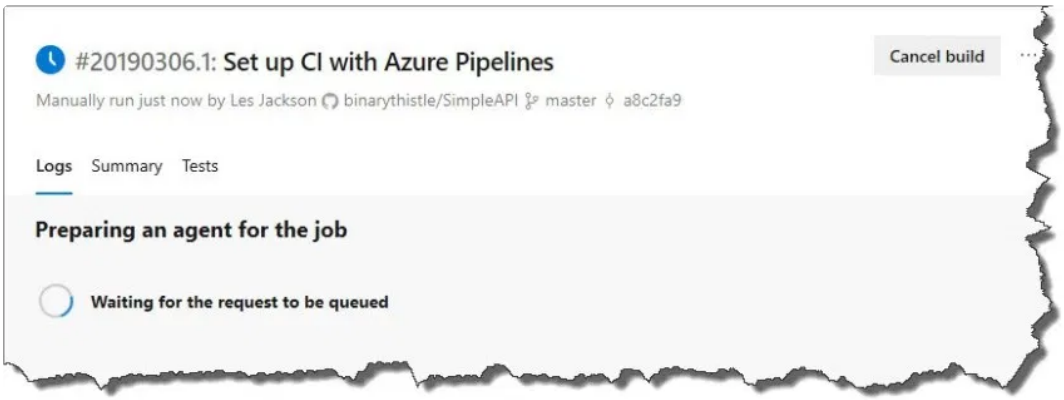
```yaml
# ASP.NET Core
# Build and test ASP.NET Core projects targeting .NET Core.
# Add steps that run tests, create a NuGet package, deploy, and more:
# https://docs.microsoft.com/azure/devops/pipelines/languages/dotnet-core

trigger:
- master

pool:
  vmImage: 'Ubuntu-16.04'

variables:
  buildConfiguration: 'Release'

steps:
- script: dotnet build --configuration $(buildConfiguration)
  displayName: 'dotnet build $(buildConfiguration)'
```

We'll go through this in detail later, suffice to say it's essentially a configurable script for what you want to happen in your build pipeline. Click Save & Run

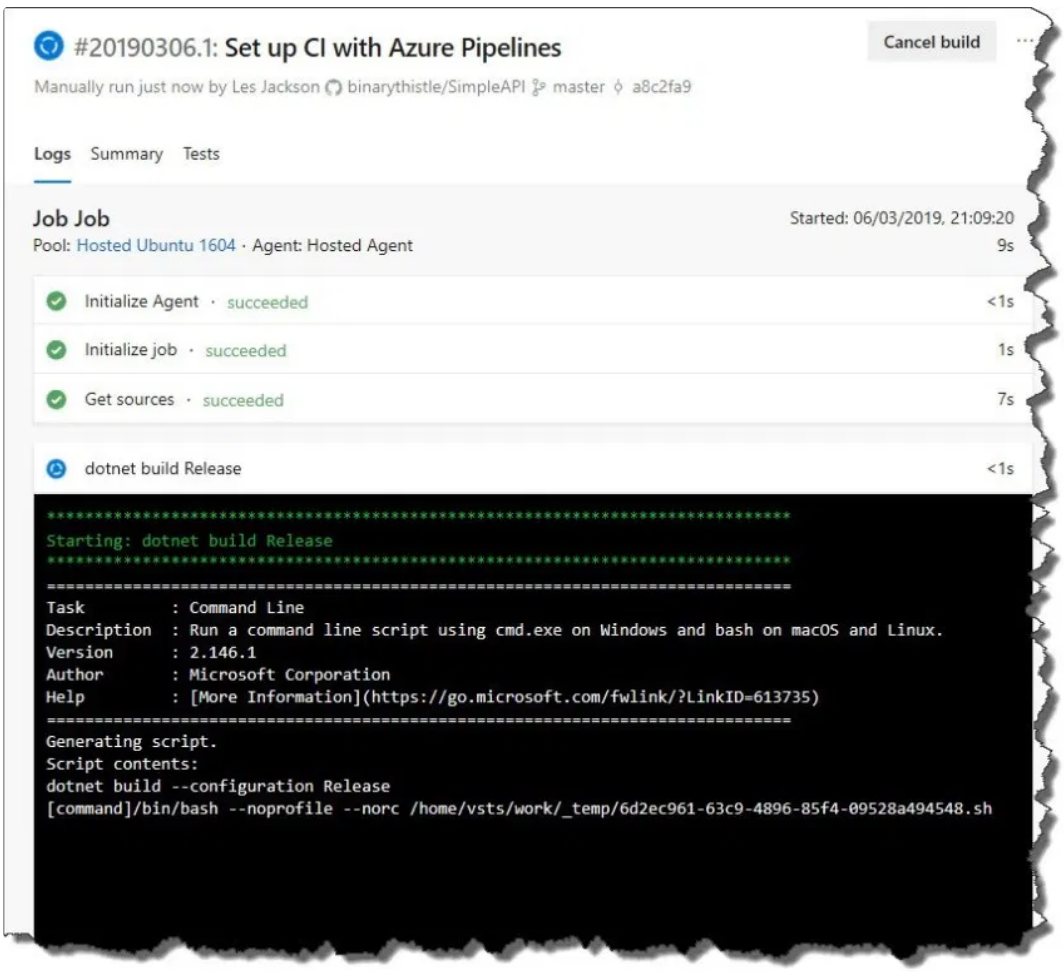


This is asking you where you want to store the azure-pipelines.yml file, (last step), in this case we want to add it directly to our Github repo, (remember this selection though

An “agent” is then assigned to execute the pipeline, you’ll see various screens, such as:

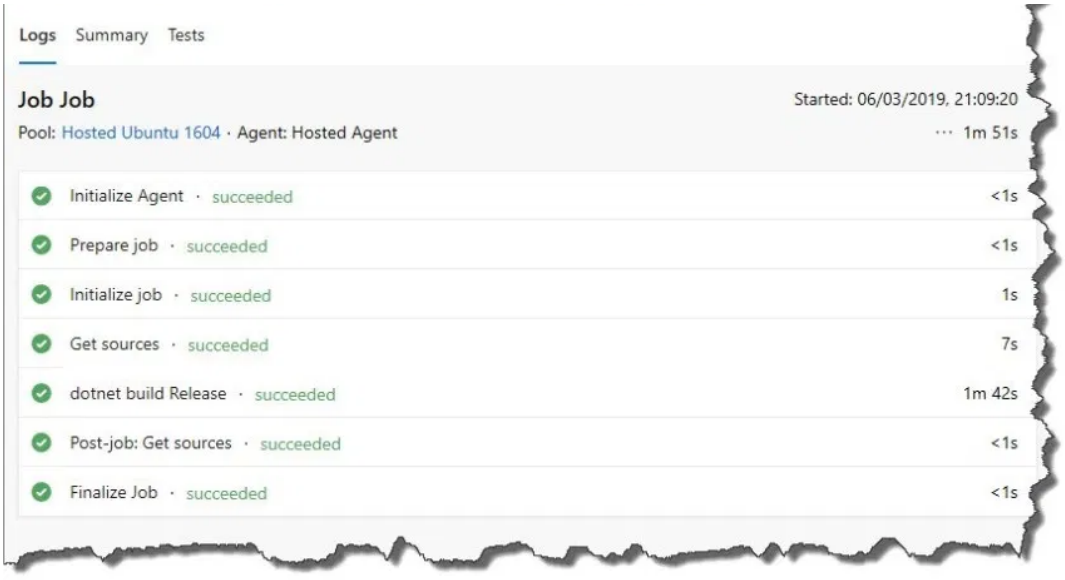


Request queued for agent to pick up



Pipeline in the midst of execution

And finally you should see the completion screen:



A Green Run!

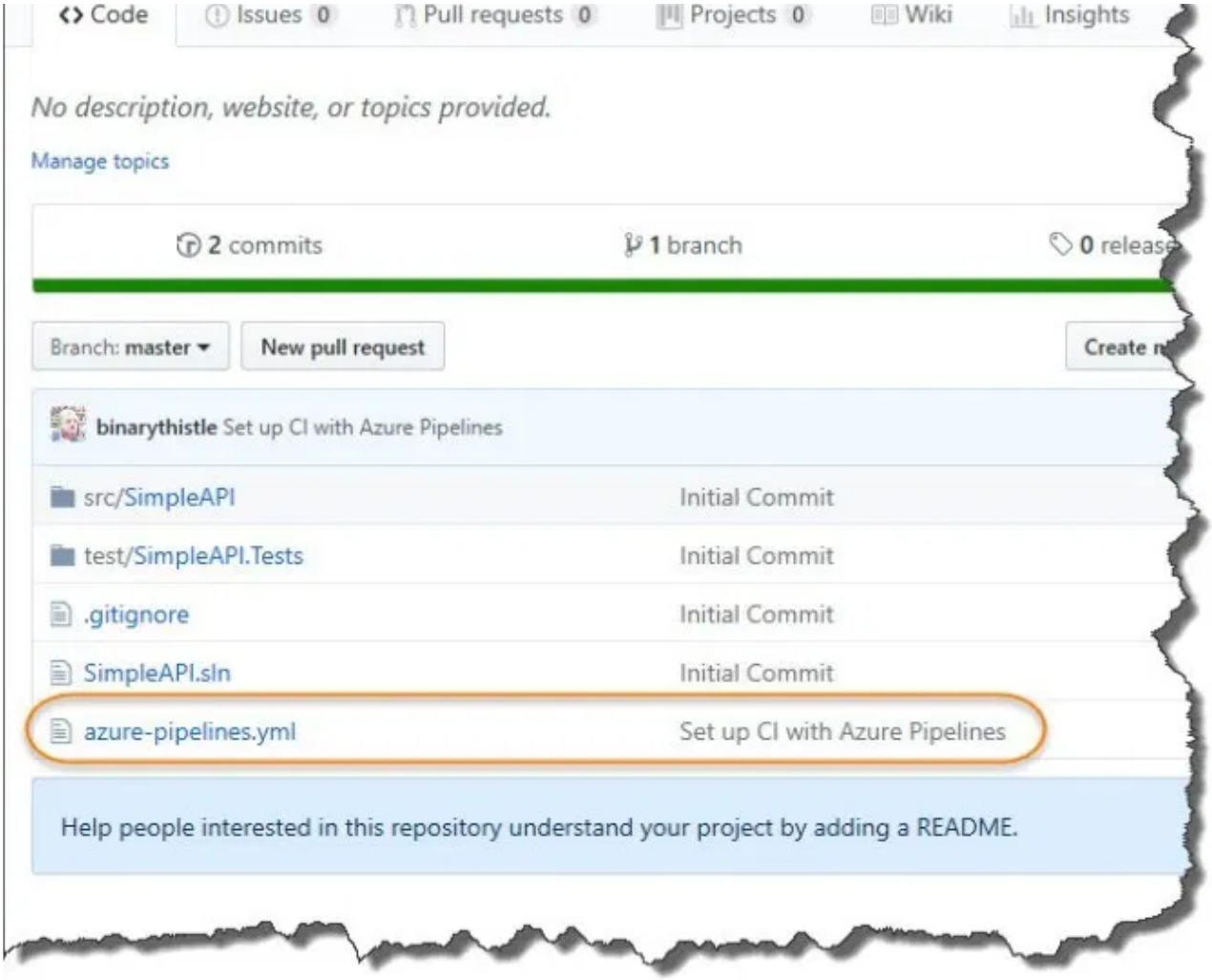
What Just Happened?

Ok to recap:

- We connected Azure DeevOps to Github
- We selected a repository
- We said that we wanted the pipeline configuration file (azure-pipelines.yml) to be placed in our repository
- We manually ran the pipeline
- Pipeline ran through the azure-pipelines.yml file and executed the steps

Azure-Pipelines.yml File

Lets pop back over to our Github repository and refresh – you should see the following:



You'll see that the azure-pipelines.yml file has been added to our repo (this is important later...)

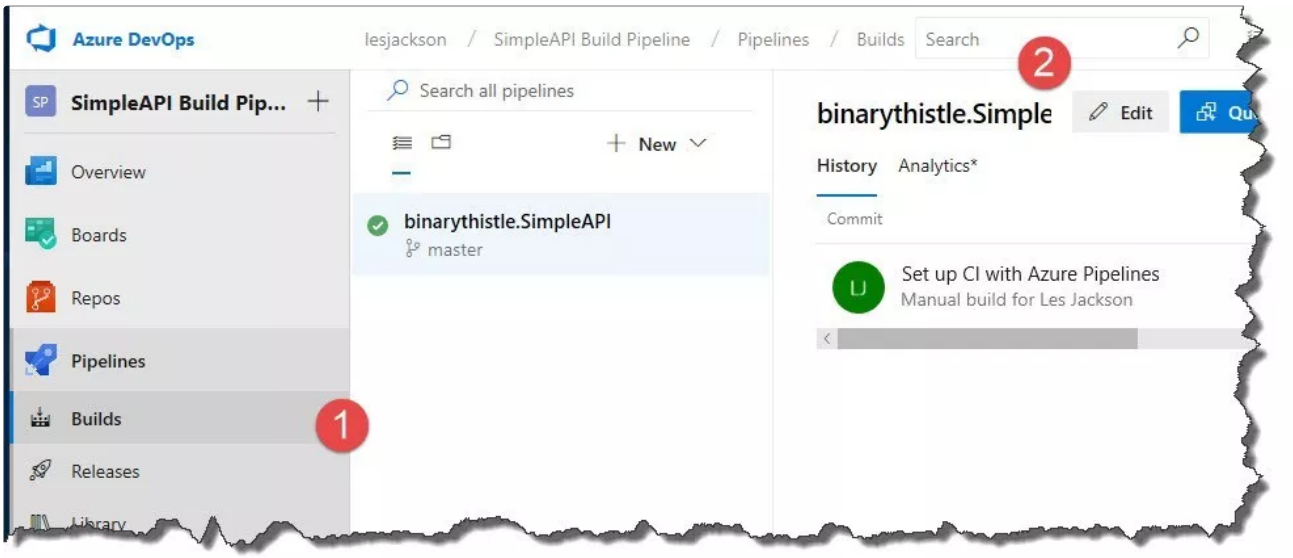
I thought we wanted to automate?

One of the benefits of a CI/CD pipeline is the automation opportunities it affords, so why did we manually execute the pipeline?

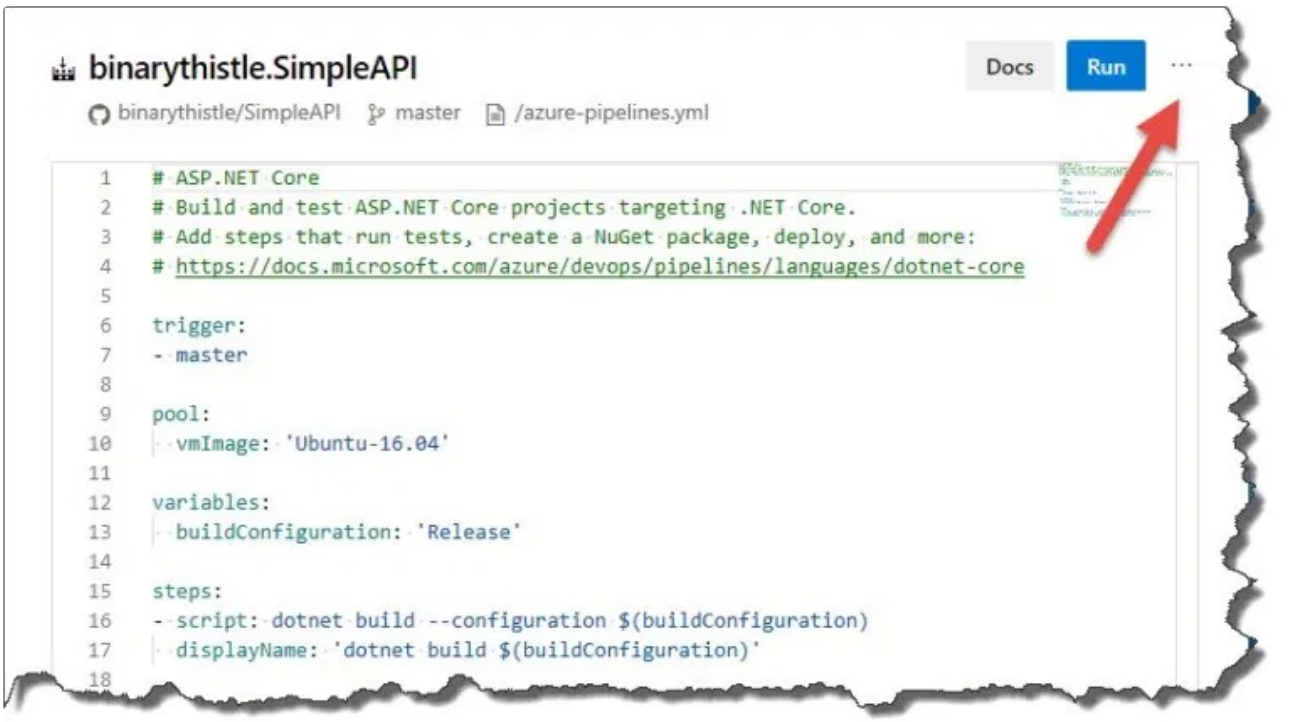
Great Question!

We are asked to execute when we created the pipeline that is true, but we can also set up "triggers", meaning we can configure the pipeline to execute when it receives a

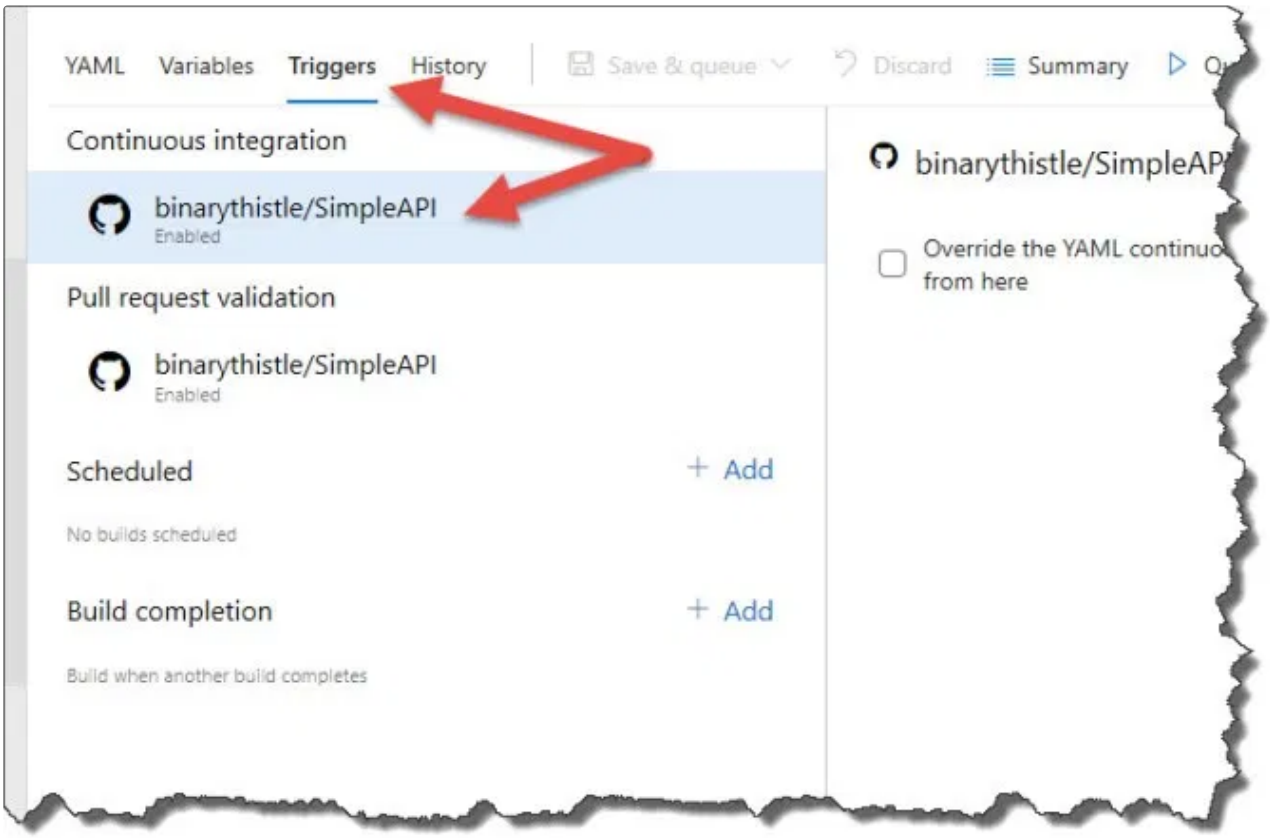
In your Azure DevOps project click on “Builds” under the Pipelines section, then click the “Edit” button at the top right of the screen, as shown below:



After doing that you should be returned to the azure-pipelines.yml file, (we will return here to edit it later).



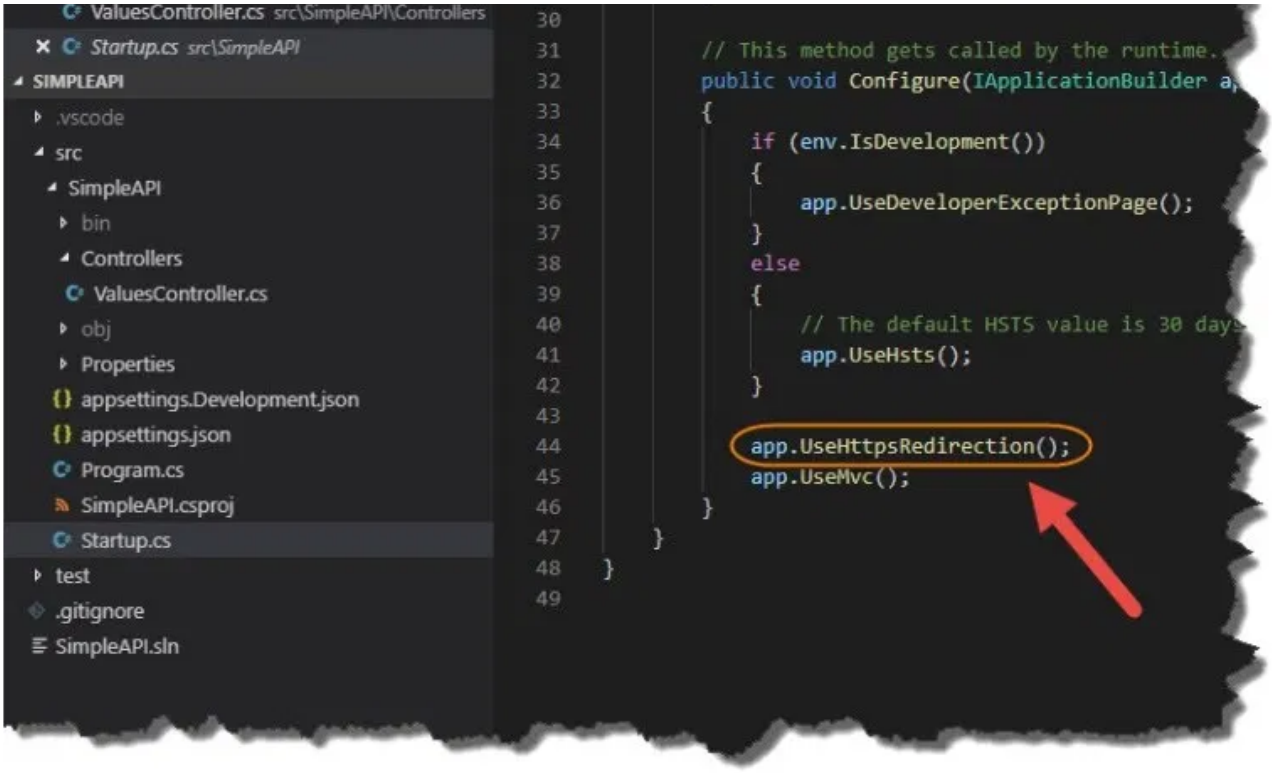
Click the ellipsis, and select “Pipeline Settings”



In essence, every time we commit to the repository, (e.g. from our local workstation), a build will be triggered! Let's test that theory...

Triggering a Build

Back at our workstation, and back in VSCode, (or whatever environment you've chosen to use), open the Startup.cs file in our SimpleAPI project and remove the following line of code, making sure to save the file:

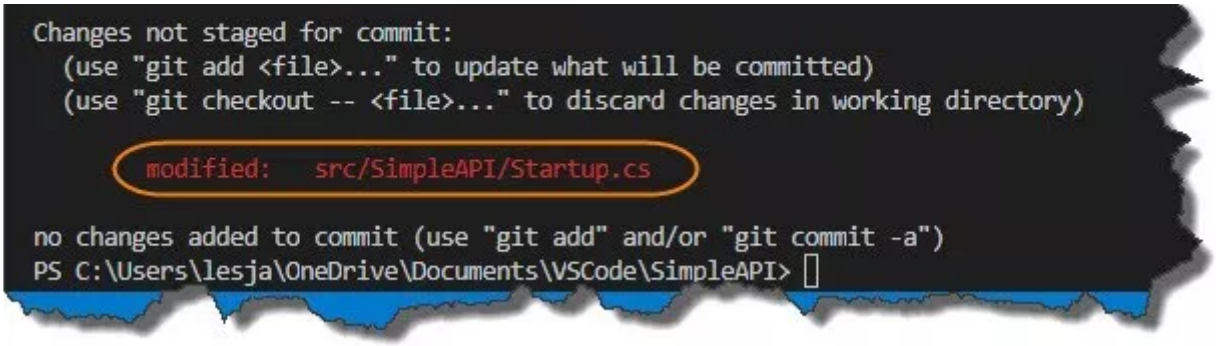


Now I'm not necessarily recommending this is a change you should make in production.. I just want to make any code change so you can see how our local git repo responds, and how we can then push the change to our Github repo and trigger a Azure DevOps build.

Ensuring the deletion is made and the page is saved, go to your command line, (ensure you're in the solution root folder), and type:

```
git status
```

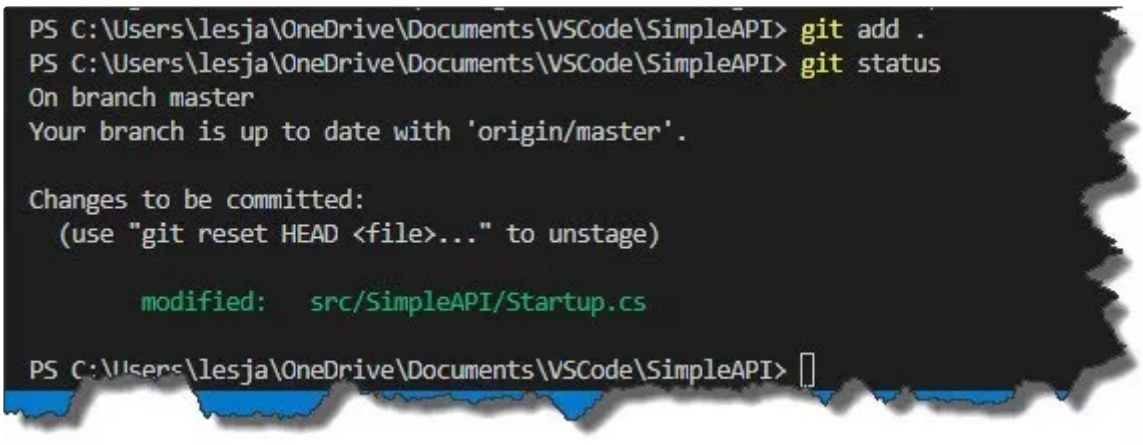
Assuming you've not changed any other files, you should see something like this:



Git is telling us that we have modifed a file, (startup.cs), since the last commit – remember we are tracking changes on this file. Type:

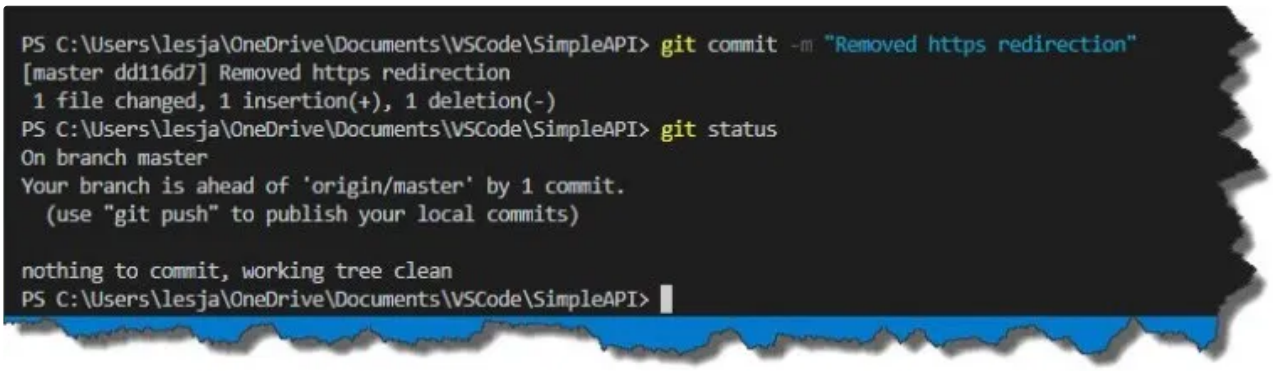
```
git add .
git status
```

This stages the file for commit:



Finally we commit the changed file to our local repo with the following command:

Another git status will reveal that there is nothing left to commit:



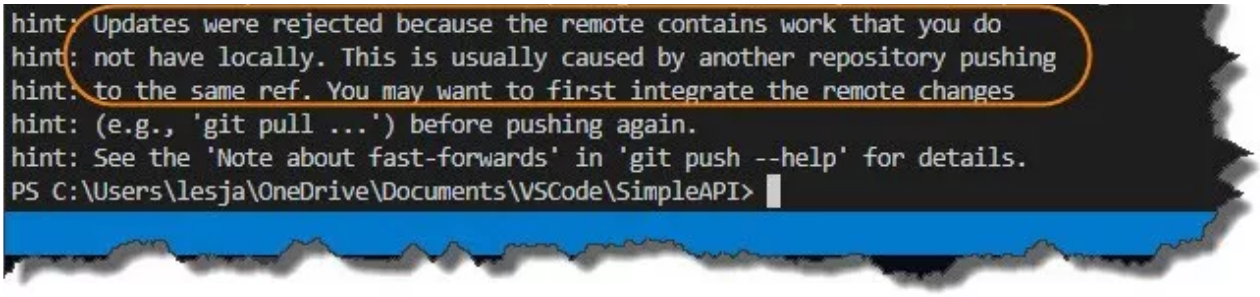
We have made a local code change, and committed it to our local git repository, now we need to push it up to Github to trigger the Build Pipeline!

Type the following at the command line:

```
git push origin master
```

What!???

Yeah that's right we get an error:

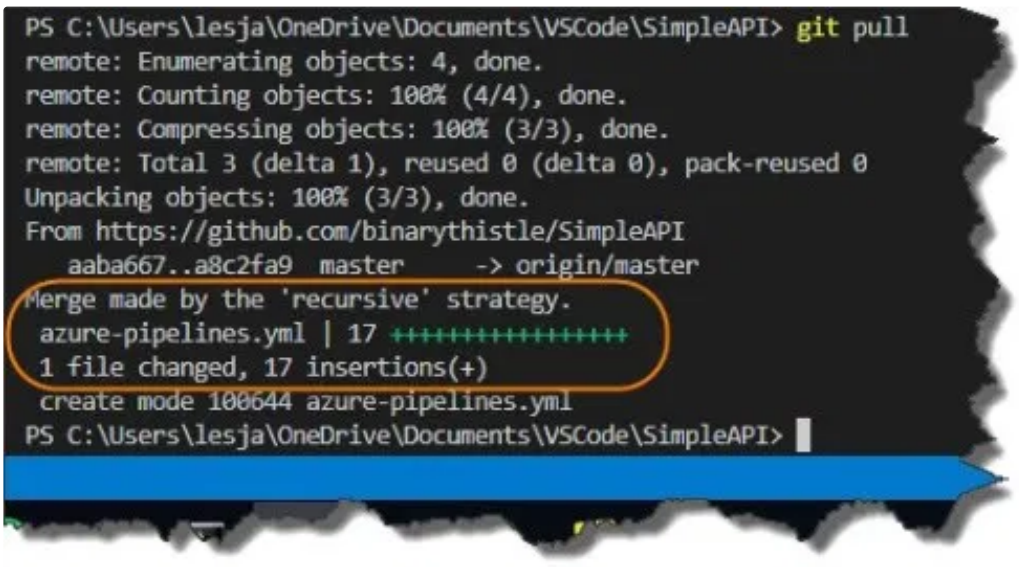


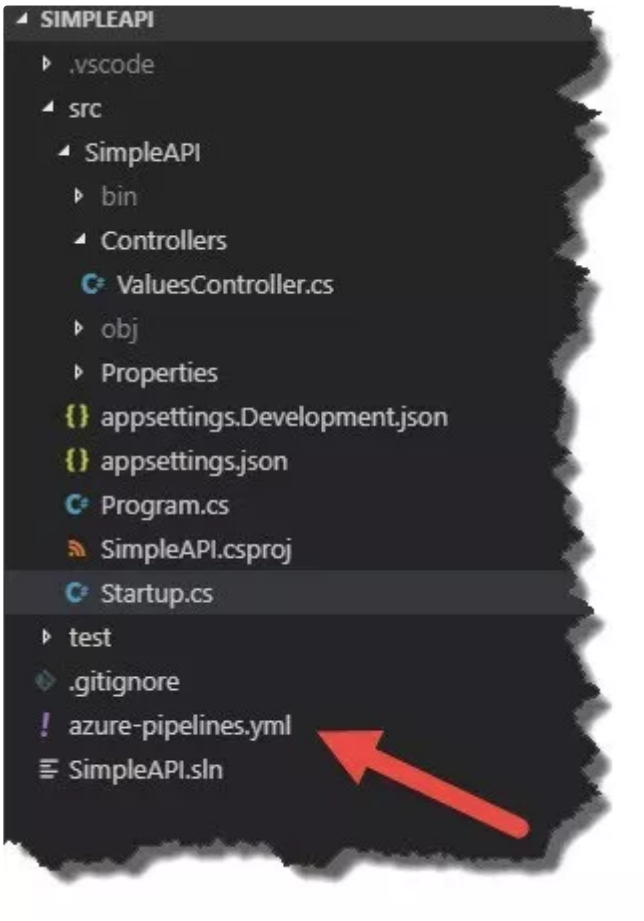
What does this mean?

Well remember we added the *azure-pipelines.yml* file to the Github repo? Yes? Well that's the cause, essentially the local repository and the remote Github repository are out of sync. To remedy this, we simply type:

```
git pull
```

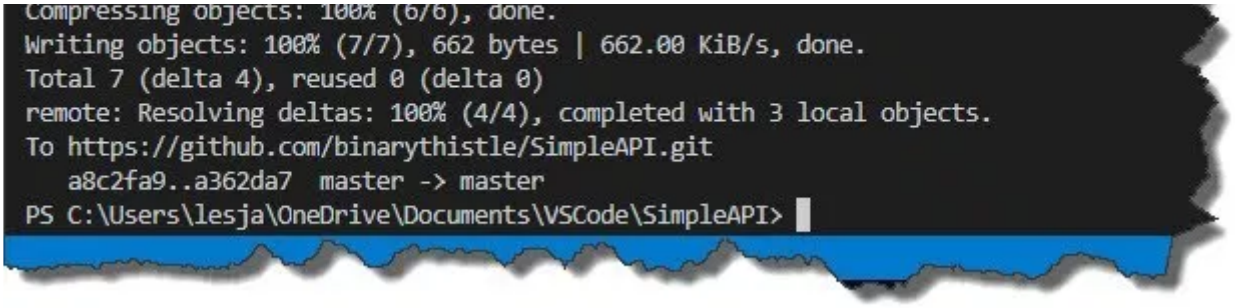
This pulls down the changes from the remote Github repository and merges them with our local one:



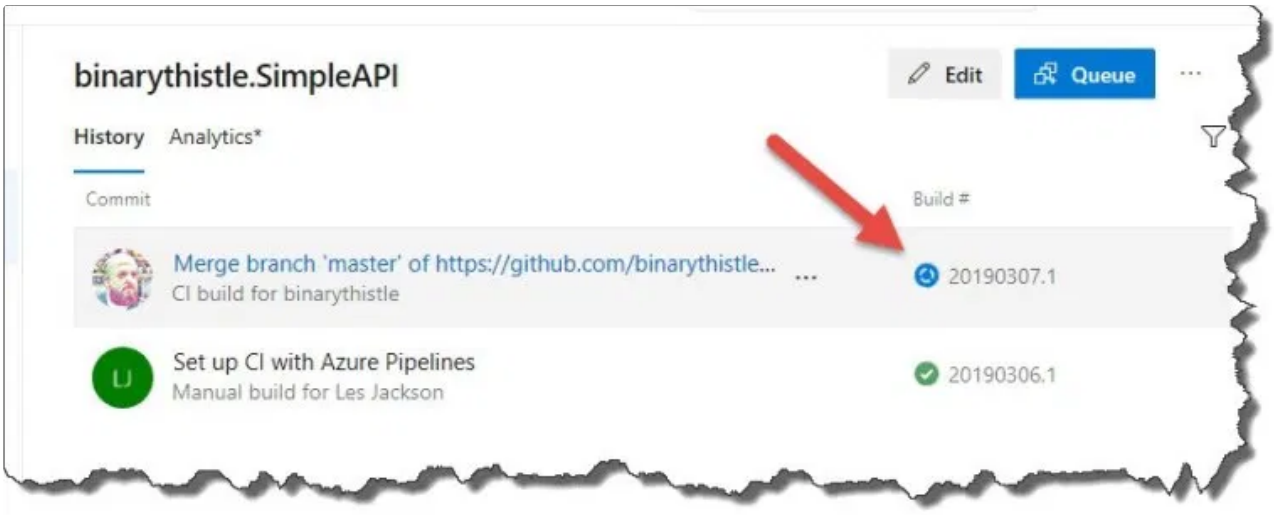


Now we have synced our remote repository, we still have to push our local changes up, again issue the following command and this time it should be successful:

```
git push origin master
```



Quickly jump over to Azure DevOps and click on Pipelines -> Builds, you should see something like this:



Another build process has been kicked off, this time triggered by a remote commit to Github!

All being well this should succeed.

We are getting there, but there is still some work to do on our build pipeline before we move on to deploying – and that is ensuring that our Unit Tests are run – which currently they are not...

Revisit azure-pipelines.yml

For brevity I'm not going to cover sections 1-3, (they're quite self explanatory anyway), the "meat" of what we're doing is contained in step 4.

Step 4 is simply executing the "dotnet build" command as you would if you were issuing it at the command line... Nothing more, nothing less.

It does not:

- Run our unit tests
- Package our project for deployment

Running Unit Tests

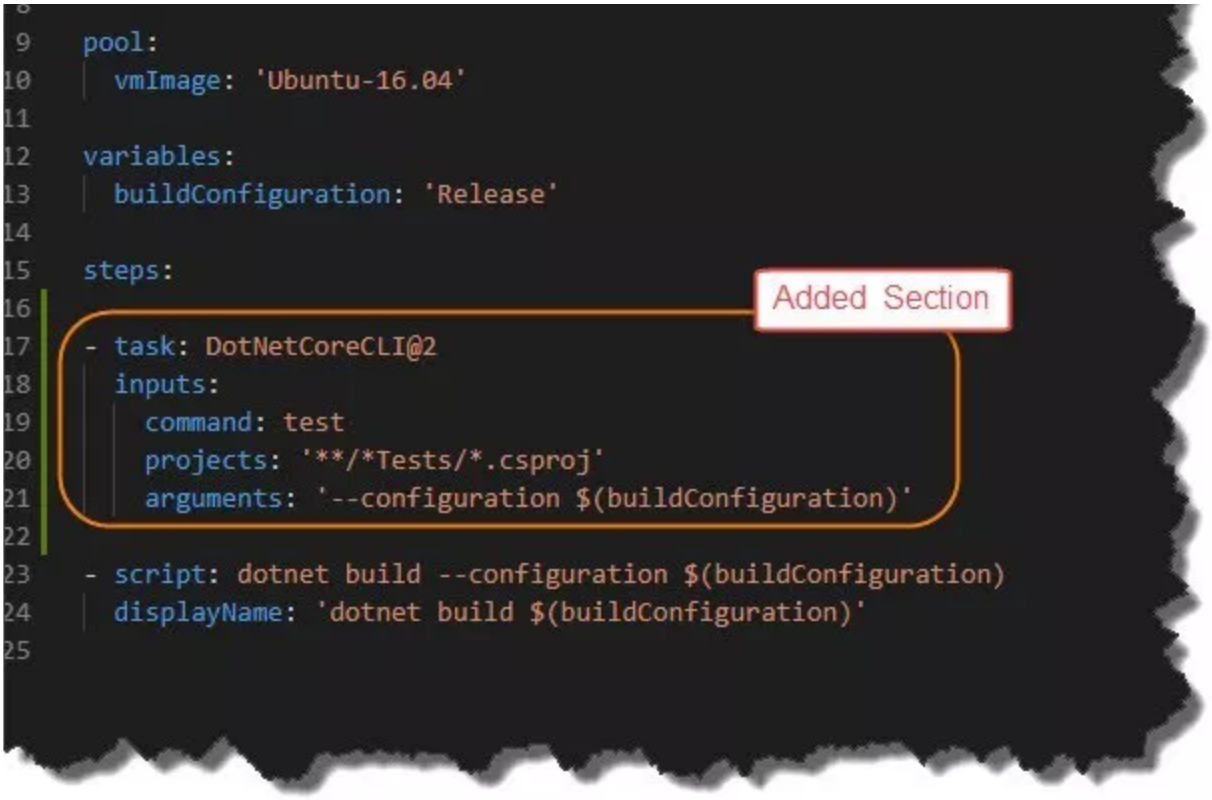
We need to edit our .yml file and we can do it either:

- Directly in the browser
- In VSCode

We're going to do the latter, so move back to VSCode and open "azure-pipelines.yml" and add the following directly AFTER "steps:", (noting to be really careful with adding the correct spacing!):

```
steps:
- task: DotNetCoreCLI@2
  inputs:
    command: test
    projects: '**/*Tests/*.csproj'
    arguments: '--configuration $(buildConfiguration)'
```

Overall your file should look like this:



It basically attempts to do a:

```
dotnet test
```

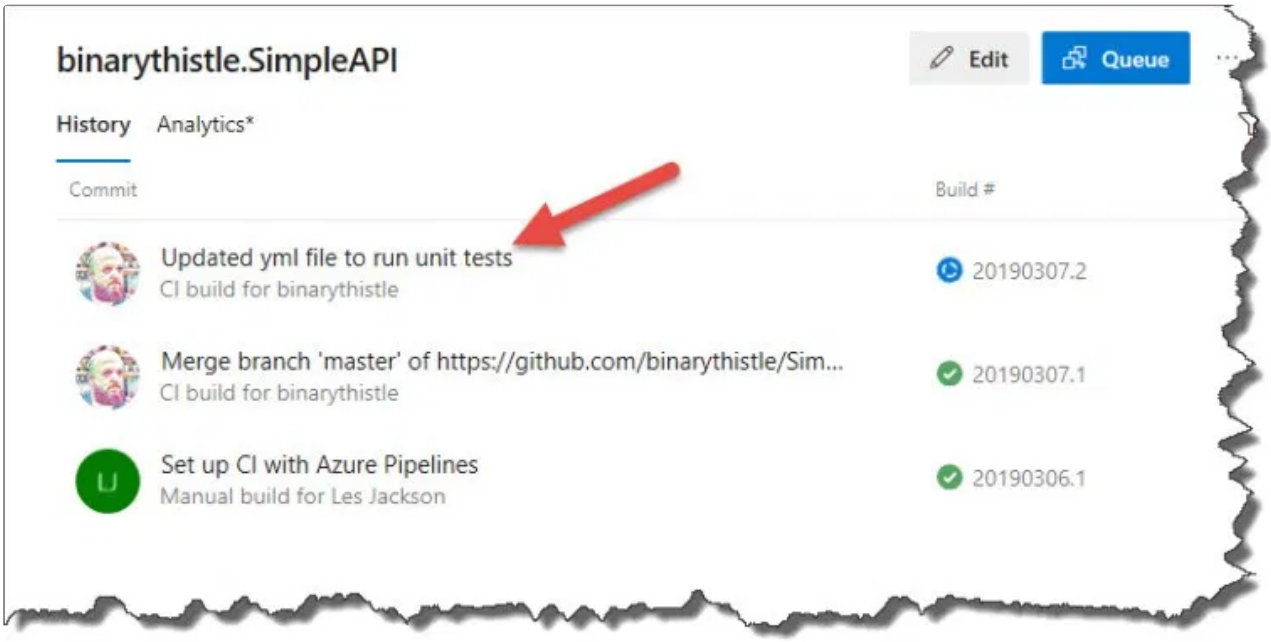
On our SimpleAPI.Tests project with an additional configuration switch.

Save the file, and issue the following commands, (note “git status” is optional, it’s just useful if starting out with Git):

```
git status
git add .
git status
```

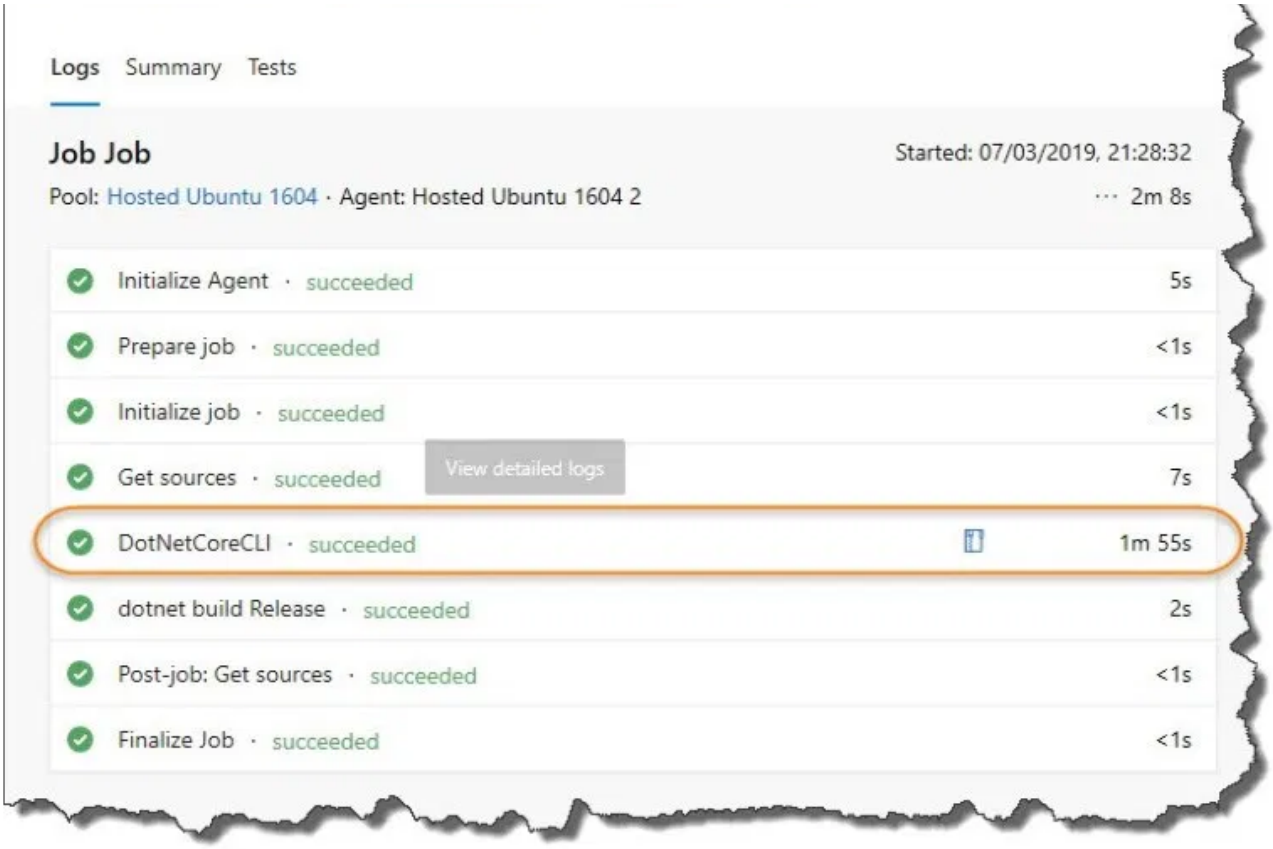
```
git push origin master
```

Pop over to Azure DevOps and refresh your Build Pipeline:



Eventually it should succeed, click the build to have a look at the execution steps:

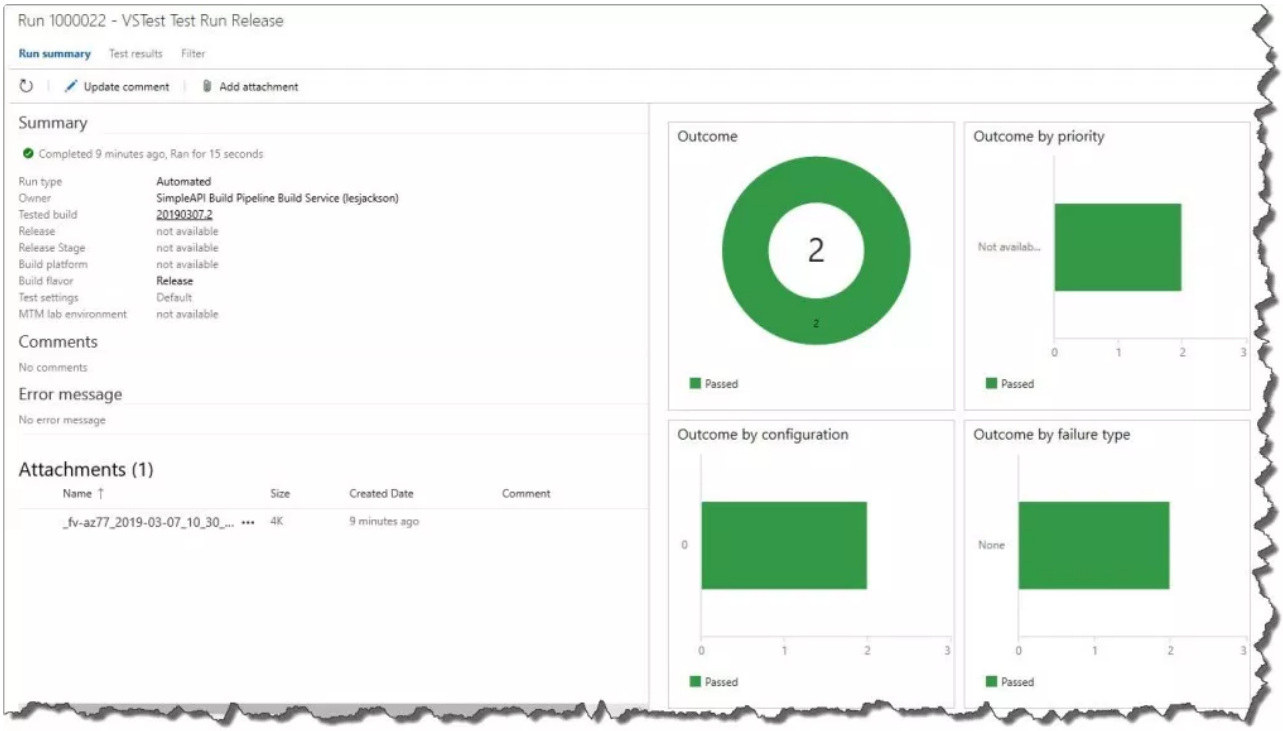
Success Steps:



Select the DotNetCoreCLI step we created in the azure-pipelines.yml file to run tests and drill down, you should see something similar to the following:

```
================================================================================
Task         : .NET Core
Description  : Build, test, package, or publish a dotnet application, or run a custom dotnet command
Version      : 2.147.2
Author       : Microsoft Corporation
Help         : [More Information](https://go.microsoft.com/fwlink/?linkid=832194)
================================================================================
[command]/usr/bin/dotnet test /home/vsts/work/1/s/test/SimpleAPI.Tests/SimpleAPI.Tests.csproj --logg
Build started, please wait...
Build completed.

Test run for /home/vsts/work/1/s/test/SimpleAPI.Tests/bin/Release/netcoreapp2.2/SimpleAPI.Tests.dll(
Microsoft (R) Test Execution Command Line Tool Version 15.9.0
Copyright (c) Microsoft Corporation.  All rights reserved.

Starting test execution, please wait...
Results File: /home/vsts/work/_temp/_fv-az77_2019-03-07_10_30_35.trx

Total tests: 2. Passed: 2. Failed: 0. Skipped: 0.
Test Run Successful.
Test execution time: 15.2566 Seconds
##[section]Async Command Start: Publish test results
Publishing test results to test run '1000022'
Test results remaining: 2. Test run id: 1000022
Published Test Run : https://dev.azure.com/lesjackson/SimpleAPI%20Build%20Pipeline/_TestManagement/R
##[section]Async Command End: Publish test results
##[section]Finishing: DotNetCoreCLI

```

Clicking on the suggested link in the output will take you to Azure DevOps Test Dashboard – very pretty!

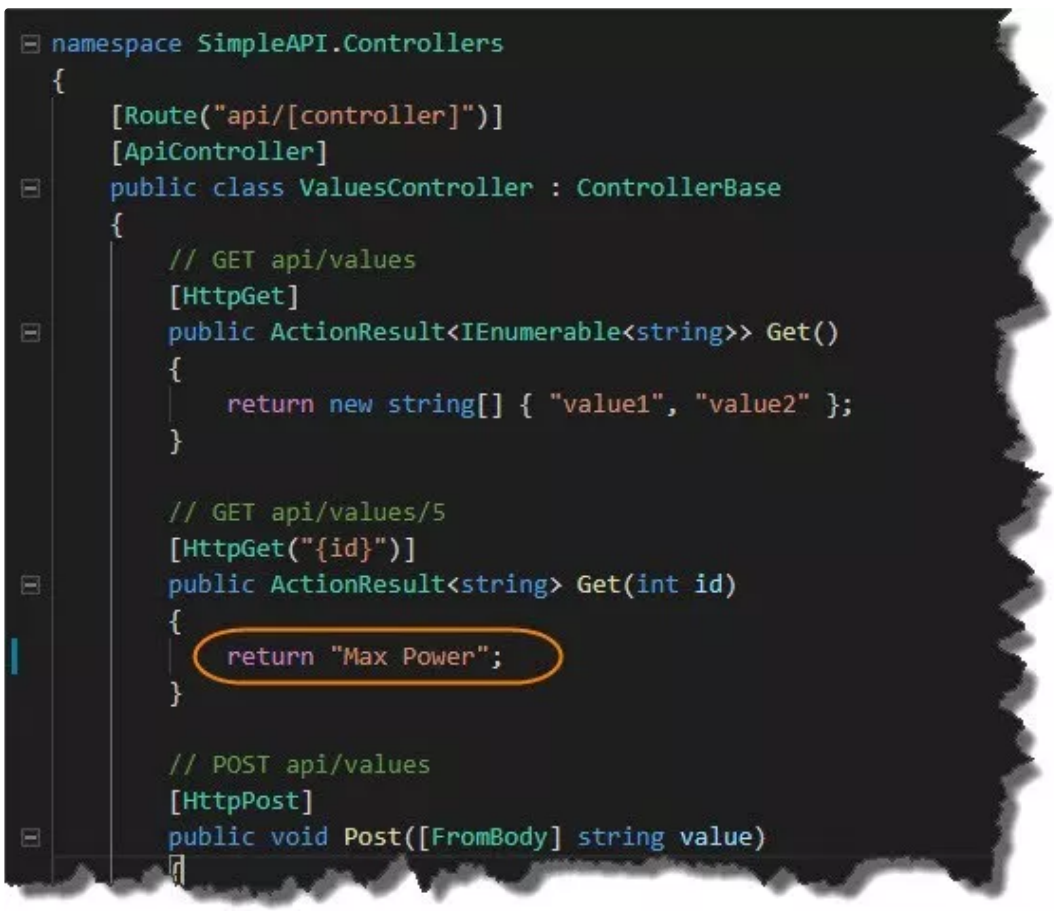


Break Our Unit Test

Ok, so return to VSCode and to our test project: SimpleAPI.Tests, and open the UnitTests.cs file. You'll remember we have 2 unit tests:

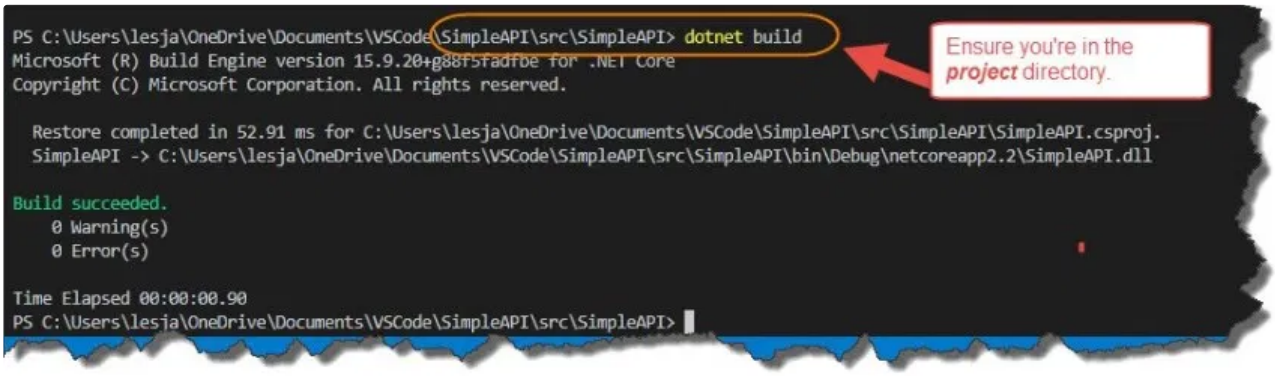
1. An empty default test that does nothing and passes
2. A unit test we wrote to test the return value of our API controller

So we want to "break" the 2nd test from passing, so go back to the SimpleAPI project and open the ValuesController.cs file, and edit the return value of our 2nd action method to anything other than "Les Jackson", (this will cause our test to fail), e.g. :



The name I always wish I had...

```
dotnet build
```



The **build** succeeds. I just wanted to make this point. We have changed the return value of the action method, but there is nothing wrong syntactically with the code – it's fine. Now...

In the command line, change into the SimpleAPI.Tests project and type:

```
dotnet test
```

You should see the test failing:

So the *behavior* of our method is not as we expected, but the code is ok, (i.e. the build succeeded)..

Now ordinarily, having just caused our unit test suite to fail locally, you ***would not*** then commit the changes and push them to Github! That is exactly what we are going to do just to prove the point that the tests will fail in the Azure DevOps build pipeline too.

Note: In this instance *we know* that we have broken our tests locally, but there may be circumstances where the developer may be unaware that that have done so and commit their code, again this just highlights the value in a CI/CI build pipeline.

Commit Our Code and Break the Pipeline

At the command line, make sure that you're in the *main solution directory*, and type:

```
git status
```

You should see that our ValuesController.cs file has changed.

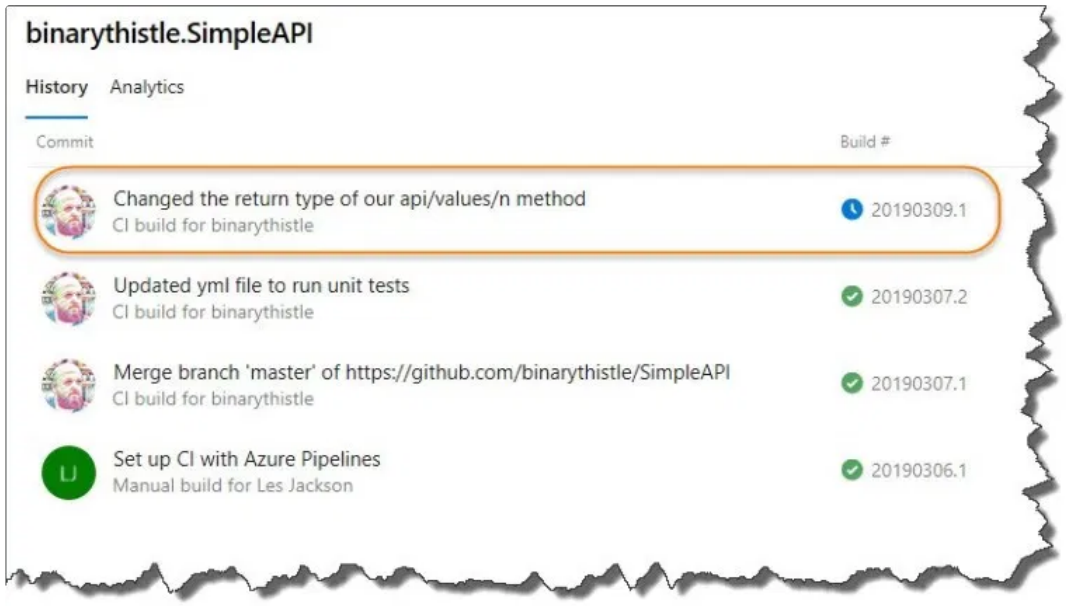
Add the file for pre-commit then commit the change to our local git repo:

```
git commit -m "Changed the return type of our api/values/n method"
```

We now want to push those changes to our remote Gitbub repository:

```
git push origin master
```

Jump over to Azure DevOps, click on Pipelines-> Builds, yoiu should see the pipeline building...



Our doomed build...

Of course if you wait long enough, the build will inevitably fail:

Oh dear, but to be expected...

Now clicking on the failed build you can drill down as to why it failed, for brevity I won't show that here, but I'm sure you are aware why this has happened.

Testing – The Great Catch All?

Now this shows us the power of unit testing, (as well as the other forms of automated testing that we mentioned above), in that it will cause the build pipeline to fail and buggy software won't be released or even worse deployed to production! It also means we can take steps to remediate the failure – huzzah!

So conversely does this mean that if all tests pass that you won't have failed code in production? No it doesn't for the simple reason that your tests are only as good as, well your tests!

We can fix this broken test and it will pass, (and in turn all tests will pass), but our overall test coverage is poor – for example we're not testing our other API Action Result methods.

So the point that I'm making, (maybe rather depressingly), is that even if all your tests pass, the confidence you have in your code will only be as good as your test coverage.

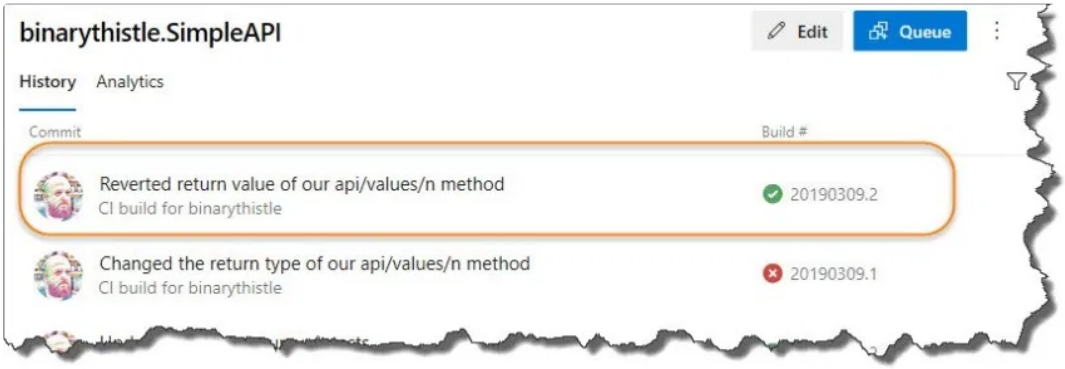
Revert Our Change

multiple files in your proejct, however as our change was so minimal, it's easier just to change the Action Method in our API Project back to "Les Jackson", (or whatever value you're unit test is using).

So:

- Make the change
- Save the ValuesController.cs file
- Test the build (*dotnet build* in the SimpleAPI project)
- Run the unit tests (*dotnet test* in the SimpleAPI.Tests project)
- Add the ValuesController.cs for pre-commit (*git add .* in the main solution directory)
- Commit the change (*git commit -m "Reverted return value of our api/values/n method"*)
- Push the changes to Github (*git push origin master*)

Once the Azure DevOps pipeline has finished – it should be green again:



All is good in the world again...

So we have to make one more change to our azure-pipelines.yml file – but what change?

This actually caught me out until I actually read the documentation, (and in fact was one of the reasons why I decided to do this tutorial)...

So far our azure-pipelines.yml does the following:

- Builds our project
- Runs the Unit Tests project

What it does not do is produce an artifact that an Azure DevOps ***Release Pipeline*** can take and deploy...

So the final change we need to make to our azure-pipelines.yml file is to add some steps to package the build (assuming the build and test steps have passed)

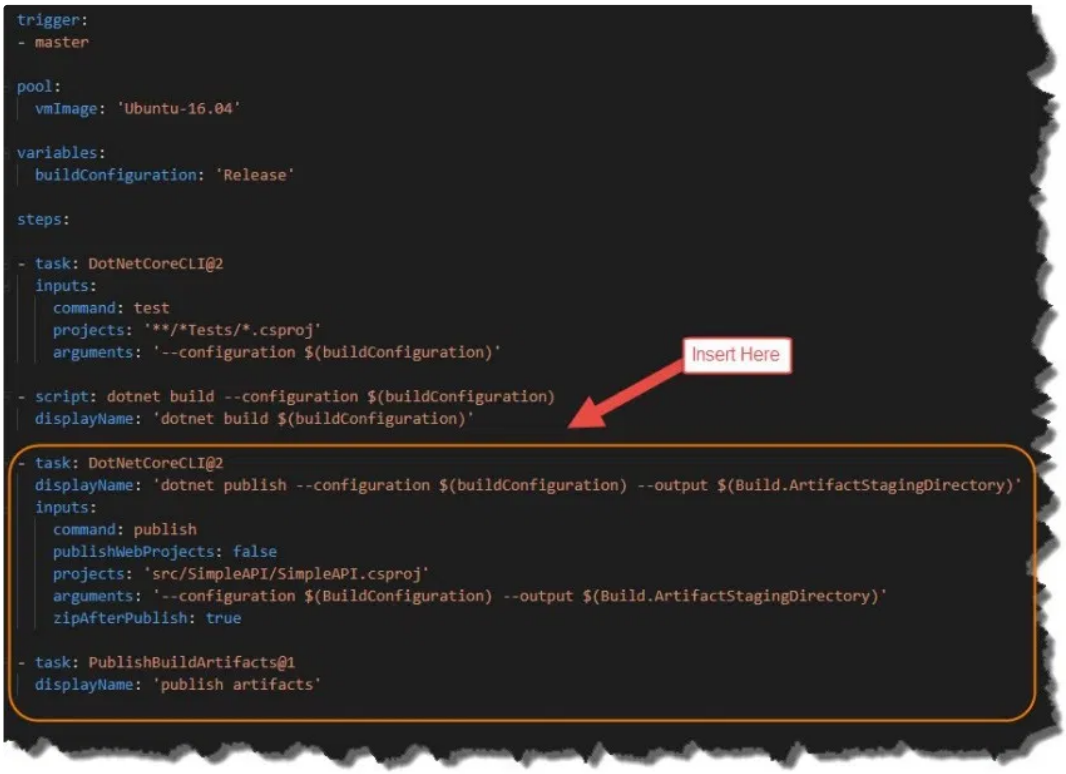
Add the Packaging Steps

So back to VSCode and open the azure-pipelines.yml file and append the following 2 "tasks" to the end of file:

```
- task: DotNetCoreCLI@2
  displayName: 'dotnet publish --configuration $(buildConfiguration)'
  inputs:
    command: publish
    publishWebProjects: false
    projects: 'src/SimpleAPI/SimpleAPI.csproj'
```

```
- task: PublishBuildArtifacts@1
  displayName: 'publish artifacts'
```

So your file should look like:



Final changes to yml

The steps are explained in more detail in this **msdn article**, but in short:

- A dotnet build command is issued for our SimpleAPI project, (not the SimpleAPI.Tests project)
- The output of that is zipped
- Finally zipped output is published

```
    publishWebProjects: false
```

The default is true I guess, for if you don't include that it assumes this is a web project, and the pipeline will fail... urgh!

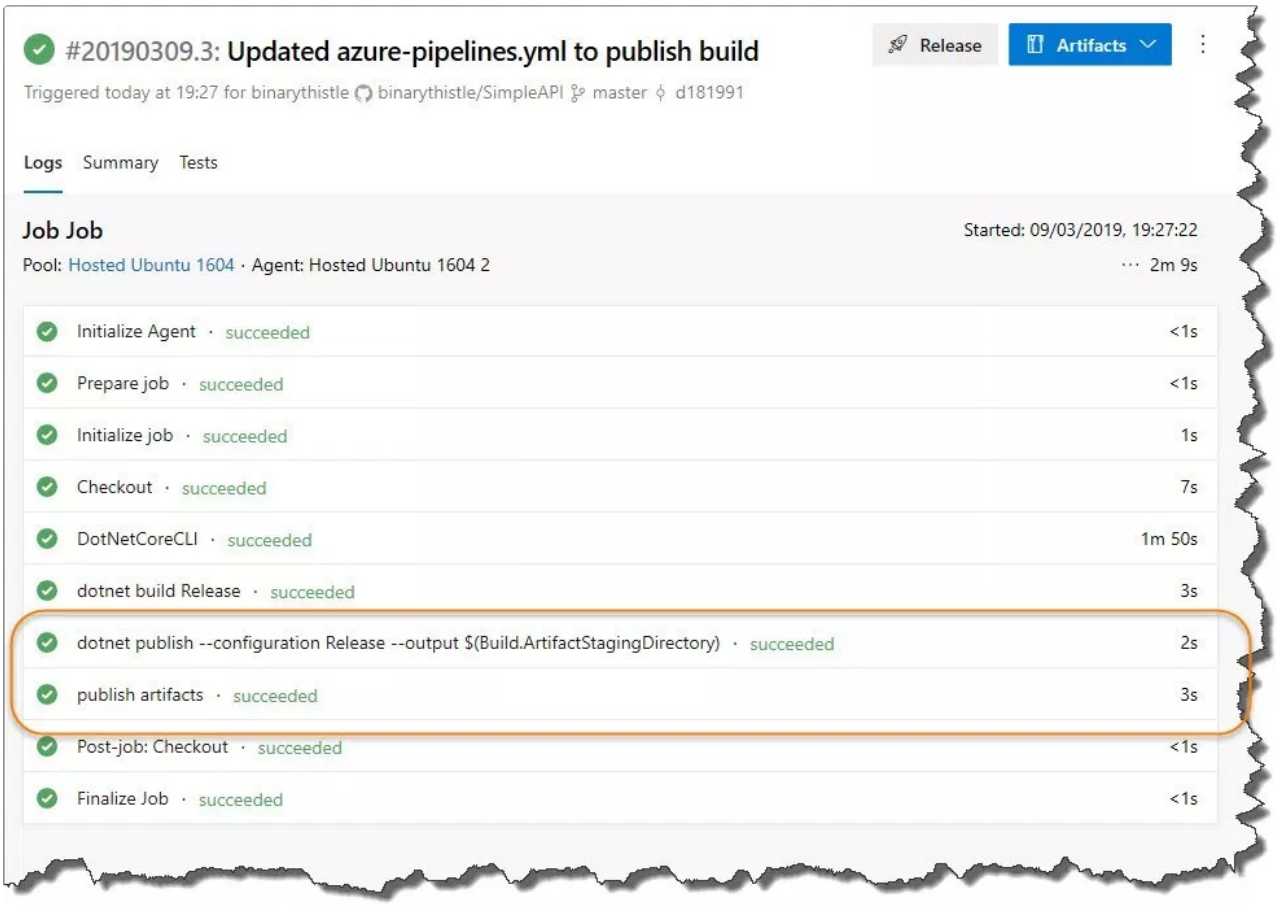
Commit the Change & Push

So you should be used to this process now:

- Save the file
- git add . (in the main solution directory)
- git commit -m "Updated azure-pipelines.yml to publish build"
- git push origin master

Again the push to Github, will kick off the Azure DevOps Build pipeline, it should succeed:

Build Published



We are almost ready to deploy!

Create Our Azure Resource

Now we move over to Azure.

Azure is a MASSIVE subject area, and given the length this post has gotten, I'm not going to go into details here. Basically we need to create an "API App" on Azure that will host our production REST API, (there are alternative ways we can do this, but for me this is the most appropriate method).

There are 2 ways we can create that API App "resource", (everything in Azure is essentially a resource):

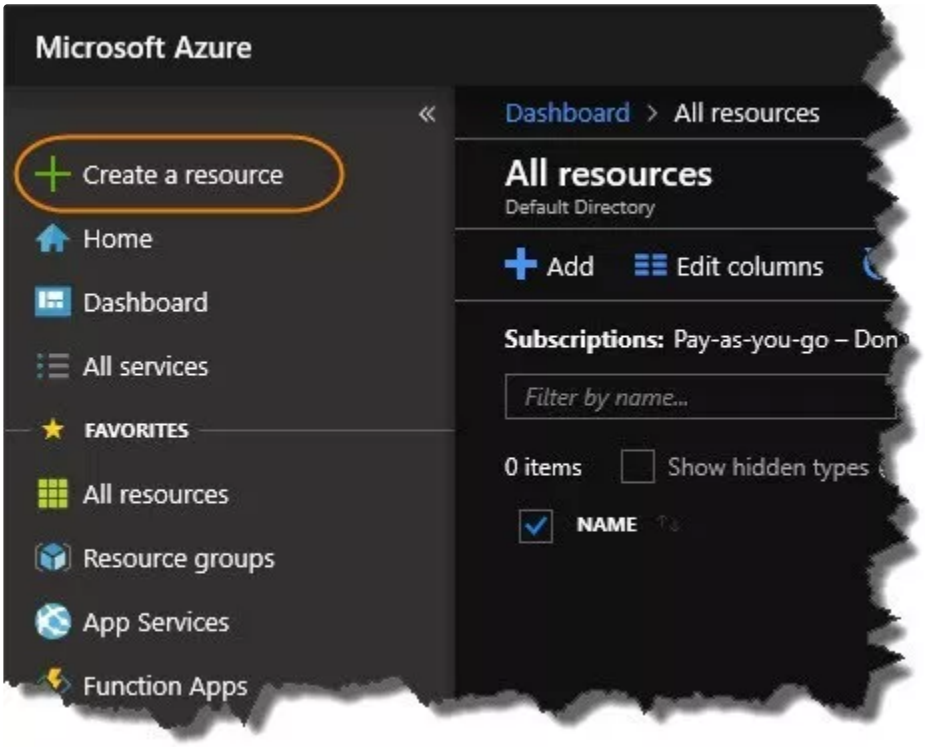
2. Create it via a script

For simplicity, (and brevity), we'll go with Option 1, don't worry we only have to do this once, it's not something we need to repeat with every deployment, (which would defeat the whole purpose of attempting to automate our deployment).

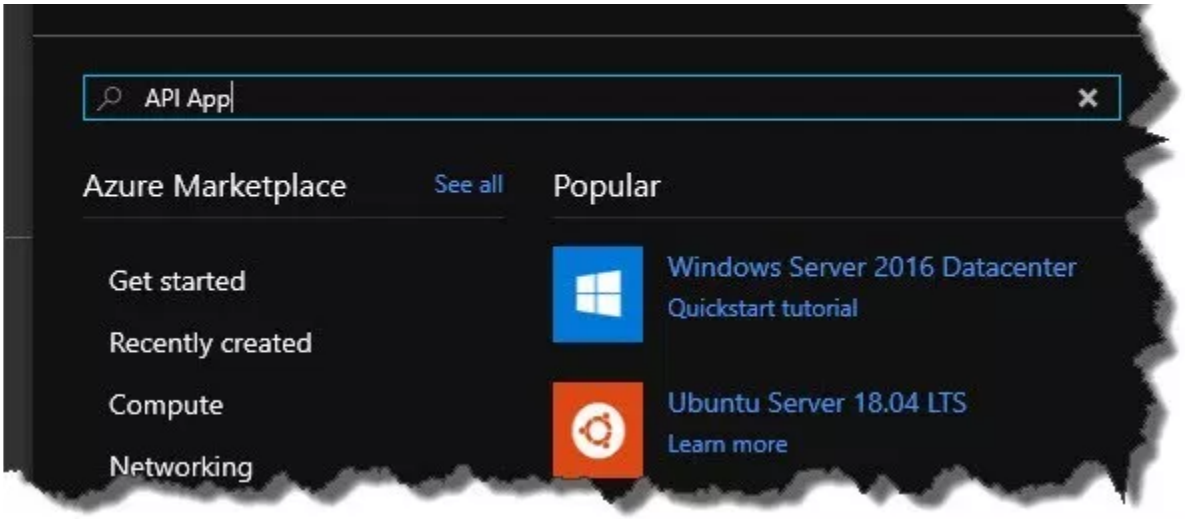
If you are interested in the scripting approach to create the API App, then Google "Azure Resource Manager Templates", these are also known as ARM Templates.

Create Our API App

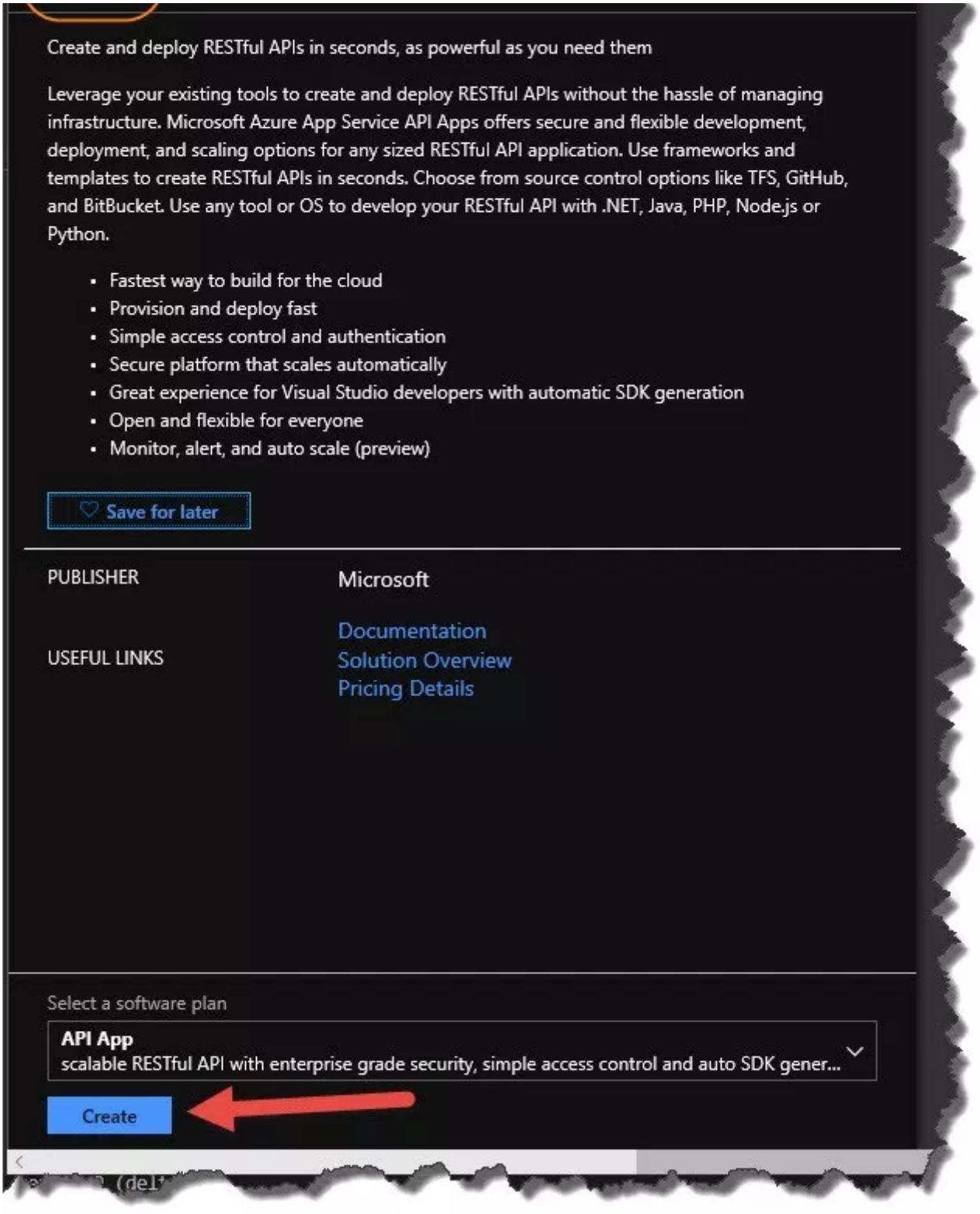
Login to Azure, (or if you don't have an account you'll need to create one), and click on "Create a resource":



In the "search box" that appears in the new resource page, start to type "API App", you will be presented with the API App resource type:



Select “API App”, then click “Create”:



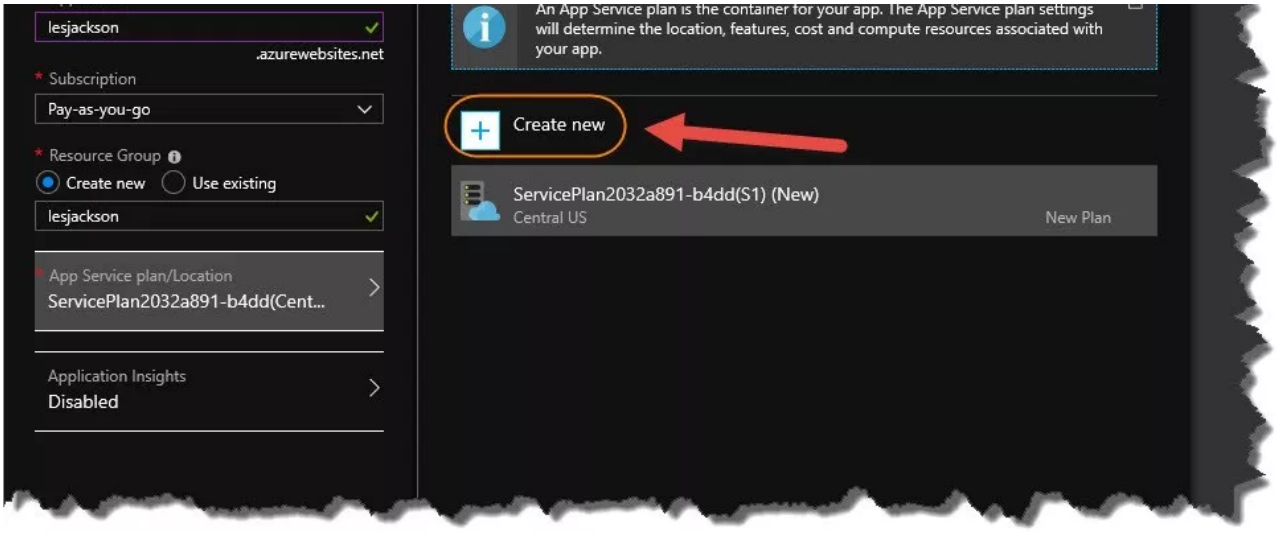
On the Next “page”, enter:

1. A name for your API App

3. A name for your new “Resource Group” – these are just groupings of “resources” – duh!

WAIT! Before you click “Create” click on the “App Service plan/Location”

After clicking on the Service Plan, click on “Create new”:

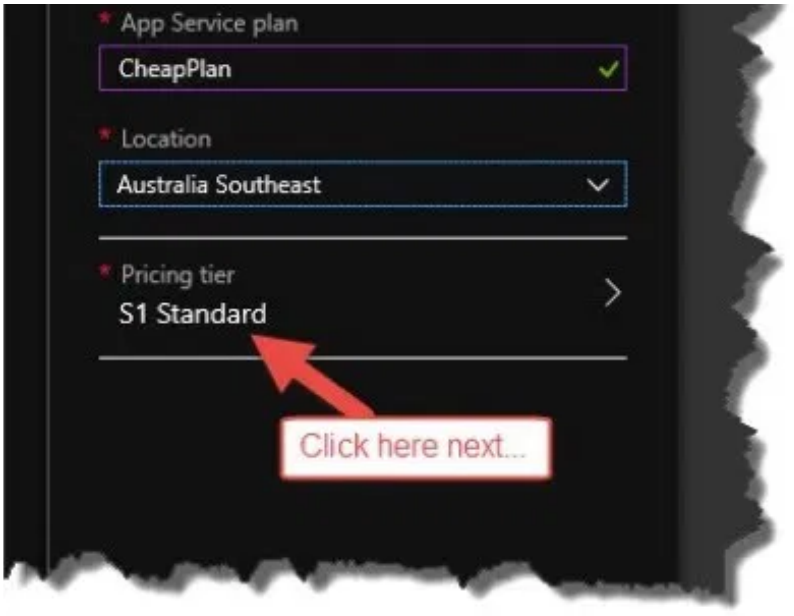


What is A Service Plan?

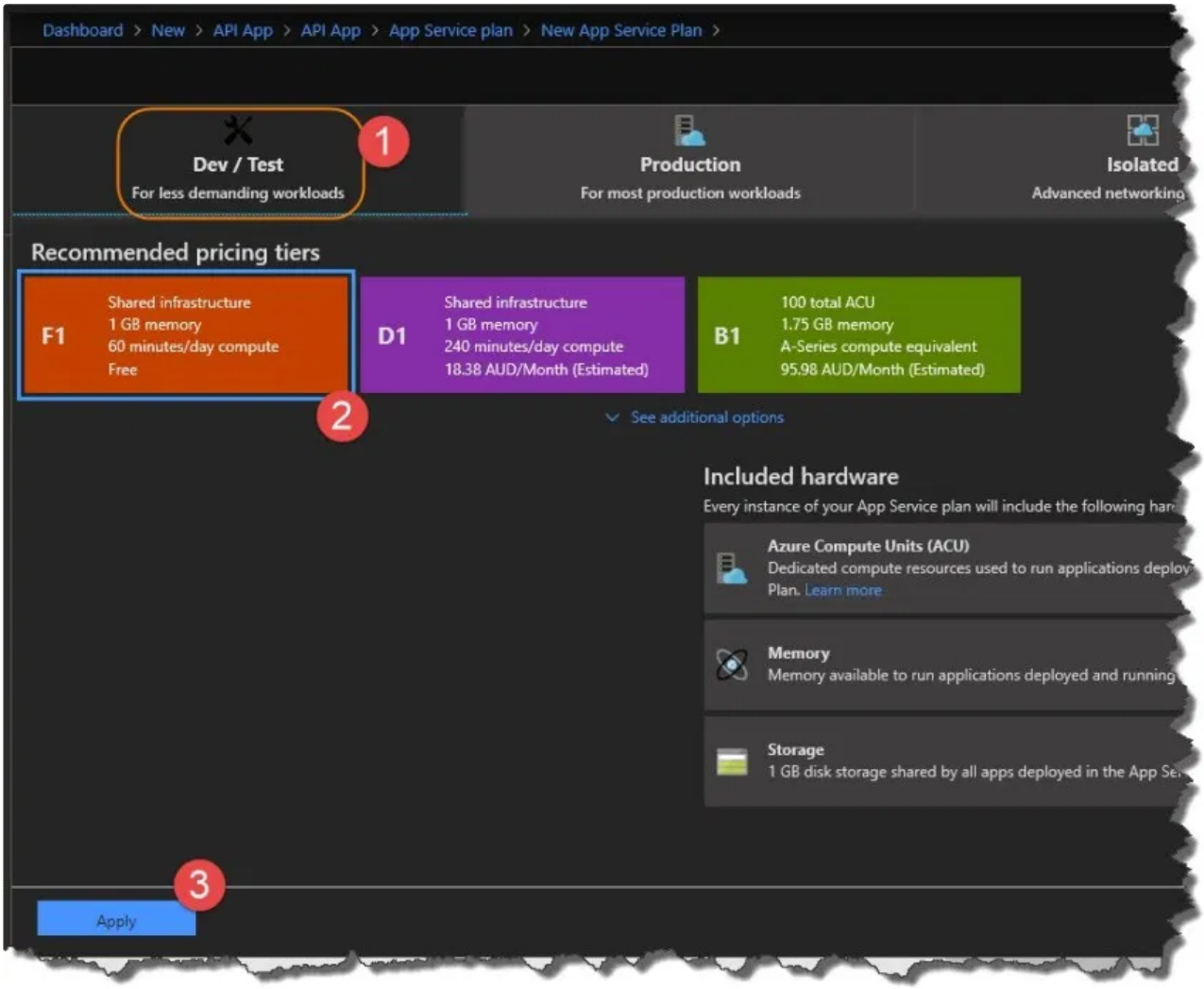
Basically this is where you select things like:

- Location of your API App (i.e. which Microsoft data center its hosted in)
- Pricing Tier, e.g. do you want dedicated hosting with large CPU, or do you just want a dev/ test box on shared infrastructure?

So on the “New App Service Plan” widget, enter an App Service Plan name, and pick your location, then click on the Pricing Tier...



After click on the “Pricing Tier”:

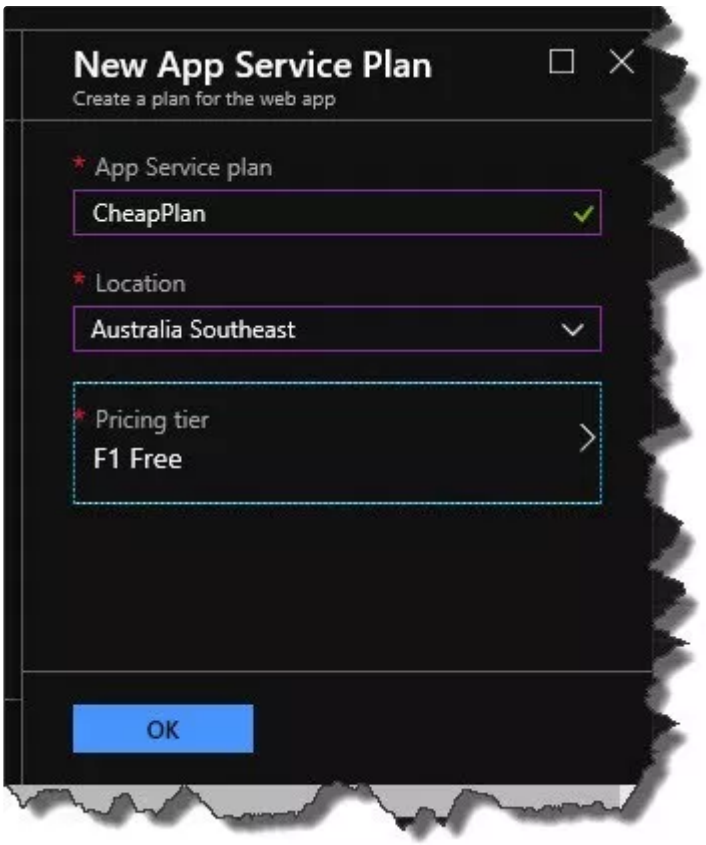


2. Select the “F1” Option (Shared Infrastructure / 60 minutes compute)

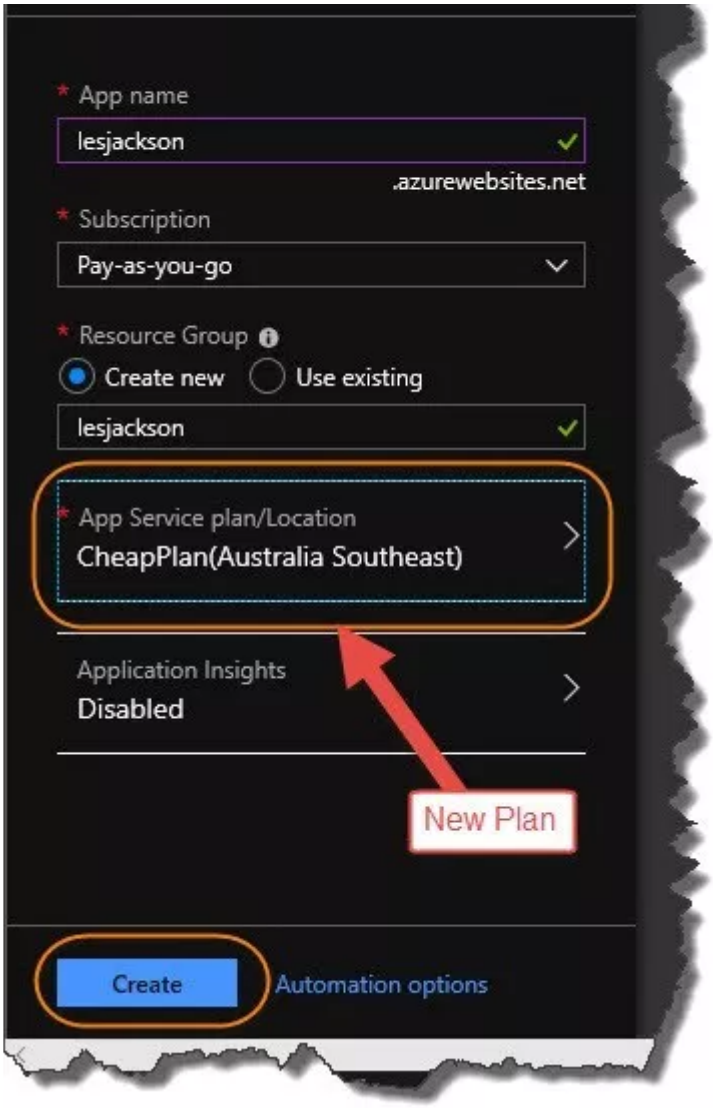
3. Click Apply

We have selected the cheapest tier with “Free Compute Minutes”, although please be aware that I cannot be held responsible for any charges on your Azure Account! (After I create and test a resource if I don’t need it – I “stop it” or delete it).

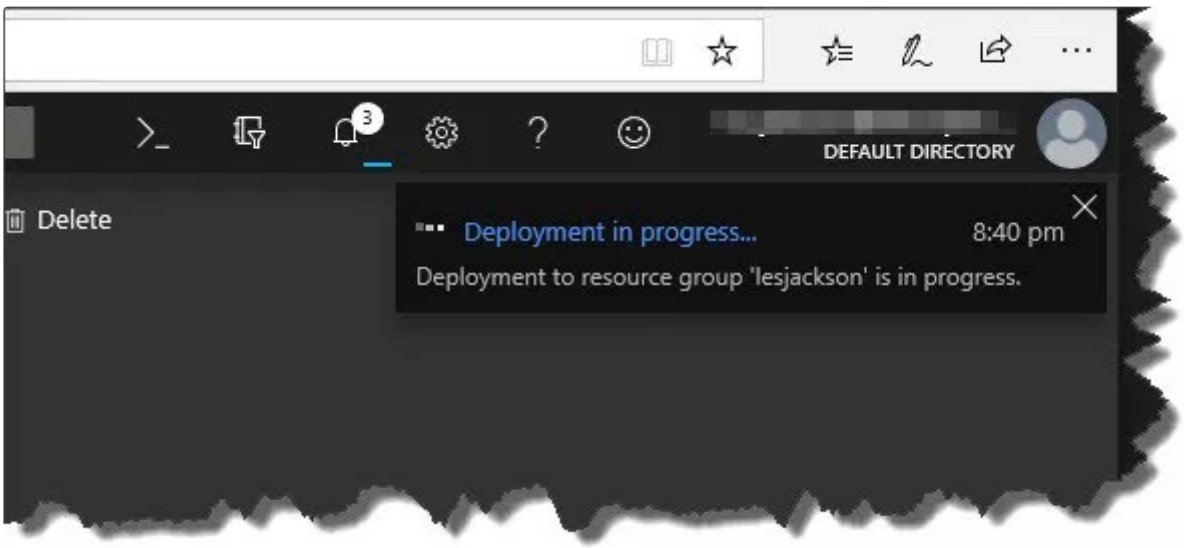
Then Click OK...

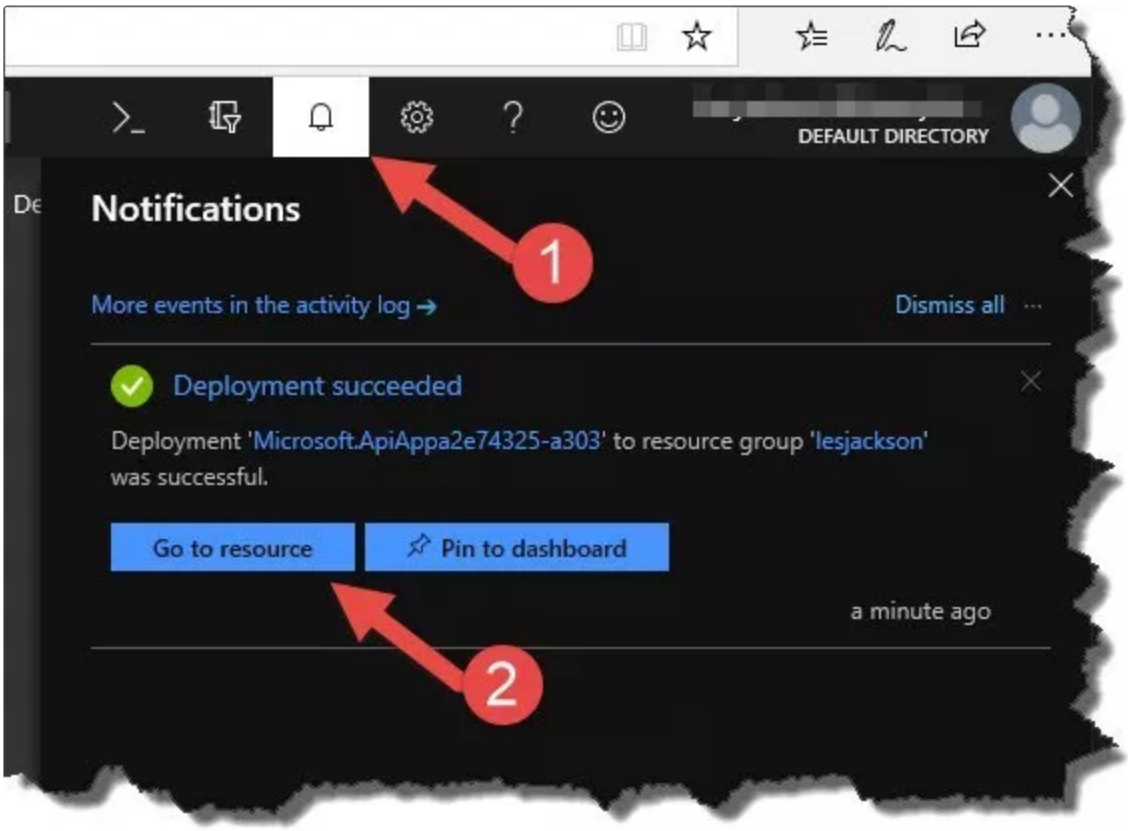


Then click “Create”, (ensure your new App Service Plan is selected):

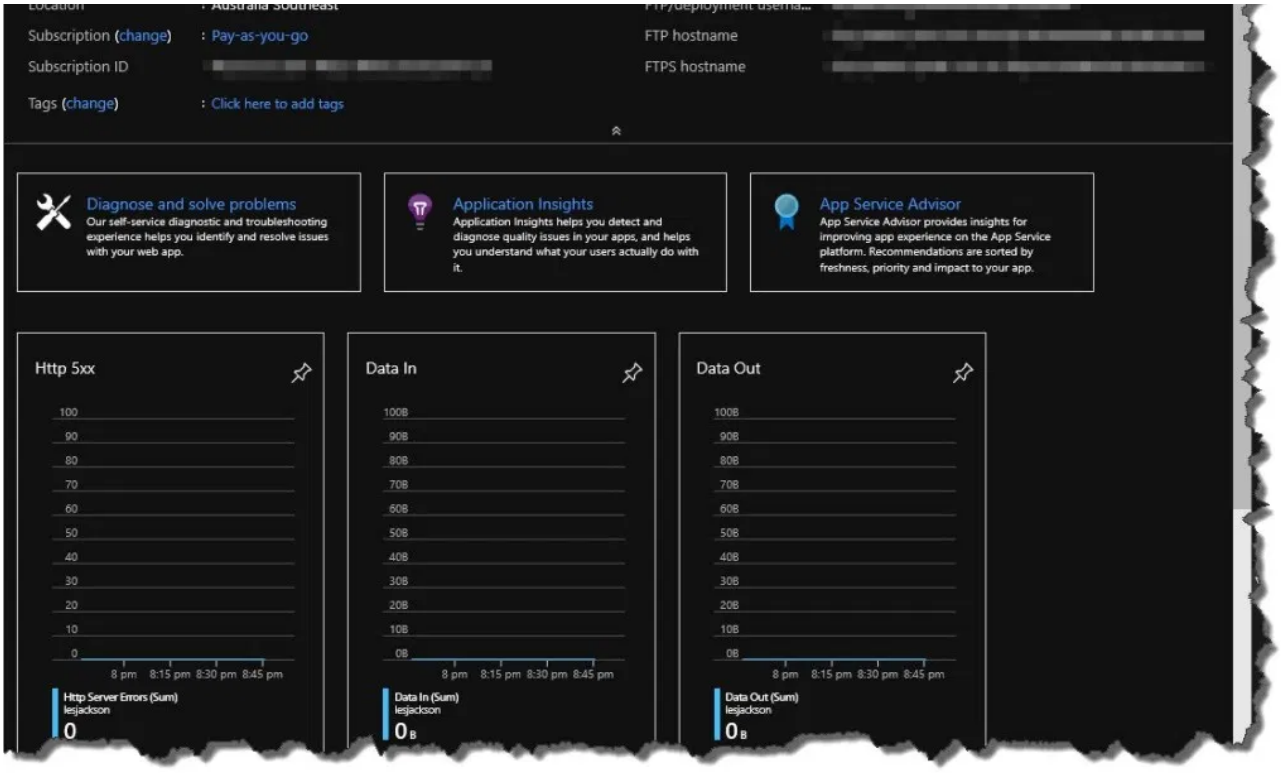


After clicking Create, Azure will go off an create the resource ready for use:

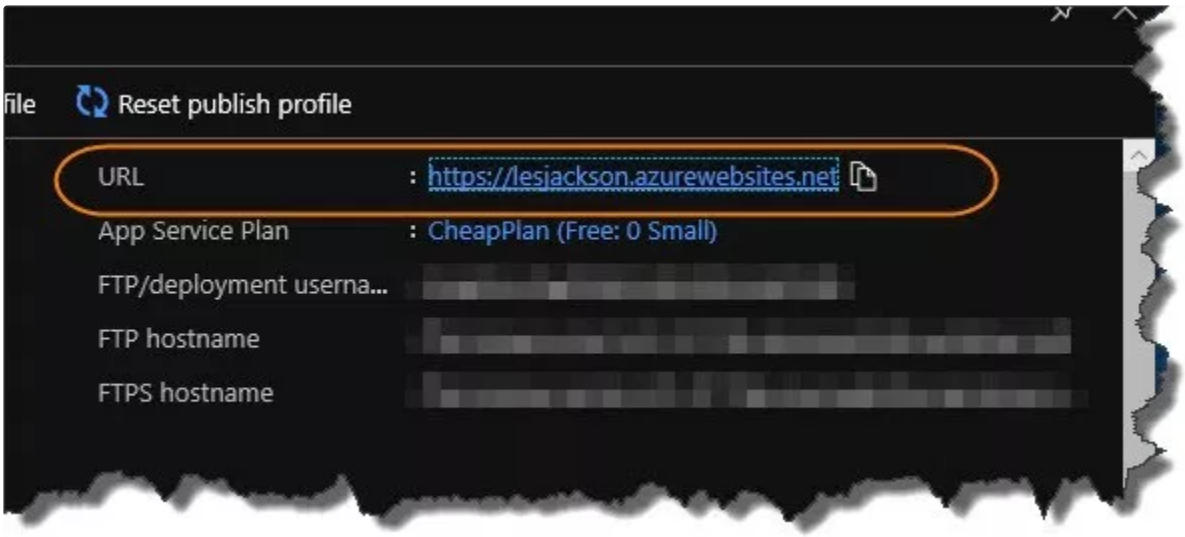




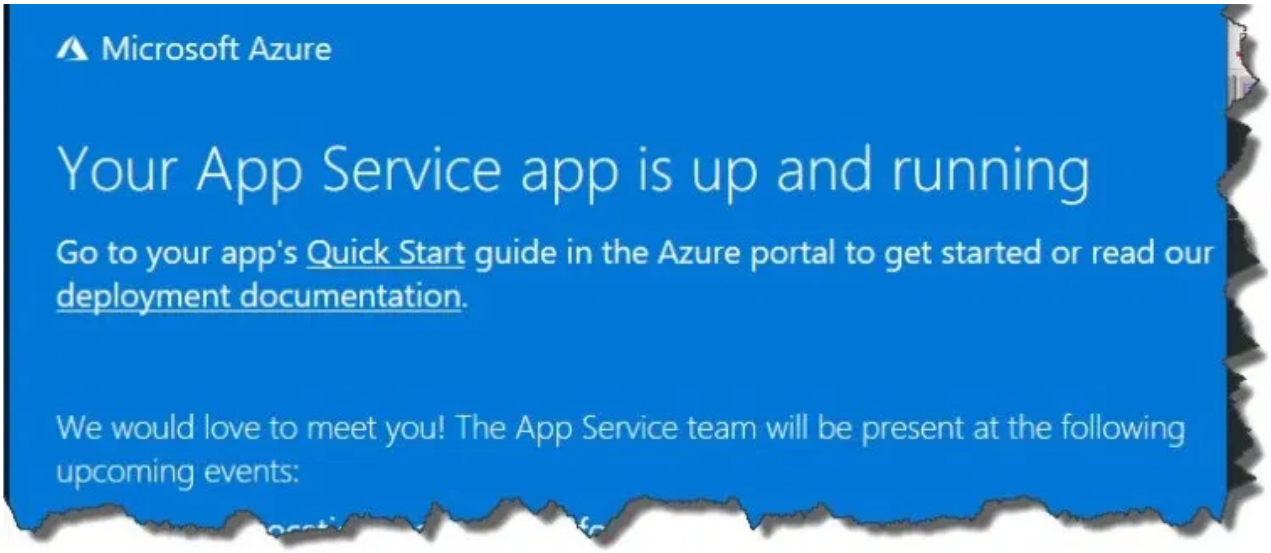
Here you can see the resource was successfully created, now click on “Go to resource”:



This just gives us an overview of the resource we created, and gives us the ability to stop or even delete it. You can even click on the location URL and it will take you to where the API App resides:



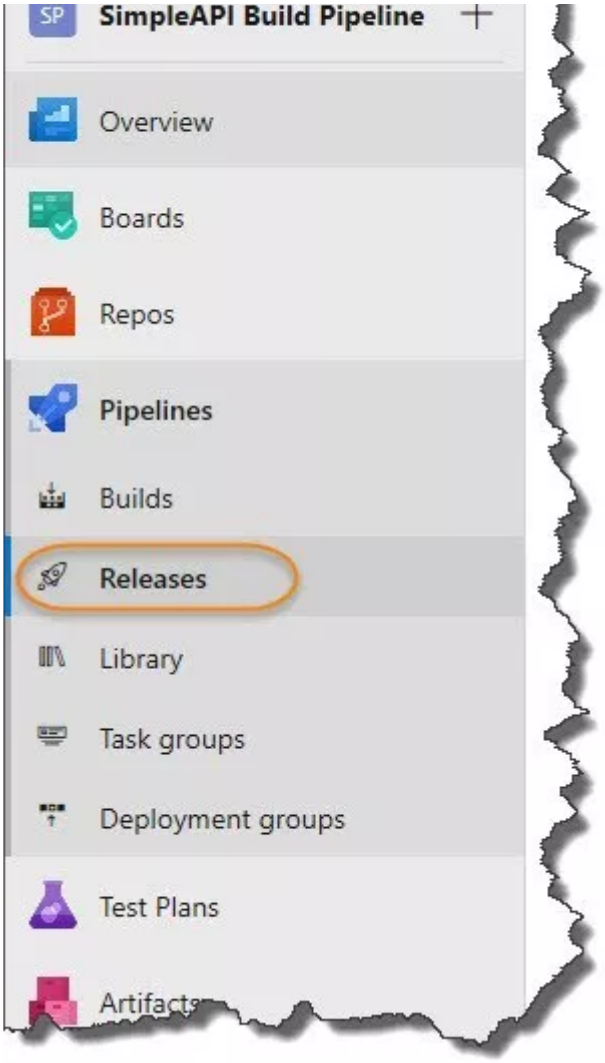
Our “Live” site – although we’ve not deployed our SimpleAPI here yet – we do that next!



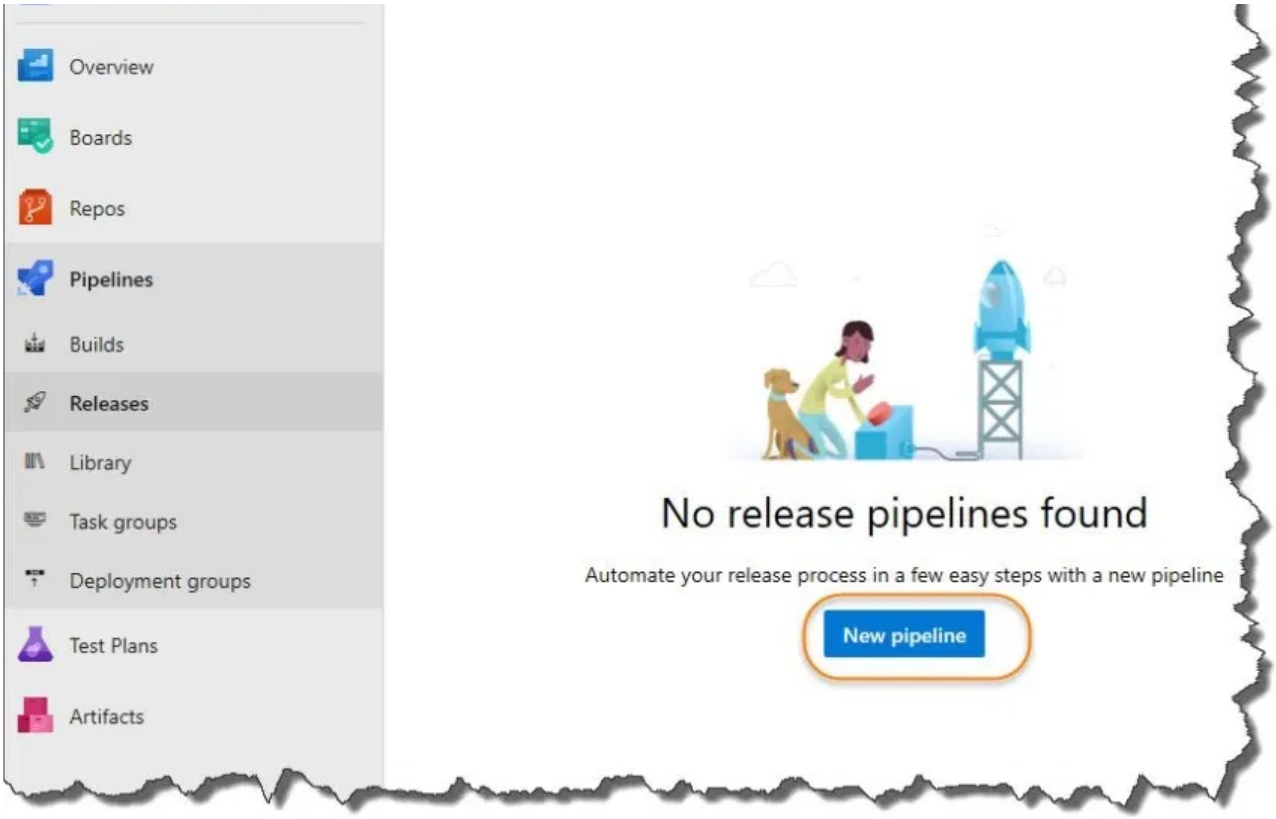
Create Our Release Pipeline

At last! We create the final piece of the puzzle: The Release Pipeline...

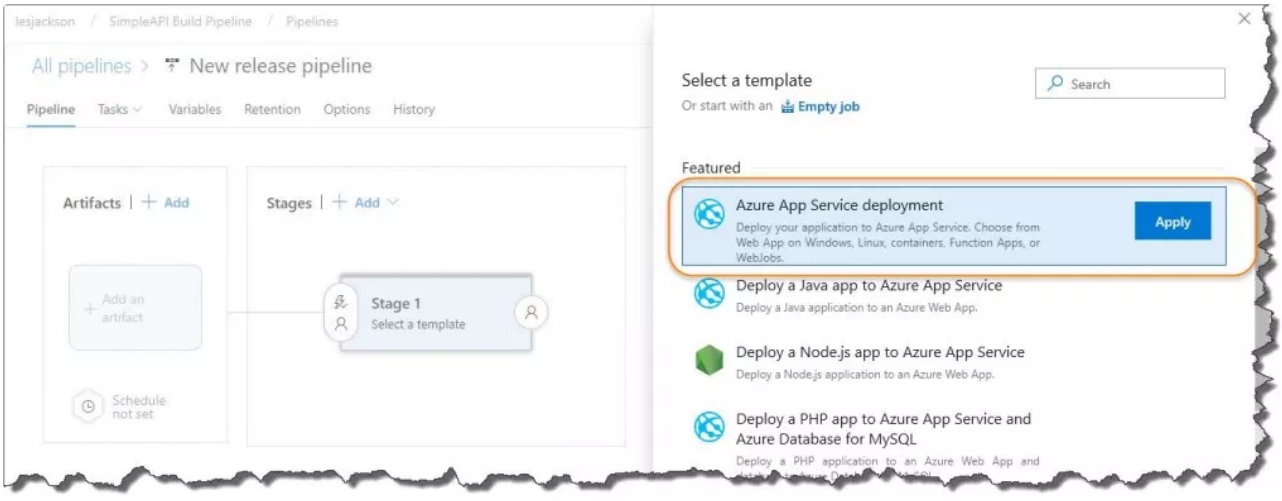
The Release Pipeline takes our build artifact and deploys it, (in this case), to our Azure API App. So back in Azure DevOps, click on Pipelines -> Releases:



Then click on “New pipeline”:



On the next screen, select & “Apply” the “Azure App Service deployment” Template:

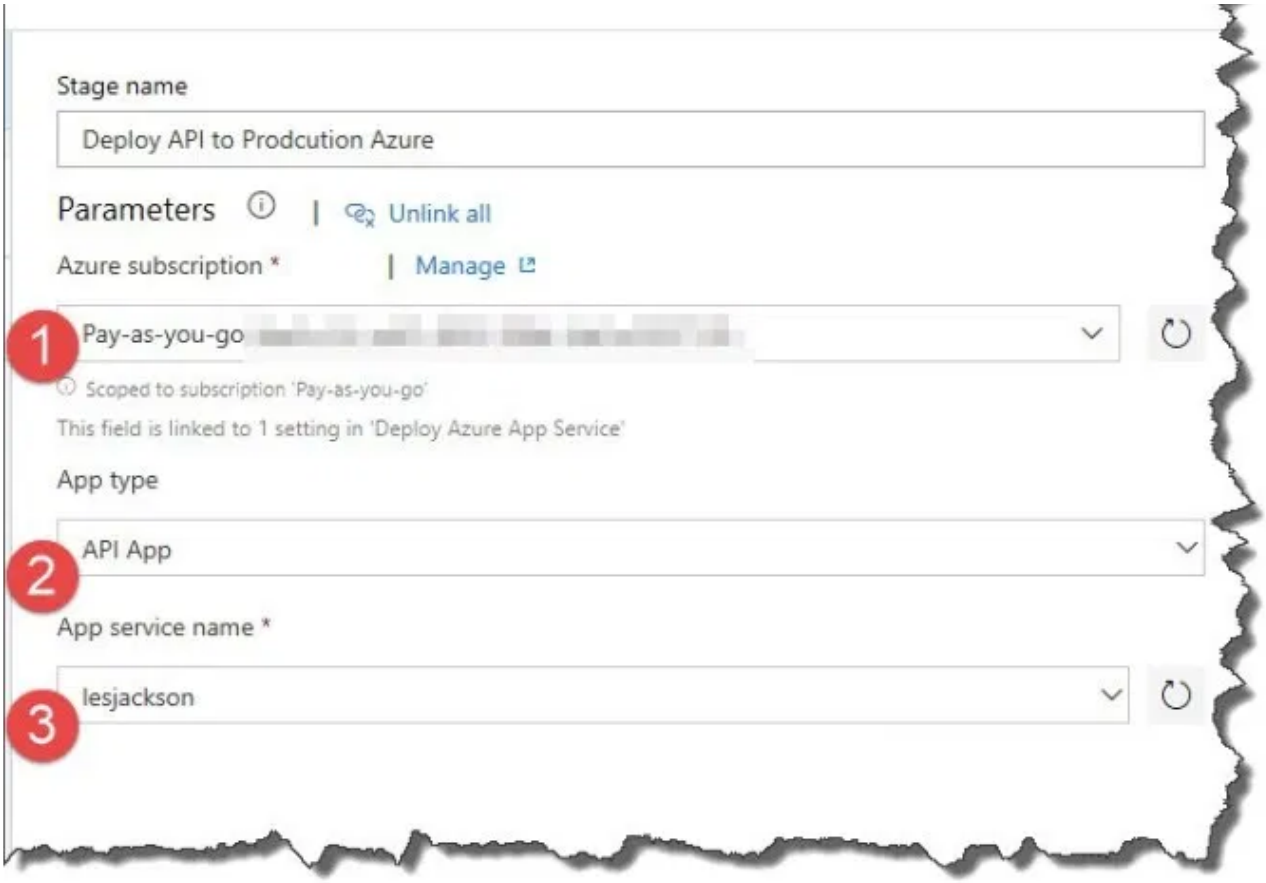


In the “Stage” widget:

1. Change the stage name to: “Deploy API to Production Azure”
2. Click on the Job / Task link in the designer

Here we need to:

1. Select Our Azure Subscription
2. App Type
3. App Service Name



For the Azure Subscription you'll be asked to provide your Azure credentials, then Authorise Azure DevOps to use this account.

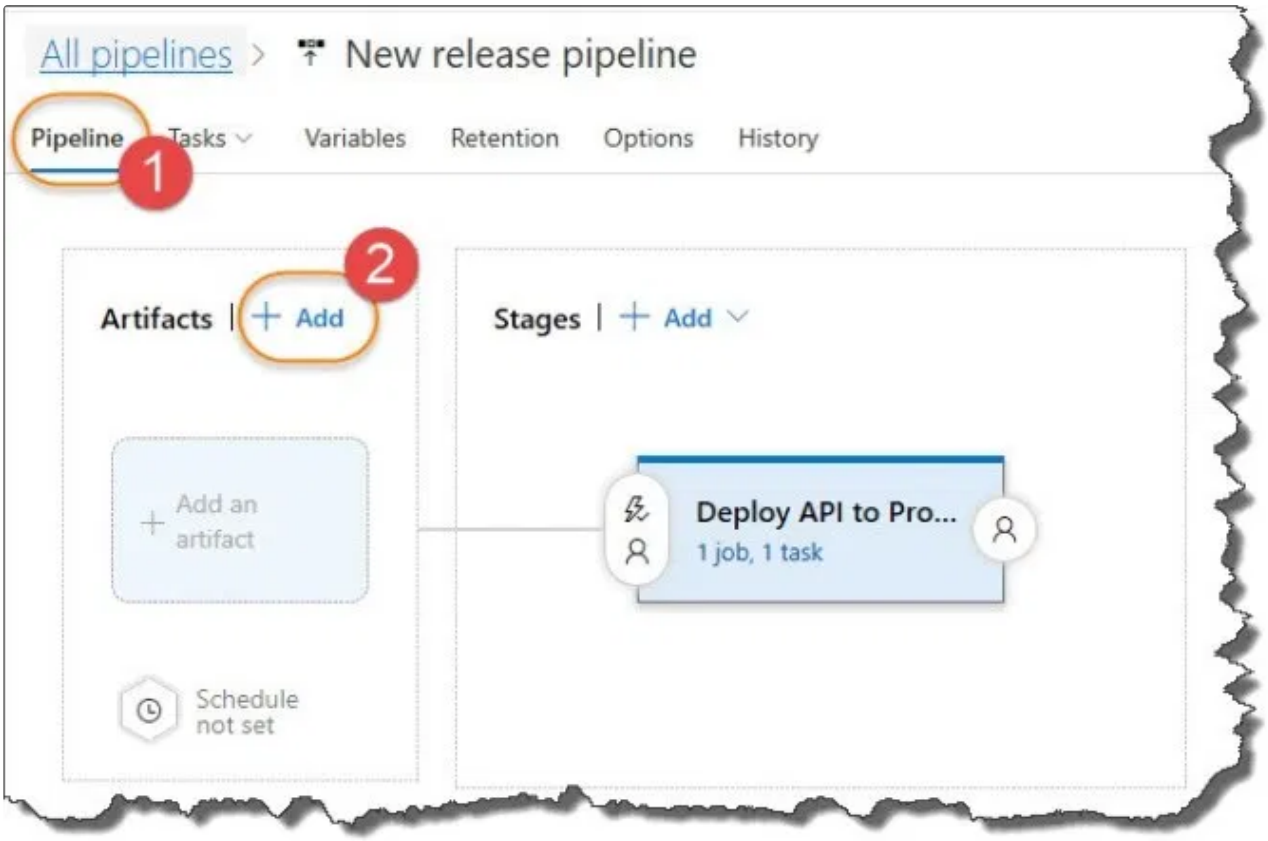
The App Type is: API App.

The if you click on the App Service Name drop down, a list of the API Apps that you have on the provided subscription should appear, in this case we have just one.

Finally click "Save"

You'll be presented with a Folder pop up, just click ok:

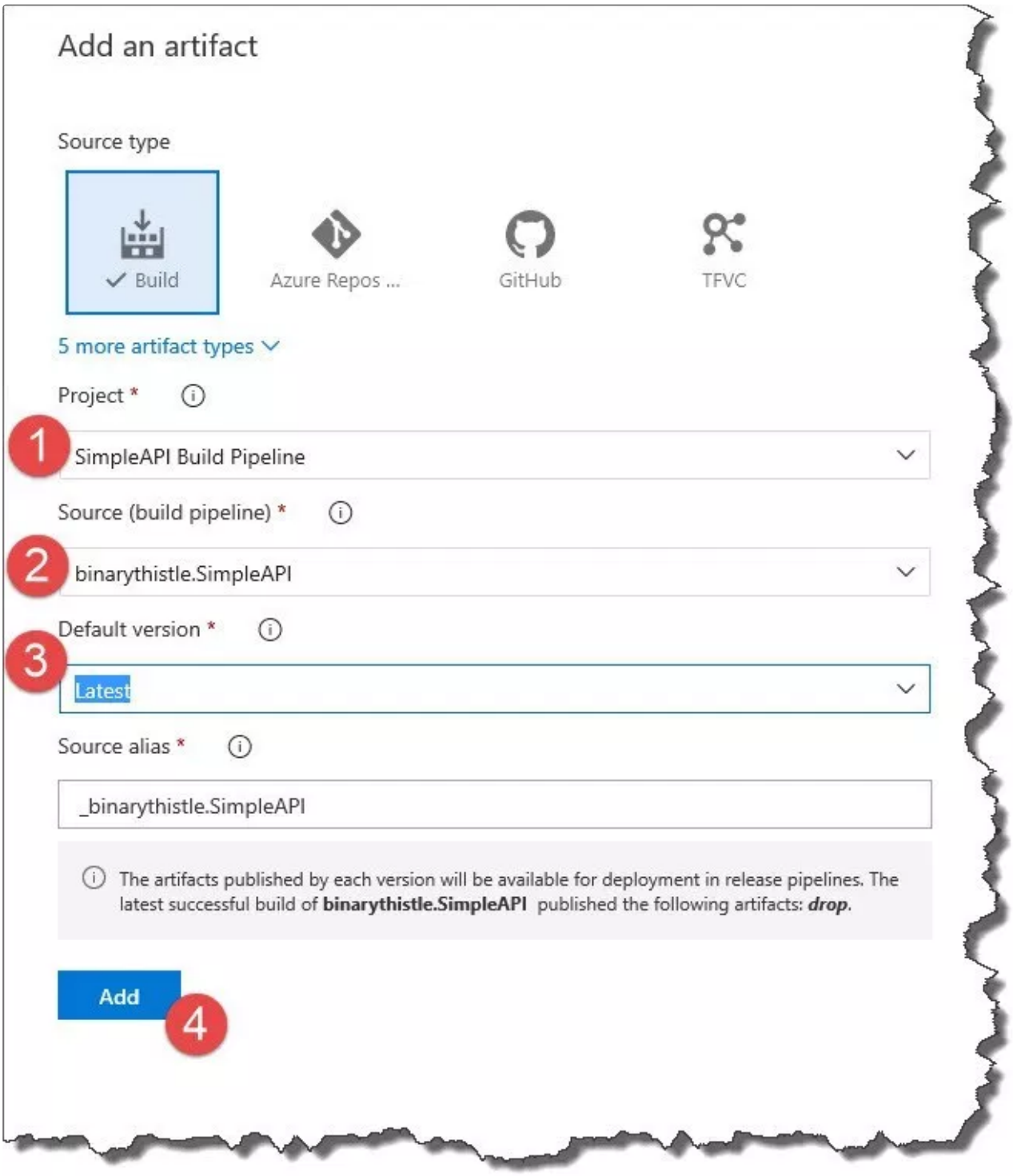
Click back on the “Pipeline” tab, then on Add (to add an artifact):



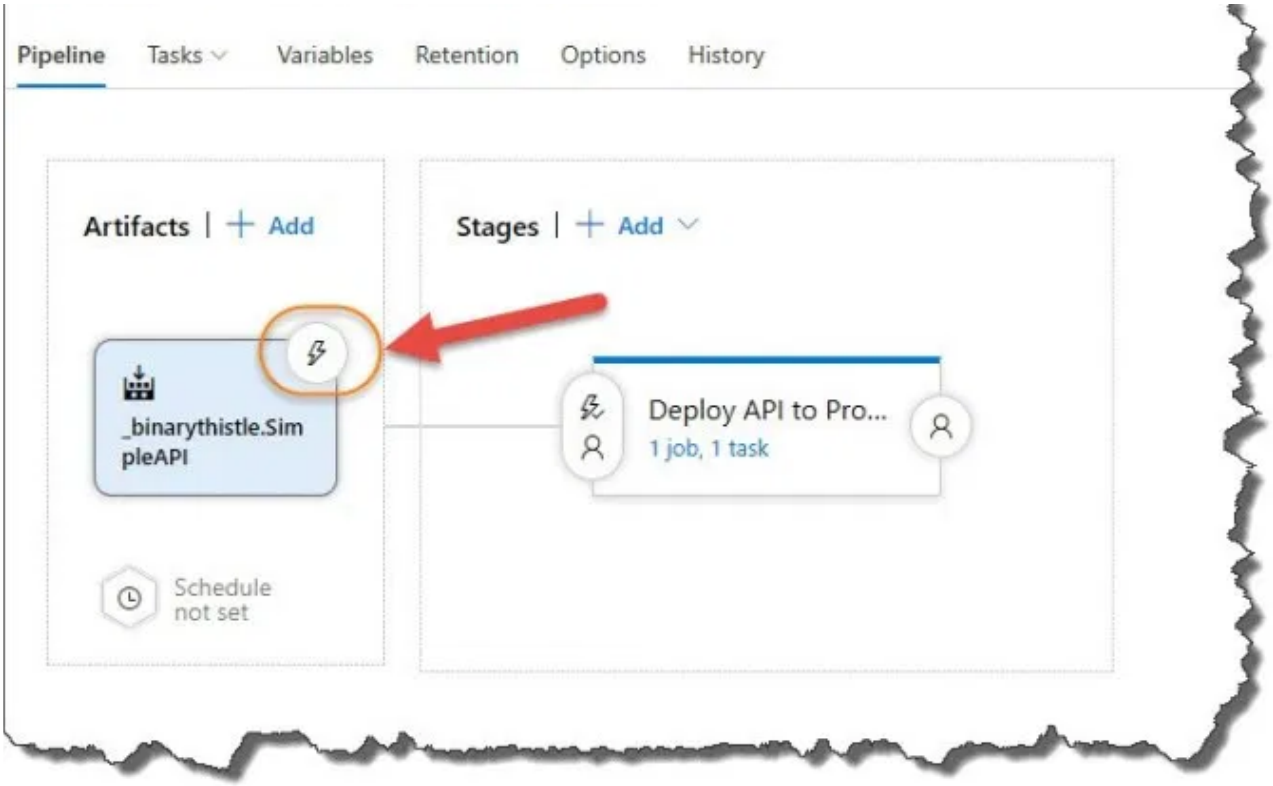
Here you will need to provide:

2. The Source Pipeline (this is our build pipeline we created previously)

3. Default version (select “Latest” from the drop down)

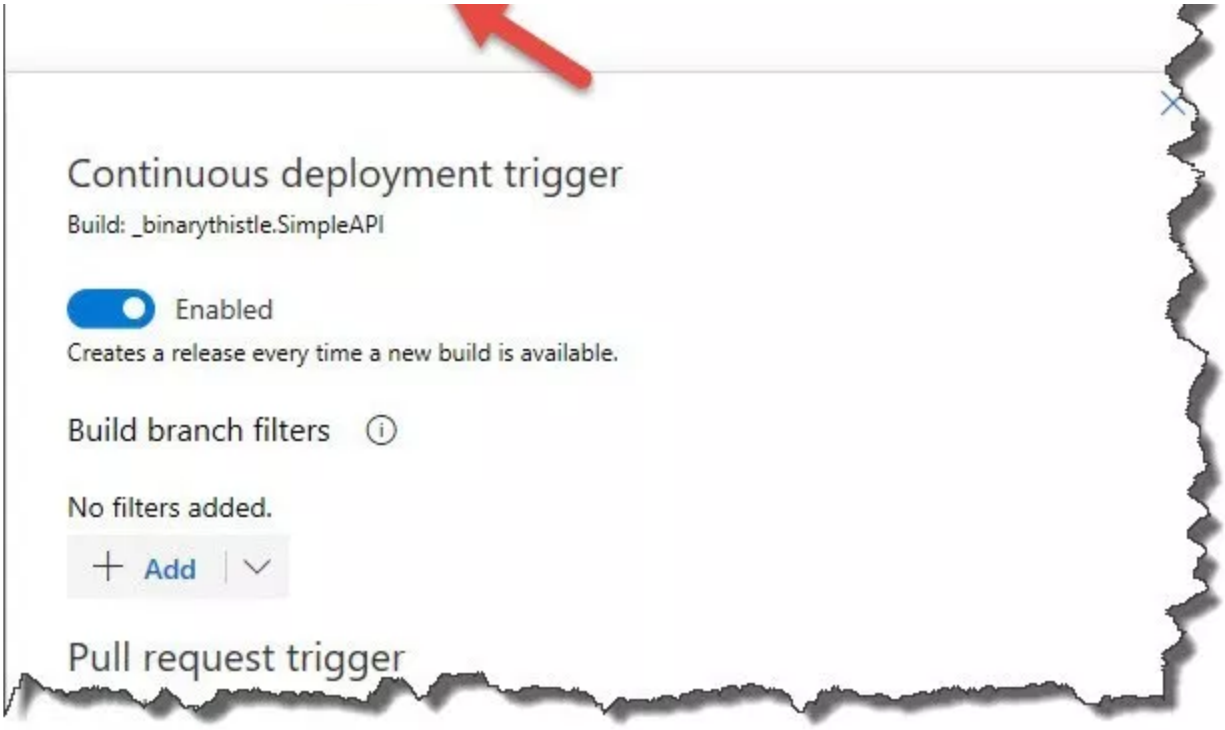


Click “Add”, this will detail your Release Pipeline:



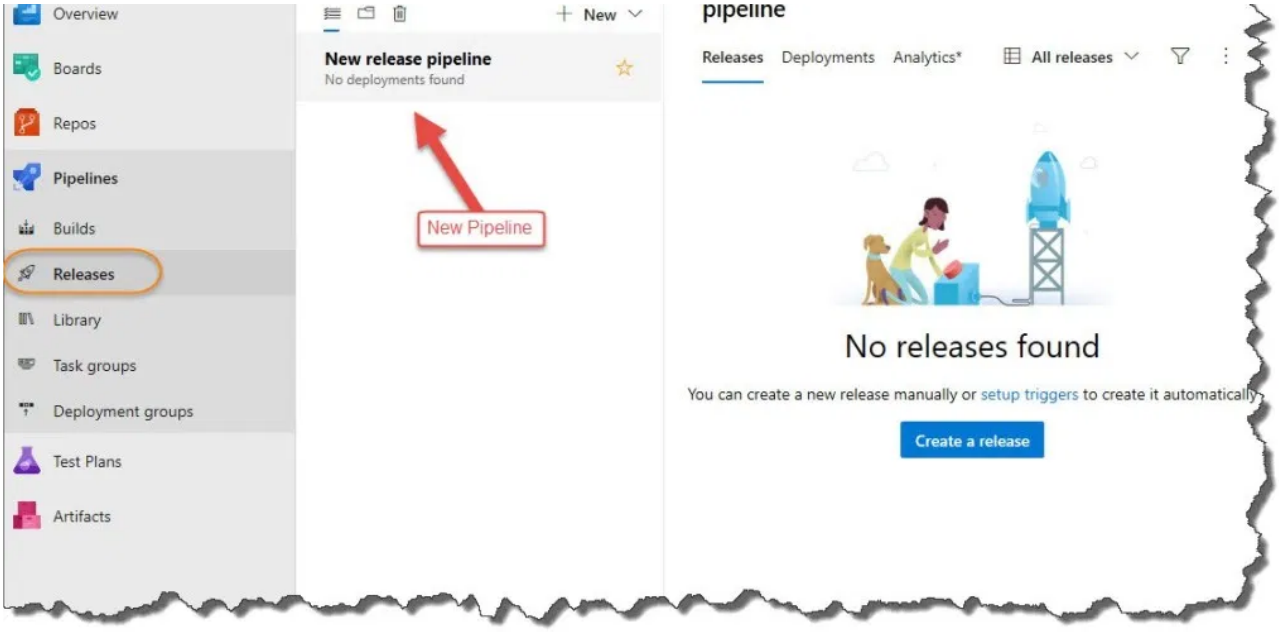
Click on the Lightening Bolt on the Artifact node, on the resulting widget ensure that the “Continuous deployment trigger” is enabled:

The click “Save”, (you may be asked to provide a comment – do so if you please):



This now means that when the *Build Pipeline* completes a build the *Release Pipeline* is triggered too – we then have full Continuous Integration and Continuous Deployment!

Click on Releases, you'll see that we have a new pipeline but no release, this is because the pipeline has not yet been executed:



Bring It All Together

Finally let's test our end to end pipeline...

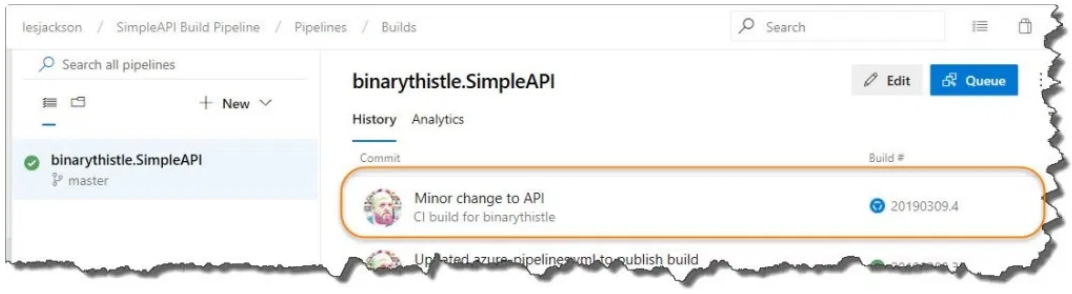
In VSCode, go to the ValuesController.cs file in the SimpleAPI project and change the return values of the 1st Action Method from "value1" and "value2" to something else, e.g.:

```
[ApiController]
public class ValuesController : ControllerBase
{
    // GET api/values
    [HttpGet]
    public ActionResult<IEnumerable<string>> Get()
    {
        return new string[] { "Dot Net", "Play Book" };
    }

    // GET api/values/5
    [HttpGet("{id}")]
    public ActionResult<string> Get(int id)
    {
        return "Les Jackson";
    }
```

Note: As there are no associated unit tests with this method there will be no impact to our “test suite”.

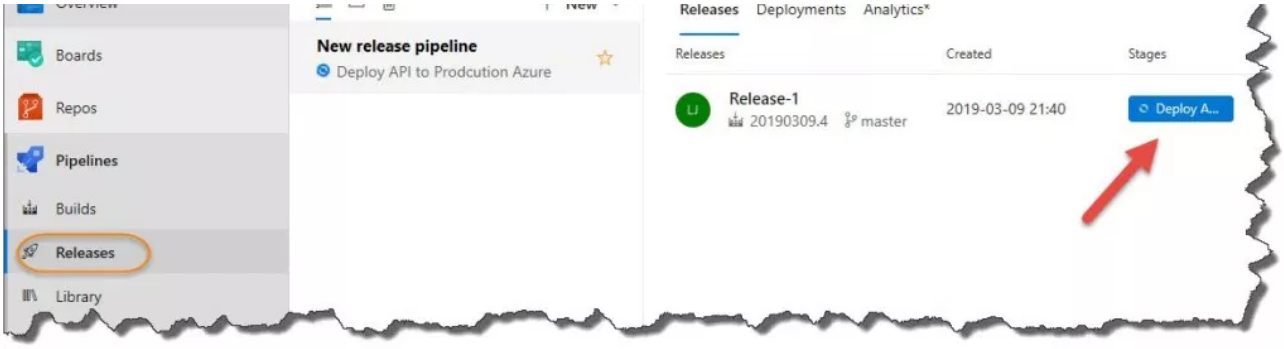
Save the file, commit to git, the push to Github as usual, (I’ll not detail the steps you should know these by now, and I’m tired of typing!).

This should trigger the build pipeline....

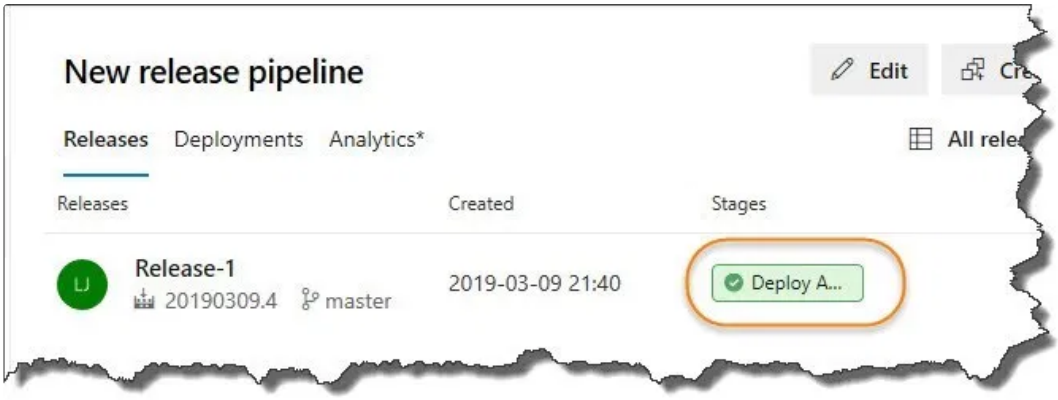


Build Pipeline executing...

When the Build Pipeline finished executing, (successfully), click on “Releases”:



You'll see the Release Pipeline attempting to deploy to Azure... And eventually it should deploy, (you may need to navigate away from the Release Pipeline and back again):



Deployed!

Finally, go to your web browser an let's see if our API is actually deployed, (this should be the URL provided by Azure that we browsed to above followed by /api/values), e.g.:

```
https://lesjackson.azurewebsites.net/api/values
```

And, yes – our API has been deployed, (with our changed values!):

I can't believe this article is this long!

Final Thoughts

Well once again the article turned out much longer than I intended! But to cover the steps in sufficient detail – I guess that was required.

Overall I found using Azure DevOps pretty straightforward, the key to the whole thing, (for me anyway), is understanding the azure-pipelines.yml file and what's possible with it.

The only other addition I'd make, (and I may write a follow up article), is to use Azure Resource Manager, (ARM), templates to set up the API App automatically – but that's for another time...

.NET API APP AZURE AZURE DEVOPS AZURE-PIPELINES.YML BUILD CI/CD CONTINUOUS CORE DELIVERY DEPLOY DEVOPS DOTNET GIT GITHUB PIPELINE REST API XUNIT

Les enjoys understanding how things work, proving concepts then telling people about it! He lives and works in Melbourne, Australia but is originally from Glasgow, Scotland. He's just obtained an MCSD accreditation after almost a year, so now has more time for writing this blog, making YouTube videos, as well as enjoying the fantastic beer, wine, coffee and food Melbourne has to offer.

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