Building Power BI custom visuals with React and D3.js | Pt. One

welcomedeveloper.com/building-power-bi-custom-visuals-with-react-and-d-3-js-pt-one

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It's good to have you back, developer! And for the first-timers, be very welcome to our blog 🖖

Before we start talking about technology today, in times of coronavirus, I send my ♡ to all of you around the world. I hope you are all safe at your homes and looking after each other. In times like this, kindness and empathy are the most admirable feelings people can share. Better days are coming, so be strong and never lose hope!

Here we go with another exciting subject to talk about today. What about using web frameworks to build Business Intelligence (BI) reporting visuals? It does sound interesting, doesn't it?

And what if I tell you that we just need to add one more variable to our lastest post's tutorial? Yep, that's true; and this variable is called Microsoft Power BI 🤘

In today's post, we will build together a Power BI custom visual using React and D3.js. Pretty cool, huh?

I can even imagine, you're probably now wondering how limiteless it can be to combine the powerful of D3.js SVG charts with the self-service approach of Power BI. And you're totally right 🔥

My point on this new post is to show you how we can create cool Power BI custom visuals, and not essentially how to use Power BI. Although, I really care about all of you be able to follow the examples. So for those with some experience with the reporting tool, I apologize for the basic steps we'll cover. The idea is only to not exclude anyone ♡

With the only purpose of providing you with an enjoyable reading and a post that is easy to follow, and effective to get the most of it, I've decided to split the subject into two parts.

In the *first* part, we talk about environment setup, creating a Power BI dataset and report, developing a basic custom visual using D3.js, and how to debug it. In the second part, we cover building a more advanced visual to present financial data, but this time combining it with React components. How does it sound?

I hope you enjoy! Grab your source of caffeine, open your favourite code editor, and let's dive into it!

To start building our first reporting visual, first we must check a few boxes I have to assume. But hey, let's keep up the momentum. **The harder the battle the sweeter the victory!**

Sign Up Power BI Pro License

To visualize and test the visual we're developing together, you need a Power BI license to start. It's *free* and easy to sign up for a trial on the *Pro* version, just go to the official page and follow the instructions when clicking on ***Try free***. Once the trial period has expired, there is no charge at all and you are just assigned back to a basic free license.

Power BI is a fantastic self-service reporting tool, I'm sure you will have plenty of stuff to explore during your trial period. Give it a go and have fun, developer!

Development Setup

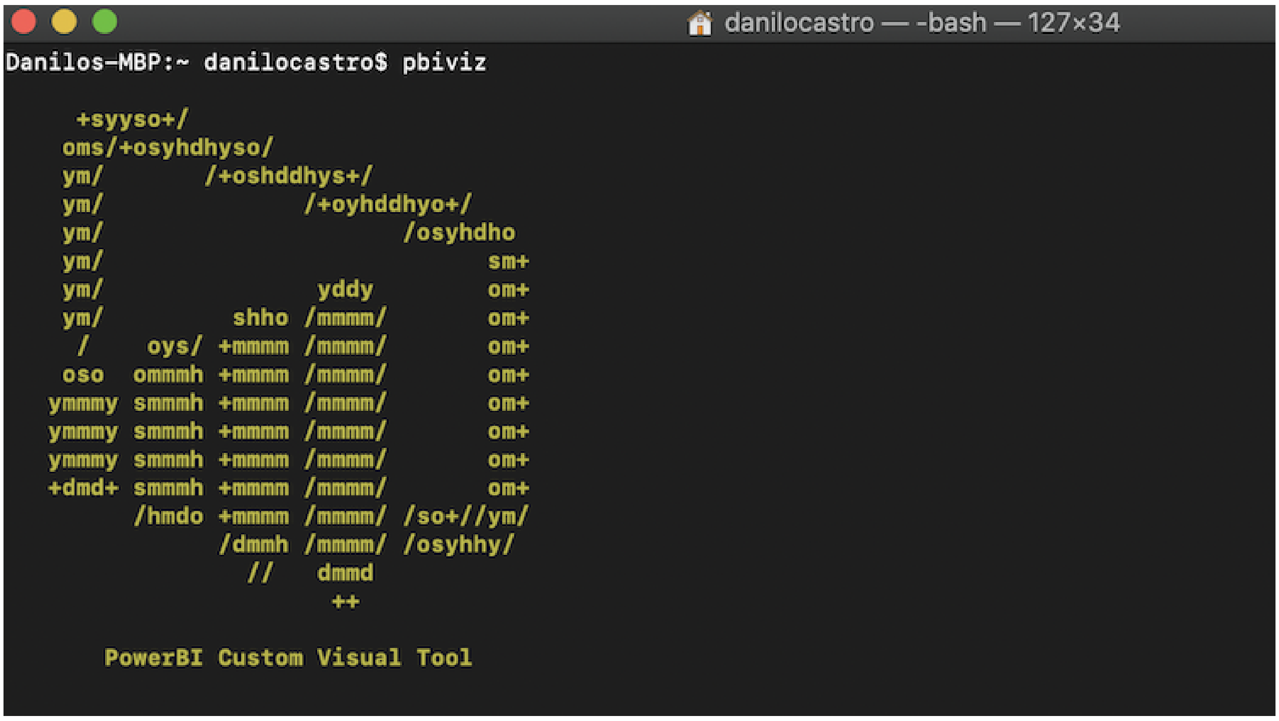
The first requirement of our list is to have Node.js installed on our machine. If you have followed our previous post, you can skip this step; otherwise, just download and install it. Once it's done, please restart your computer and let's go to the next step!

Now, we must install the *PowerBI Visual Tools (pbiviz)* package. It gives us the ability to build custom visuals:

```
npm i -g powerbi-visuals-tools
```

By the way, do you want to learn some handy NPM CLI commands? Check it out the NPM CLI official documentation.

By quickly running the ***pbiviz*** command on your terminal (or *Windows PowerShell*), you should get this cool output:


```
Danilos-MBP:~ danilocastro$ pbiviz

     +syyso+/
    oms/+osyhdhyso/
    ym/       /+oshddhys+/
    ym/              /+oyhddhyo+/
    ym/                     /osyhdho
    ym/                           sm+
    ym/               yddy        om+
    ym/         shho /mmmm/       om+
     /    oys/ +mmmm /mmmm/       om+
    oso  ommmh +mmmm /mmmm/       om+
   ymmmy smmmh +mmmm /mmmm/       om+
   ymmmy smmmh +mmmm /mmmm/       om+
   ymmmy smmmh +mmmm /mmmm/       om+
   +dmd+ smmmh +mmmm /mmmm/       om+
         /hmdo +mmmm /mmmm/ /so+//ym/
               /dmmh /mmmm/ /osyhhy/
                 //   dmmd
                       ++

       PowerBI Custom Visual Tool
```

Brilliant, a first movement towards our goal. Now, our computers are ready to create our first custom visual app using React and D3.js!

Oh wait...not quite yet. First, a certificate must be created and installed.

Installing OS Certificate

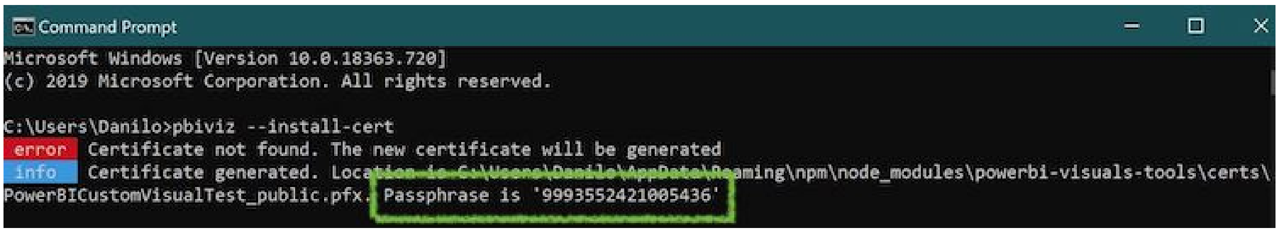
Depending on which OS you are a fan, how we create and install a certificate can varies a bit. Do not worry, Windows and OSX's users, I've got you all covered guys 👌

`<` Windows `/>`

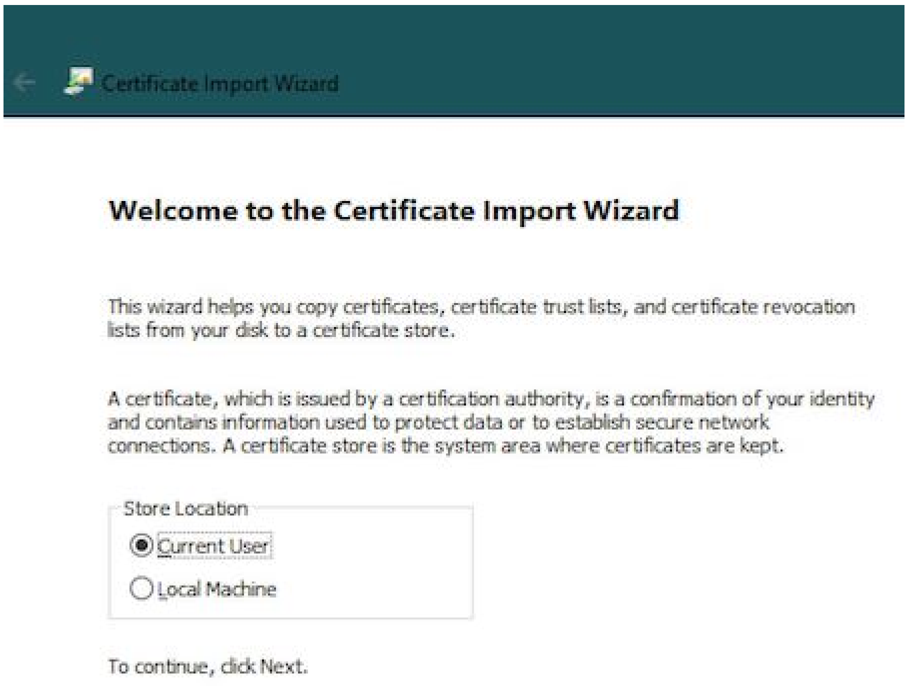
To create a certificate on *Windows*, let's run the following code:

```
pbiviz --install-cert
```

The result of the command above should guide us into the next phase by providing a passphrase and opening the *Certificate Import Wizard*:


```
Microsoft Windows [Version 10.0.18363.720]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\Danilo>pbiviz --install-cert
 error  Certificate not found. The new certificate will be generated
 info   Certificate generated. Location is C:\Users\Danilo\AppData\Roaming\npm\node_modules\powerbi-visuals-tools\certs\
PowerBICustomVisualTest_public.pfx. Passphrase is '9993552421005436'
```


Certificate Import Wizard

Welcome to the Certificate Import Wizard

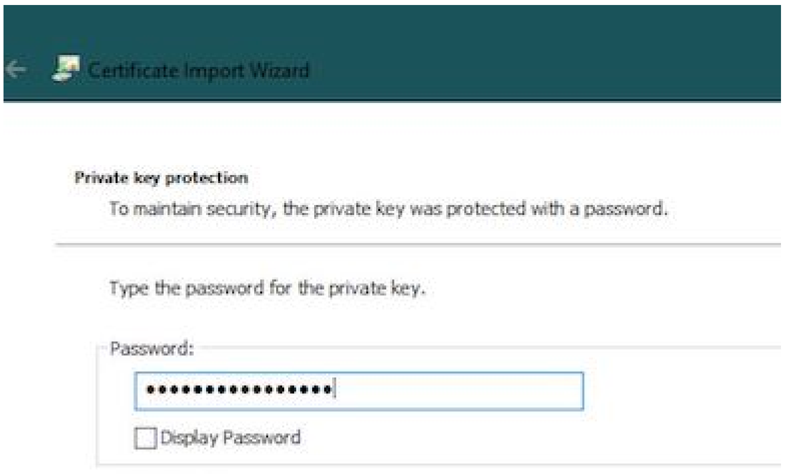
This wizard helps you copy certificates, certificate trust lists, and certificate revocation lists from your disk to a certificate store.

A certificate, which is issued by a certification authority, is a confirmation of your identity and contains information used to protect data or to establish secure network connections. A certificate store is the system area where certificates are kept.

Store Location
[✓ Current User]
Local Machine

To continue, click Next.

In the next step, enter your ***passphrase***:


Certificate Import Wizard

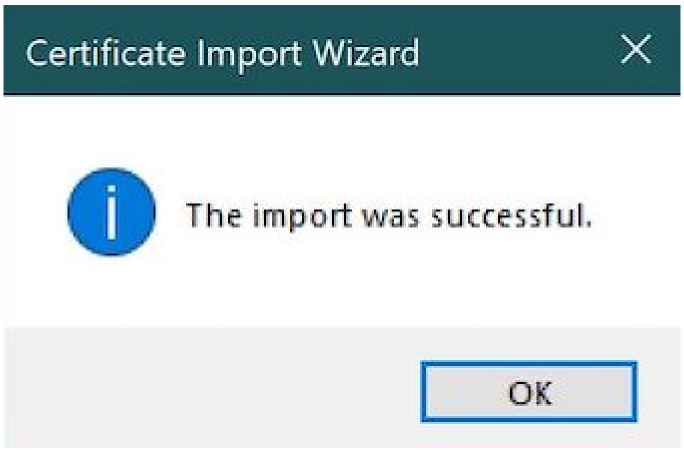
Private key protection
To maintain security, the private key was protected with a password.

Type the password for the private key.

Password:
••••••••••••••••

Display Password

That's it. All done!


Certificate Import Wizard

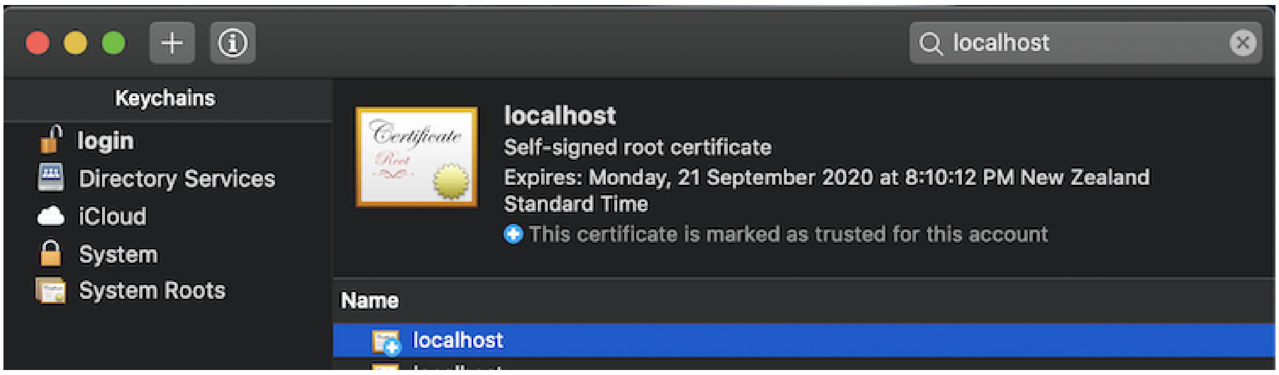
The import was successful.

OK

< OSX />

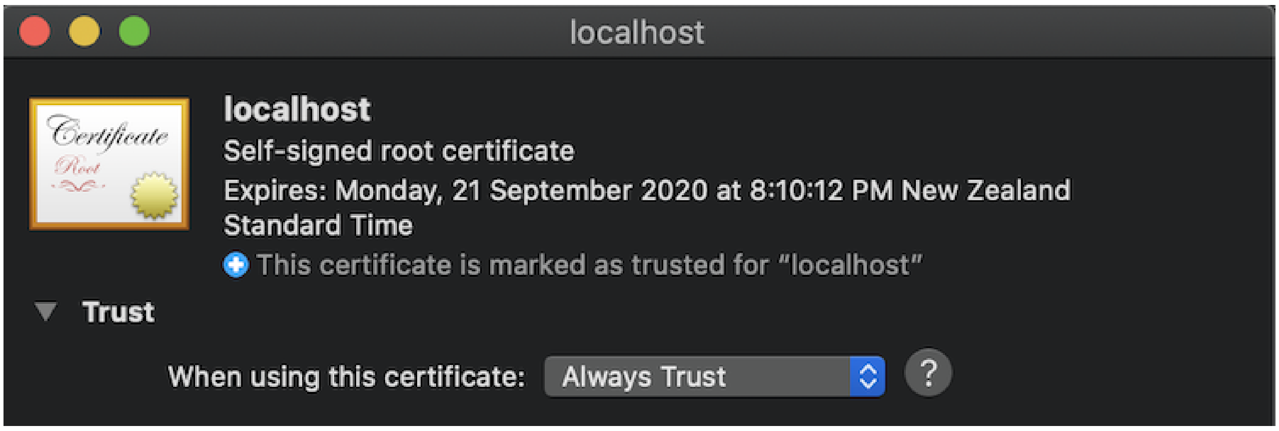
Based on the setup that we need to go through, creating a certificate on OSX is quite simplier than on Windows. You will see what I mean by looking at the steps below.

First, we must access the ***Keychain Access*** to manage the machine certificates and search for ***localhost***:



localhost
Self-signed root certificate
Expires: Monday, 21 September 2020 at 8:10:12 PM New Zealand Standard Time
This certificate is marked as trusted for this account

All you've to do now is to double-click on the certificate and set all options to ***Always Trust***:



localhost
Self-signed root certificate
Expires: Monday, 21 September 2020 at 8:10:12 PM New Zealand Standard Time
This certificate is marked as trusted for "localhost"

When using this certificate: Always Trust

Piece of cake, right? Just remember to close any browser you have opened, so we don't waste time troubleshooting cache issues (guilty!).

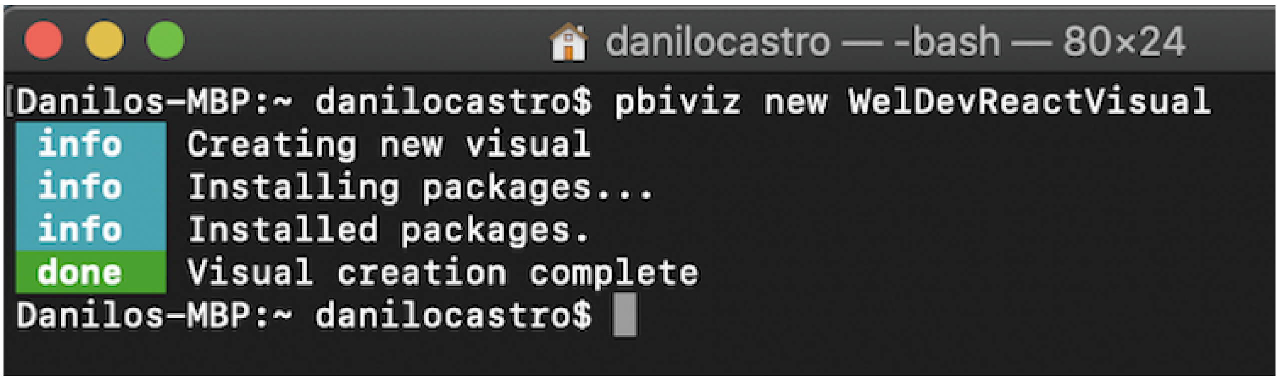
Creating a Power BI visual

Enough of configurations, don't you think? Where is the cool stuff, huh? Guess what, It starts right now 👽

All the code below have been developed using a OSX computer, however, it is exactly the same regardless your OS.

Before we start creating React components, let's create a basic Power BI custom visual, called *WelDevReactVisual*:

```
pbiviz new WelDevReactVisual
```



danilocastro — -bash — 80×24

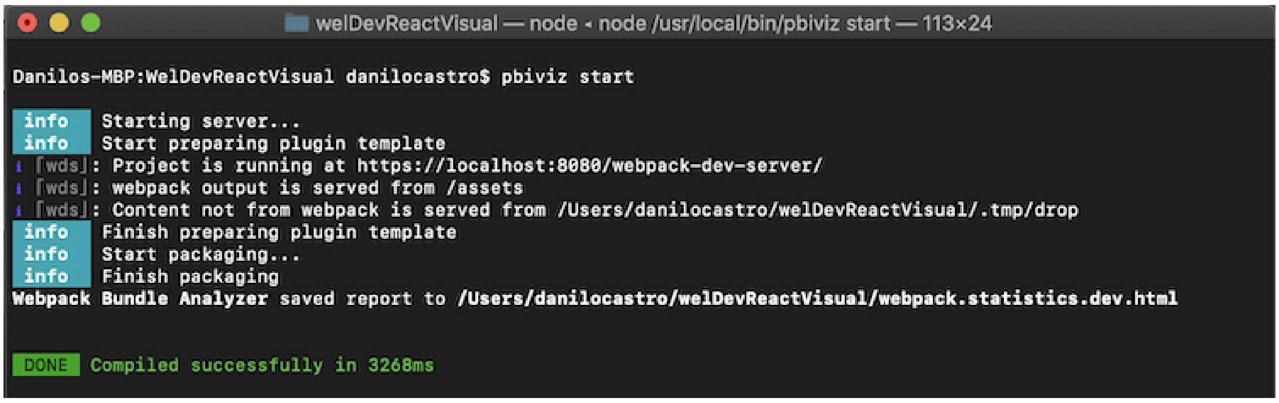
```
[Danilos-MBP:~ danilocastro$ pbiviz new WelDevReactVisual
 info   Creating new visual
 info   Installing packages...
 info   Installed packages.
 done   Visual creation complete
Danilos-MBP:~ danilocastro$
```

It provides us with a boilerplate code so we can save some development time. It's well worth it. It creates an app with TypeScript (which is a superset of JavaScript), Less, and D3.js already imported.

For the next step, let's quickly open the new application using our favorite code editor (I *personally* like to use the VS Code) and run the ***pbiviz start*** command to start our development server:

```
cd WelDevReactVisual code . pbiviz start
```

Good, the code above should produce the following output:



welDevReactVisual — node ◂ node /usr/local/bin/pbiviz start — 113×24

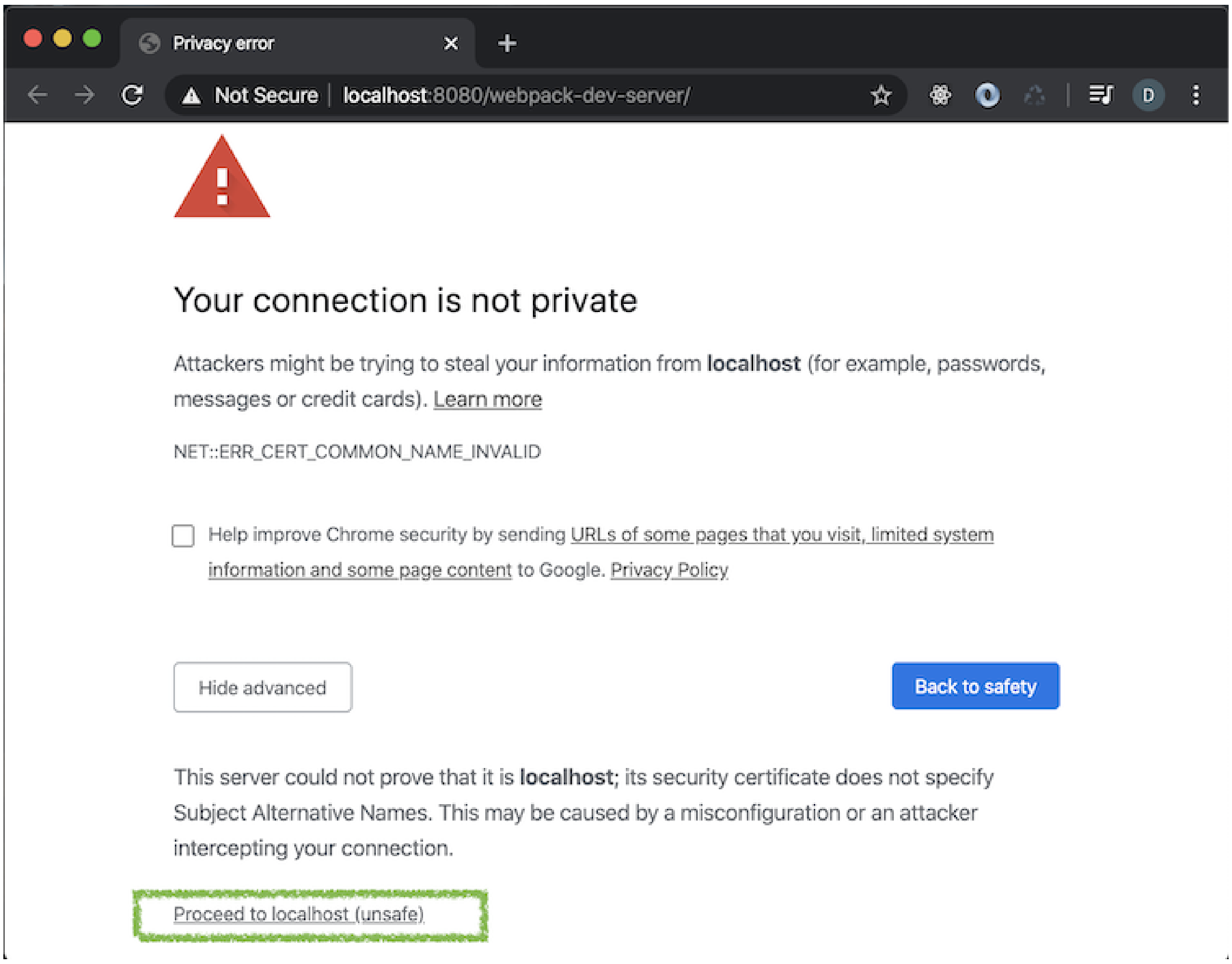
```
Danilos-MBP:WelDevReactVisual danilocastro$ pbiviz start

 info   Starting server...
 info   Start preparing plugin template
ℹ ｢wds｣: Project is running at https://localhost:8080/webpack-dev-server/
ℹ ｢wds｣: webpack output is served from /assets
ℹ ｢wds｣: Content not from webpack is served from /Users/danilocastro/welDevReactVisual/.tmp/drop
 info   Finish preparing plugin template
 info   Start packaging...
 info   Finish packaging
Webpack Bundle Analyzer saved report to /Users/danilocastro/welDevReactVisual/webpack.statistics.dev.html


 DONE  Compiled successfully in 3268ms
```

Fantastic, we're on the right path! Now if everything went as it was supposed to, we should be able to access *localhost:8080/webpack-dev-server*.

If you are presented with some kind of security warning message on your browser, just allow the access and proceed:


Privacy error

Not Secure | localhost:8080/webpack-dev-server/

Your connection is not private

Attackers might be trying to steal your information from **localhost** (for example, passwords, messages or credit cards). Learn more

NET::ERR_CERT_COMMON_NAME_INVALID

Help improve Chrome security by sending URLs of some pages that you visit, limited system information and some page content to Google. Privacy Policy

Hide advanced

Back to safety

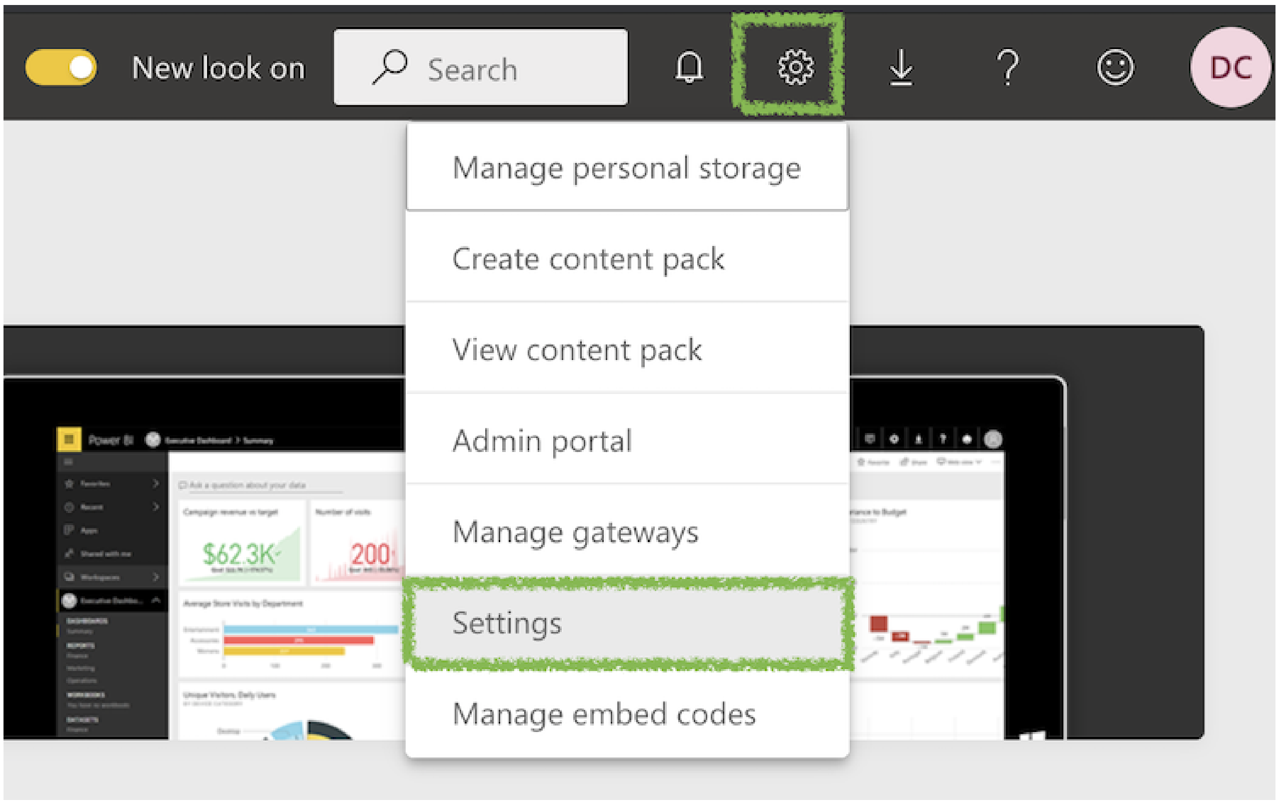
This server could not prove that it is **localhost**; its security certificate does not specify Subject Alternative Names. This may be caused by a misconfiguration or an attacker intercepting your connection.

Proceed to localhost (unsafe)

Time to see our new custom visual in action on Power BI. I'm sure this will keep you excited on keeping going with me!

Jump into PowerBI.com, and sign in using your credentials.

Once you're in, go to ***Settings***:



On the ***Developer*** section, check the option that enables custom visual debugging:

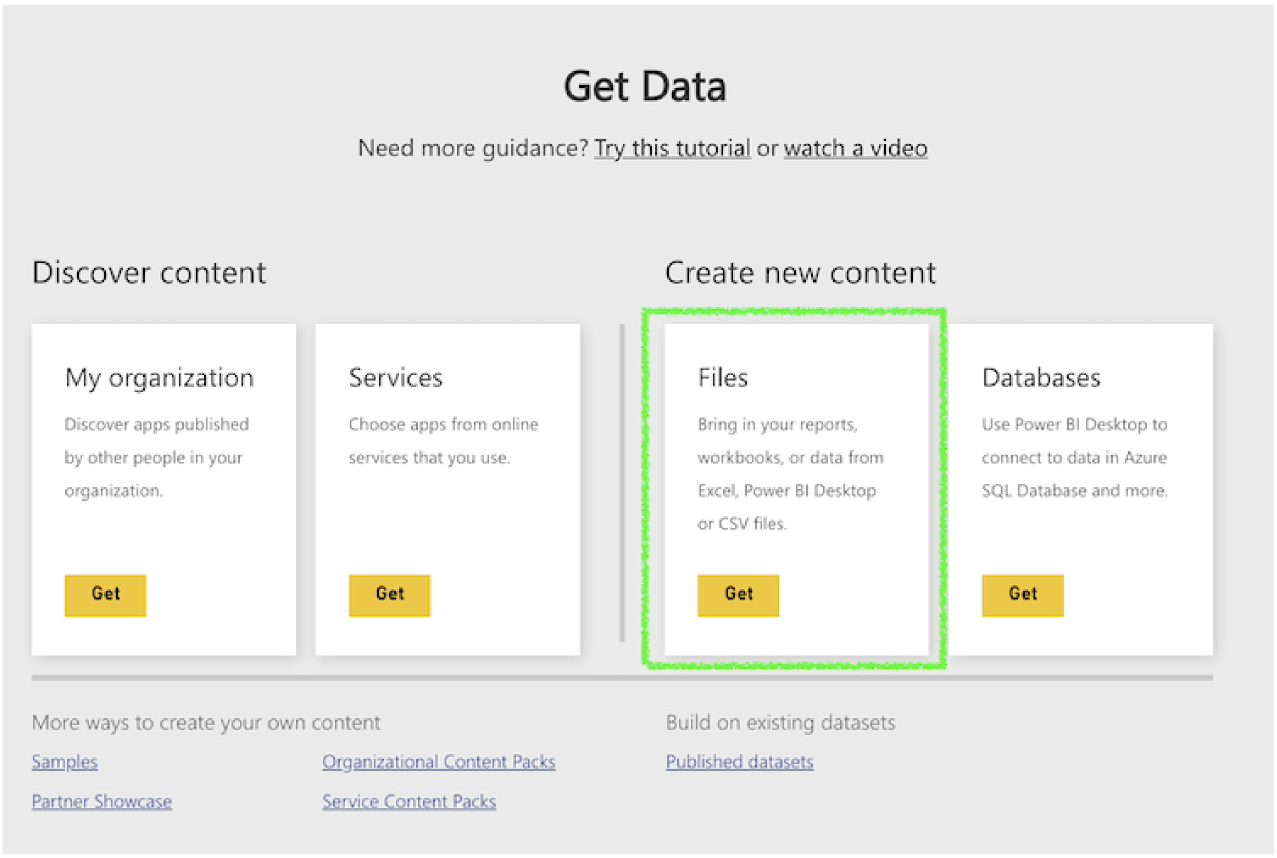
Developer

Almost there! Let's import some data and create a new Power BI report to test our visual.

Importing Data

On the root of the GitHub repository of this post, I've created a *CSV* file named ***GC=F.csv*** that contains historical financial data from Yahoo Finance. Feel free to download it to your local machine.

Next, we're gonna import the file and create a new dataset on Power BI. On your workspace, go to ***Get Data*** and select the ***Files*** option:


Get Data

Need more guidance? Try this tutorial or watch a video

Discover content

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Discover apps published by other people in your organization.

Services
Choose apps from online services that you use.

Create new content

Files
Bring in your reports, workbooks, or data from Excel, Power BI Desktop or CSV files.

Databases
Use Power BI Desktop to connect to data in Azure SQL Database and more.

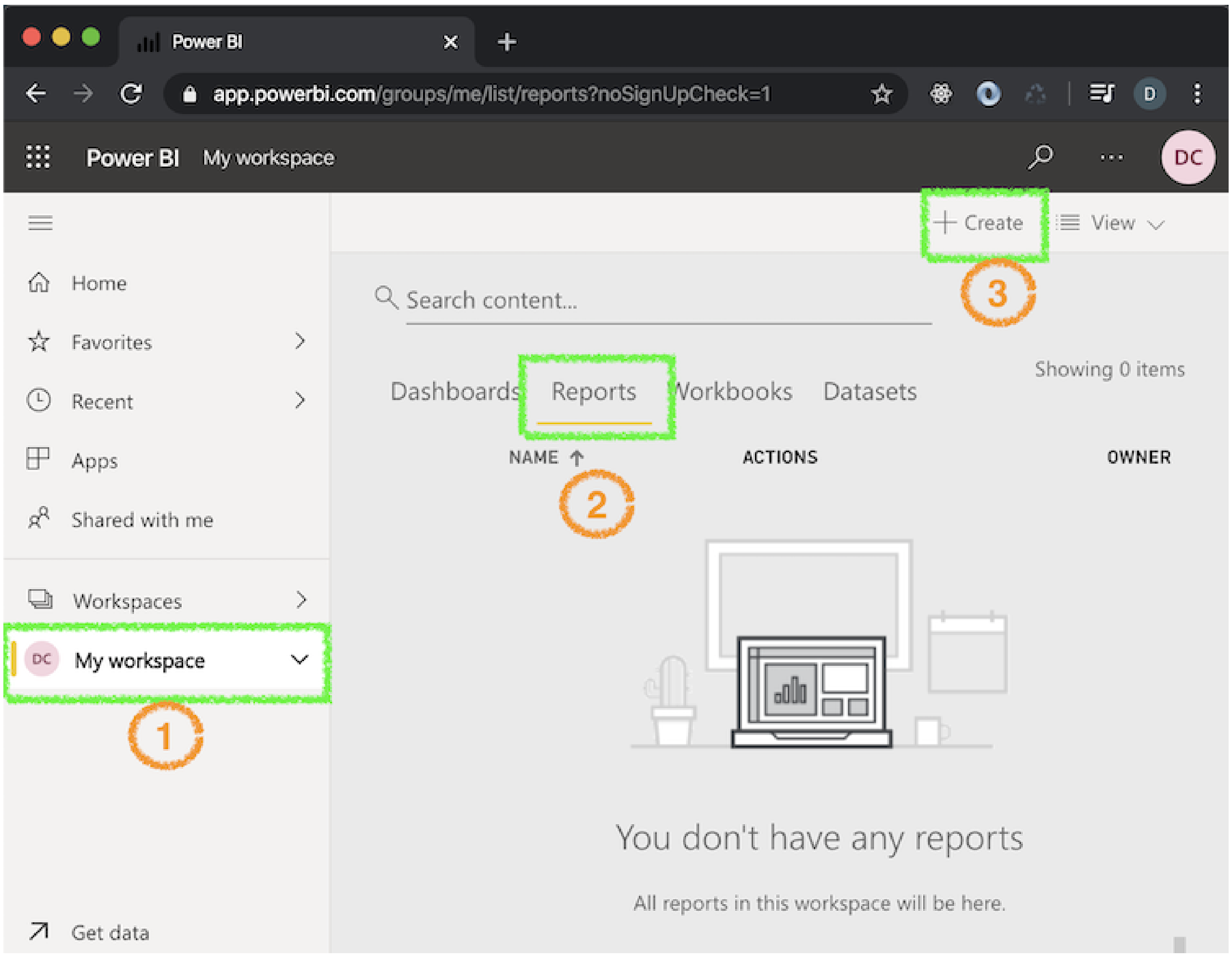
More ways to create your own content
Samples
Organizational Content Packs
Partner Showcase
Service Content Packs

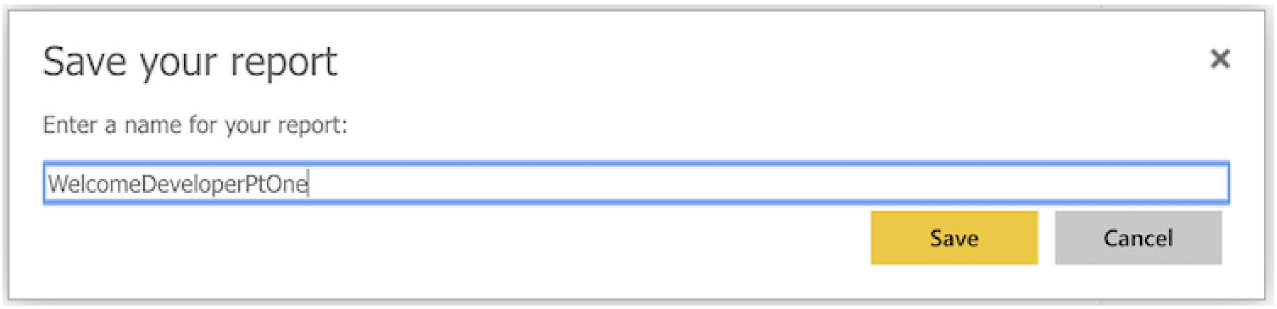
Build on existing datasets
Published datasets

Great, we have some real-world data to play with. Our financial dataset is available on your workpace.

Creating Report

Now that we have some data to consume, we can create a Power BI report linked to our financial dataset. We only need to follow the ordered steps below, choose the ***GC=F*** dataset, and we should be all good. For this exercise, the report name is ***WelcomeDeveloperPtOne***:



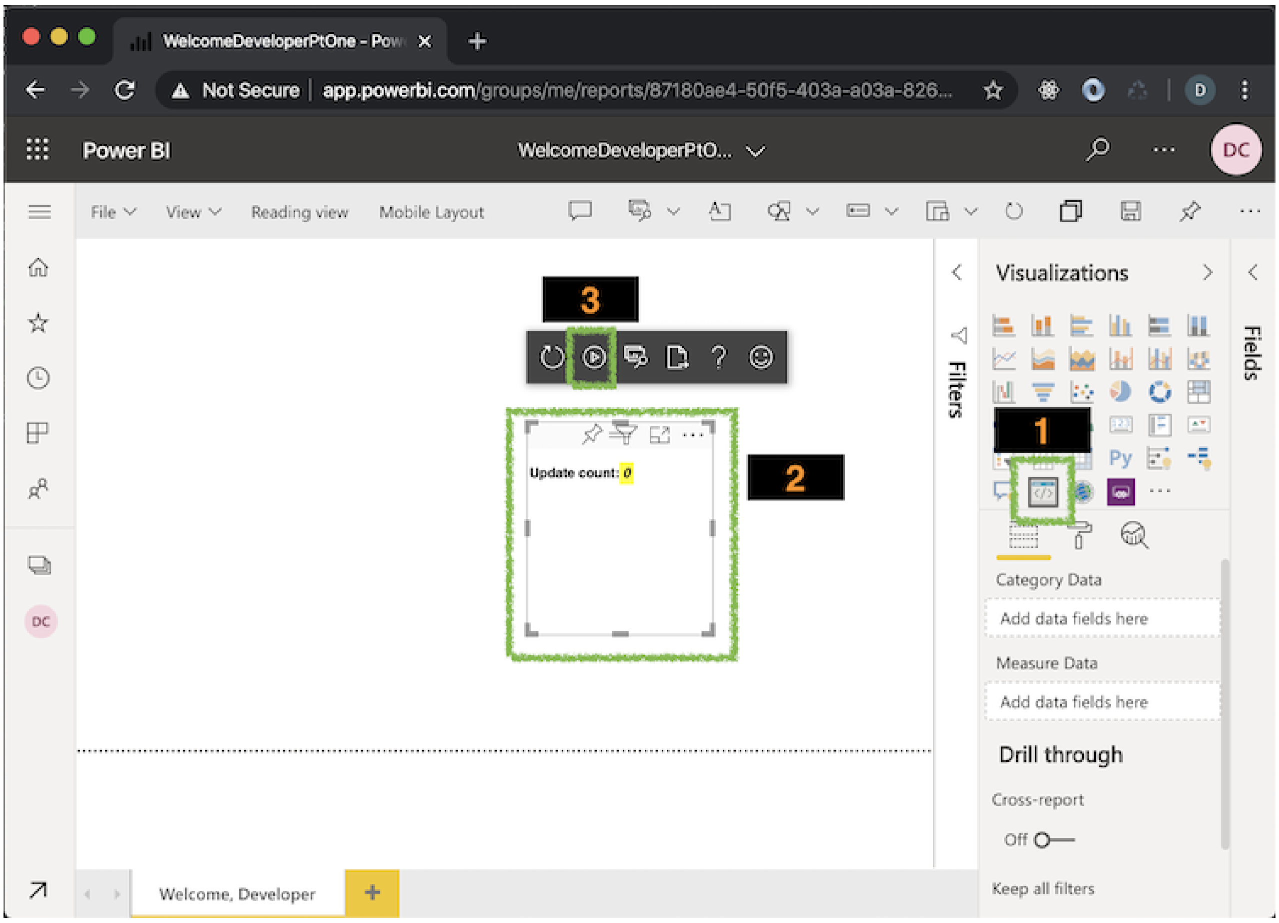


Custom Visual Online

First step to see our custom visual in action is to start your local development server, in case it hasn't already, by running the code:

```
pbiviz start
```

Go to the Power BI report we previously created, and add the ***Developer Visual*** visual to it:



Quick summary on the image above:

> 1: *Developer Visual*, required to debug a custom visual
> 2: Basic custom visual, showing the number of updates applied to it
> 3: It's handy to enable the *Auto Reload* option so we can automatically see the changes reflected on the visual

When we add a developer visual to a report, it works as a listenner to your local host. So any change we applied to the *WelDevReactVisual* app, is reflected on the Power BI report. It makes our life easier when testing it. Now, drag any field from the dataset table onto our custom visual to observe an increment happening on the visual's label.

Excellent, you have just created your first Power BI custom visual. Well done, mate!

Time to go back to our app to explore the code, and start to building something useful from it.

Enhancing with D3.js

I've got to be honest, I love this part of the post. I'm always facinated how D3 gives us the ability to acchive almost any requirement when designing and developing data visuals. It's absolutelly interesting to integrate it with self-service reporting on Power BI!

Our goal is this first part of the post is to introduce the main concepts, so we will create just a simple D3 visual.

On *WelDevReactVisual* app, expand the *node*modules_ folder to check the packages **d3**, **@type/d3**, **core-js**, and **powerbi-visuals-api** are installed. If you can't find any of these, just run the ***npm install*** for all the missing packages:

`npm istall d3 @types/d3 core-js powerbi-visuals-api`
We've got all we need now to start developing our first visual using D3.js.

App Main Components

Among the many components of the visual application, I want to get your attention to four of them:

- **src/visual.ts**

  > I'd say this is the main component. It's responsible for the visual design and update logic.

- **src/settings.ts**

  > This is responsible for reading the visual format settings.

- **style/visual.less**

  > As the name indicates, it's responsible for setting the visual style.

- **capabilities.json**

  > In this one, we set the options available to the user when using the visual on Power BI, such as fields and format options.

Now that we know the purpose of the main components, we can remove the code we won't need and start developing ours.

Building a D3 visual

Replace the existing code on *src/visual.ts* with the one below. We are simply reseting the visual to its raw form:

src/visual.ts

```
"use strict"; import "core-js/stable"; import ".../../assets/react-d3js-
powerbi-part-one/style/visual.less"; import powerbi from "powerbi-
visuals-api"; import IVisual = powerbi.extensibility.IVisual; import
VisualConstructorOptions =
powerbi.extensibility.visual.VisualConstructorOptions; import
VisualUpdateOptions = powerbi.extensibility.visual.VisualUpdateOptions;
import EnumerateVisualObjectInstancesOptions =
powerbi.EnumerateVisualObjectInstancesOptions; import
VisualObjectInstanceEnumeration =
powerbi.VisualObjectInstanceEnumeration; import IVisualHost =
powerbi.extensibility.visual.IVisualHost; import * as d3 from "d3"; type
```

```
Selection<T extends d3.BaseType> = d3.Selection<T, any,any, any>; export
class Visual implements IVisual { constructor(options:
VisualConstructorOptions) { } public update(options: VisualUpdateOptions)
{ } }
```

Next, we must develop the code to build a D3 component:

src/visual.ts

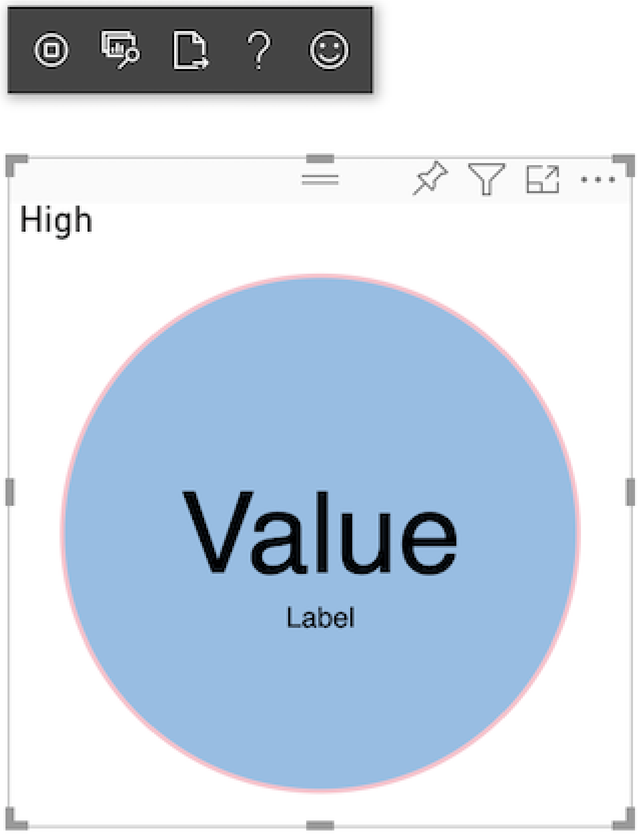
```
 "use strict"; import "core-js/stable"; import ".../../assets/react-d3js-
powerbi-part-one/style/visual.less"; import powerbi from "powerbi-
visuals-api"; import IVisual = powerbi.extensibility.IVisual; import
VisualConstructorOptions =
powerbi.extensibility.visual.VisualConstructorOptions; import
VisualUpdateOptions = powerbi.extensibility.visual.VisualUpdateOptions;
import EnumerateVisualObjectInstancesOptions =
powerbi.EnumerateVisualObjectInstancesOptions; import
VisualObjectInstanceEnumeration =
powerbi.VisualObjectInstanceEnumeration; import IVisualHost =
powerbi.extensibility.visual.IVisualHost; import * as d3 from "d3"; type
Selection<T extends d3.BaseType> = d3.Selection<T, any,any, any>; export
class Visual implements IVisual { private host: IVisualHost; private svg:
Selection<SVGElement>; private container: Selection<SVGElement>; private
circle: Selection<SVGElement>; private textValue: Selection<SVGElement>;
private textLabel: Selection<SVGElement>; constructor(options:
VisualConstructorOptions) { this.svg = d3.select(options.element)
.append('svg') .classed('circleCard', true); this.container =
this.svg.append("g") .classed('container', true); this.circle =
this.container.append("circle") .classed('circle', true); this.textValue
= this.container.append("text") .classed("textValue", true);
this.textLabel = this.container.append("text") .classed("textLabel",
true); } public update(options: VisualUpdateOptions) { } }
```

Please note the code I highlighted above. The idea is to show you how easy we can build a basic D3 SVG component. On row number 30, we append a circle to the SVG component to present the custom visual's data.

Our next step is to develop the ***update*** method, which tells the visual how it should behaviour when it gets updated on Power BI:

src/visual.ts

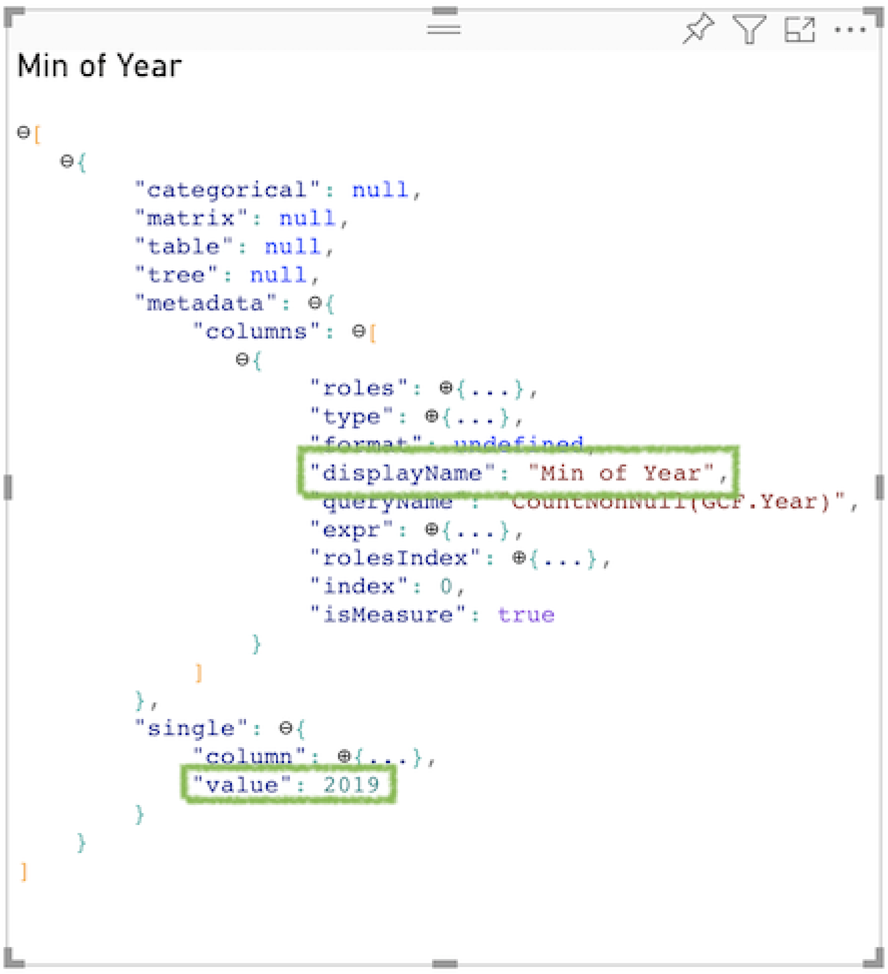
```
 ... public update(options: VisualUpdateOptions) { let width: number =
options.viewport.width; let height: number = options.viewport.height;
this.svg.attr("width", width); this.svg.attr("height", height); let
radius: number = Math.min(width, height) / 2.2; this.circle
.style("fill", "#007acc") .style("fill-opacity", 0.5) .style("stroke",
"pink") .style("stroke-width", 2) .attr("r", radius) .attr("cx", width /
2) .attr("cy", height / 2); let fontSizeValue: number = Math.min(width,
height) / 5; this.textValue .text("Value") .attr("x", "50%") .attr("y",
"50%") .attr("dy", "0.35em") .attr("text-anchor", "middle") .style("font-
size", fontSizeValue + "px"); let fontSizeLabel: number = fontSizeValue /
4; this.textLabel .text("Label") .attr("x", "50%") .attr("y", height / 2)
.attr("dy", fontSizeValue / 1.2) .attr("text-anchor", "middle")
.style("font-size", fontSizeLabel + "px"); } }
```
At this stage, the new visual is ready to be tested. Now, remember how we debug a custom visual? Ensure the development server is up and running, and open the report on Power BI:



As you can see, on the rows 19 and 27 of our *update* method code, the measure value and the label text is hard-coded. To fix it, we must do a few changes to our TypeScript application:

src/visual.ts

```
 "use strict"; ... import DataView = powerbi.DataView; export class
Visual implements IVisual { ... constructor(options:
VisualConstructorOptions) { ... } public update(options:
VisualUpdateOptions) { let dataView: DataView = options.dataViews[0]; let
width: number = options.viewport.width; let height: number =
options.viewport.height; this.svg.attr("width", width);
this.svg.attr("height", height); ... this.textValue
.text(<string>dataView.single.value) ... this.textLabel
.text(dataView.metadata.columns[0].displayName) ... }
```
Please check the highlighted code above, we are now reading the values from the visual data view. You might be wondering how I ended up finding the values into the data view object, am I right? To understand the structure of it, I've explored the ***Show Dataview*** option from the visual:



Min of Year

```
⊖[
   ⊖{
        "categorical": null,
        "matrix": null,
        "table": null,
        "tree": null,
        "metadata": ⊖{
            "columns": ⊖[
               ⊖{
                    "roles": ⊕{...},
                    "type": ⊕{...},
                    "format": undefined,
                    "displayName": "Min of Year",
                    "queryName": "CountNonNull(GCF.Year)",
                    "expr": ⊕{...},
                    "rolesIndex": ⊕{...},
                    "index": 0,
                    "isMeasure": true
               }
            ]
        },
        "single": ⊖{
            "column": ⊕{...},
            "value": 2019
        }
   }
]
```

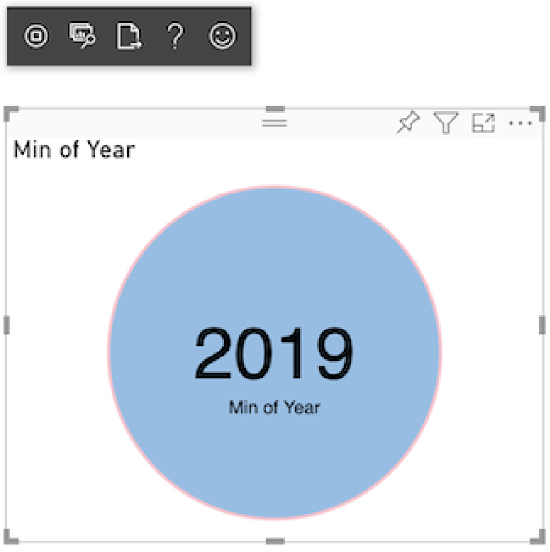
Almost there, developer. Update the sections ***dataRoles*** and ***dataViewMappings*** of your *capabilities.json* file, with the highlighted following code:

capabilities.json

```
{ "dataRoles": [ { "displayName": "Measure", "name": "measure", "kind": "Measure" } ], "objects": { ... }, "dataViewMappings": [ { "conditions": [ { "measure": { "max": 1 } } ], "single": { "role": "measure" } } ] }
```

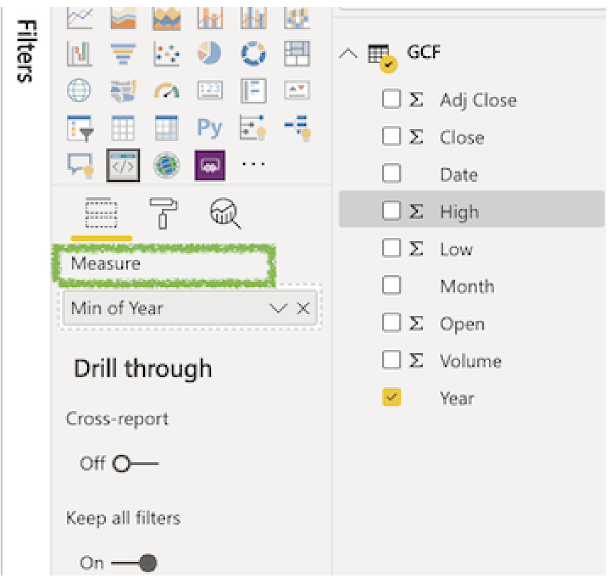
By doing it, we are telling the visual to accept exact one field as input, named as **Measure**.

Let's check how our SVG component is currently looking:


Min of Year

2019

Min of Year



Measure

Min of Year

Drill through

Cross-report

Off

Keep all filters

On

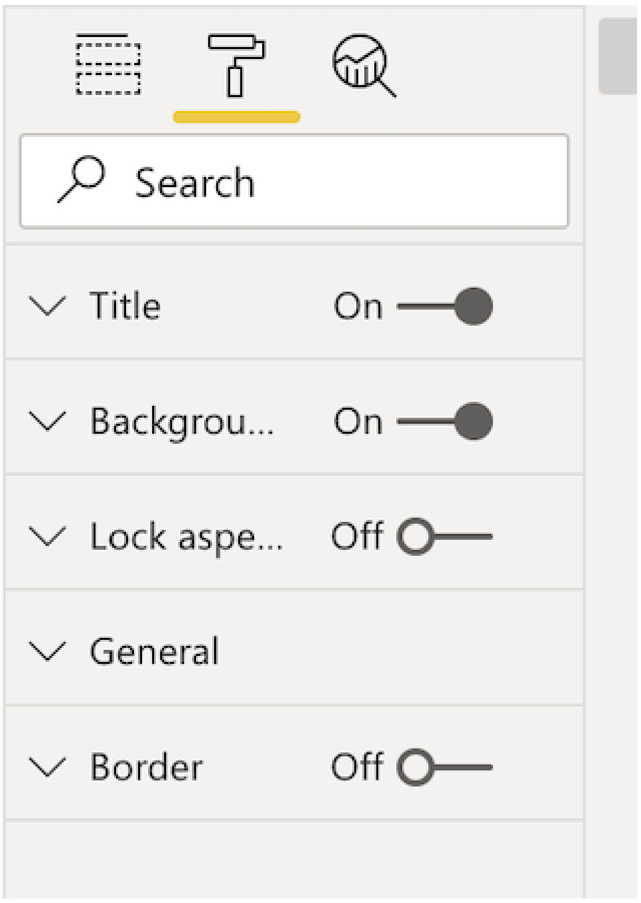
GCF

- Σ Adj Close
- Σ Close
- Date
- Σ High
- Σ Low
- Month
- Σ Open
- Σ Volume
- ✓ Year

Now it looks better! Yep, I agree with you. It does is still quite basic, specially compared with the existing ones on Power BI. But hey, one step at time. Even those fancy charts went through the same stage as we are now 🙂

Adding Format Options

If we have a look at the **Format** tab of our new custom visual, we can find options such as title, border, and others.



Title On

Backgrou... On

Lock aspe... Off

General

Border Off

I'm going to show you now how we can easily customize it. Let's go back to our *capabilities.json* file and update the **objects** section as below:

capabilities.json

```
{ "dataRoles": [ ... ], "objects": { "circle": { "displayName":
"Circle", "properties": { "circleColor": { "displayName": "Color",
"description": "The fill color of the circle.", "type": { "fill": {
"solid": { "color": true } } } }, "circleThickness": { "displayName":
"Thickness", "description": "The circle thickness.", "type": { "numeric":
true } } } } }, "dataViewMappings": [ ... ] }
```

Now we overwrite the code on ***src/settings.ts*** with the one below. The objective is to create a new class (**CircleSettings**) to control the component settings, such as visual color and border thickness.

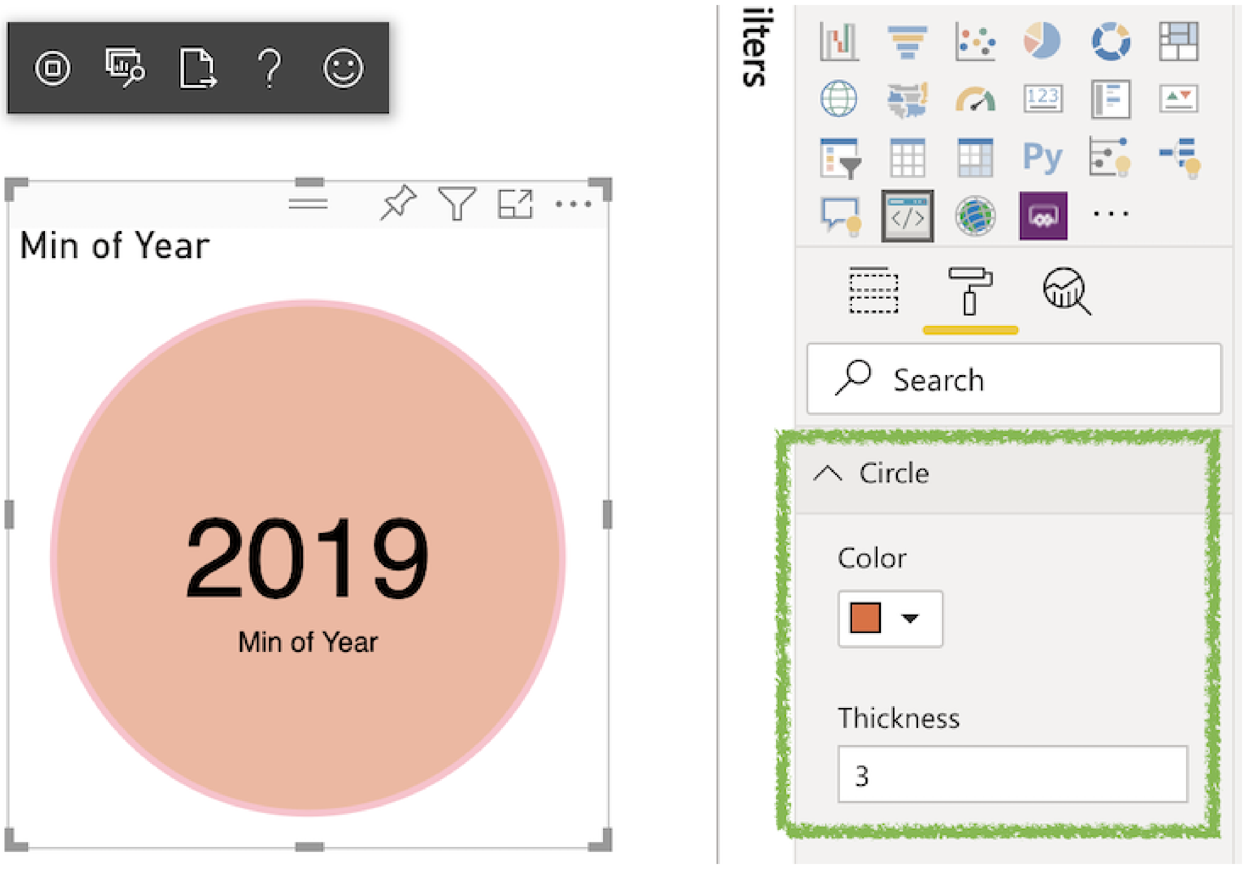
src/settings.ts

```
"use strict"; import { dataViewObjectsParser } from "powerbi-visuals-
utils-dataviewutils"; import DataViewObjectsParser =
dataViewObjectsParser.DataViewObjectsParser; export class CircleSettings
{ public circleColor: string = "#007acc"; public circleThickness: number
= 3; } export class VisualSettings extends DataViewObjectsParser { public
circle: CircleSettings = new CircleSettings(); }
```

By last (I promise), Below is the final version of our ***src/visual.ts*** file. Note the highlighted updated code where we are reading the settings from the **src/settings.ts**.

src/visual.ts

```
"use strict"; import "core-js/stable"; import ".../../assets/react-d3js-
powerbi-part-one/style/visual.less"; import powerbi from "powerbi-
visuals-api"; import IVisual = powerbi.extensibility.IVisual; import
VisualConstructorOptions =
powerbi.extensibility.visual.VisualConstructorOptions; import
VisualUpdateOptions = powerbi.extensibility.visual.VisualUpdateOptions;
import EnumerateVisualObjectInstancesOptions =
powerbi.EnumerateVisualObjectInstancesOptions; import
VisualObjectInstanceEnumeration =
powerbi.VisualObjectInstanceEnumeration; import IVisualHost =
powerbi.extensibility.visual.IVisualHost; import * as d3 from "d3"; type
Selection<T extends d3.BaseType> = d3.Selection<T, any, any, any>; import
DataView = powerbi.DataView; import { VisualSettings } from
"../../assets/react-d3js-powerbi-part-one/settings"; export class Visual
implements IVisual { private host: IVisualHost; private svg:
Selection<SVGElement>; private container: Selection<SVGElement>; private
circle: Selection<SVGElement>; private textValue: Selection<SVGElement>;
private textLabel: Selection<SVGElement>; private visualSettings:
VisualSettings; constructor(options: VisualConstructorOptions) { this.svg
= d3 .select(options.element) .append("svg") .classed("circleCard",
true); this.container = this.svg.append("g").classed("container", true);
this.circle = this.container.append("circle").classed("circle", true);
this.textValue = this.container.append("text").classed("textValue",
true); this.textLabel =
this.container.append("text").classed("textLabel", true); } public
enumerateObjectInstances( options: EnumerateVisualObjectInstancesOptions
): VisualObjectInstanceEnumeration { const settings: VisualSettings =
this.visualSettings || <VisualSettings>VisualSettings.getDefault();
return VisualSettings.enumerateObjectInstances(settings, options); }
public update(options: VisualUpdateOptions) { let dataView: DataView =
options.dataViews[0]; let width: number = options.viewport.width; let
height: number = options.viewport.height; this.svg.attr("width", width);
this.svg.attr("height", height); let radius: number = Math.min(width,
height) / 2.2; this.visualSettings = VisualSettings.parse<VisualSettings>
(dataView); this.visualSettings.circle.circleThickness = Math.max( 0,
this.visualSettings.circle.circleThickness );
this.visualSettings.circle.circleThickness = Math.min( 10,
this.visualSettings.circle.circleThickness ); this.circle .style("fill",
this.visualSettings.circle.circleColor) .style("fill-opacity", 0.5)
.style("stroke", "pink") .style("stroke-width",
this.visualSettings.circle.circleThickness) .attr("r", radius)
.attr("cx", width / 2) .attr("cy", height / 2); let fontSizeValue: number
= Math.min(width, height) / 5; this.textValue
.text(<string>dataView.single.value) .attr("x", "50%") .attr("y", "50%")
.attr("dy", "0.35em") .attr("text-anchor", "middle") .style("font-size",
fontSizeValue + "px"); let fontSizeLabel: number = fontSizeValue / 4;
this.textLabel .text(dataView.metadata.columns[0].displayName) .attr("x",
"50%") .attr("y", height / 2) .attr("dy", fontSizeValue / 1.2)
.attr("text-anchor", "middle") .style("font-size", fontSizeLabel + "px");
} }
```
Back to Power BI, a new format option called ***Circle*** should be available and enable us to customize color and border thickness:



Circle

Color

Thickness

3

That's enough for part one, it is probably *almost* becoming too much to digest at once (sorry).

Let's leave the rest for the second part of our post! (don't need to worry, it is just a week away 👌)

Useful Resources

Update ⚡

Here is the second part of this post series, developers 💪

Conclusion

I've prepared some nice stuff for the second and last part of this subject, including React components, some cool visual styles and events, and how to pack a custom visual and share with our colleagues.

Congrats for getting to the end of the first part of this exercise. I admire your effort 👏

We can learn, do, and be anything we put our mind into. Remember, your only limit is your soul 💪

Stay tuned and remember to follow me on LinkedIn so you don't miss any post!

See you on the next week, developers!

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