Extending Power BI's Visualisation Capabilites

R and Plotly to the Rescue!

Sammi Rosser

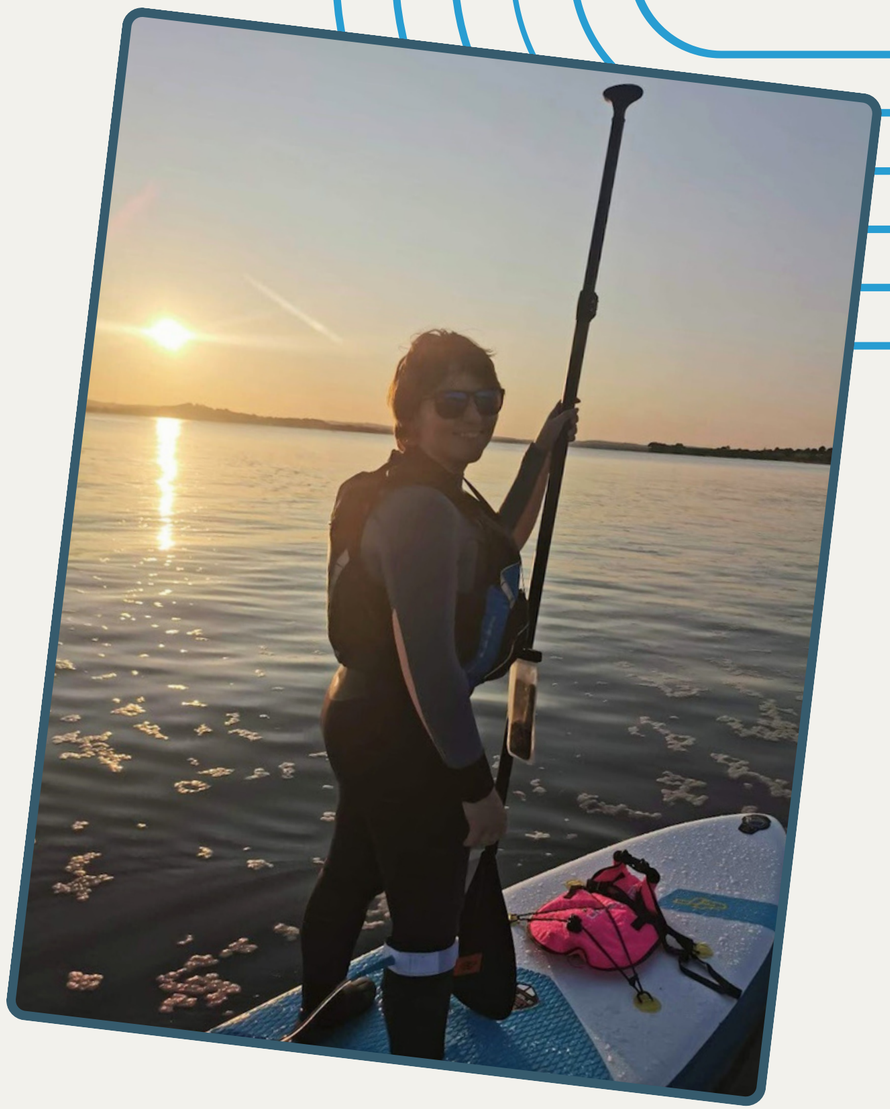
NHS-R Conference 2023

WHO AM I?

Health Data Science MSc Student

Data Scientist at Devon Partnership Trust

Postdoctoral Research Fellow
@ University of Exeter



github.com/Bergam0t

linkedin.com/in/sammijaderosser

What’s the Issue?

Lots of organisations are investing in Power BI...

And if your organisation has it, then there are some good things about it!

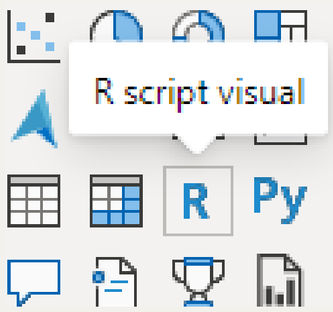
- It’s a great tool for sharing certain things
- Someone else in your organisation is probably taking care of the hosting and security
- It’s easy to manage permissions

AND IT SUPPORTS R!

You can use R to transform your data
(sort of)

You can use R to create plots too
(sort of)

The same applies to Python



File Home Insert Modeling View Optimize Help

Paste Cut Copy Format painter — Clipboard

Get data Excel workbook Data hub SQL Server Enter data Dataverse Recent sources — Data

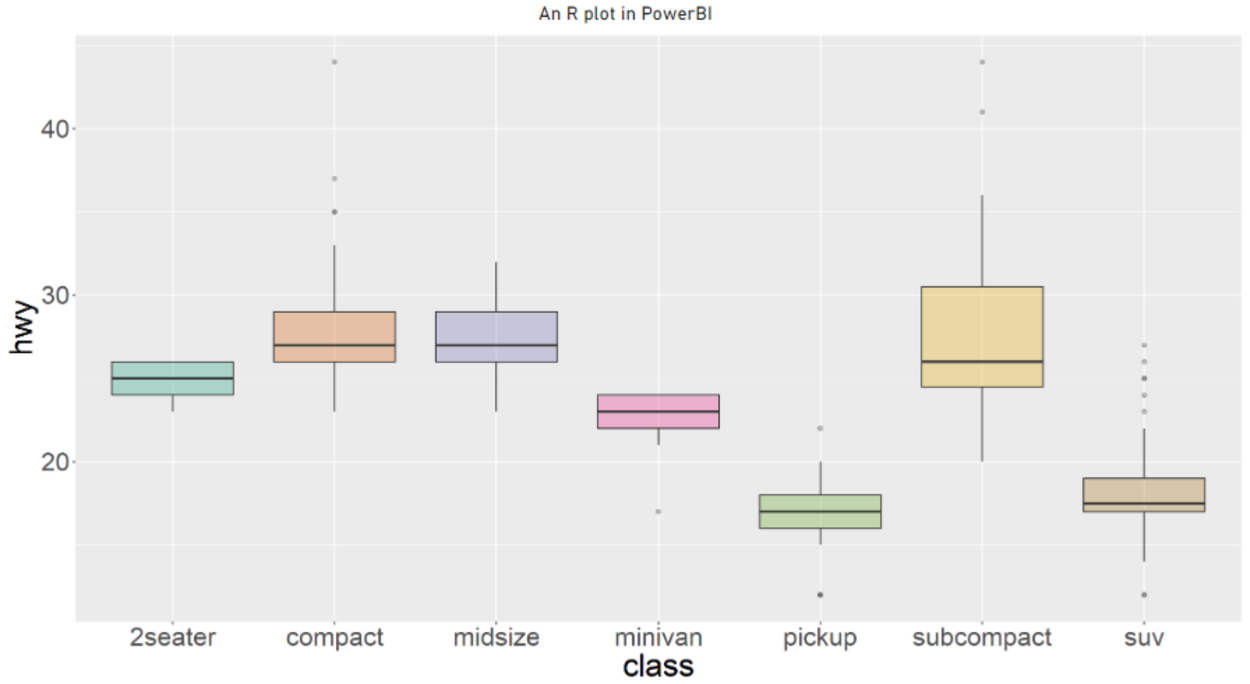
Transform data Refresh — Queries

New visual Text box More visuals — Insert

New measure Quick measure — Calculations

Sensitivity — Sensitivity

Publish — Share



Filters

Search

Filters on this page

Add data fields here

Filters on all pages

Add data fields here

Visualizations

Build visual

Values

Add data fields here

Drill through

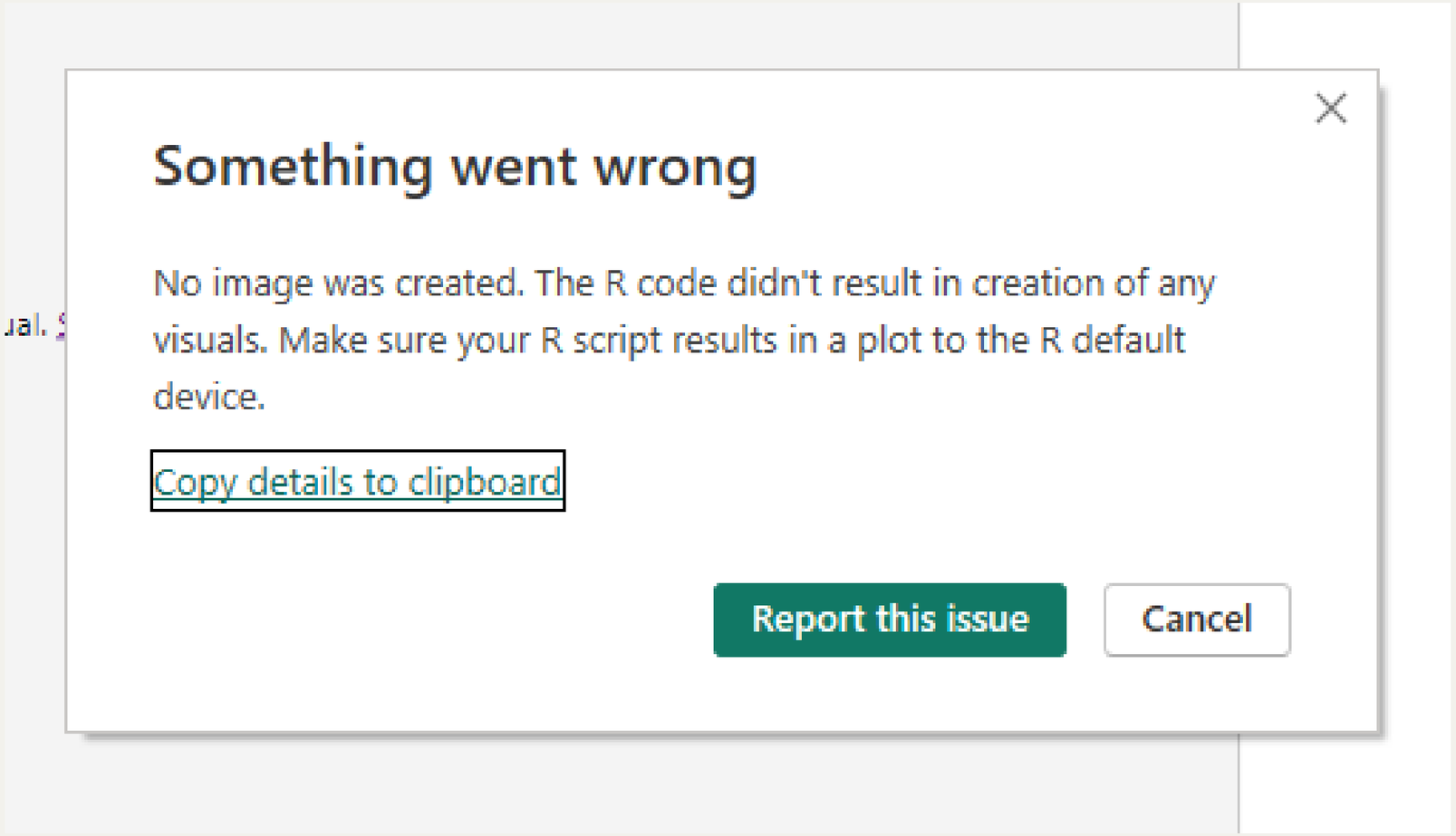
Cross-report Off

Keep all filters On

Add drill-through fields here

https://r-graph-gallery.com/264-control-ggplot2-boxplot-colors.html

But if we try to make this plot interactive...



“That’s fine, my users can just have static plots.

But I can use any package I want... right?”

Yes!
(sort of)

If you’re only using the file locally, you’re free to use whatever you want.

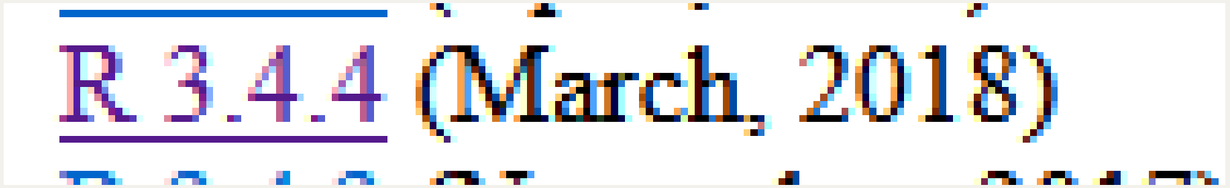
Export the output to a pdf, or share the .pbix, and everything is fine.

Hosting on the Power BI Service? Not so much.

Requirements and limitations of R packages

There are a handful of requirements and limitations for R packages:

- Current R runtime: Microsoft R 3.4.4



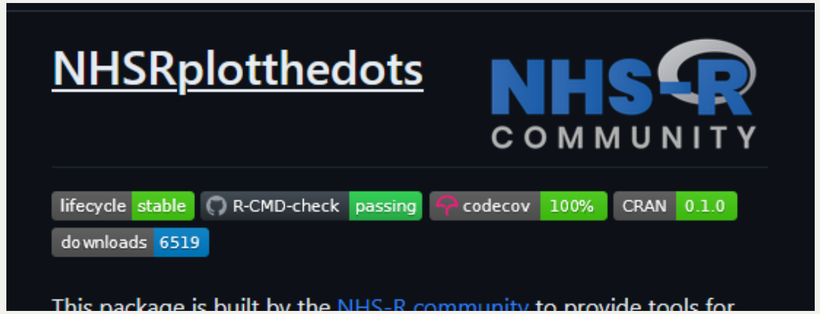
R packages that are supported in Power BI

The following table shows which packages are supported in the Power BI service.

Package	Version	Link
dplyr	0.8.3	https://cran.r-project.org/web/packages/dplyr/index.html

Request support for a new R package

Supported R packages for the Power BI service are found in the following section. If you would like to request support of an R package not found in that list, submit your request to Power BI Ideas.



network	1.13.0	https://cran.r-project.org/web/packages/network/index.html
networkD3	0.4	https://cran.r-project.org/web/packages/networkD3/index.html
neuralnet	1.33	https://cran.r-project.org/web/packages/neuralnet/index.html
ngram	3.0.4	https://cran.r-project.org/web/packages/ngram/index.html
nlme	3.1-131.1	https://cran.r-project.org/web/packages/nlme/index.html
nloptr	1.0.4	https://cran.r-project.org/web/packages/nloptr/index.html

At this point, maybe we could just... copy in all of the relevant code for that package?

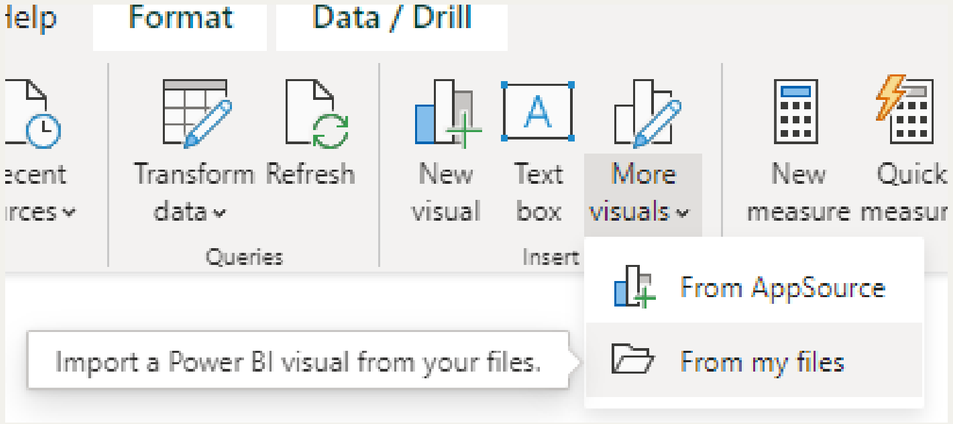
But then each time you want to do a new plot... you have to do that all over again.

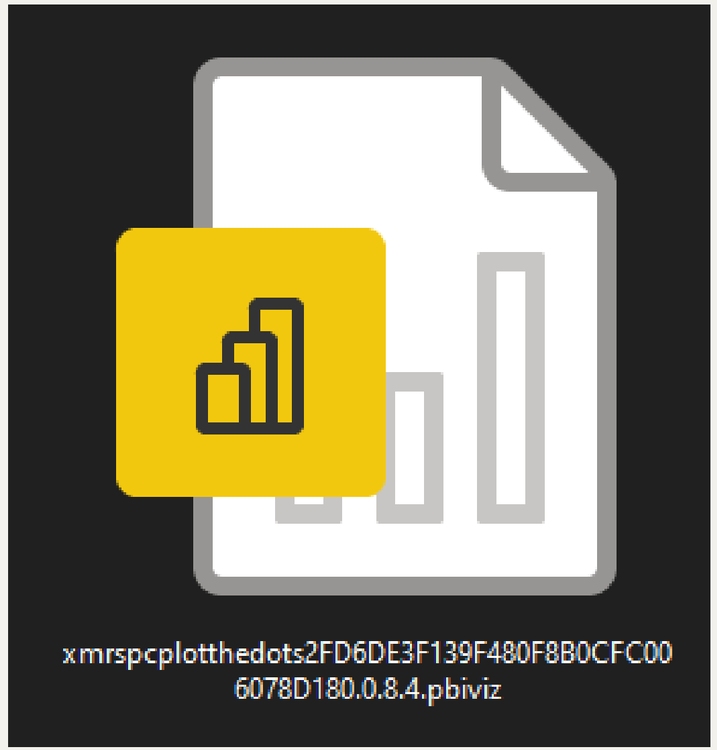
Alter it for your new variable names...

And what if you actually want to change something... everywhere?

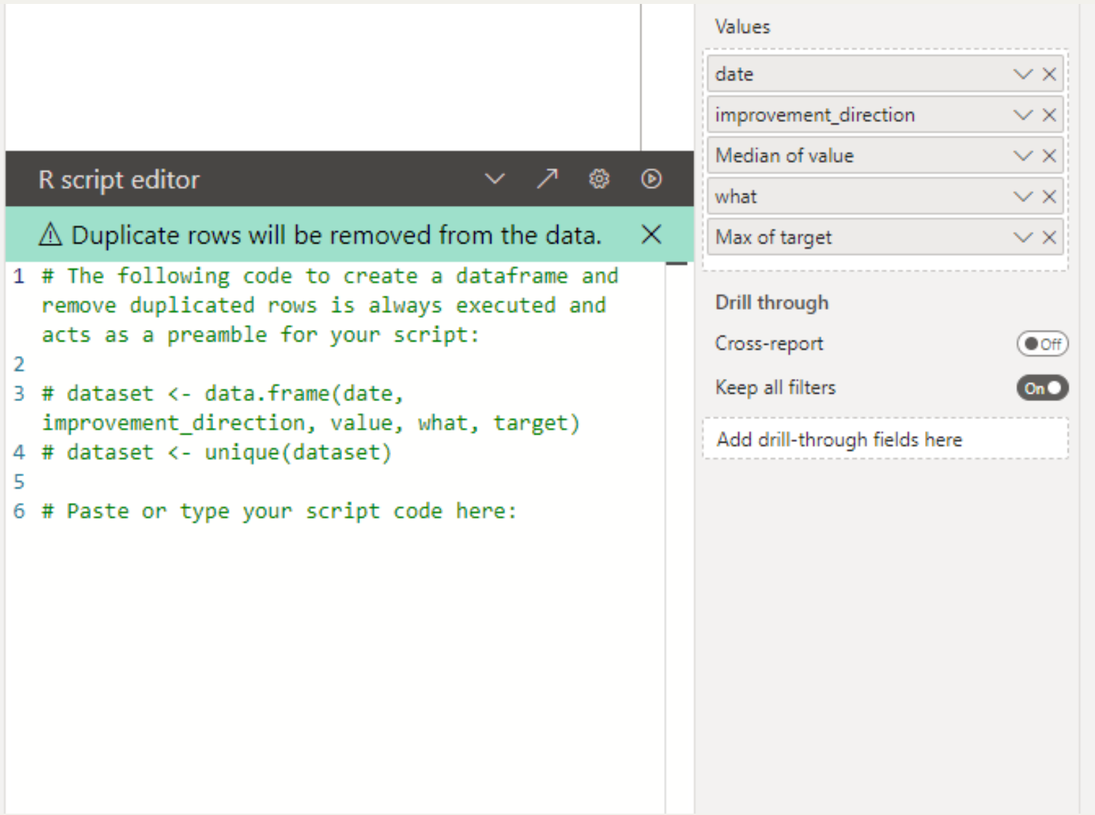
Maybe there’s a better way?

R HTML Custom Visuals

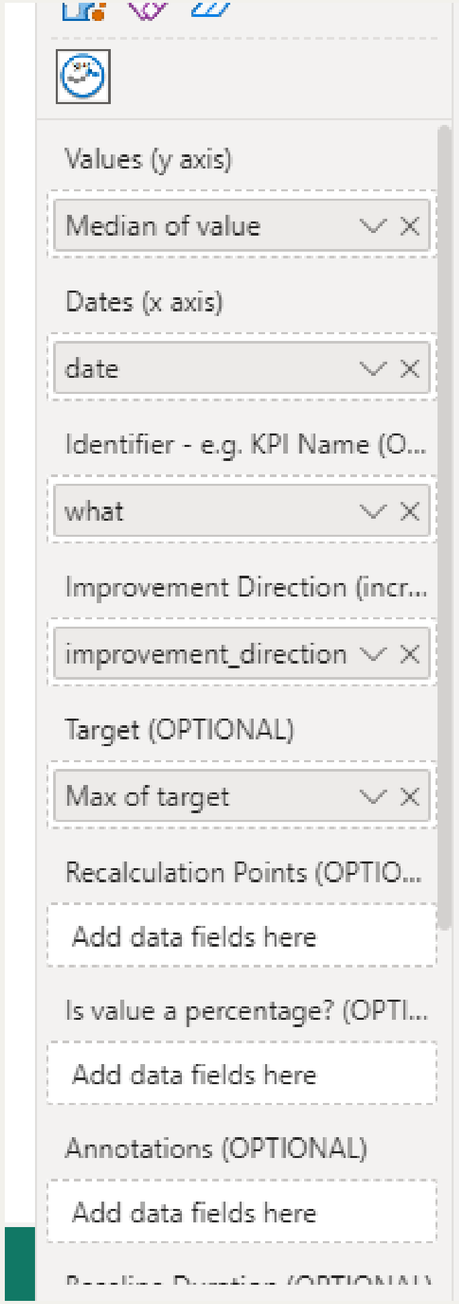


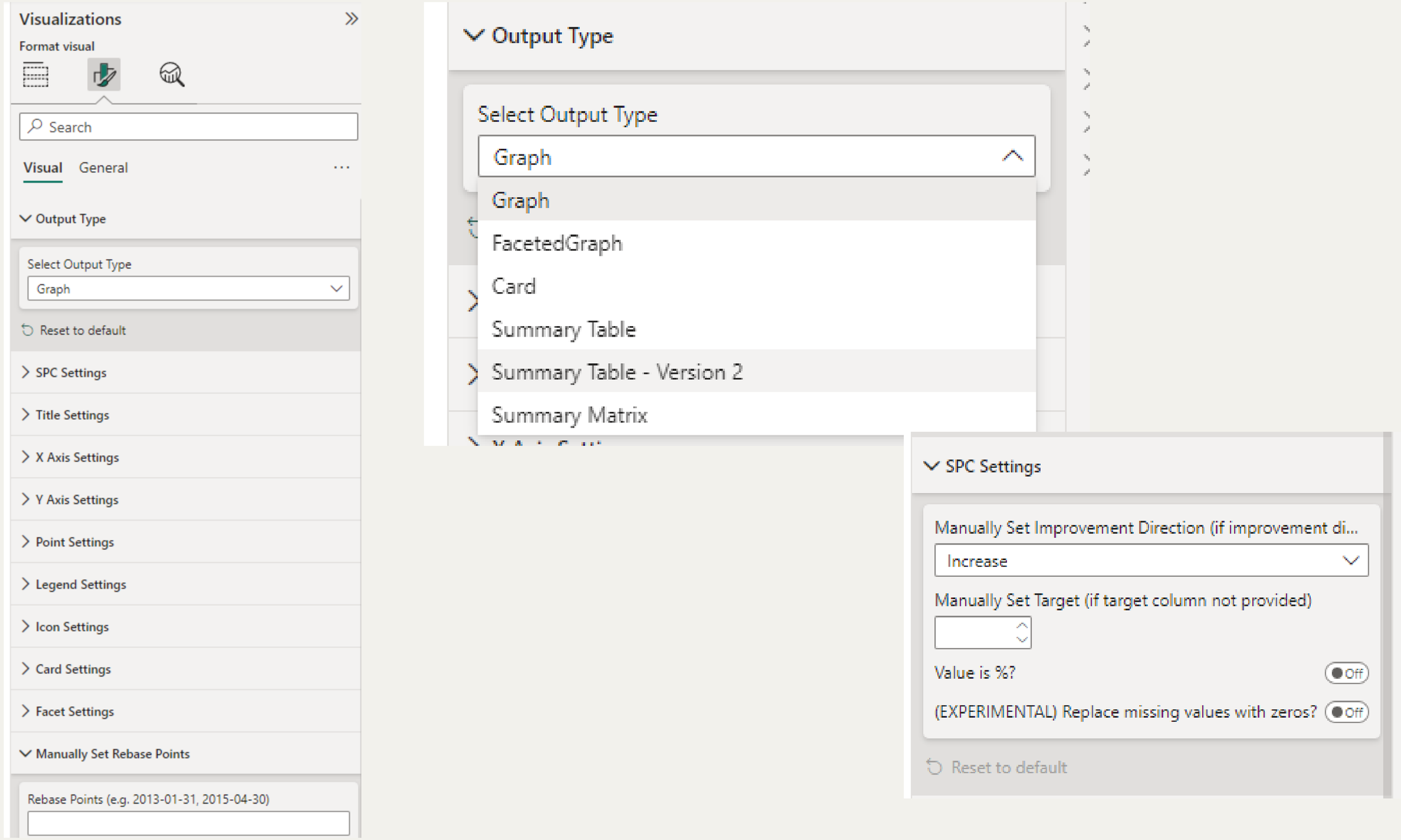


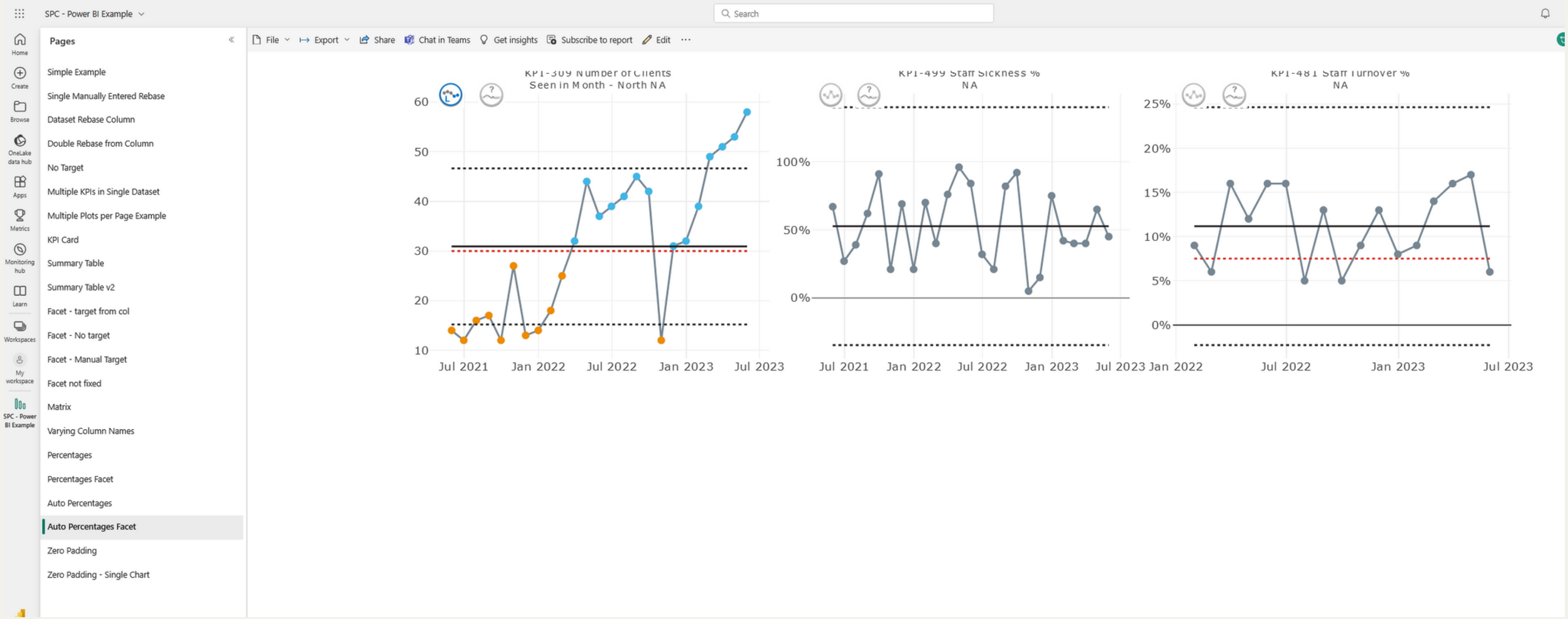
R script visual

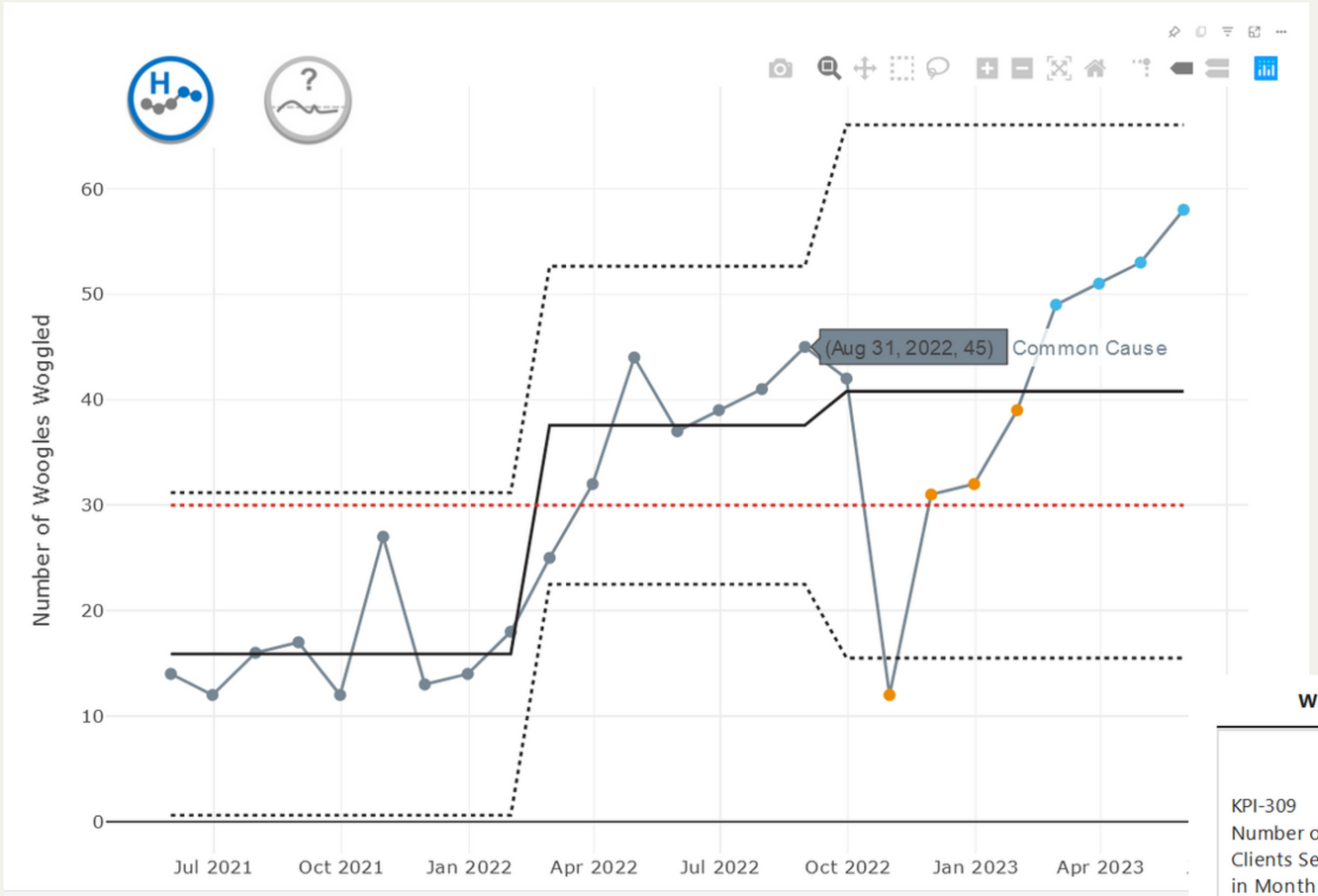


Custom R HTML visual

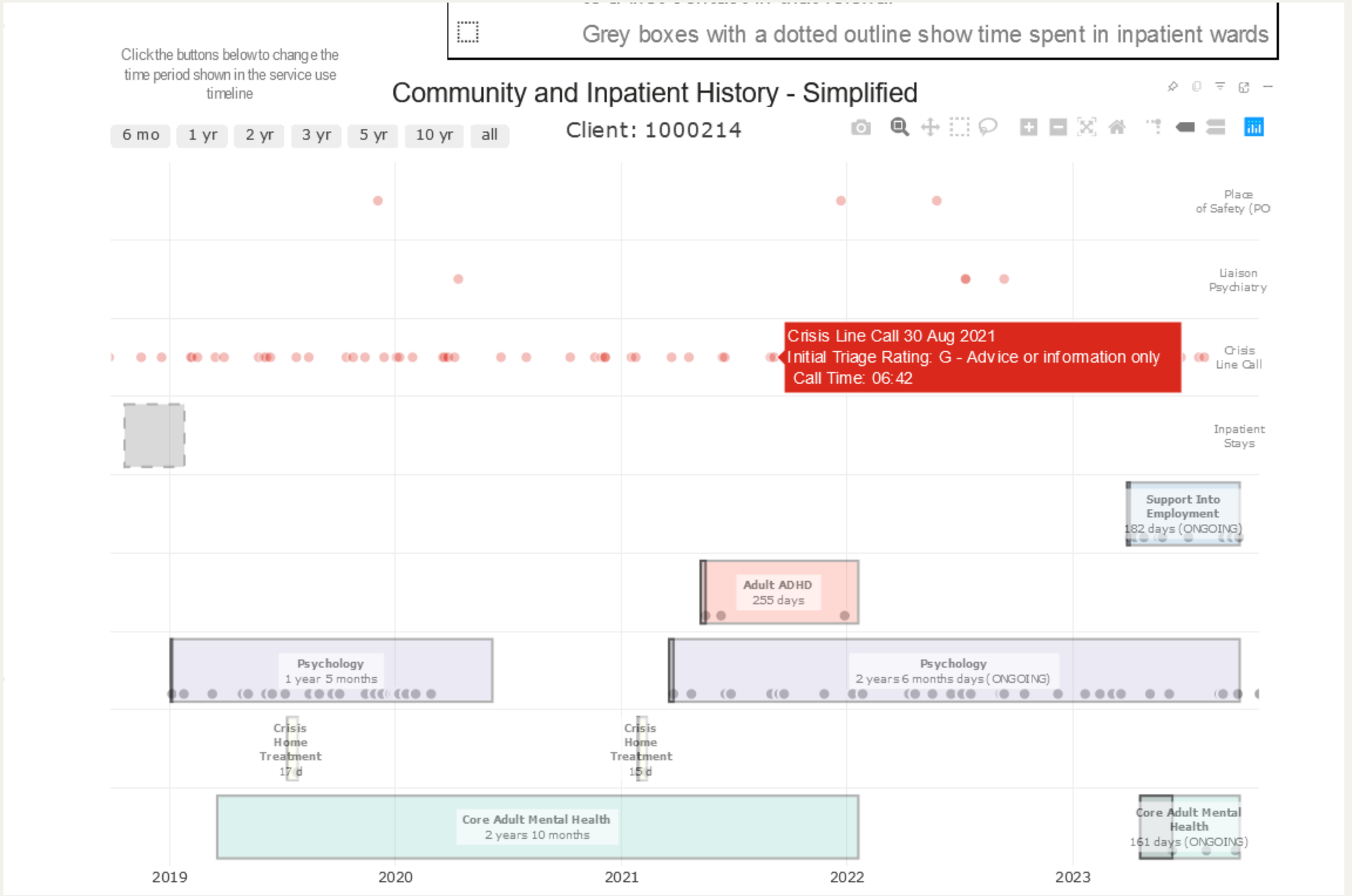



Visualizations
Format visual
Search
Visual
General
Output Type
Select Output Type
Graph
Reset to default
SPC Settings
Title Settings
X Axis Settings
Y Axis Settings
Point Settings
Legend Settings
Icon Settings
Card Settings
Facet Settings
Manually Set Rebase Points
Rebase Points (e.g. 2013-01-31, 2015-04-30)
Output Type
Select Output Type
Graph
Graph
FacetedGraph
Card
Summary Table
Summary Table - Version 2
Summary Matrix
SPC Settings
Manually Set Improvement Direction (if improvement di...
Increase
Manually Set Target (if target column not provided)
Value is %?
Off
(EXPERIMENTAL) Replace missing values with zeros?
Off
Reset to default


SPC - Power BI Example
Search
Home
Create
Browse
OneLake data hub
Apps
Metrics
Monitoring hub
Learn
Workspaces
My workspace
SPC - Power BI Example
Pages
Simple Example
Single Manually Entered Rebase
Dataset Rebase Column
Double Rebase from Column
No Target
Multiple KPIs in Single Dataset
Multiple Plots per Page Example
KPI Card
Summary Table
Summary Table v2
Facet - target from col
Facet - No target
Facet - Manual Target
Facet not fixed
Matrix
Varying Column Names
Percentages
Percentages Facet
Auto Percentages
Auto Percentages Facet
Zero Padding
Zero Padding - Single Chart
File
Export
Share
Chat in Teams
Get insights
Subscribe to report
Edit
KPI-309 Number of Clients Seen in Month - North NA
60
50
40
30
20
10
Jul 2021
Jan 2022
Jul 2022
Jan 2023
Jul 2023
KPI-499 Staff Sickness % NA
100%
50%
0%
Jul 2021
Jan 2022
Jul 2022
Jan 2023
Jul 2023
KPI-481 Staff Turnover % NA
25%
20%
15%
10%
5%
0%
Jan 2022
Jul 2022
Jan 2023
Jul 2023



What	North	South
KPI-309 Number of Clients Seen in Month	**Not Consistently Meeting Target** Most Recent Value: 58 31 May 21 to 31 May 23	**Not Consistently Meeting Target** Most Recent Value: 56 31 May 21 to 31 May 23
KPI-481 Staff Turnover %	**Not Consistently Meeting Target** Most Recent Value: 6% 31 Jan 22 to 31 May 23	Most Recent Value: 45% 31 May 21 to 31 May 23
KPI-587 Number of		Most Recent Value: 31


Grey boxes with a dotted outline show time spent in inpatient wards
Click the buttons below to change the time period shown in the service use timeline
Community and Inpatient History - Simplified
Client: 1000214
6 mo
1 yr
2 yr
3 yr
5 yr
10 yr
all
Place of Safety (PO
Liaison Psychiatry
Crisis Line Call
Inpatient Stays
Crisis Line Call 30 Aug 2021
Initial Triage Rating: G - Advice or information only
Call Time: 06:42
Support Into Employment
182 days (ONGOING)
Adult ADHD
255 days
Psychology
1 year 5 months
Psychology
2 years 6 months days (ONGOING)
Crisis Home Treatment
17 d
Crisis Home Treatment
15 d
Core Adult Mental Health
2 years 10 months
Core Adult Mental Health
161 days (ONGOING)
2019
2020
2021
2022
2023

File Home Insert Modeling View Optimize Help Format Data / Drill

Paste Cut Copy Format painter — Clipboard

Get data Excel workbook Data hub SQL Server Enter data Dataverse Recent sources — Data

Transform data Refresh — Queries

New visual Text box More visuals — Insert

New measure Quick measure — Calculations

Sensitivity — Sensitivity

Publish — Share

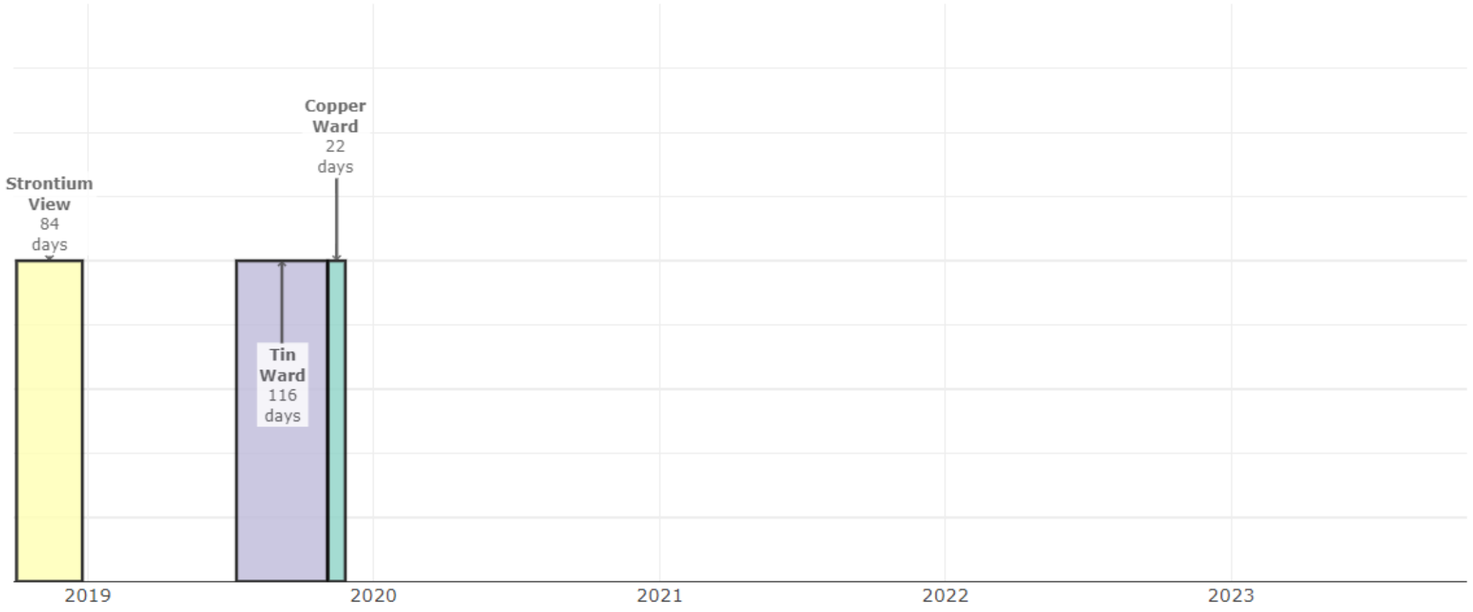
Assessment but Stable

ongoing support

Inpatient Stays - In and Out of Area

Client: 1000387

6 mo | 1 yr | 2 yr | 3 yr | 5 yr | 10 yr | all



Click and drag these white handles to focus in on a time period

British Journal of Healthcare Management

Journal Home | Early view | Current Issue | Archive | Authors | Subscribe | More

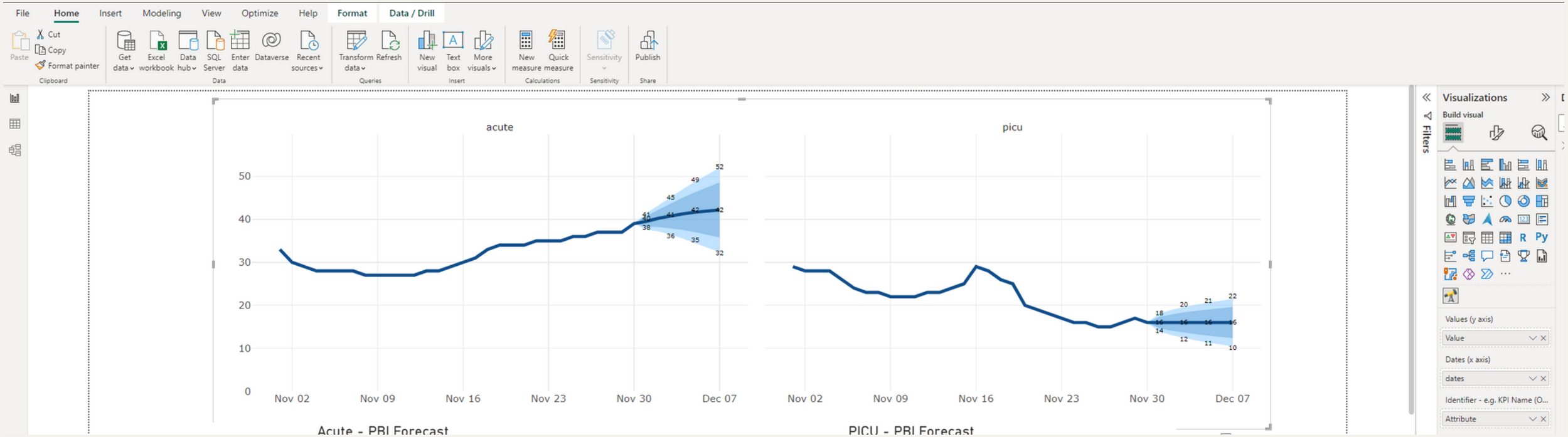
British Journal of Healthcare Management, Vol. 27, No. 2 · Comment

Free Access

Nowcasting for improved management of COVID-19 acute bed capacity

Richard M Wood

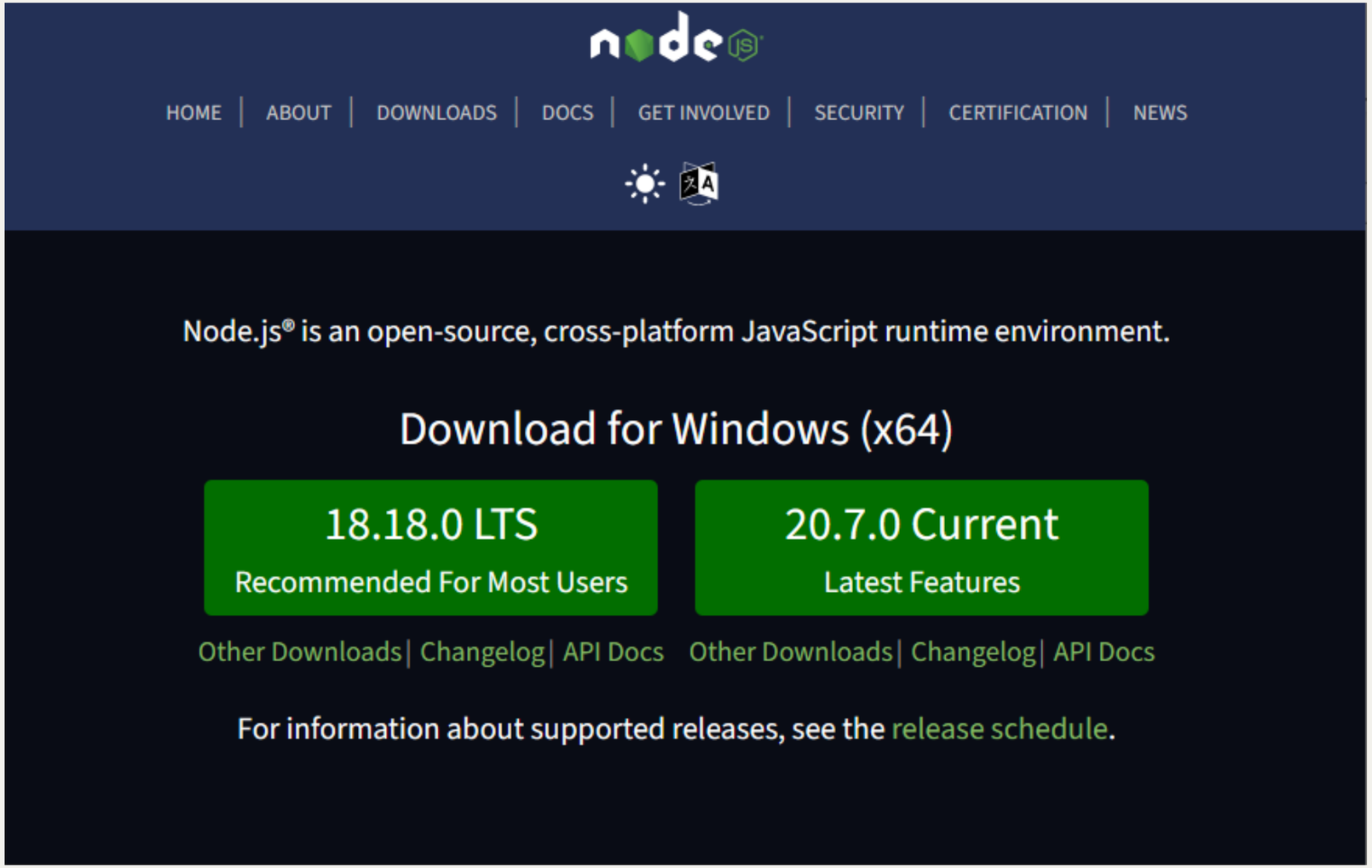
Published Online: 8 Jan 2021 | https://doi.org/10.12968/bjhc.2020.0179



https://www.magonlinelibrary.com/doi/full/10.12968/bjhc.2020.0179

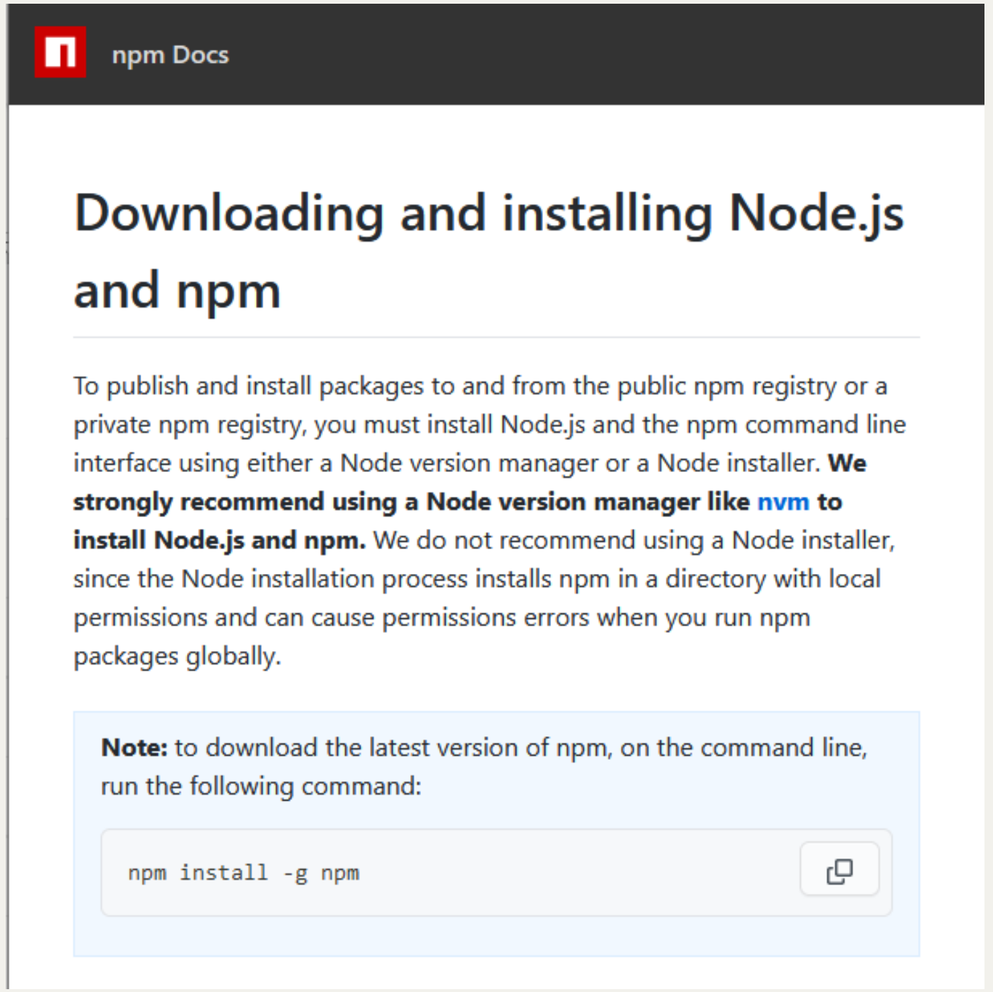
But How Do I Do It?

1. Install node.js

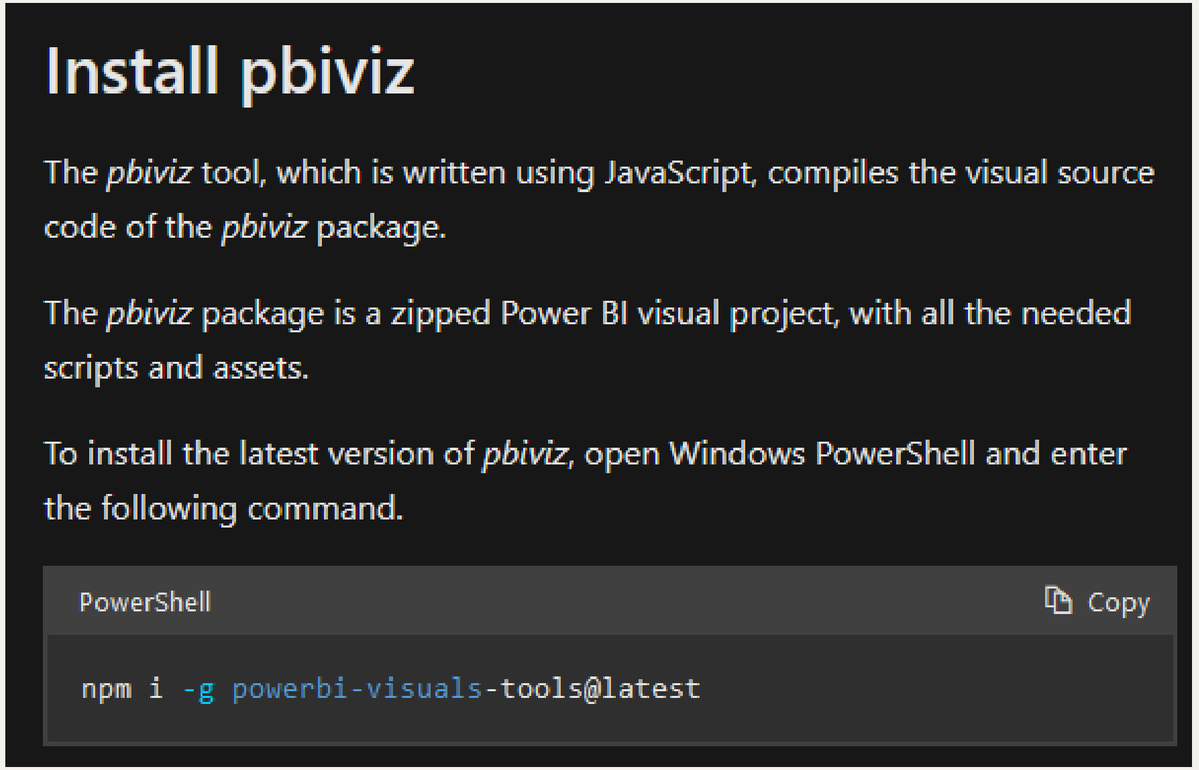


https://nodejs.org/en

2. Install node package manager



3. Install pbiviz



Install pbiviz

The *pbiviz* tool, which is written using JavaScript, compiles the visual source code of the *pbiviz* package.

The *pbiviz* package is a zipped Power BI visual project, with all the needed scripts and assets.

To install the latest version of *pbiviz*, open Windows PowerShell and enter the following command.

PowerShell Copy

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

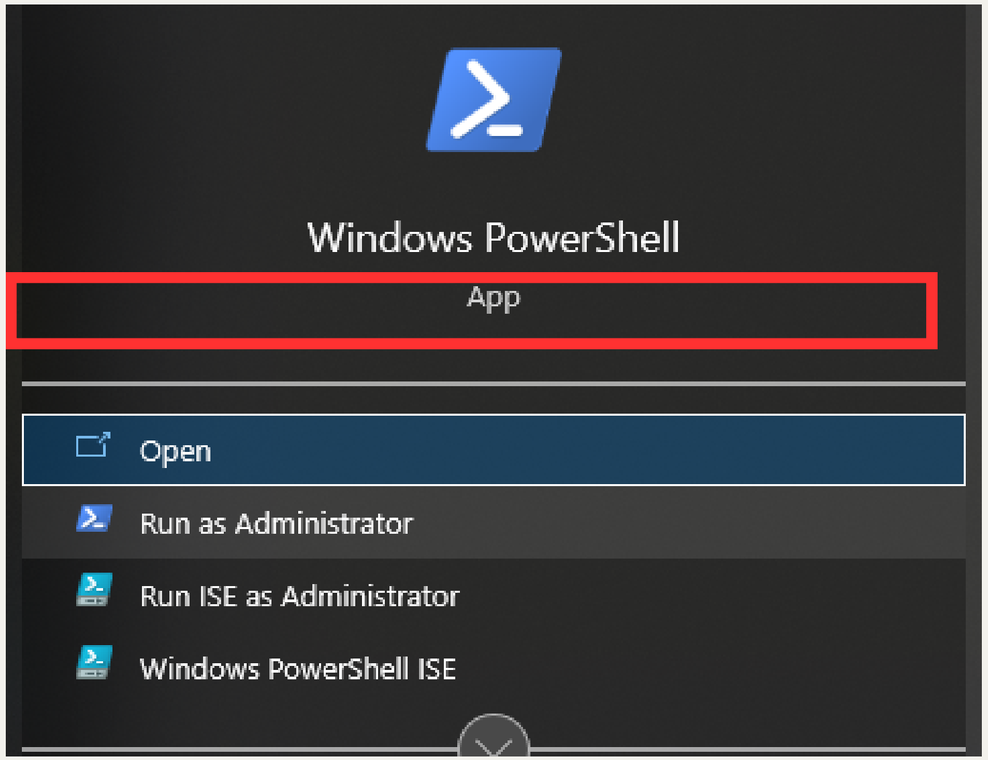
WARNING!

As of May 2023, there was a bug in the newest version of pbiviz that prevents generated R html visuals from rendering.

Version 4.0.5 is known to be working and can be installed with

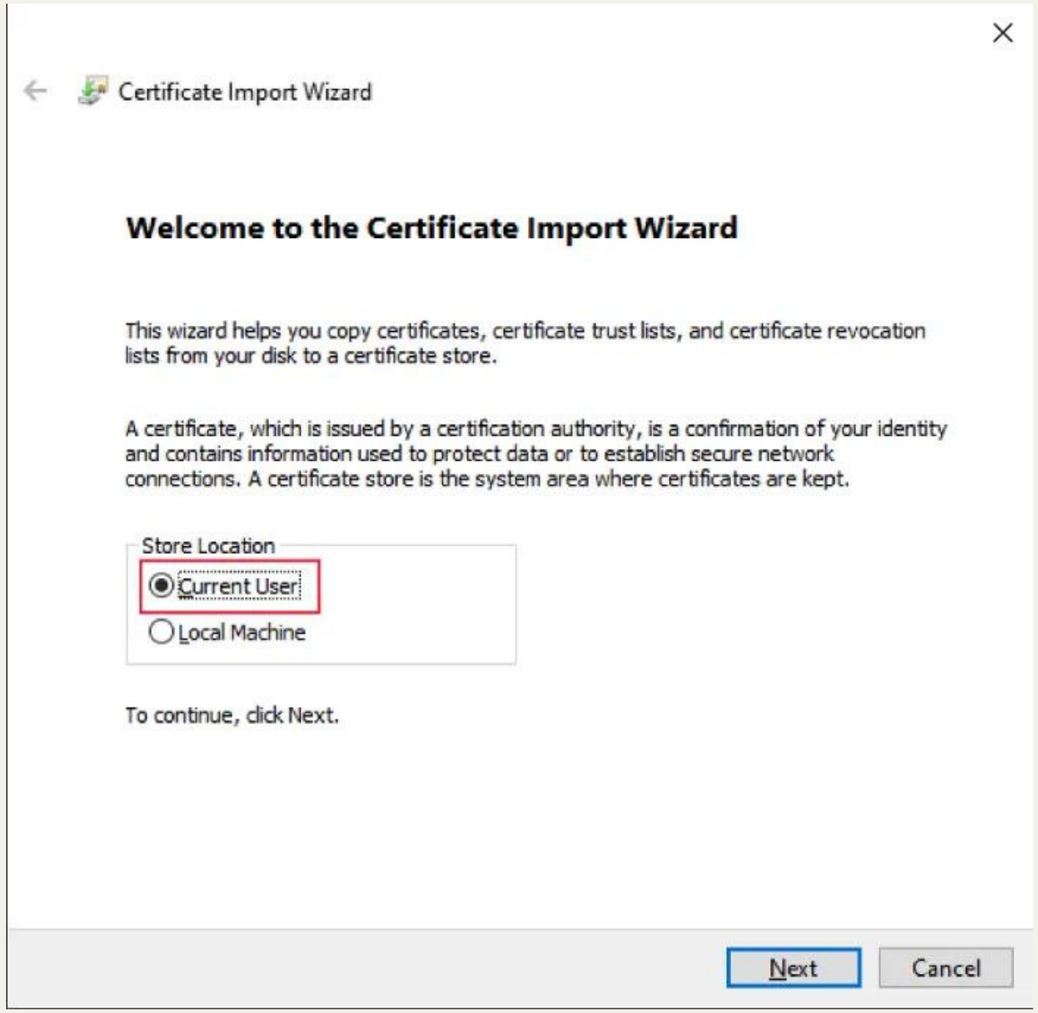
```
npm i -g Power BI-visuals-tools@4.0.5
```

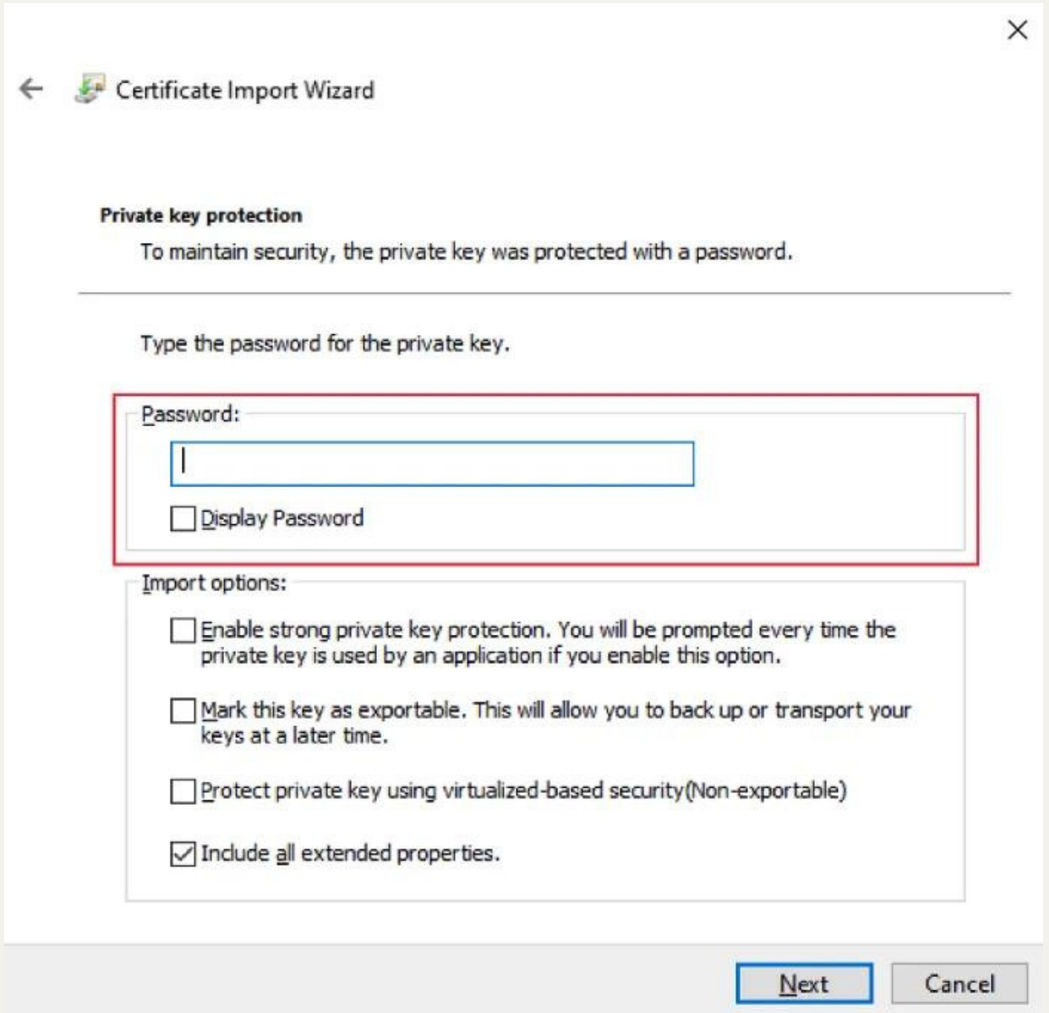
4. Install certificates



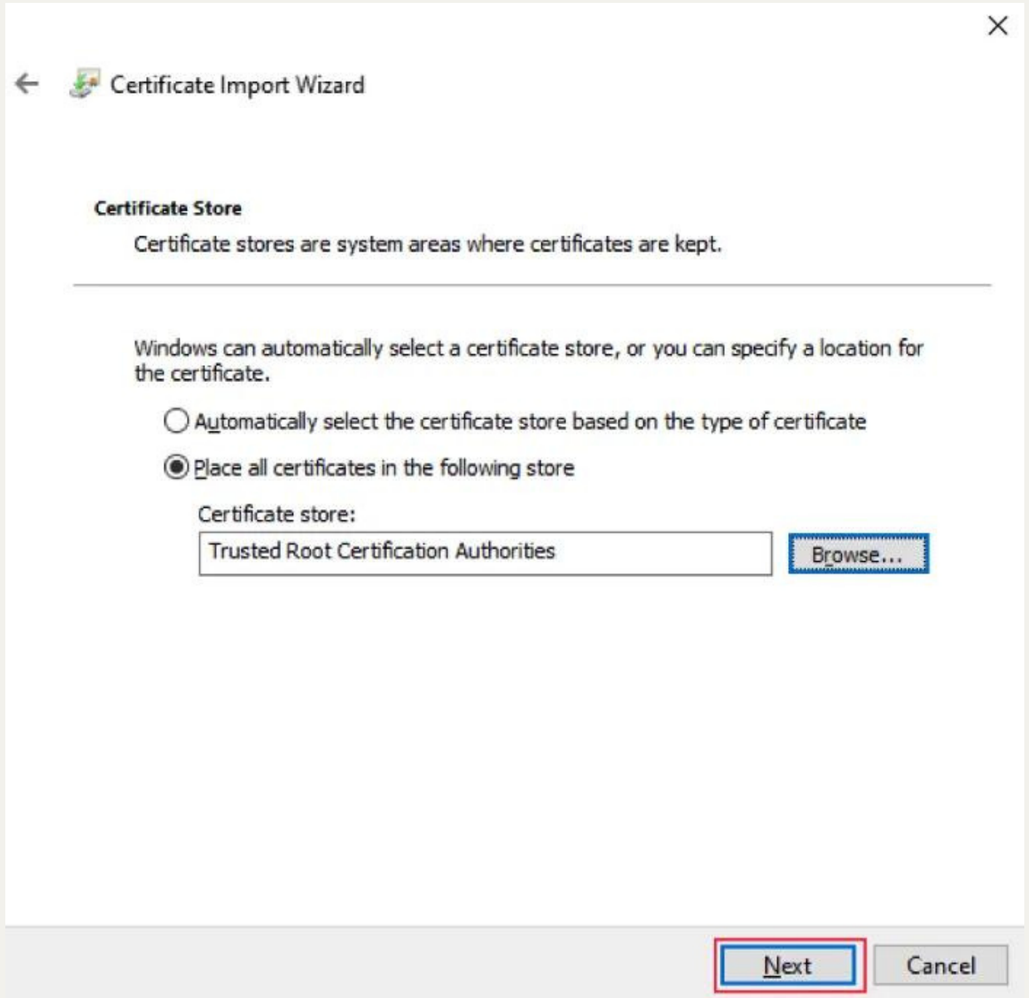

```
Set-ExecutionPolicy RemoteSigned
```

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





https://medium.com/@thakurshalabh/create-dynamic-custom-visual-in-power-bi-using-r-ggplot2-and-plotly-4b15a73ef506



https://medium.com/@thakurshalabh/create-dynamic-custom-visual-in-power-bi-using-r-ggplot2-and-plotly-4b15a73ef506

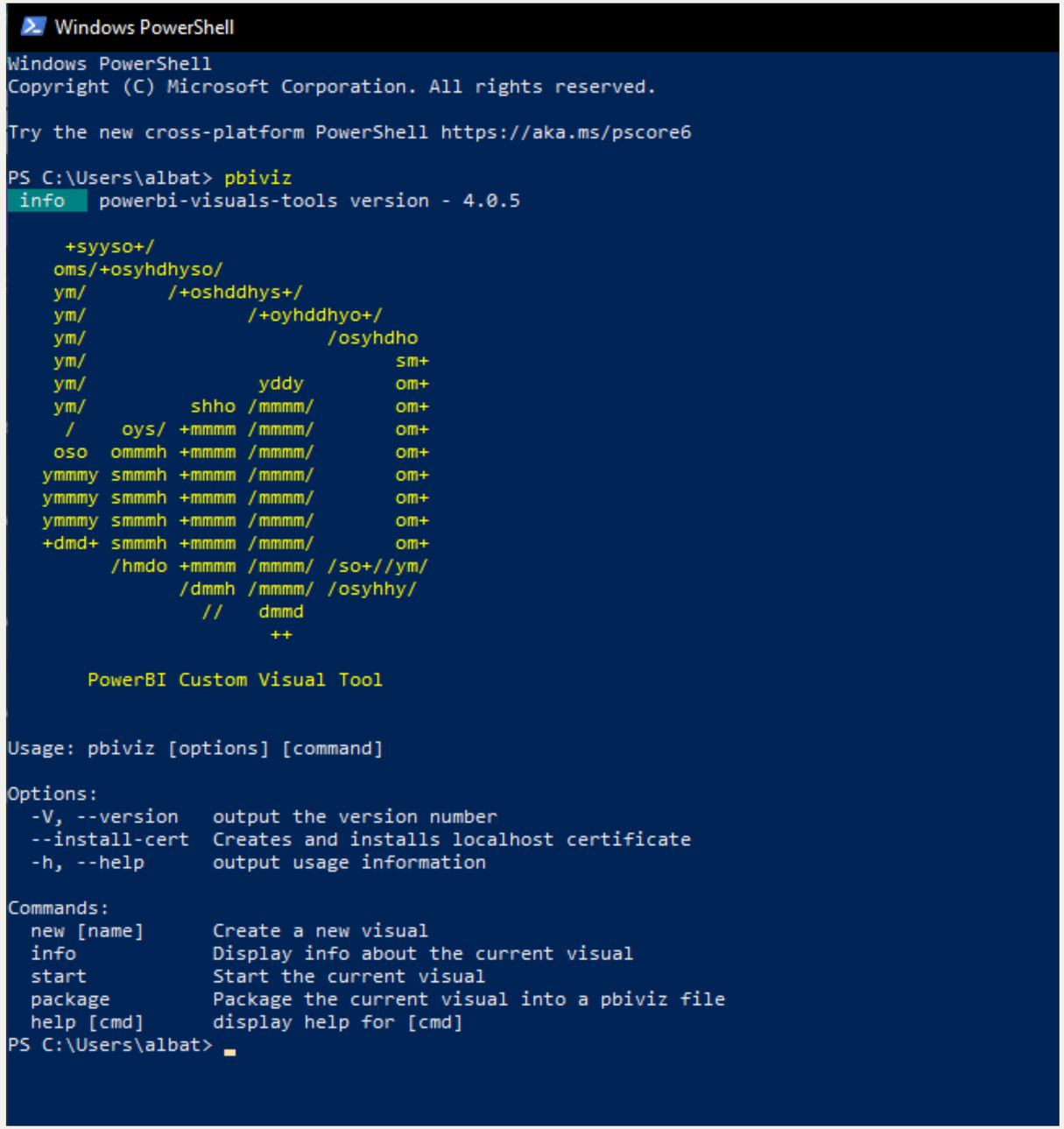
5. Check it’s working!

Open a Windows PowerShell terminal

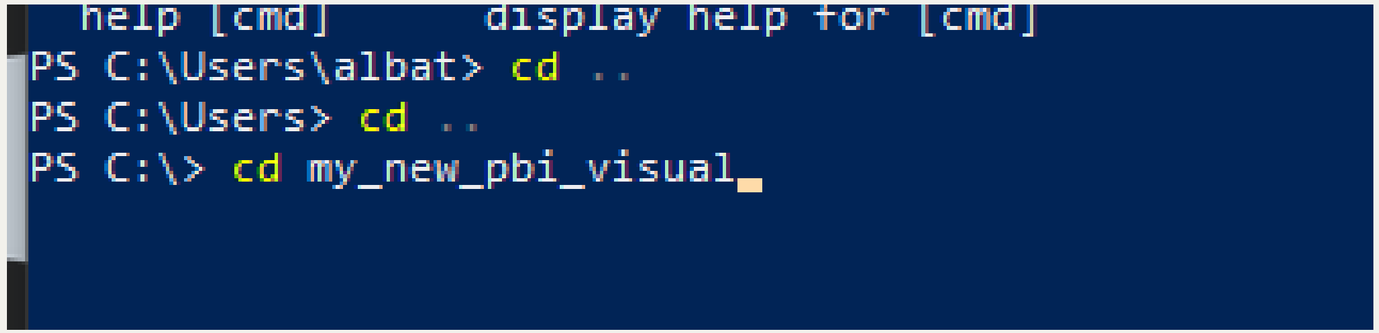
Type in

`pbiviz`

And click enter

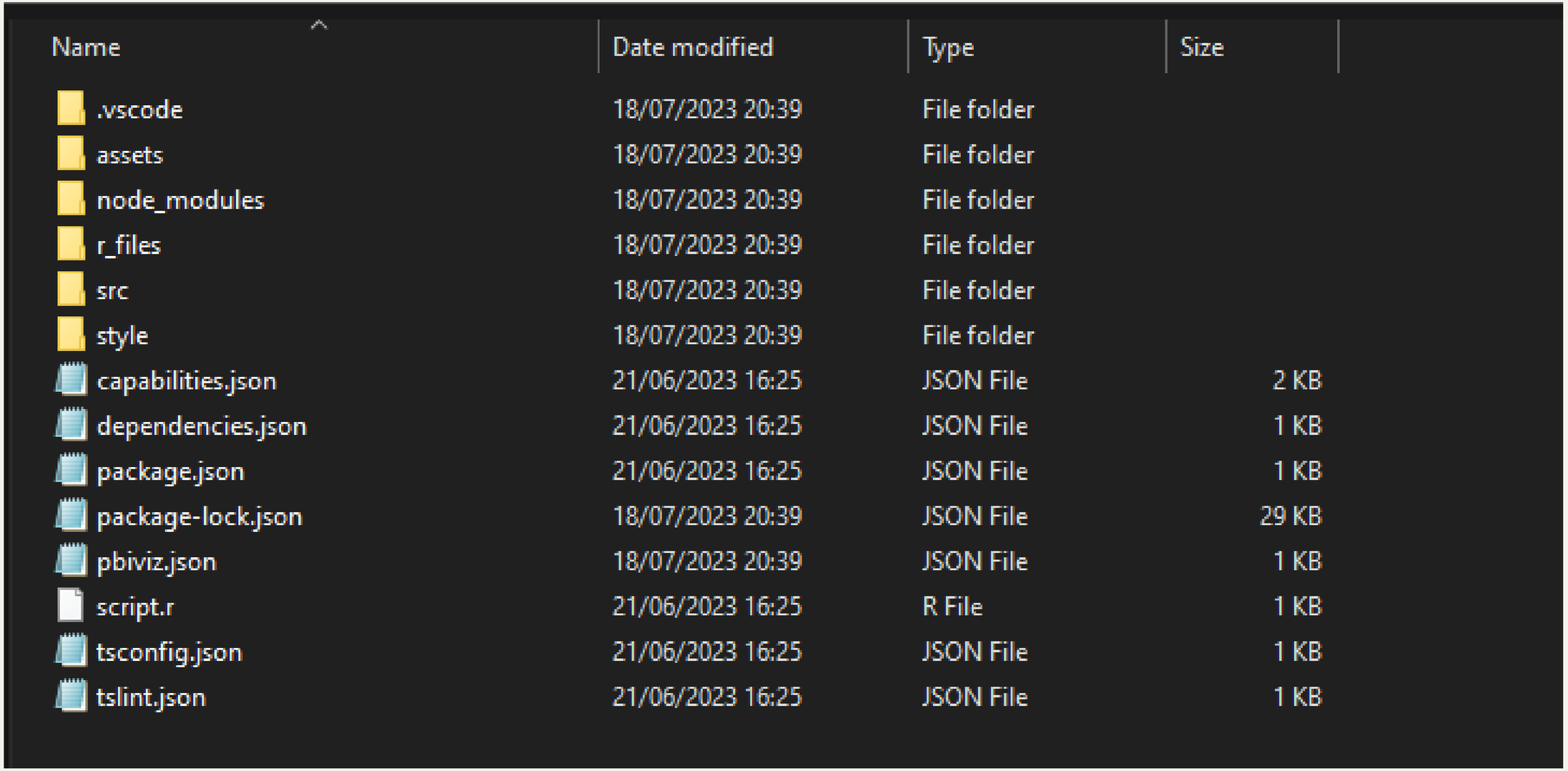


6. Navigate to the folder you want to create the project in using PowerShell



7. Create a new R visual project

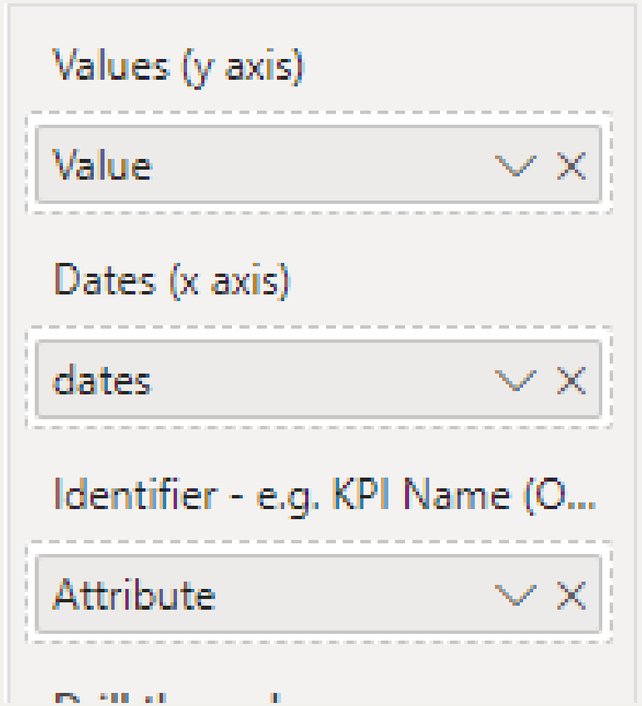
```
pbiviz new [YOUR VISUAL NAME HERE] -t rhtml
```



Name	Date modified	Type	Size
.vscode	18/07/2023 20:39	File folder	
assets	18/07/2023 20:39	File folder	
node_modules	18/07/2023 20:39	File folder	
r_files	18/07/2023 20:39	File folder	
src	18/07/2023 20:39	File folder	
style	18/07/2023 20:39	File folder	
capabilities.json	21/06/2023 16:25	JSON File	2 KB
dependencies.json	21/06/2023 16:25	JSON File	1 KB
package.json	21/06/2023 16:25	JSON File	1 KB
package-lock.json	18/07/2023 20:39	JSON File	29 KB
pbiviz.json	18/07/2023 20:39	JSON File	1 KB
script.r	21/06/2023 16:25	R File	1 KB
tsconfig.json	21/06/2023 16:25	JSON File	1 KB
tslint.json	21/06/2023 16:25	JSON File	1 KB

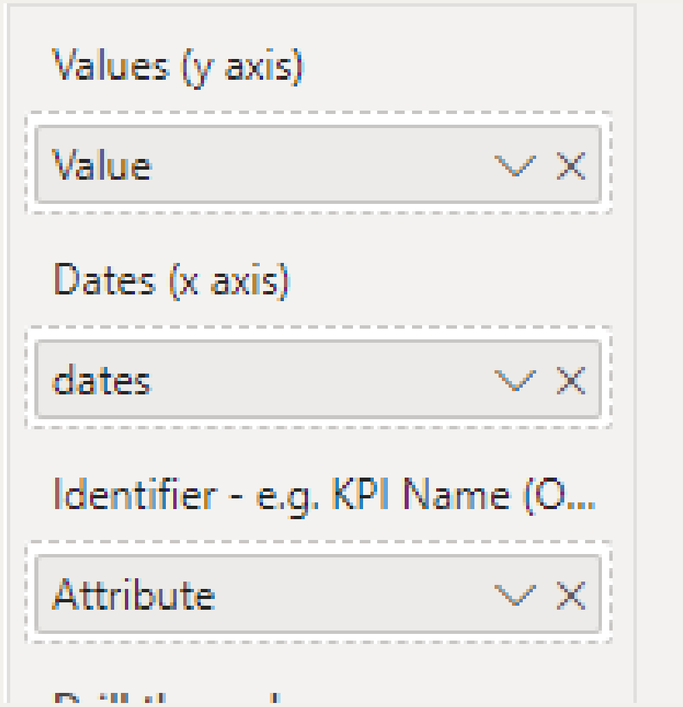
File	Function
script.r	The main R script that ingests the data then creates and saves the plotly visual. Additional settings specified in settings.ts and capabilities.json will need to be referenced in here to have an effect.
pbiviz.json	Version numbers are updated in here.
capabilities.json	Used when adding additional options to the Power BI visualisation customisation panel
src/settings.ts	Used when adding additional options to the Power BI visualisation customisation panel
r_files/flatten_HTML.r	Helper functions generated automatically by PBI viz tools when using the RHTML template. Referenced by script.r

8. Set up your input variables in capabilities.json



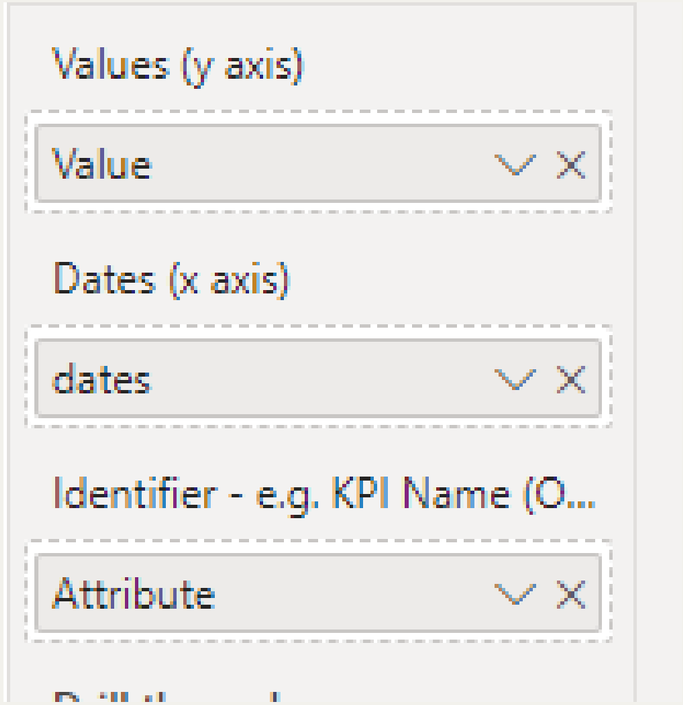

```
{
  "dataRoles": [
    {
      "displayName": "Values (y axis)",
      "description": "Numeric values - the thing you are measuring.",
      "kind": "GroupingOrMeasure",
      "name": "value"
    },

    {
      "displayName": "Dates (x axis)",
      "description": "Dates (text column in format yyyy-mm-dd or dd-mm-yyyy, or PowerBI date column).",
      "kind": "GroupingOrMeasure",
      "name": "date"
    },

    {
      "displayName": "Identifier - e.g. KPI Name (OPTIONAL)",
      "description": "Optional for single graph or card. If a single value for the whole dataset, will be used as the graph/card t
      "kind": "GroupingOrMeasure",
      "name": "what"
    }
  ],
  "dataViewMappings": [
```

Set up your input variables in capabilities.json




```
    ],
    "dataViewMappings": [
      {

    "conditions": [
          {
            "value": {
              "max": 1
            },
            "date": {
              "max": 1
            },
            "what": {
              "max": 1
            }
          }

```

Set up your input variables in capabilities.json



9. Import your variables into script.R

```r
# Import the mandatory columns
if(exists("value")) value <- value else value <- NULL
if(exists("date")) date <- date else date <- NULL

dataset <- cbind(value, date)

# Import the optional columns
if(exists("what") && !is.null(what)) dataset <- bind_cols(dataset, what) else dataset <- dataset %>% mutate(what = NA)

colnames(dataset) <- c("value", "date", "what")
```

10. Make your plot

In script.R,
do everything you would usually do in R, until you have a visual ready to go

```
############## Create and save widget ###############
internalSaveWidget(my_plot, 'out.html');
#####################################################

################## Reduce paddings ###################
ReadFullFileReplaceString('out.html', 'out.html', ',"padding":[0-9]*,', ',"padding":0,')
#####################################################
```

11. Now we can add some additional options in src/settings.ts

Here, we are going to add an option to change the y axis label

```
33  export class VisualSettings extends DataViewObjectsParser {
34      // public rcv_script: rcv_scriptSettings = new rcv_scriptSettings();
35
36      public yaxissettings: YAxisSettings = new YAxisSettings();
37
38  }
39
40
```

```
export class YAxisSettings {
    public YAxisTitle: string = "";
}
```

12. We then just need to add in the final touches in capabilities.json

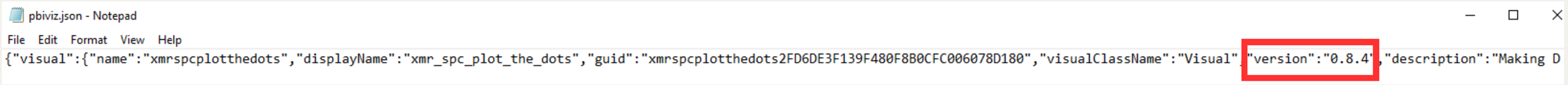
```
  "objects": {

    "yaxissettings": {
      "displayName": "Y Axis Settings",
      "description": "Y Axis theme and title",
      "properties": {

        "YAxisTitle" {
          "displayName": "Y Axis Title",
          "description": "Set Y Axis Title",
          "type": {
            "text": true
          }
        }

    }
},
```

```
33  export class VisualSettings extends DataViewObjectsParser {
34      // public rcv_script: rcv_scriptSettings = new rcv_scriptSettings();
35
36      publi  yaxissettings: YAxisSettings = new YAxisSettings();
37
38  }
39
40
```

Notice what we match from src/settings.ts

```
export class YAxisSettings {
  public YAxisTitle: string = "";
}
```

12. Finally we need to fill in the key information about our visual in pbiviz.json



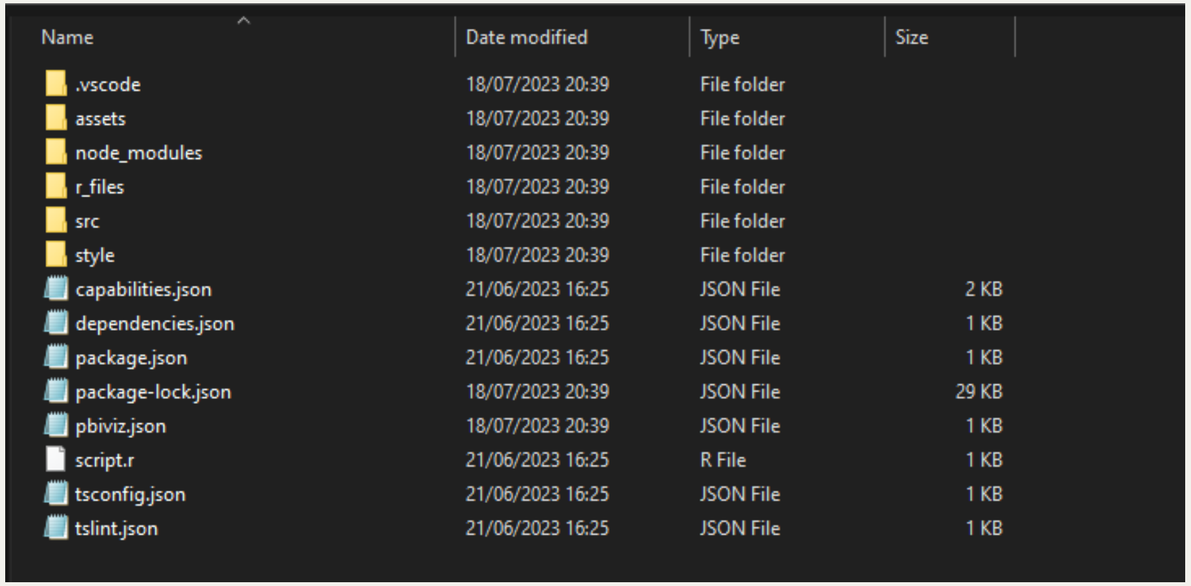
You will want to frequently update the version number

As a minimum, so that the package will compile correctly, we need to fill in

- description
- supportUrl
- gitHubUrl
- author
- email

14. Now we can package our file

First, in a Powershell window, make sure we are in the root folder for our visual (the folder we created at the beginning, where our script.R file lives)



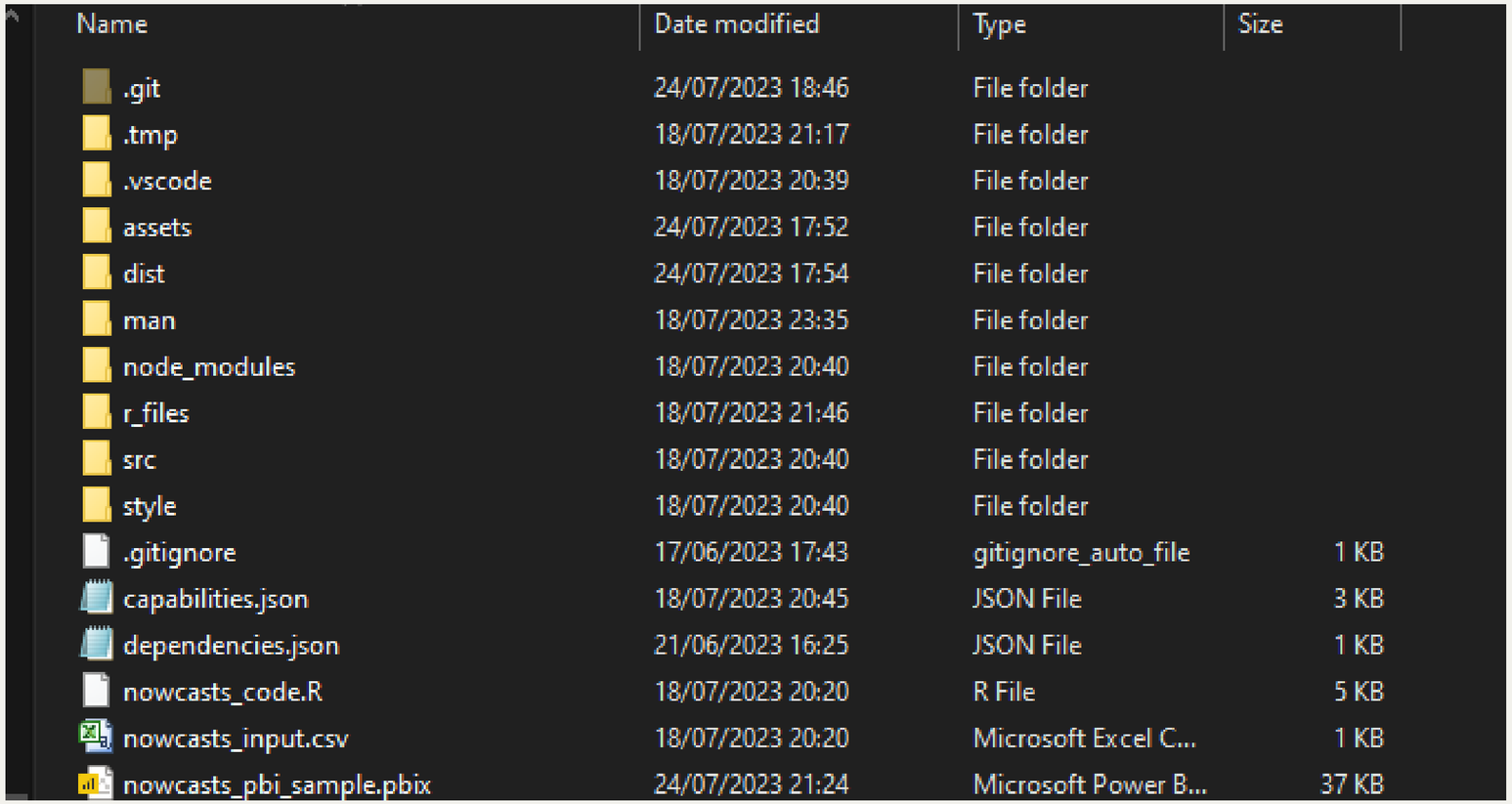
Name	Date modified	Type	Size
.vscode	18/07/2023 20:39	File folder	
assets	18/07/2023 20:39	File folder	
node_modules	18/07/2023 20:39	File folder	
r_files	18/07/2023 20:39	File folder	
src	18/07/2023 20:39	File folder	
style	18/07/2023 20:39	File folder	
capabilities.json	21/06/2023 16:25	JSON File	2 KB
dependencies.json	21/06/2023 16:25	JSON File	1 KB
package.json	21/06/2023 16:25	JSON File	1 KB
package-lock.json	18/07/2023 20:39	JSON File	29 KB
pbiviz.json	18/07/2023 20:39	JSON File	1 KB
script.r	21/06/2023 16:25	R File	1 KB
tsconfig.json	21/06/2023 16:25	JSON File	1 KB
tslint.json	21/06/2023 16:25	JSON File	1 KB

Run the command

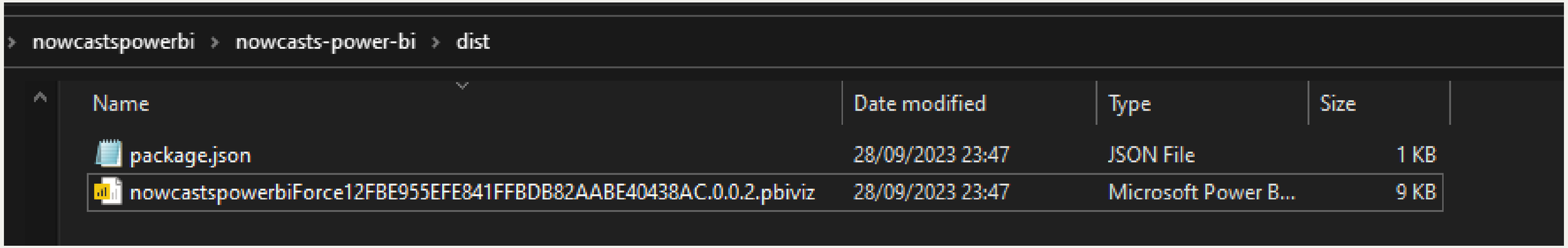
`pbiviz package`

```
PS H:\nowcastspowerbi\nowcasts-power-bi> pbiviz package
 info   powerbi-visuals-tools version - 4.0.5
 info   Building visual...
 info   Certificate is valid.
 info   Start preparing plugin template
 info   Finish preparing plugin template
 info   Start packaging...
(node:37240) [DEP_WEBPACK_COMPILATION_ASSETS] DeprecationWarning: Compilation.assets will be frozen in future, all modif
ications are deprecated.
BREAKING CHANGE: No more changes should happen to Compilation.assets after sealing the Compilation.
        Do changes to assets earlier, e. g. in Compilation.hooks.processAssets.
        Make sure to select an appropriate stage from Compilation.PROCESS_ASSETS_STAGE_*.
(Use `node --trace-deprecation ...` to show where the warning was created)
 info   Package compression enabled
 info   Package created!
 info   Finish packaging
Webpack Bundle Analyzer saved report to H:\nowcastspowerbi\nowcasts-power-bi\webpack.statistics.prod.html

 warn   Please, make sure that the visual source code matches to requirements of certification:

 info   Visual must use API v3.2.0 and above
 info   The project repository must:
 info   Include package.json and package-lock.json;
 info   Not include node_modules folder
 info   Run npm install expect no errors
 info   Run pbiviz package expect no errors
 info   The compiled package of the Custom Visual should match submitted package.
 info   npm audit command must not return any alerts with high or moderate level.
 info   The project must include Tslint from Microsoft with no overridden configuration, and this command shouldn't retu
rn any tslint errors.
 info   https://www.npmjs.com/package/tslint-microsoft-contrib
 info   Ensure no arbitrary/dynamic code is run (bad: eval(), unsafe use of settimeout(), requestAnimationFrame(), setin
terval(some function with user input).. running user input/data etc.)
 info   Ensure DOM is manipulated safely (bad: innerHTML, D3.html(<some user/data input>), unsanitized user input/data d
irectly added to DOM, etc.)
 info   Ensure no js errors/exceptions in browser console for any input data. As test dataset please use this sample rep
ort

 info   Full description of certification requirements you can find in documentation:
 info   https://docs.microsoft.com/en-us/power-bi/power-bi-custom-visuals-certified#certification-requirements
```

Find the .pbiviz file in the dist folder



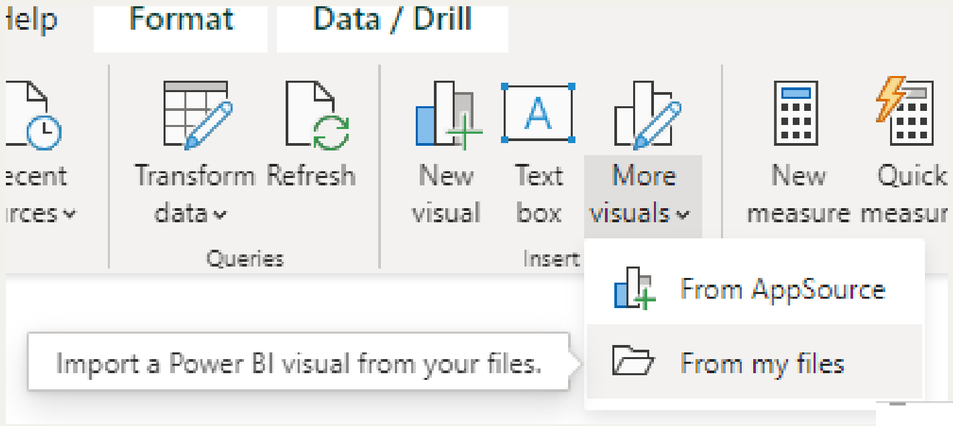
Name	Date modified	Type	Size
.git	24/07/2023 18:46	File folder	
.tmp	18/07/2023 21:17	File folder	
.vscode	18/07/2023 20:39	File folder	
assets	24/07/2023 17:52	File folder	
dist	24/07/2023 17:54	File folder	
man	18/07/2023 23:35	File folder	
node_modules	18/07/2023 20:40	File folder	
r_files	18/07/2023 21:46	File folder	
src	18/07/2023 20:40	File folder	
style	18/07/2023 20:40	File folder	
.gitignore	17/06/2023 17:43	gitignore_auto_file	1 KB
capabilities.json	18/07/2023 20:45	JSON File	3 KB
dependencies.json	21/06/2023 16:25	JSON File	1 KB
nowcasts_code.R	18/07/2023 20:20	R File	5 KB
nowcasts_input.csv	18/07/2023 20:20	Microsoft Excel C...	1 KB
nowcasts_pbi_sample.pbix	24/07/2023 21:24	Microsoft Power B...	37 KB

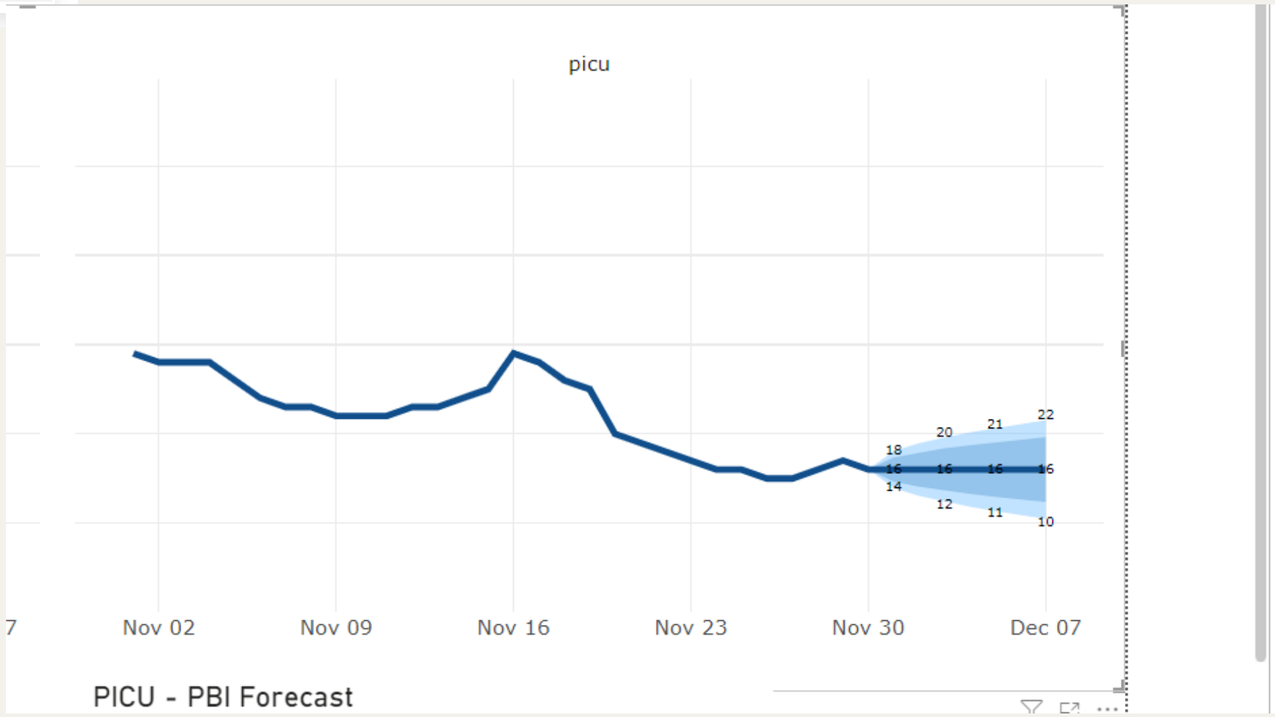


nowcastspowerbi › nowcasts-power-bi › dist

Name	Date modified	Type	Size
package.json	28/09/2023 23:47	JSON File	1 KB
nowcastspowerbiForce12FBE955EFE841FFBDB82AABE40438AC.0.0.2.pbiviz	28/09/2023 23:47	Microsoft Power B...	9 KB

Import and enjoy!





Limitations

1. They’re a bit slow

Can minimise size of the Plotly libraries when saving your fig

```
out <- fig %>% plotly::partial_bundle(local=FALSE)
```

Also, anecdotally each object you create gets written out to a temporary environment - so create as few intermediate objects as possible

2. PBI Service Package Limitations Still Apply

You may need to dig around in package documentation to work out when certain functions were added

3. It Doesn’t Behave Completely Like a Native Power BI Visual

These visuals can still can be a suboptimal experience for users versus a truly native plot

Clicking on an interactive R plot won't filter other items on the page in the way they might expect

4. It’s Not Easy to Test Online

Testing online is useful, but a bit of a pain if you don't have a Power BI account

There are ways to get an official email Microsoft will recognise

5. Setting Up a Test Environment is Tricky

If you are debugging something, it's really helpful to be able to do that on your machine - which means you need the package versions the Power BI service uses

I have set up a barebones script that installs the right packages in the right order - but doesn't cover every package.

You also need to install R 3.4.4

Tips

Start simple.

ggplotly is magic!

It doesn't just have to be plots

It can be any html output!

If you use the standard R visual template, it doesn't have to be interactive

```
pbiviz new my_fancy_new_r_plot -t rvisual
```

But you still get all the benefits of

- reproducibility
- shareability
- customisibility
- ease of use for less technical users

Closing thoughts

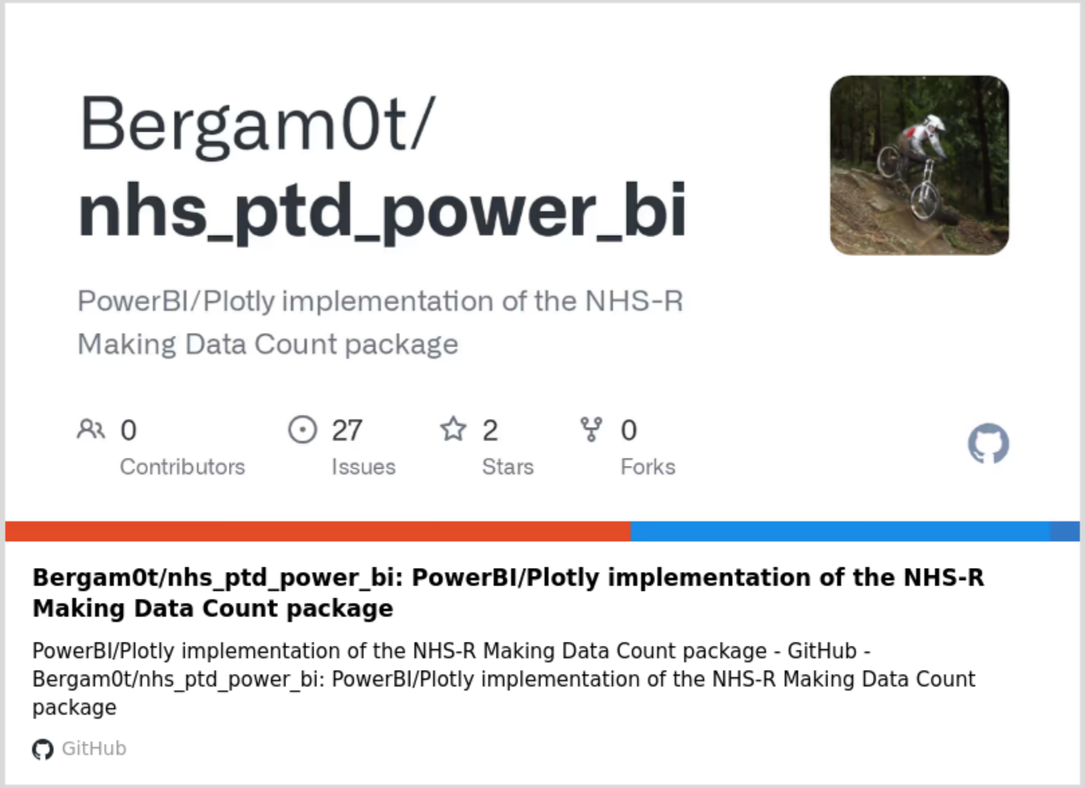
- This is a powerful way to extend what Power BI is capable of
- They shouldn’t be used where a native visual will do the job
- Consider the deneb project as an alternative

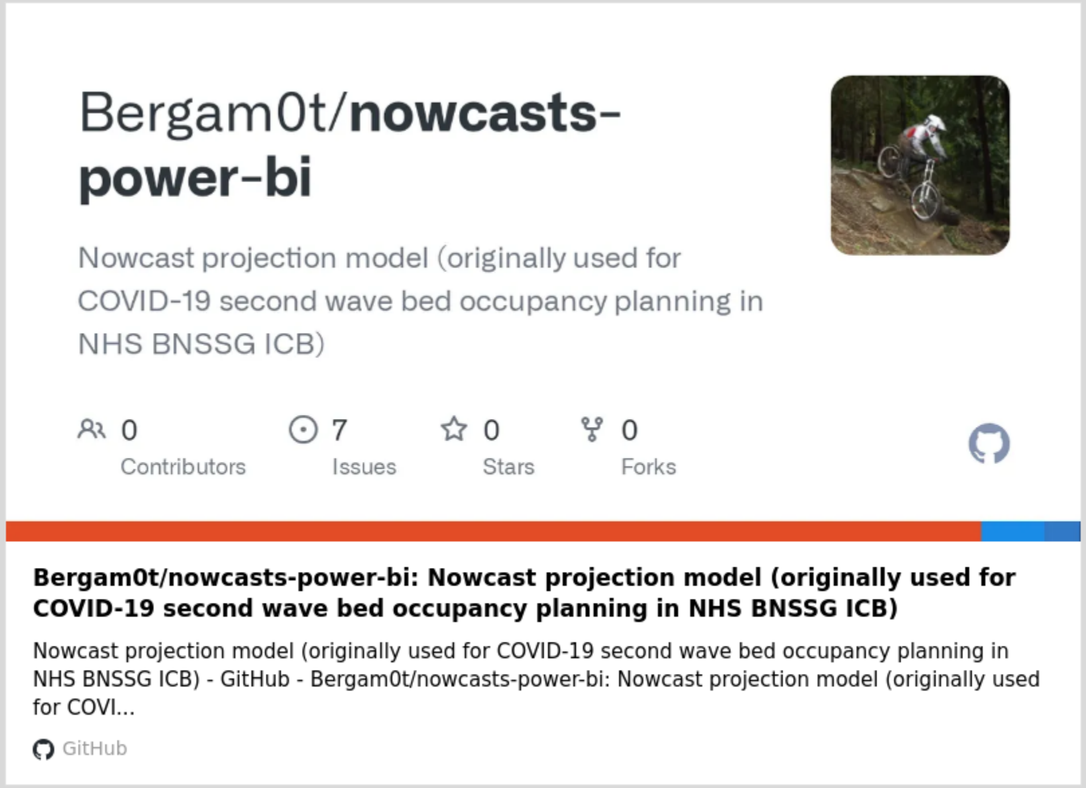
“The power of Open Source is the power of the people.

The people rule.”

- Philippe Kahn

References and Links

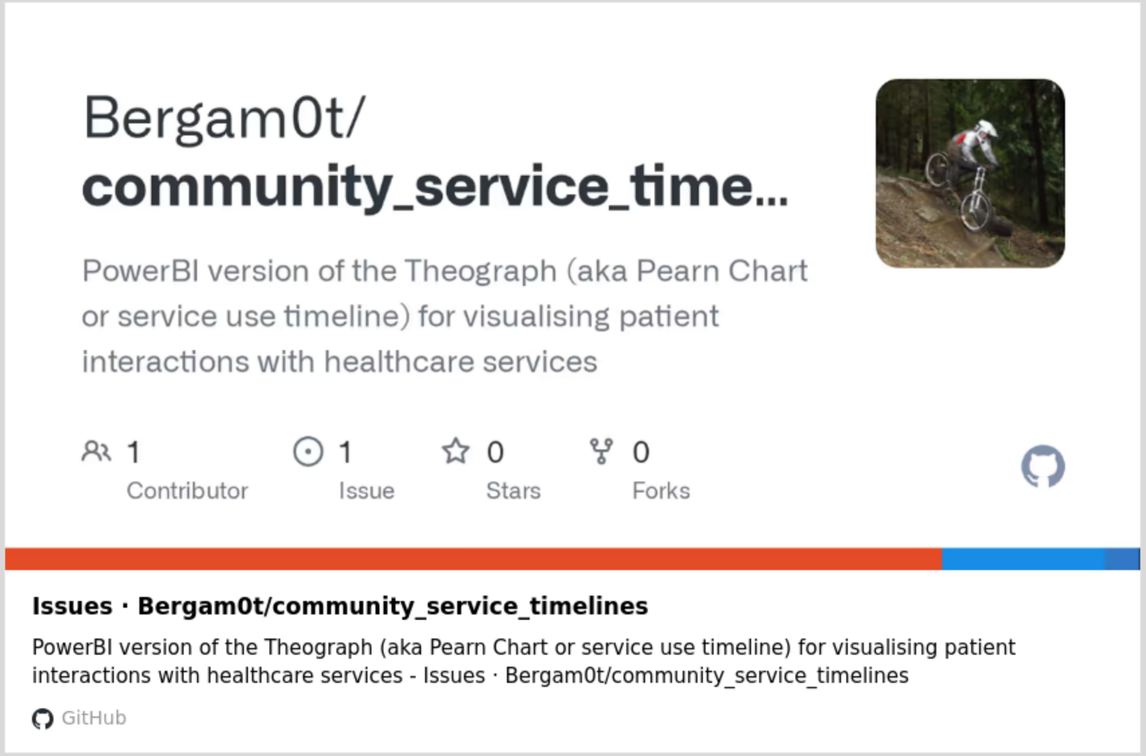


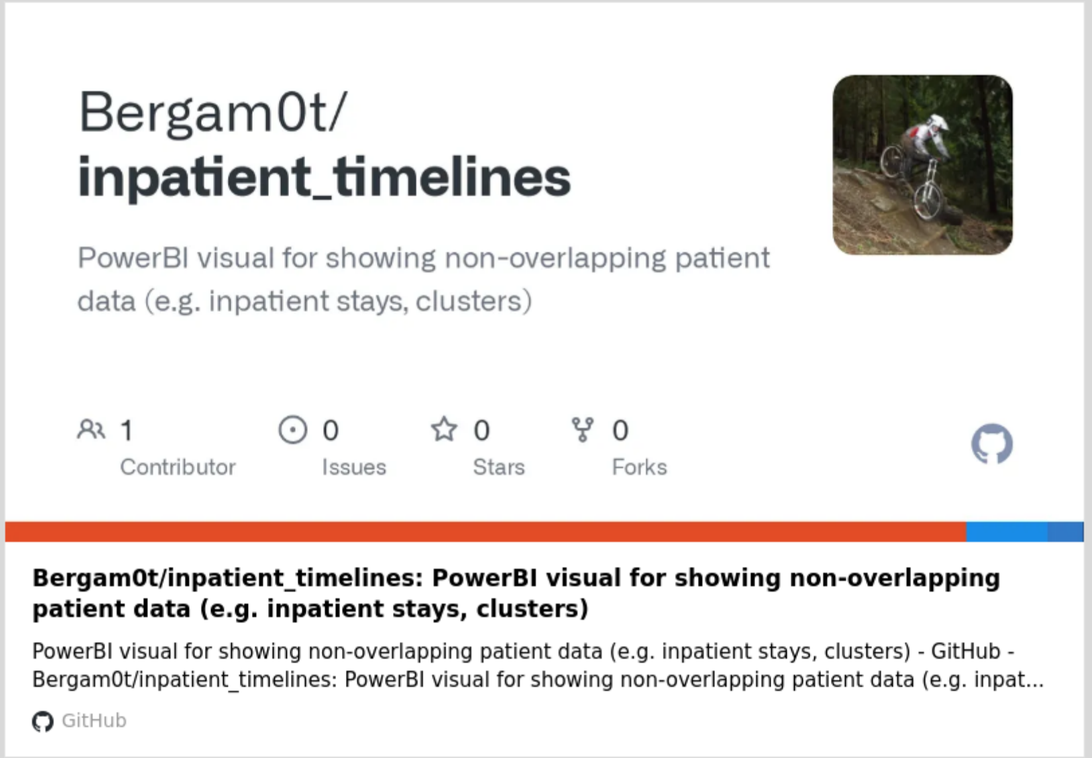


https://github.com/Bergam0t/nhs_ptd_power_bi

https://github.com/Bergam0t/nowcasts-power-bi

References and Links





https://github.com/Bergam0t/community_service_timelines

https://github.com/Bergam0t/inpatient_timelines

References and Links

https://learn.microsoft.com/en-us/power-bi/create-reports/desktop-r-powered-custom-visuals

https://github.com/PowerBi-Projects/PowerBI-visuals/blob/master/RVisualTutorial/CreateNewVisual.md

https://medium.com/@thakurshalabh/create-dynamic-custom-visual-in-power-bi-using-r-ggplot2-and-plotly-4b15a73ef506

https://laustep.github.io/stlahblog/posts/pbiviz.html