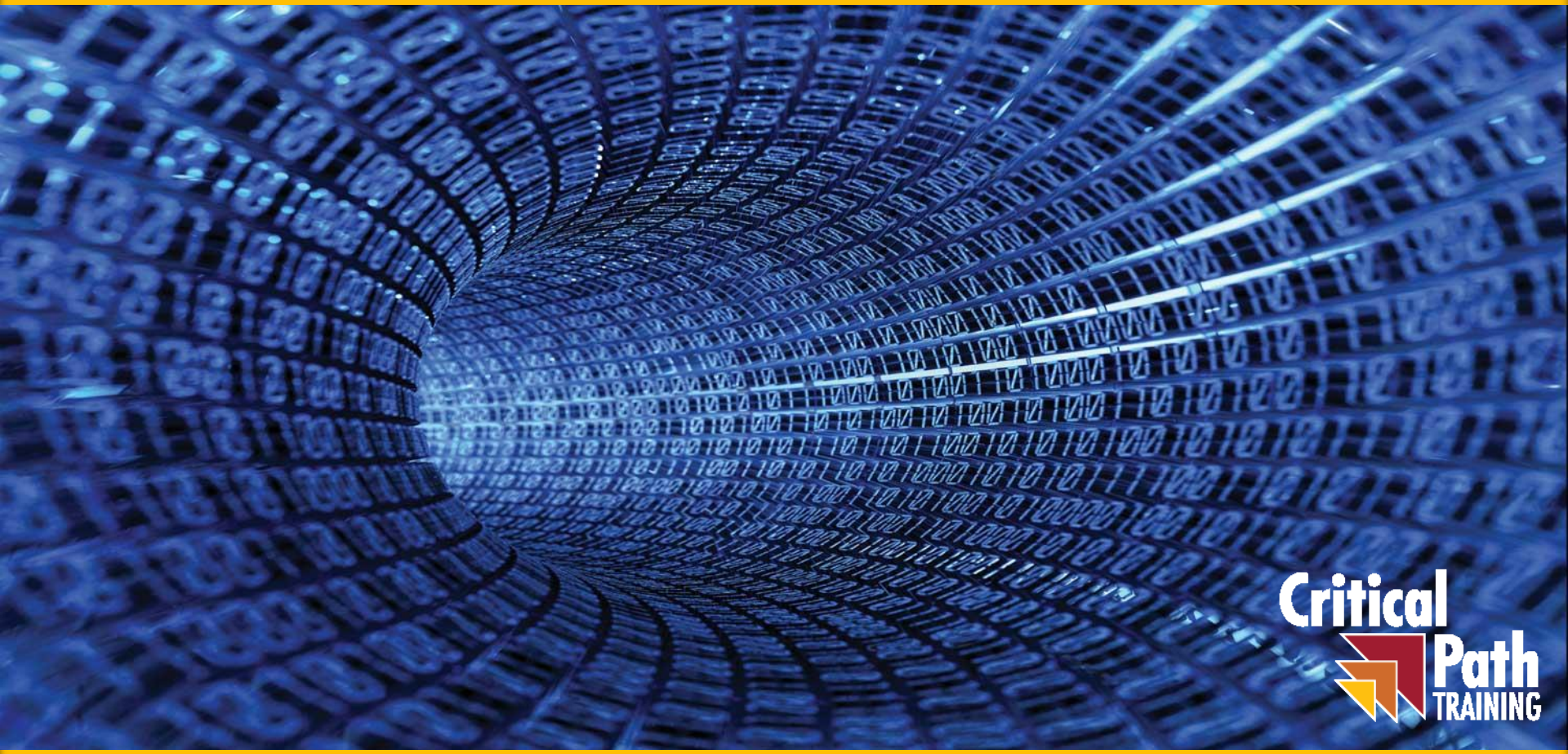
Developing Custom Visuals for Power BI



Agenda

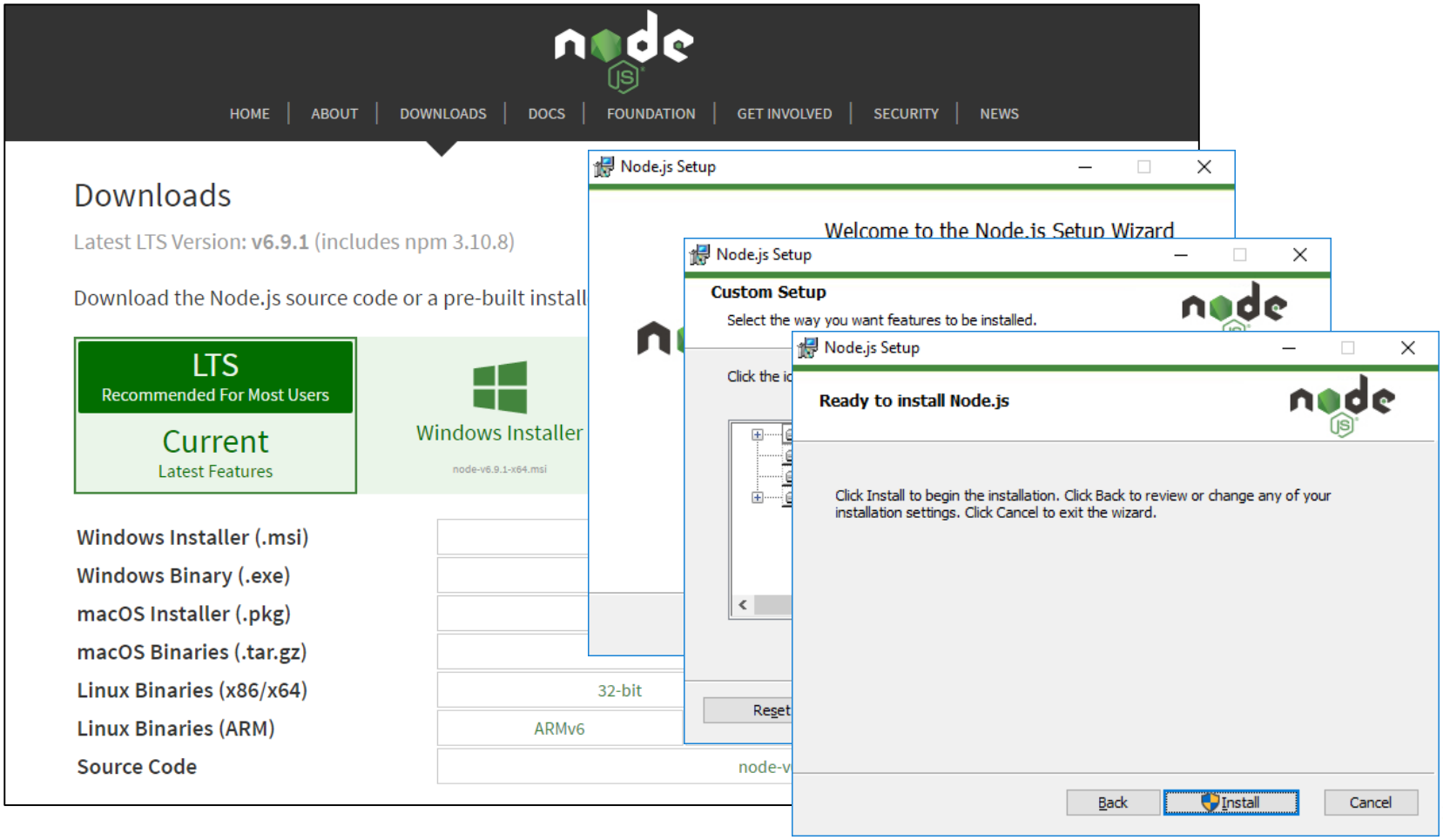
- Installing the Power BI Developer Tools
- Creating Your First Custom Visual
- Defining Data Roles and Data Mappings
- Extending a Visual with Custom Properties
- Migrating to Version 3 of the Power BI Developer Tools

Installing the Power BI Developer Toolchain

- Install Node.JS
  - Installs Node Package Manage (npm)
- Install Visual Studio Code
  - Lightweight Alternative to Visual Studio for Node.js Development
- Install the Power BI Developer Tools (pbiviz)
  - Install using Node Package Manager (npm)
- Create and install a local self-signed certificate
  - Install using Power BI visuals CLI tool (pbiviz)

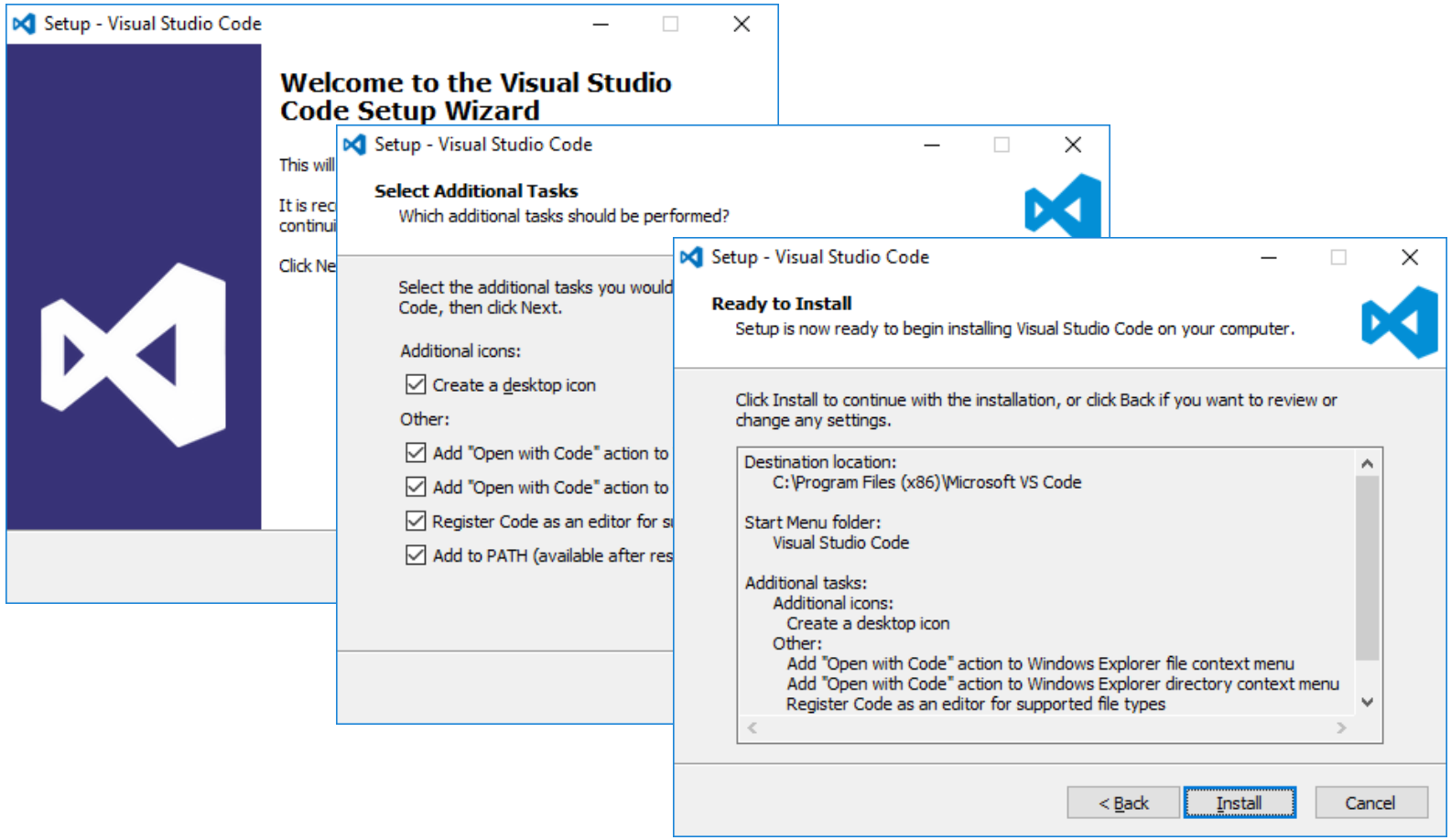
Installing node.js

- https://nodejs.org/en/download/



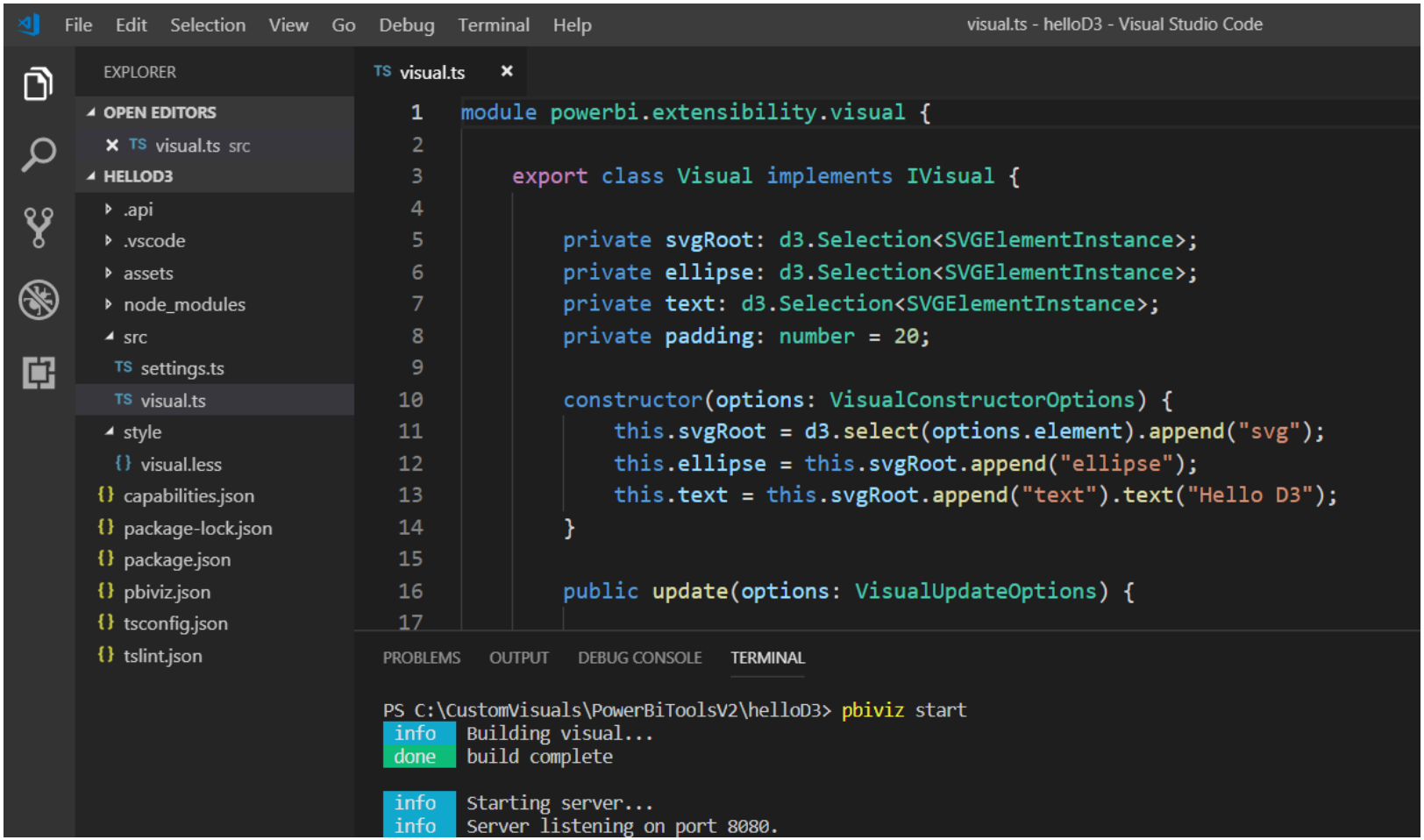
Install Visual Studio Code

- http://code.visualstudio.com/



Developing with Visual Studio Code

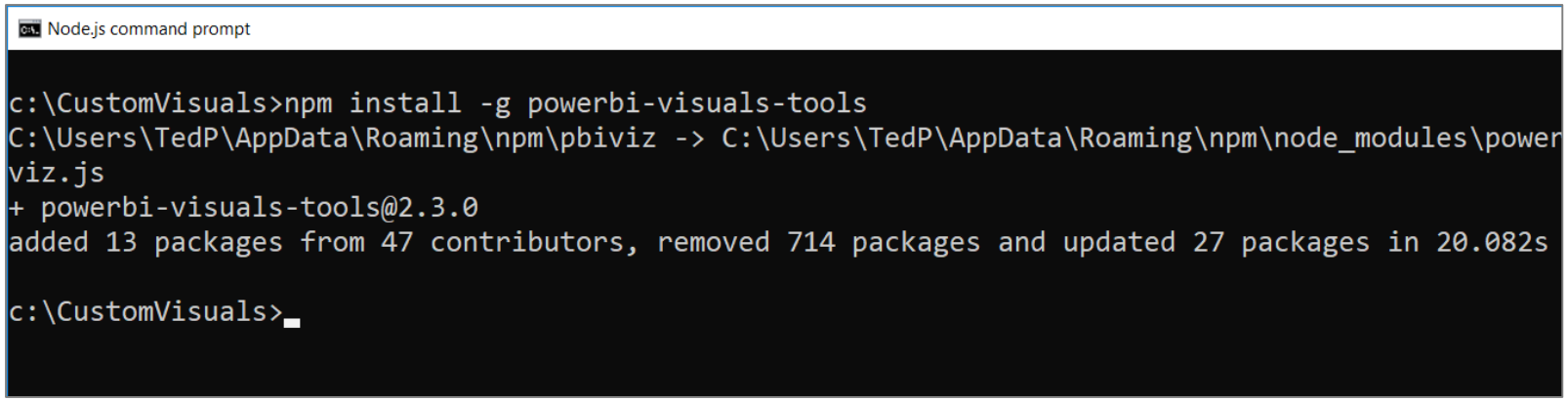
- Provides great development experience with node.js



Power BI Visual CLI Tool (PBIVIZ)

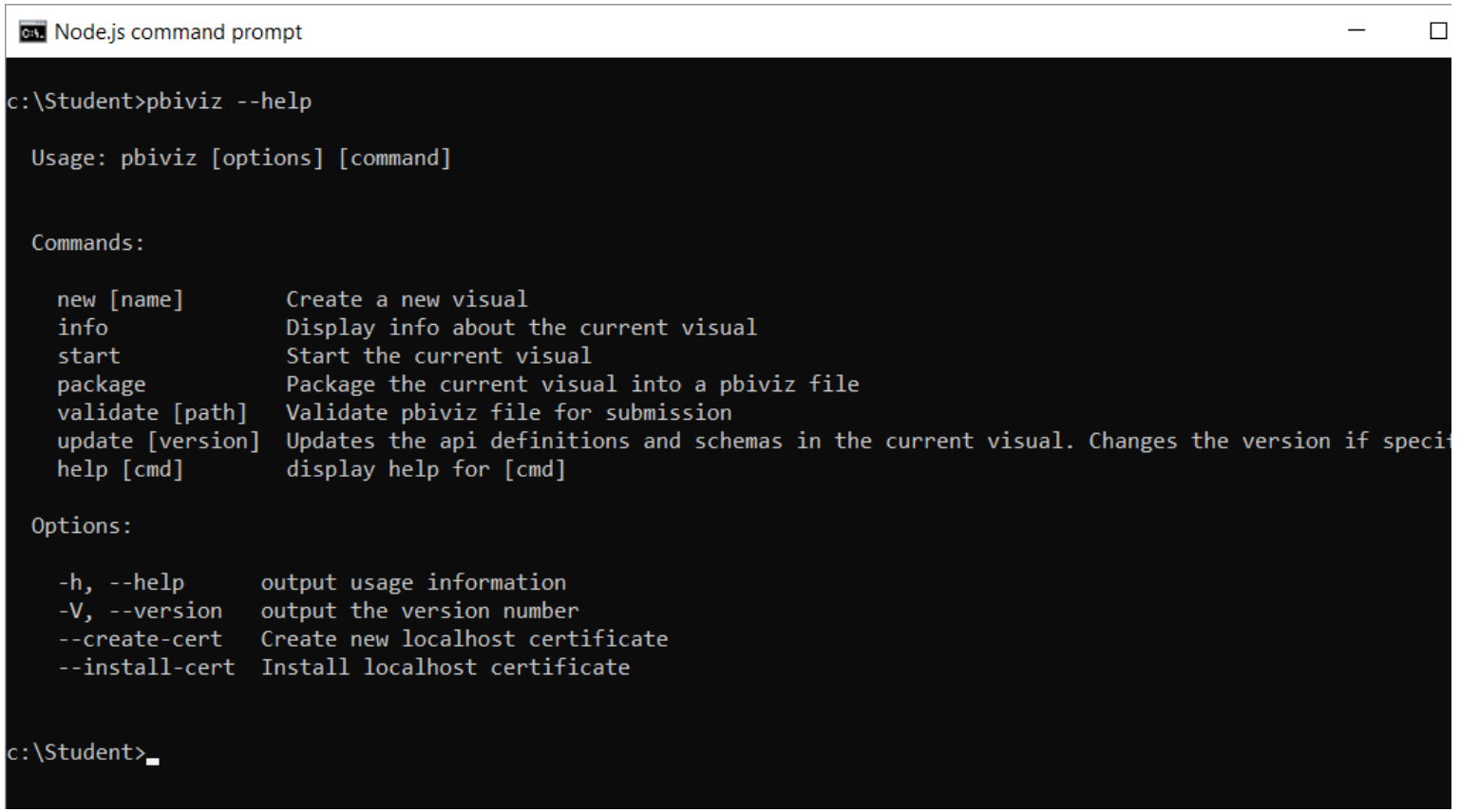
- What is the Power BI Custom Visual Tool?
  - Command-line utility for cross-platform dev
  - Use it with Visual Studio or Visual Studio Code
  - Requires that you first install node.js
  - Install by running command from node.js command prompt

    `npm install -g powerbi-visuals-tools`



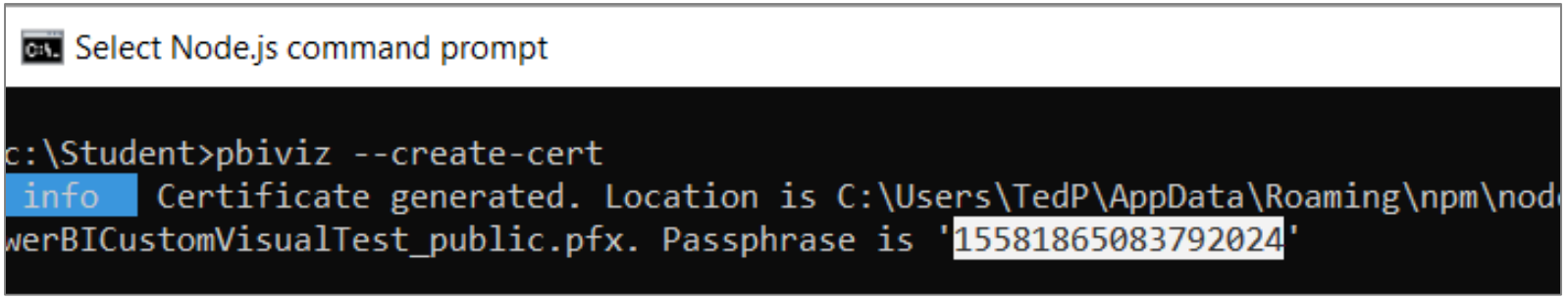
Getting Started with PBIVIZ

- PBIVIZ.EXE is a command-line utility
  - You execute PBIVIZ commands from the NODE.JS command line



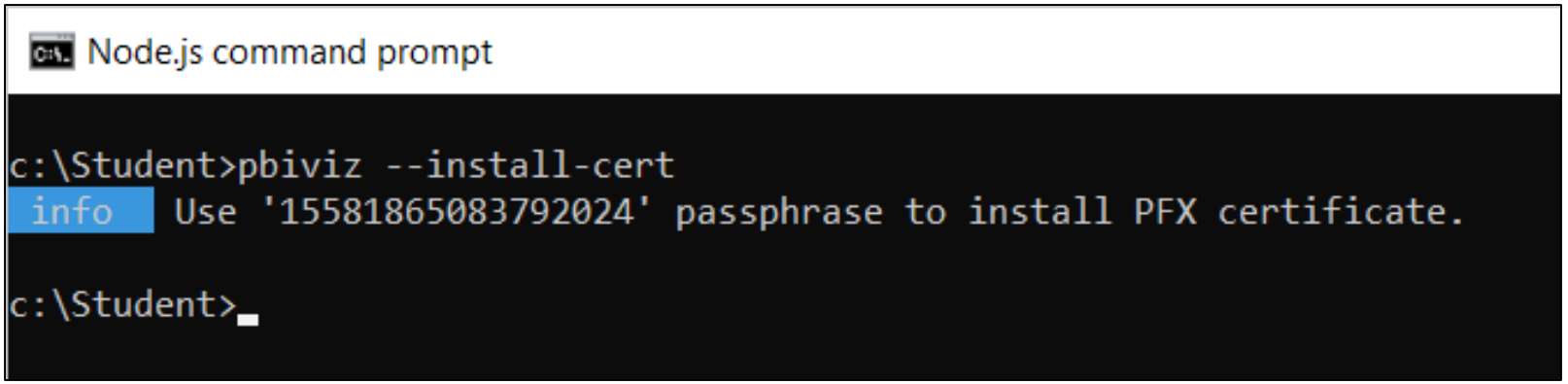
Creating a Certificate for Local Testing

- PBIVIZ provide local web server for testing & debugging
  - Web server runs locally on developer's workstation in Node.js
  - Makes it possible to test custom visuals in Power BI Service
  - Custom visual resources served up from https://localhost
  - Setup requires creating self-signed SSL certificate
  - SSL certificate created using **pbiviz --create-cert** command
  - You must copy a passphrase to properly install the certificate



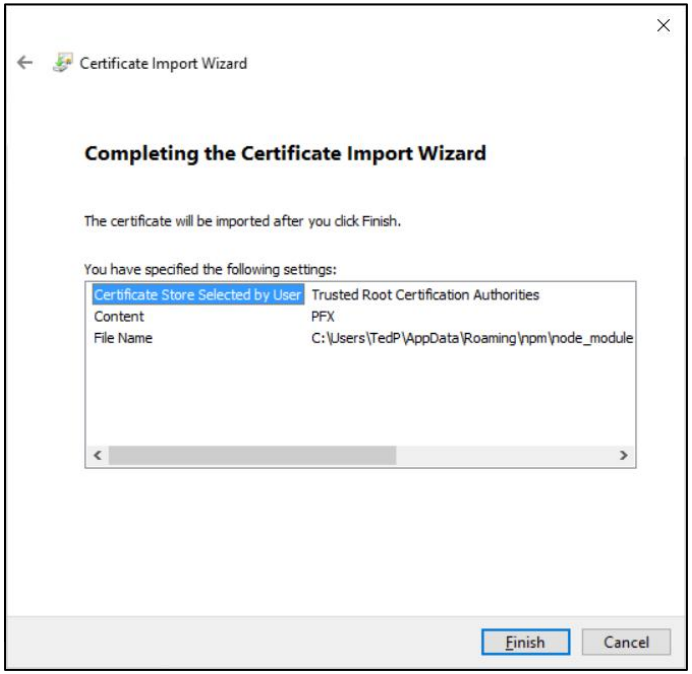
Installing the SSL Certificate

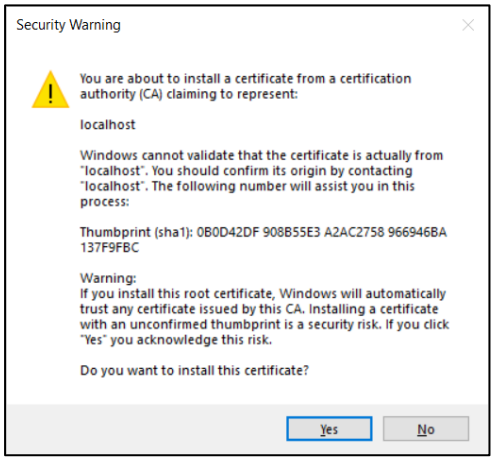
- Installing certificate enables SSL through https://localhost
  - Installing certificate is a one time operation – not once per project
  - SSL certificate installed using **pbiviz --install-cert** command
  - Running **--install-cert** command starts Certificate Import Wizard

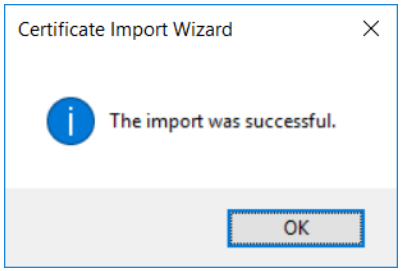


The Certificate Import Wizard

- Wizards steps you through process of installing certificate
  - You enter certificate passphrase as part of installation process







Agenda

- ✓ Installing the Power BI Developer Tools
- ➢ Creating Your First Custom Visual
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- Extending a Visual with Custom Properties
- Migrating to Version 3 of the Power BI Developer Tools

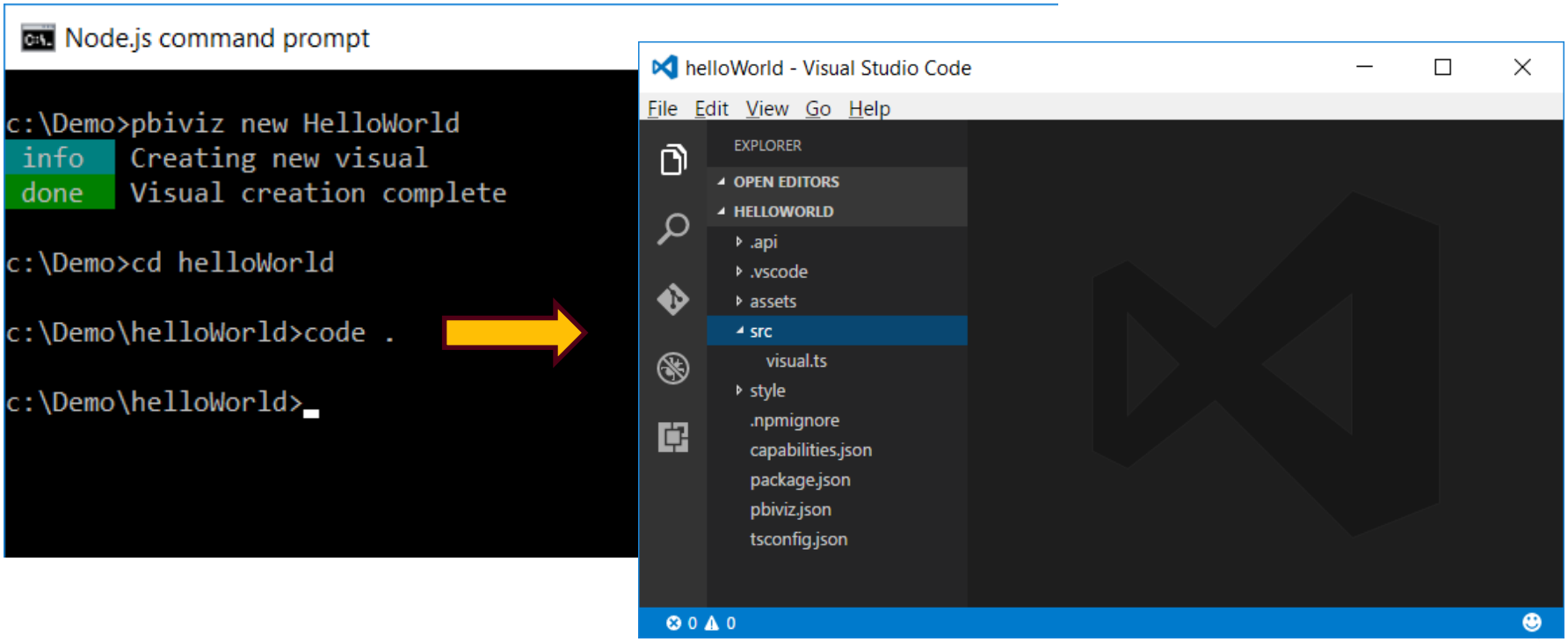
Creating a New Custom Visual Project

- Creating a new project

  ```
  pbiviz new <ProjectName>
  ```

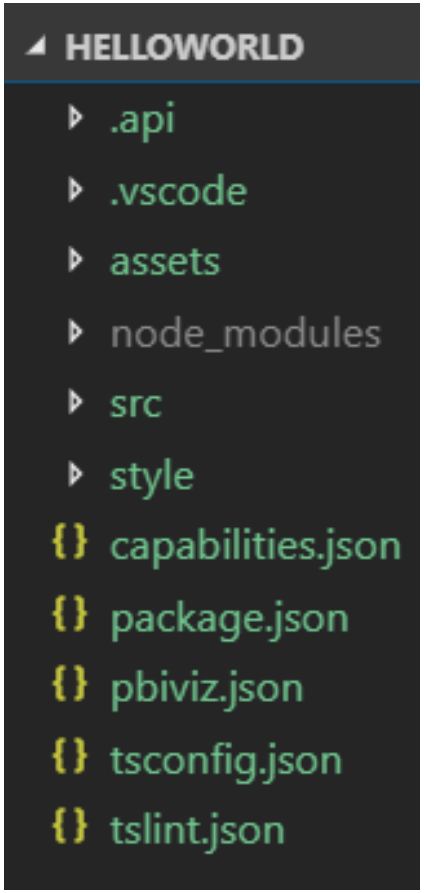
- Open the Project with Visual Studio Code

  ```
  code .
  ```



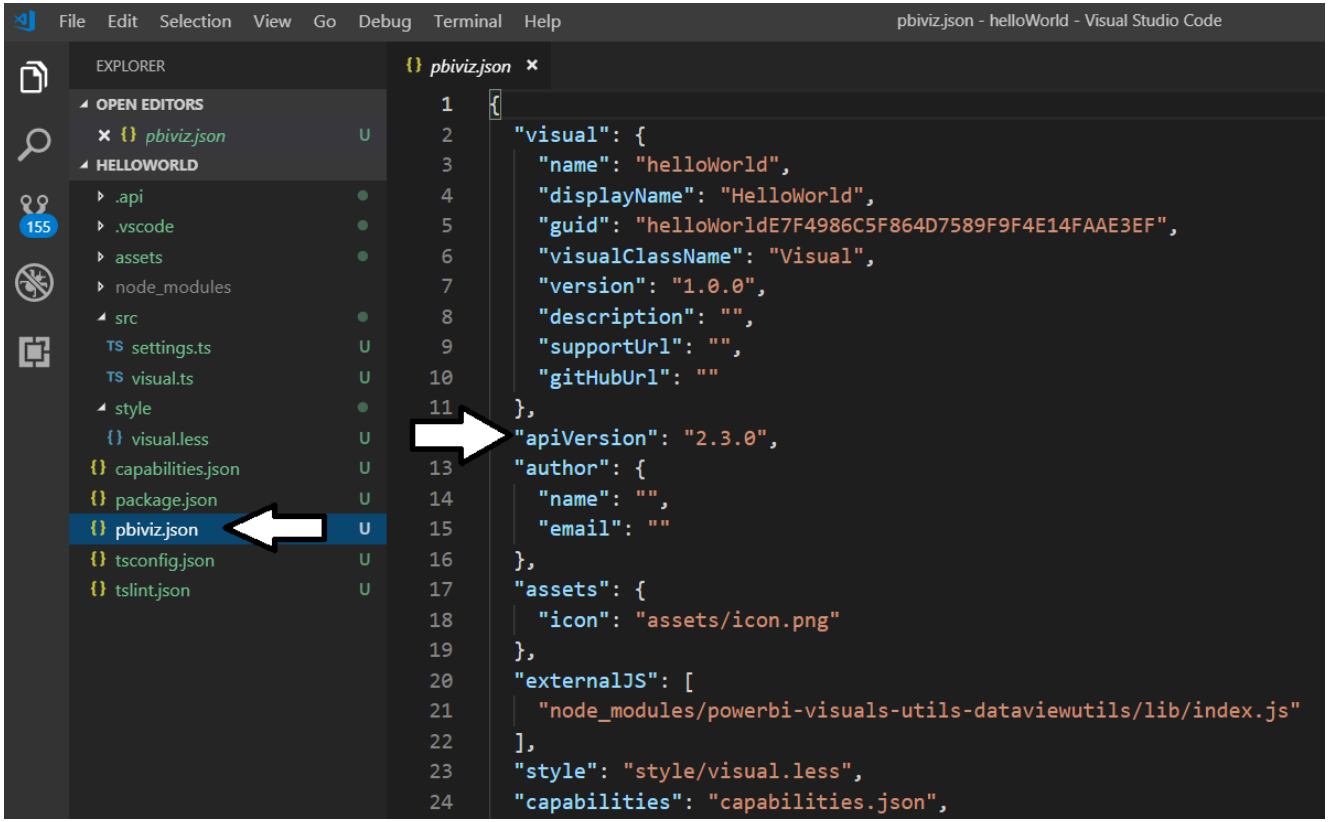
Top-level project files

- package.json
  - Used by npm to manage packages
- pbiviz.json
  - Main manifest file for your custom visual project
- capabilities.json
  - File used to define visual capabilities
- tsconfig.json & tslint.json
  - Typescript compiler settings



The pbiviz.json File

- Acts as top-level manifest file for custom visual project
  - Indicated which version of the Custom Visual API is used
  - External JS library files must be referenced in **externalJS** section



The tsconfig.json File

- Used to add references to other TypeScript files
  - Controls which TypeScript files are passed to TypeScript compiler
  - No need to reference *.d.ts files in the **node_modules/@types** folder

tsconfig.json

```
{
  "compilerOptions": {
    "allowJs": true,
    "emitDecoratorMetadata": true,
    "experimentalDecorators": true,
    "target": "ES5",
    "sourceMap": true,
    "out": "./.tmp/build/visual.js"
  },
  "files": [
    ".api/v1.11.0/PowerBI-visuals.d.ts",
    "node_modules/powerbi-visuals-utils-dataviewutils/lib/index.d.ts",
    "node_modules/powerbi-visuals-utils-typeutils/lib/index.d.ts",
    "node_modules/powerbi-visuals-utils-formattingutils/lib/index.d.ts",
    "src/settings.ts",
    "src/visual.ts"
  ]
}
```

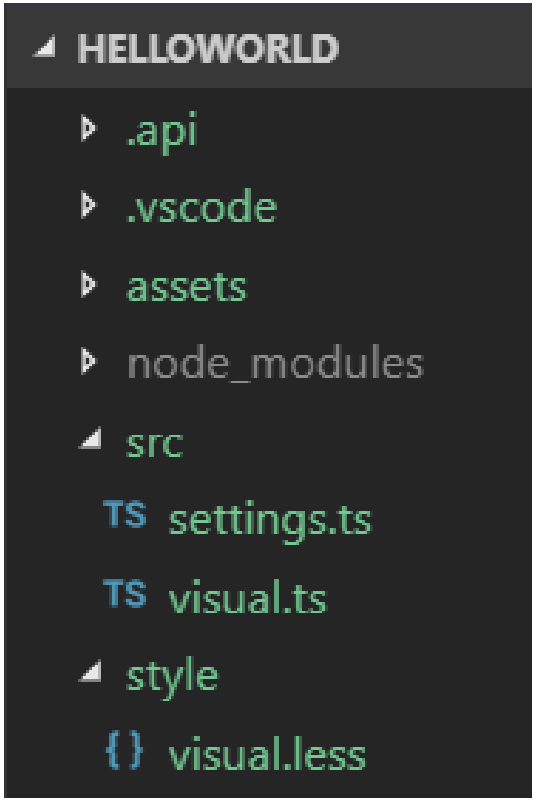
Installing D3 when using PBIVIZ Version 2

- Install package for D3 library version 3.x
  npm install d3@3 --save-dev
- Install package for type definition files version 3
  npm install @types/d3@3 --save-dev
- Update **externalJS** section of **pbiviz.json**

```
17    "assets": {
18      "icon": "assets/icon.png"
19    },
20    "externalJS": [
21      "node_modules/powerbi-visuals-utils-dataviewutils/lib/index.js",
22      "node_modules/d3/d3.js"
23    ],
24    "style": "style/visual.less",
25    "capabilities": "capabilities.json",
26    "dependencies": "dependencies.json",
27    "stringResources": []
28  }
```

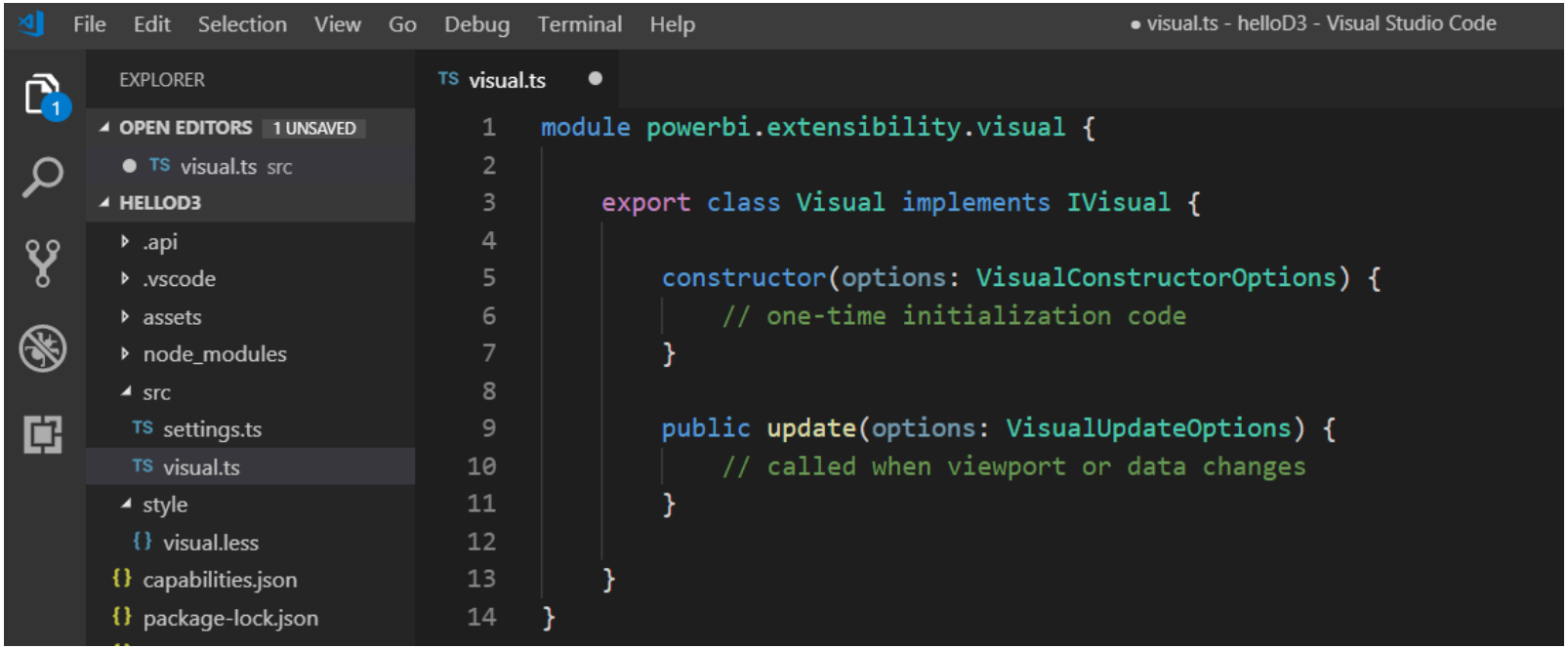
Visual Source Files

- visual.ts
  - visual class definition
- settings.ts
  - helper class to manage visual properties
- visual.less
  - CSS used to style custom visual



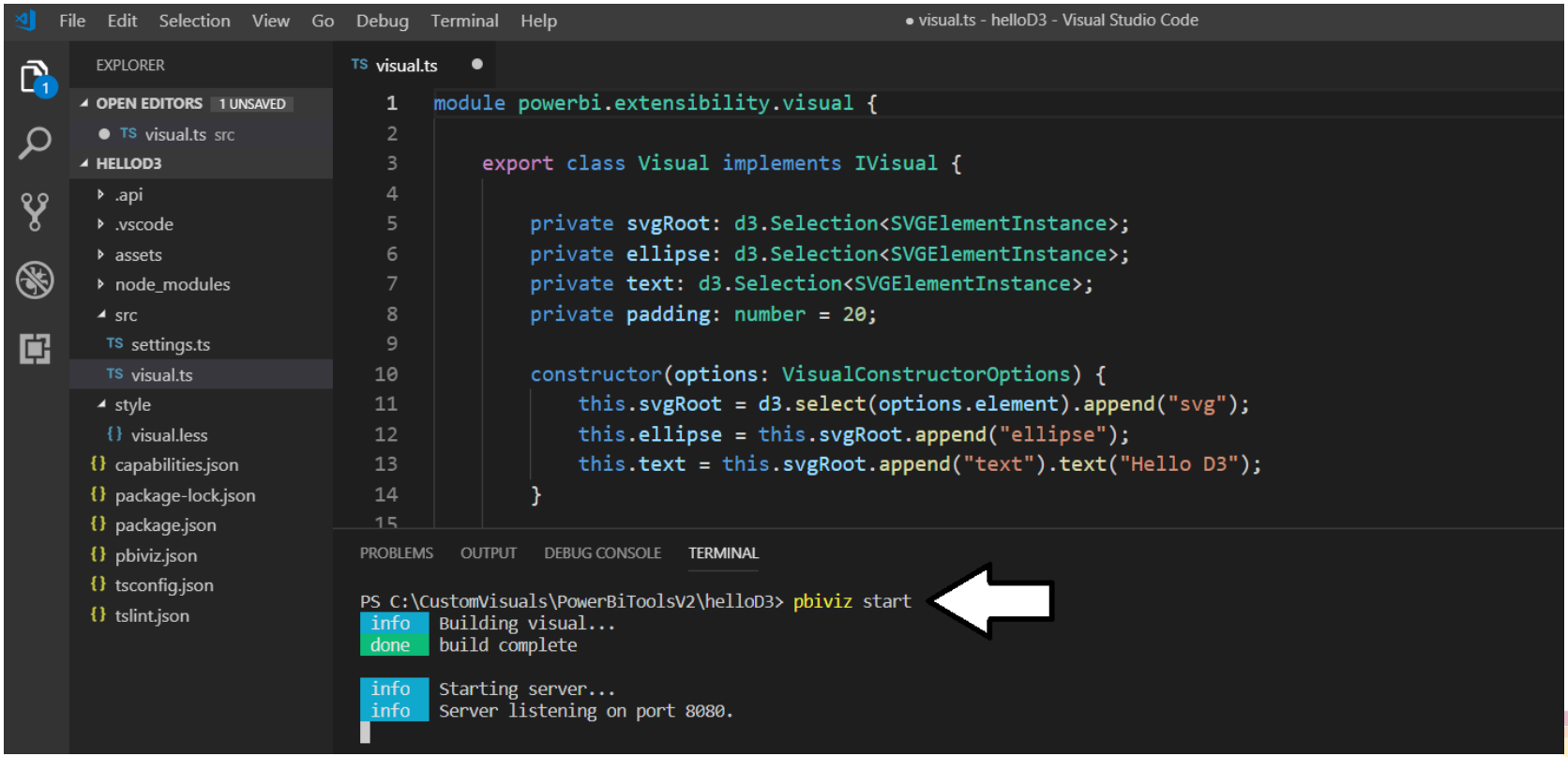
Authoring a Custom Visual Class

- Custom visual is a class that implements **IVisual**
  - Class must be defined in **powerbi.extensibility.visual** namespace
  - Minimum visual class must provide **update** method
  - Parameterized **constructor** used to create visual elements



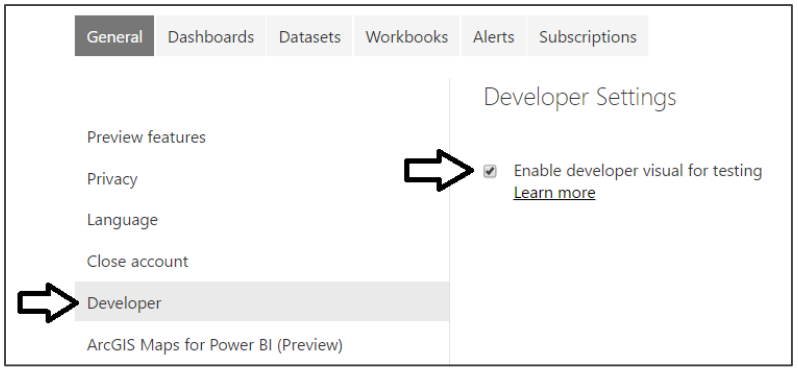
Running a Custom Visual Project

- Visual projects run & tested using **pbiviz start** command
  - Run **pbiviz start** from Visual Studio Code from Integrated console
  - Command starts local debugging session in node.js

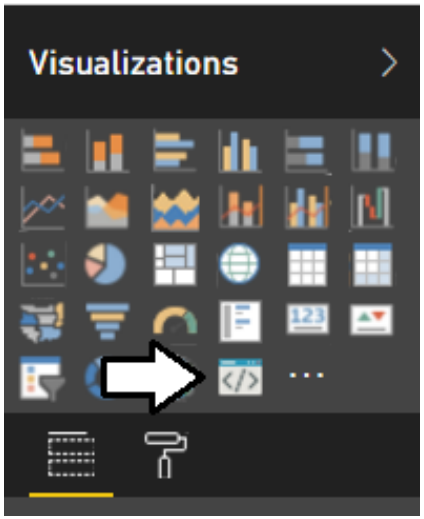


The Developer Visual

- Must be enabled on Developer Settings page



- Provides new visual for testing and debugging custom visuals



Working with the Developer Visual

- Developer visual loads custom visual from node.js
  - Makes it possible to test custom visual inside Power BI Service
  - Developer visual provides toolbar with development utilities

Agenda

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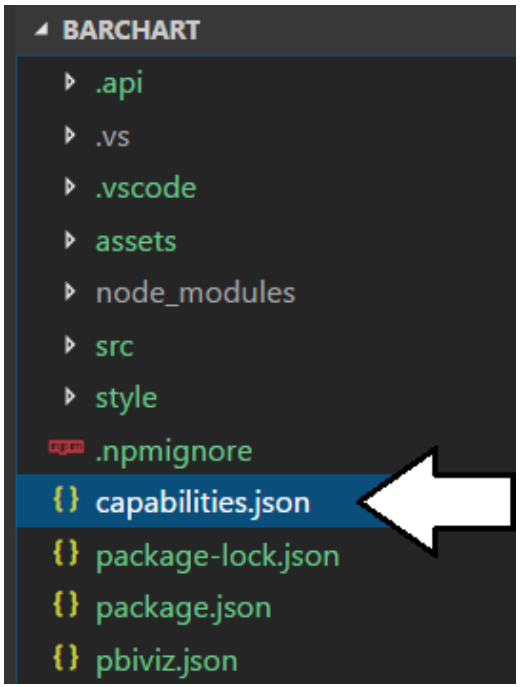
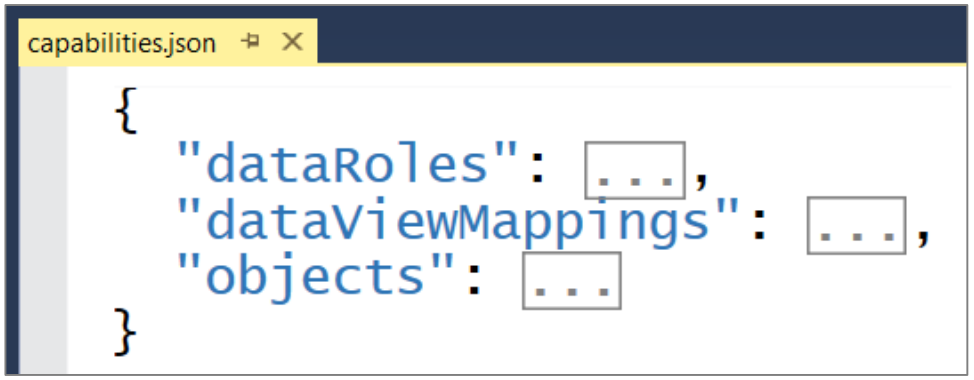
Visual Capabilities

- Visual capabilities defined inside **capabilities.json**
  - **dataRoles** defines the field wells displayed on Fields pane
  - **dataViewMappings** defines the type of DataView used by visual
  - **objects** defines custom properties for visual

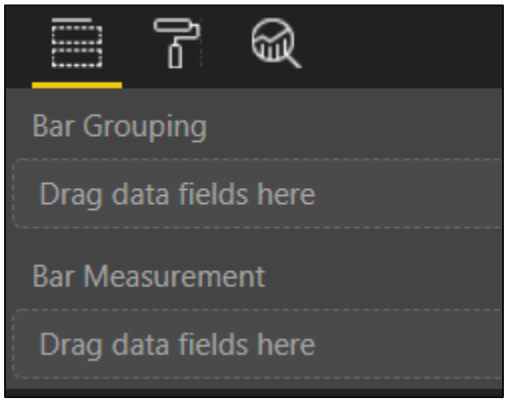




Data Roles

- DataRoles define how fields are associated with visual
  - Each dataRole is display as field well in the Field pane
  - dataRoles can be defined with conditions and data mappings

```
"dataRoles": [
  {
    "displayName": "Bar Grouping",
    "name": "myCategory",
    "kind": "Grouping"
  },
  {
    "displayName": "Bar Measurement",
    "name": "myMeasure",
    "kind": "Measure"
  }
]
```



Data Mapping Modes

- Power BI visual API provides several mapping modes
  - Single
  - Table
  - Categorical
  - Matrix
  - Tree

Single Mapping

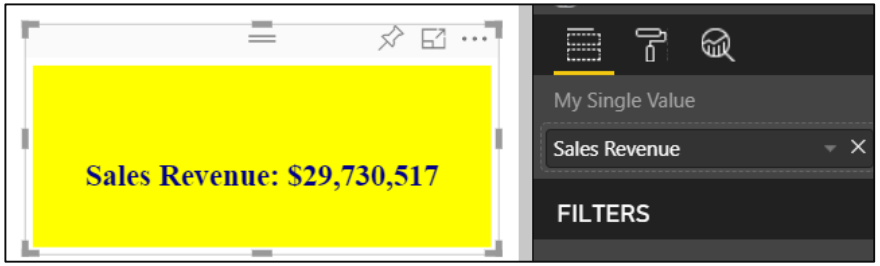
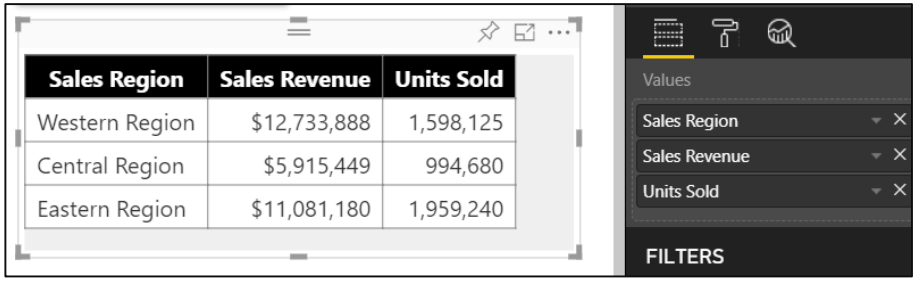


Table Mapping



Categorical Mapping

Developer Visual DataView

- Developer visual supports DataView mode
  - Allows you to see and explore data mapping
  - Allows you to see metadata for custom properties

Designing with View Model

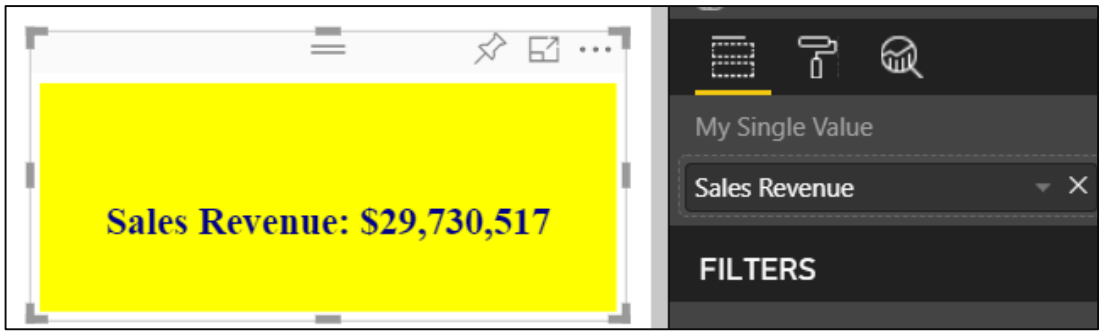
- Best practice involves creating view model for each visual
  - View model defines data required for rendering
  - createViewModel method gets data to generate view model
  - update method calls createViewModel to get view model

```
export interface BarchartDataPoint {
  Category: string;
  Value: number;
}

export interface BarchartViewModel {
  IsNotValid: boolean;
  DataPoints?: BarchartDataPoint[];
  Format?: string;
  SortBySize?: boolean;
  XAxisFontSize?: number;
  YAxisFontSize?: number;
  BarColor?: string;
}
```

Single Mapping Example: oneBigNumber

- dataRole can use dataViewMapping mode of single
  - For visuals like Card which only display single value
  - Condition can define that a dataRole requires exactly one measure

```
"dataRoles": [
  {
    "displayName": "My Single Value",
    "name": "myvalue",
    "kind": "Measure"
  }
],
"dataViewMappings": [
  {
    "conditions": [ { "myvalue": { "min": 1, "max": 1 } } ],
    "single": { "role": "myvalue" }
  }
]
```



Programming in Single Mapping Mode

- Single mapping easy to access through visuals API
  - DataView object provides single.value property
  - value property defined as PrimativeValue { bool | number | string }
  - PrimativeValue must be explicitly cast
  - Other measure properties available through column metadata


```
"tree": ⊕{...},
"categorical": ⊕{...},
"table": ⊕{...},
"matrix": ⊕{...},
"single": ⊖{
    "column": ⊕{...},
    "value": 29730517.14
},
"metadata": ⊖{
    "columns": ⊖[
       ⊖{
            "roles": ⊕{...},
            "type": ⊕{...},
            "format": "\\$#,0;(\\$#,0);\\$#,0",
            "displayName": "Sales Revenue",
            "queryName": "Sales.Sales Revenue",
            "expr": ⊕{...},
            "index": 0,
            "isMeasure": true
        }
```

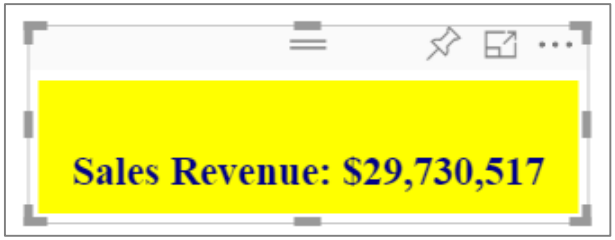

```
public update(options: VisualUpdateOptions) {

  // get DataView object
  this.dataView = options.dataViews[0];

  // get single value
  var value: number = <number>this.dataView.single.value;

  // get metadata to discover field name and format string
  var column: DataViewMetadataColumn = this.dataView.metadata.columns[0];
  var valueName: string = column.displayName
  var valueFormat: string = column.format;
```

Using the Power BI Formatting Utilities

- Used to format values using Power BI formatting strings
  - Requires installing powerbi-visuals-utils-formattingutils package

```
var value: number = <number>this.dataView.single.value;
var column: DataViewMetadataColumn = this.dataView.metadata.columns[0];
var valueName: string = column.displayName
var valueFormat: string = column.format;

var valueFormatterFactory = powerbi.extensibility.utils.formatting.valueFormatter;
var valueFormatter = valueFormatterFactory.create({
  format: valueFormat,
  formatSingleValues: true
});

var valueString: string = valueFormatter.format(value);
```

```
"column": ⊖{
    "roles": ⊕{...},
    "type": ⊕{...},
    "format": "\\$#,0;(\\$#,0);\\$#,0",
    "displayName": "Sales Revenue",
    "queryName": "Sales.Sales Revenue",
```

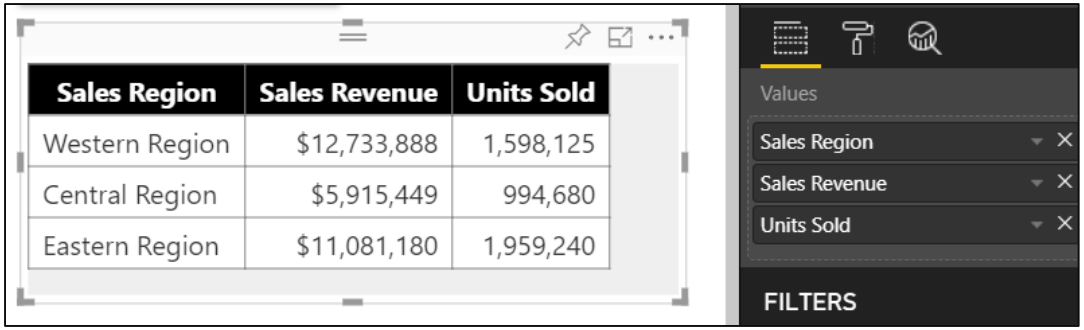



```
"column": ⊖{
    "roles": ⊕{...},
    "type": ⊕{...},
    "format": "#,0",
    "displayName": "Units Sold",
    "queryName": "Sales.Units Sold",
```

Table Mapping Example: Snazzy Table

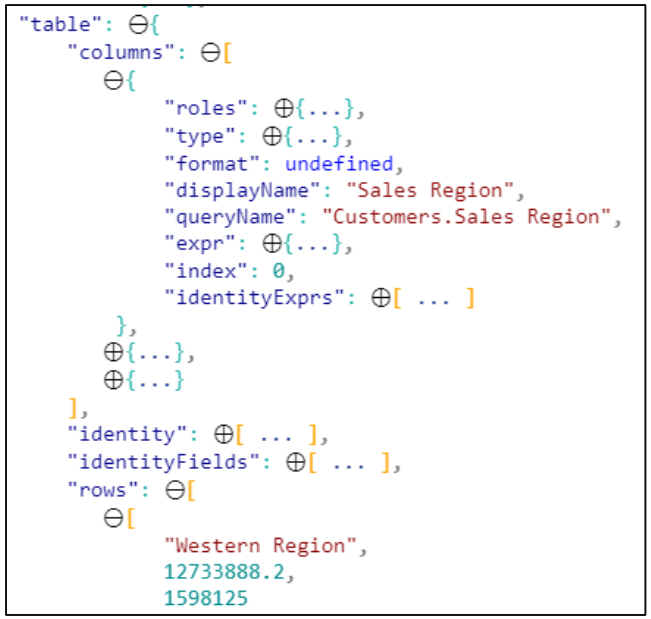
- dataRole can use dataViewMapping mode of table
  - For visuals which display rows & columns for ordered set of fields
  - condition can define number of fields that can be added

```
"dataRoles": [
  {
    "displayName": "Values",
    "name": "values",
    "kind": "GroupingOrMeasure"
  }
],
"dataViewMappings": [
  {
    "conditions": [ {"values": { "min": 1, "max": 5 } } ],
    "table": { "rows": { "for": { "in": "values" } } }
  }
]
```



Programming in Table Mapping Mode

- Table mapping data accessible through visuals API
  - DataView object provides table property
  - table property provides columns property and rows property

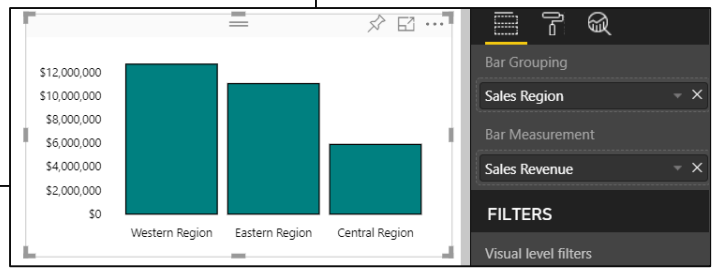



```
public update(options: VisualUpdateOptions) {

  var dataView: DataView = options.dataViews[0];

  var table: DataViewTable = dataView.table;
  var columns: DataViewMetadataColumn[] = table.columns;
  var rows: DataViewTableRow[] = table.rows;
```

Categorical Mapping Example: Barchart

- dataRole can use dataViewMapping mode of categorical
  - This is the most common type of data mapping
  - For visuals which divide data into groups for analysis
  - Groups defined as columns and values defined as measures

```
"dataRoles": [
  { "displayName": "Bar Grouping", "name": "myCategory", "kind": "Grouping" },
  { "displayName": "Bar Measurement", "name": "myMeasure", "kind": "Measure" }
],
"dataViewMappings": [
  {
    "conditions": [ { "myCategory": { "max": 1 }, "myMeasure": { "max": 1 } } ],
    "categorical": {
      "categories": {
        "for": { "in": "myCategory" },
        "dataReductionAlgorithm": { "top": {} }
      },
      "values": {
        "select": [ { "bind": { "to": "myMeasure" } } ]
      }
    }
  }
]
```



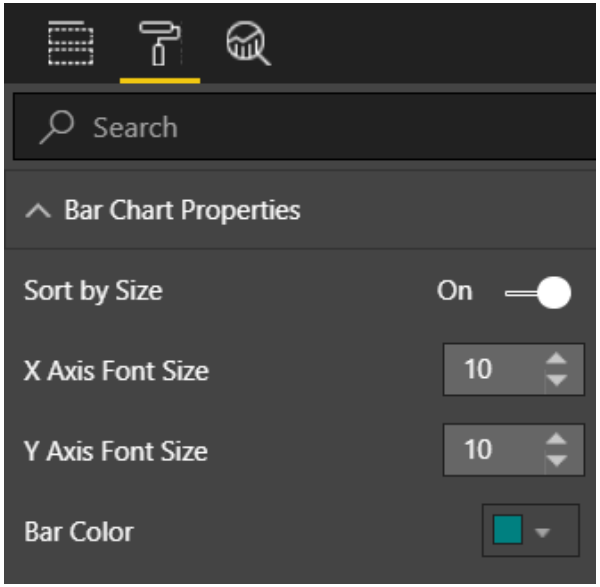
Agenda

- ✓ Installing the Power BI Developer Tools
- ✓ Creating Your First Custom Visual
- ✓ Defining Data Roles and Data Mappings
- ➢ Extending a Visual with Custom Properties
- • Migrating to Version 3 of the Power BI Developer Tools

Extending Visuals with Custom Properties

- Custom properties defined using **objects**
  - You can define one or more objects in **capabilities.json**
  - Each object defined with name, display name and properties
  - object properties automatically persistent inside visual metadata
  - properties can be seen and modified by user in Format pane
  - Custom properties require extra code to initialize Format pane

```
"objects": {
  "barchartProperties": {
    "displayName": "Bar Chart Properties",
    "properties": {
      "sortBySize": {
        "displayName": "Sort by Size",
        "type": { "bool": true }
      },
      "xAxisFontSize": {
        "displayName": "X Axis Font Size",
        "type": { "integer": true }
      },
      "yAxisFontSize": {
        "displayName": "Y Axis Font Size",
        "type": { "integer": true }
      },
      "barColor": {
        "displayName": "Bar Color",
        "type": { "fill": { "solid": { "color": true } } }
      }
    }
  }
}
```



DataViewObjectParser and VisualSettings

- Power BI visual utilities provide DataViewObjectParser
  - Abstracts away tricky code to initialize and read property values

TS settings.ts

```
module powerbi.extensibility.visual {

  import DataViewObjectsParser = powerbi.extensibility.utils.dataview.DataViewObjectsParser;

  export class VisualSettings extends DataViewObjectsParser {
    public barchartProperties: BarchartProperties = new BarchartProperties();
  }

  export class BarchartProperties {
    sortBySize: boolean = true;
    xAxisFontSize: number = 10;
    yAxisFontSize: number = 10;
    barColor: Fill = { "solid": { "color": "teal" } };
  }

}
```

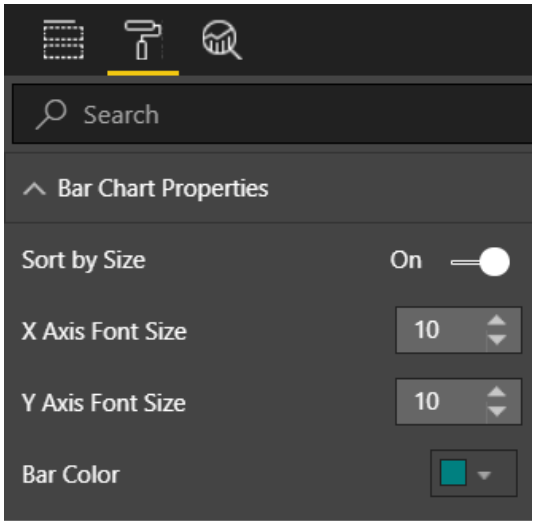
Mapping Object Properties to VisualSettings

- VisualSettings class must map to named objectnamed
  - VisualSetting class contains named field that maps to object name
  - Named field based on custom class with mapped properties
  - Object & property names must match what's in capabilities.json

Initializing Objects in the Format Pane

- Visual must initialize properties in Format pane
  - Visual must implement enumerateObjectInstances
  - VisualSettings makes this relatively easy
  - Extra code required to make property appear as spinner

```
public enumerateObjectInstances(options: EnumerateVisualObjectInstancesOptions): VisualObjectInstanceEnumeration {

  // register object properties
  var visualObjects: VisualObjectInstanceEnumerationObject =
    <VisualObjectInstanceEnumerationObject>VisualSettings
      .enumerateObjectInstances(this.settings, options);

  // configure spinners for integers properties
  visualObjects.instances[0].validValues = {
    xAxisFontSize: { numberRange: { min: 10, max: 36 } },
    yAxisFontSize: { numberRange: { min: 10, max: 36 } },
  };

  // return visual object collection
  return visualObjects;
}
```



Retrieving Property Values

- Property values persisted into visual metadata
  - Properties not persisted white they still retain default values

```
"tree": ⊕{...},
"categorical": ⊕{...},
"table": ⊕{...},
"matrix": ⊕{...},
"single": undefined,
"metadata": ⊖{
    "columns": ⊕[ ... ],
    "objects": ⊖{
        "barchartProperties": ⊖{
            "sortBySize": false,
            "xAxisFontSize": 14
        }
    }
}
```

  - Property values retrieved using VisualSettings object

```
public update(options: VisualUpdateOptions) {

  if (options.dataViews[0]) {

    // create VisualSettings object
    this.settings = VisualSettings.parse(options.dataViews[0]) as VisualSettings;

    // retrieve property values
    var sortBySize: boolean = this.settings.barchartProperties.sortBySize
    var xAxisFontSize: number = this.settings.barchartProperties.xAxisFontSize;
```

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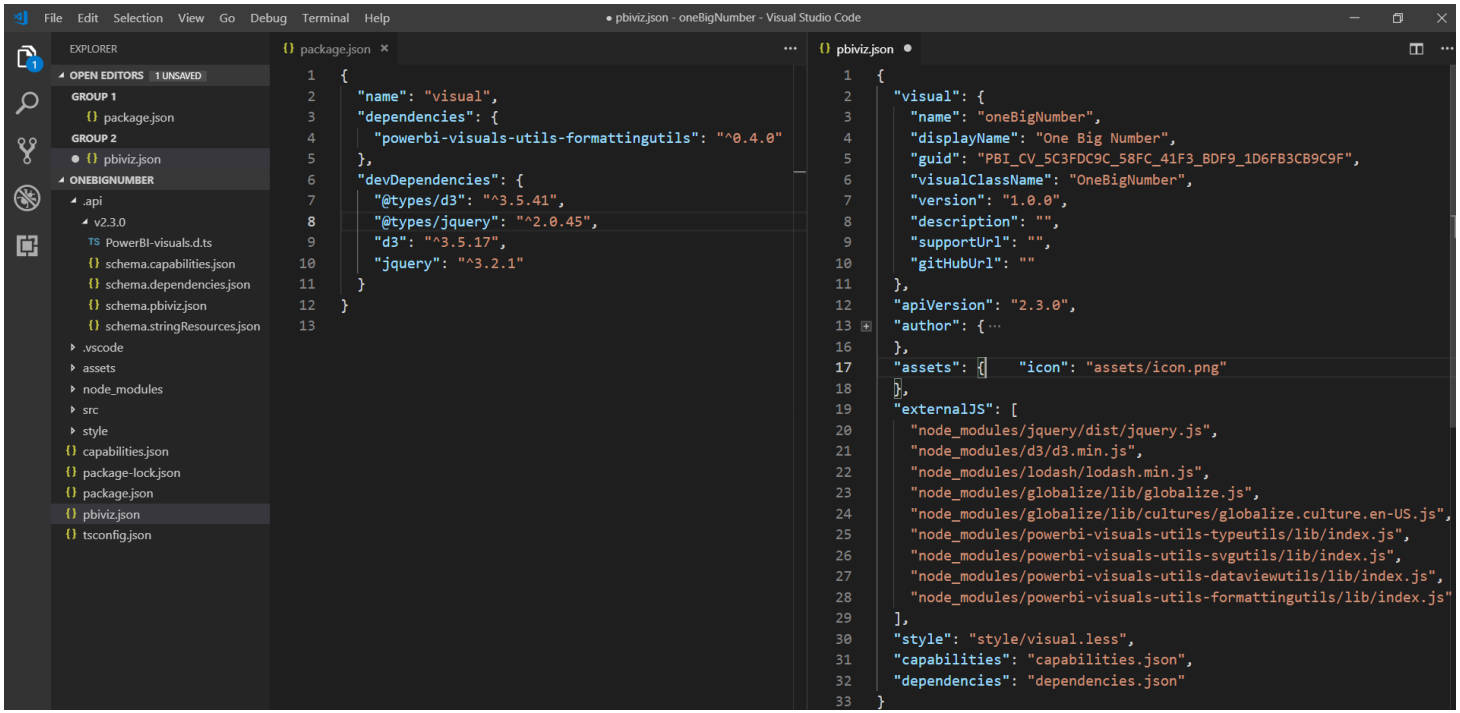
Tools v2

- Power BI API added to your project
  - Power BI API files added to project
  - You install packages for utilities
  - Add externalJS entries for JavaScript libraries required on page



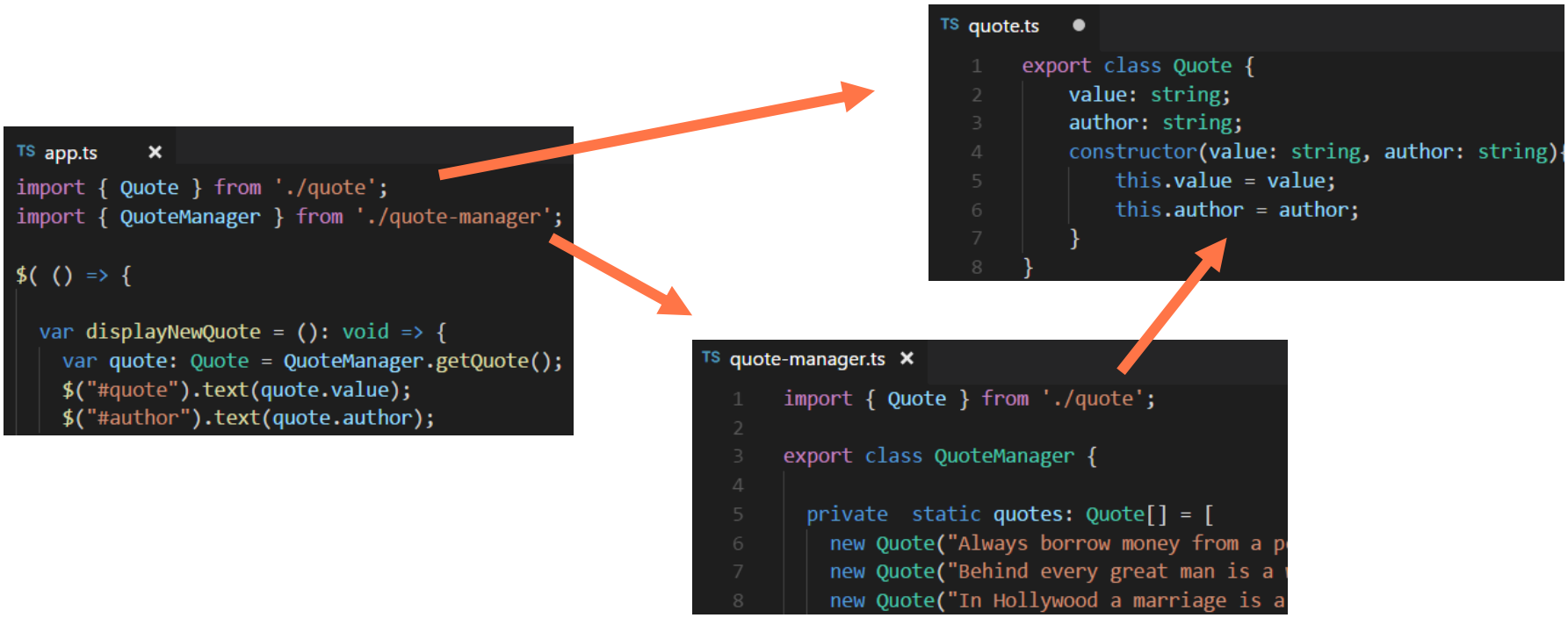
EcmaScript2015 Modules and D3 version 5

- ECMAScript 2015 add modules to JavaScript
  - TypeScript builds on the concept
  - Each file defines it own module

- Modules execute in their own scope not at global scope
  - Code in module not visible to other modules by default
  - Classes and function must be exported to use across modules
  - Modules must import types from other modules
  - relationships between modules defined using imports and exports

Dynamic Module Loading

- Webpack controls dynamic module loading
  - Your project just references app.ts
  - Compiler dynamically determines other files to include



WebPack

- WebPack serves as a bundling utility
  - Bundles many js/ts files into a single file
  - Can handle dynamic module loading
  - Provides a dev server for testing and debugging

- When using Webpack version 4 or later
  - Install packages for webpack and webpack-cli
    - npm install webpack webpack-cli --save-dev

Webpack Loaders

- Loaders do two things
  - Identify which file or files should be transformed
  - Transform files and ad them to dependency graph

- Example loaders
  - awesome-typescript-loader
  - style-loader
  - css-loader
  - url-loader

Summary

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