

TurbineMap7 Instructions

TurbineModel7 Class Description (just for background)

- Data
 - Object.TurbineMapData – input map data
 - Object.TurbineModel – output model results
- Functions
 - Object.TurbineMapDataPrep("PathToTurbineDataFile","DataType") – reads turbine mapping data and creates obj.TurbineMapData
 - "DataType" = 'Training' or 'Validation'
 - Object.BuildTurbineModel – fits model to training data and creates Object.TurbineModel
 - Object.SolveTurbineModel – returns estimated turbine map data to Object.TurbineModel for each map in TurbineMapData
 - Object.CreateScaledTurbine(GeometryScaleFactors) – returns estimated turbine map data for scaling model
 - GeometryScaleFactors = 1x3 or 3x1 array, [RotorInletRadiusScaleRatio, RotorOutletRadiusScaleRatio, HousingA/RScaleRatio]
 - Object.PlotModel – creates 3 plots for each map in Turbine Model (training, validation, or scale)

A Warning About Older Matlab Versions (known for R2019b and earlier, maybe R2020a/b)

```
1 classdef TurbineModel7
2     %build model from turbine mapping data
3     %estimate turbine map for scaled geometry
4     %this version only works for fixed geometry
5     %created by Bob McMullen
6
7     properties
8         TurbineMapData
9         TurbineModel
10    end
11
12    properties(Constant)
13        ConvergenceEfficiencyError = 0.0001;
14    end
15
16    methods
17        function obj = TurbineModel7
18            obj.TurbineMapData = [];
19            obj.TurbineModel = [];
20        end
21
22        function obj = TurbineMapDataPrep(obj, PathTurbineData, DataType)
23            %% read turbine map data
24            %older Matlab versions
25            %TurbineGeometryInputTable = readtable(PathTurbineData, 'Sheet', 'Flow Area Geometry');
26            %newer Matlab versions
27            TurbineGeometryInputTable = readtable(PathTurbineData, 'Sheet', 'Flow Area Geometry', 'NumHeaderLines', 1);
28            TurbineMapPrep = readmatrix(PathTurbineData, 'Sheet', 'Turbine Map Data');
29            TurbineGeometryInput = TurbineGeometryInputTable(:, 3);
30            TurbineDataSort = sortrows(TurbineMapPrep, 1); %sort data by vane position
31        end
32    end
33 end
```

Older Matlab versions do not recognize 'NumHeaderLines' parameter for loading excel file, requiring line 25 to be uncommented, and line 27 to be commented in the TurbineModel7 object file.

Turbine Mapping Data

1. Create turbine mapping data files (one for each turbine map) using TurbineMappingDataTemplate.xlsx as a guide.
 - a. Paste turbine mapping data into “Turbine Map Data” worksheet.
 - b. Fill in geometry information on “Flow Area Geometry” worksheet.

Three turbine mapping data files populated with made-up data are also included in the repository.

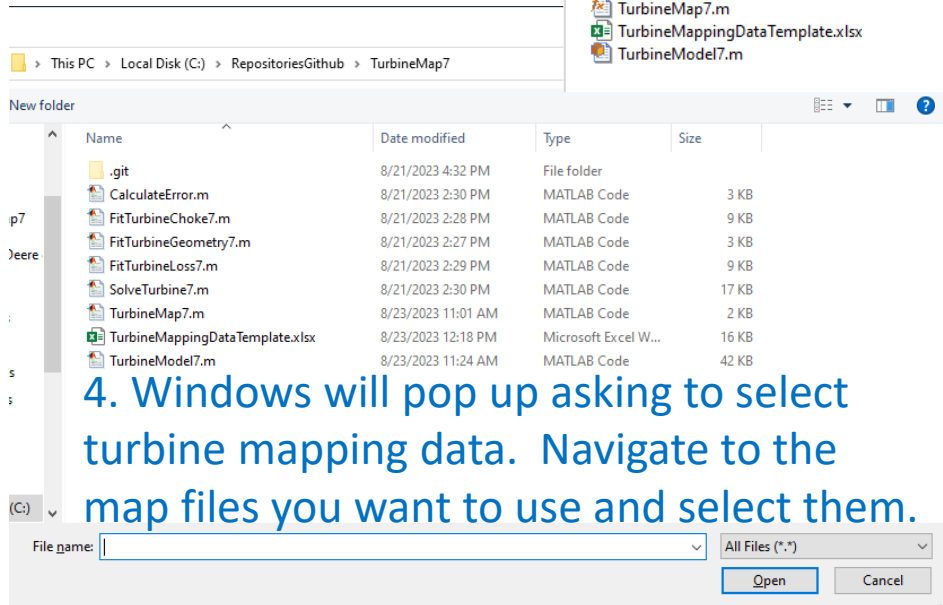
a.

Make sure all values in the vane position column are the same. This version of code will not solve variable geometry.

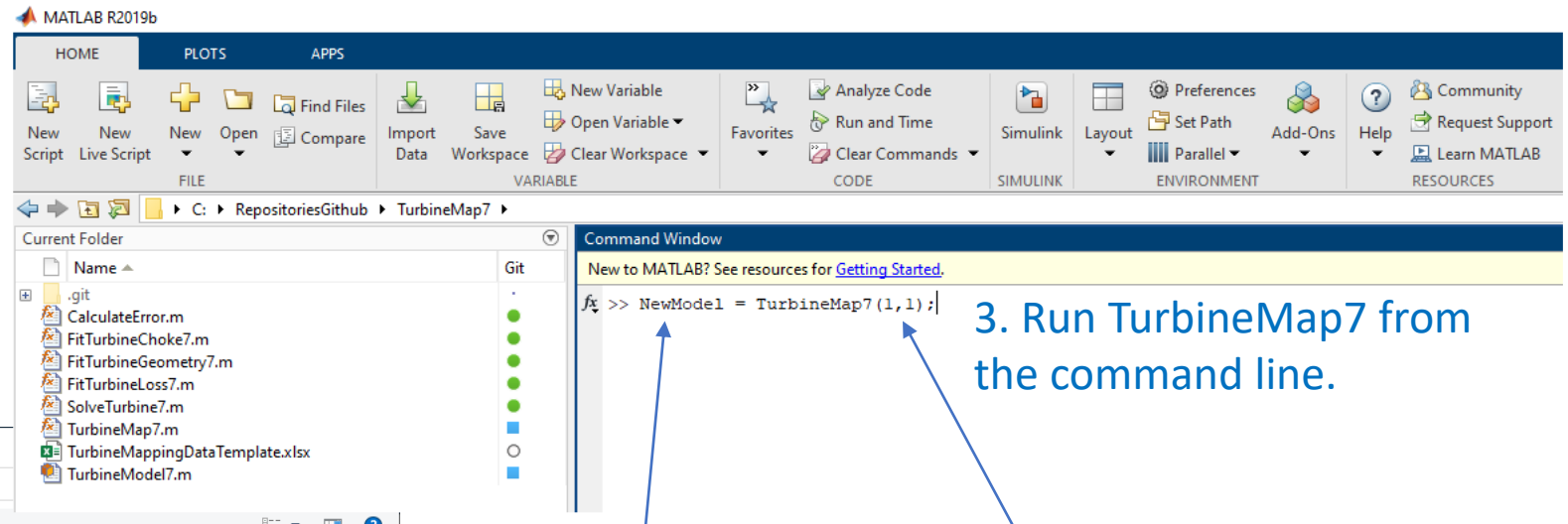
b.

TurbineMap7.m

2. Set the working directory to the local copy of the files in TurbineMap7 repository, or make sure this location is on Matlab's path.



4. Windows will pop up asking to select turbine mapping data. Navigate to the map files you want to use and select them.



3. Run TurbineMap7 from the command line.

Replace "NewModel" with what you want to call the turbine model.

Arguments are (number of training maps, number of validation maps). Number of training maps must be ≥ 1 . Number of validation maps must be ≥ 0 .

TurbineMap7.m Output

MATLAB R2019b

HOME PLOTS APPS

File Edit View Command Window

Current Folder: C:\RepositoriesGithub>TurbineMap7

Command Window:

```
>> NewModel = TurbineMap7(1,1);
```

Variables - NewModel

Property	Value
TurbineMapData	1x2 struct
TurbineModel	1x1 struct
ConvergenceEfficiencyError	1.0000e-04

Variables - NewModel.TurbineMapData

Fields	TurbineMap	DataType	GeometryInput	TurbineData
1	'C:\Users\rm57...	'Training'	[0.0495,0.0454,0.03...	1x1 struct
2	'C:\Users\rm57...	'Validation'	[0.0495,0.0454,0.03...	1x1 struct
3				

Variables - NewModel.TurbineModel

Field	Value
Model	1x13 table
Scale	1x3 table
ErrorTrainingData	2x9 table
TurbineMappingModel	1x2 struct

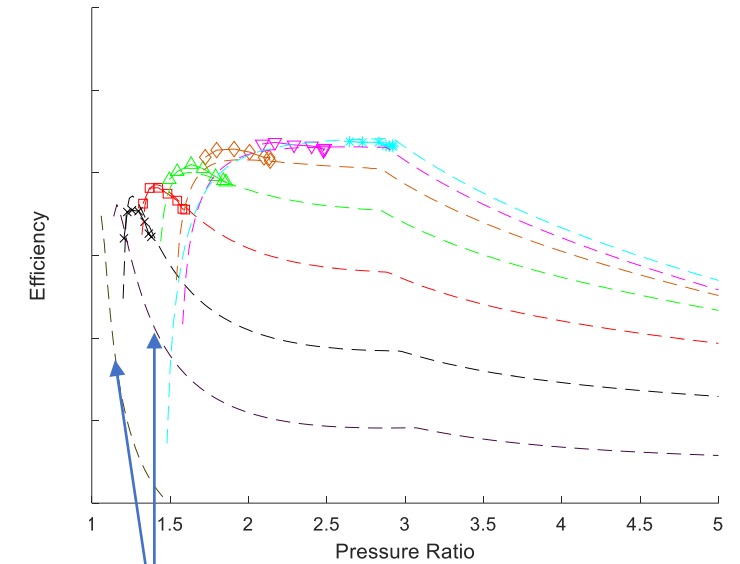
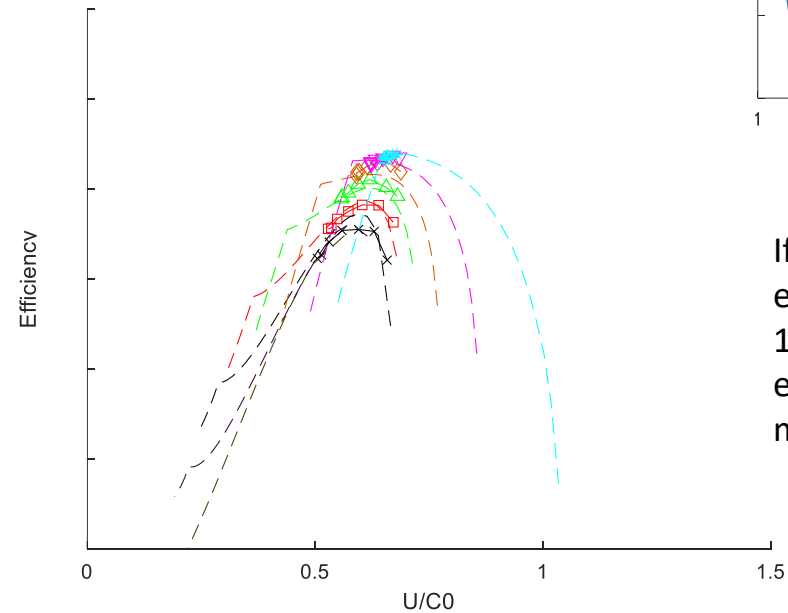
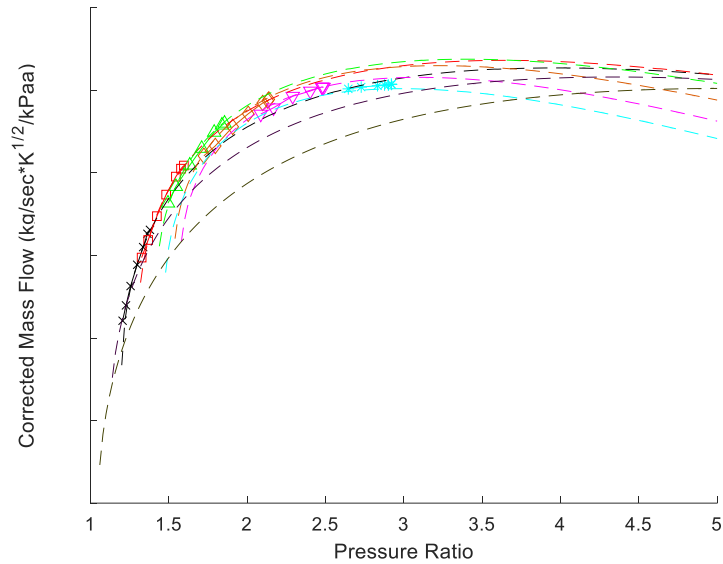
Variables - NewModel.TurbineModel.TurbineMappingModel

Fields	TurbineMap	DataType	ScaleFactors	ModelOutput	ModelError	ModelExtended
1	'C:\Users\rm57...	'Training'	[1,1,1,1,1,1]	42x8 double	2x9 table	1469x8 double
2	'C:\Users\rm57...	'Validation'	[1,1,1,1.1935,1,1...	47x8 double	2x9 table	1691x8 double
3						
4						

Data points from turbine mapping data

Converged data points from 1 to 5 pressure ratio

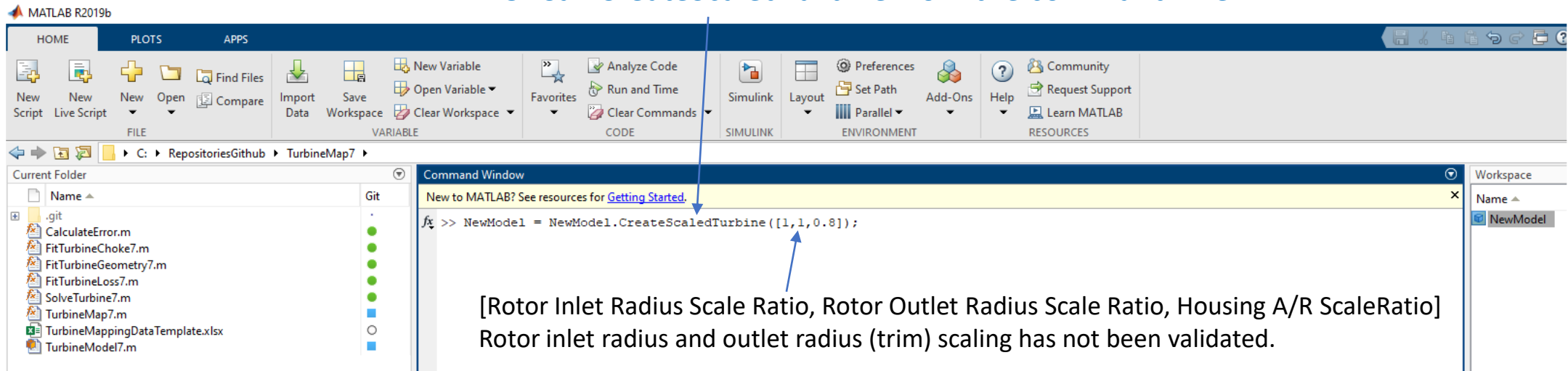
TurbineMap7.m Plots



If data starts higher than 150 m/sec, extended model adds lower speedlines to 100 m/sec rotor inlet tip speed. If data ends lower than 450 m/sec, extended model adds higher speedlines to 500 m/sec

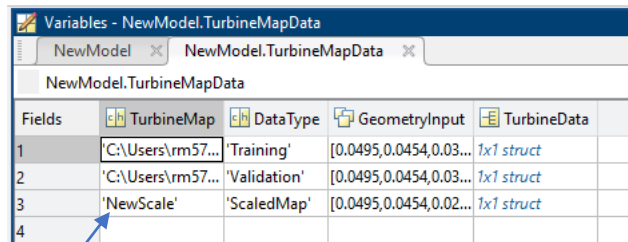
Scaling a Turbine Map

5. Call CreateScaledTurbine from the command line.



The MATLAB R2019b interface is shown. The Command Window displays the command: `NewModel = NewModel.CreateScaledTurbine([1,1,0.8]);`. The Workspace shows the variable `NewModel`. A blue arrow points from the text "5. Call CreateScaledTurbine from the command line." to the command in the Command Window. Another blue arrow points from the text "[Rotor Inlet Radius Scale Ratio, Rotor Outlet Radius Scale Ratio, Housing A/R ScaleRatio]" to the array `[1,1,0.8]` in the command.

[Rotor Inlet Radius Scale Ratio, Rotor Outlet Radius Scale Ratio, Housing A/R ScaleRatio]
Rotor inlet radius and outlet radius (trim) scaling has not been validated.

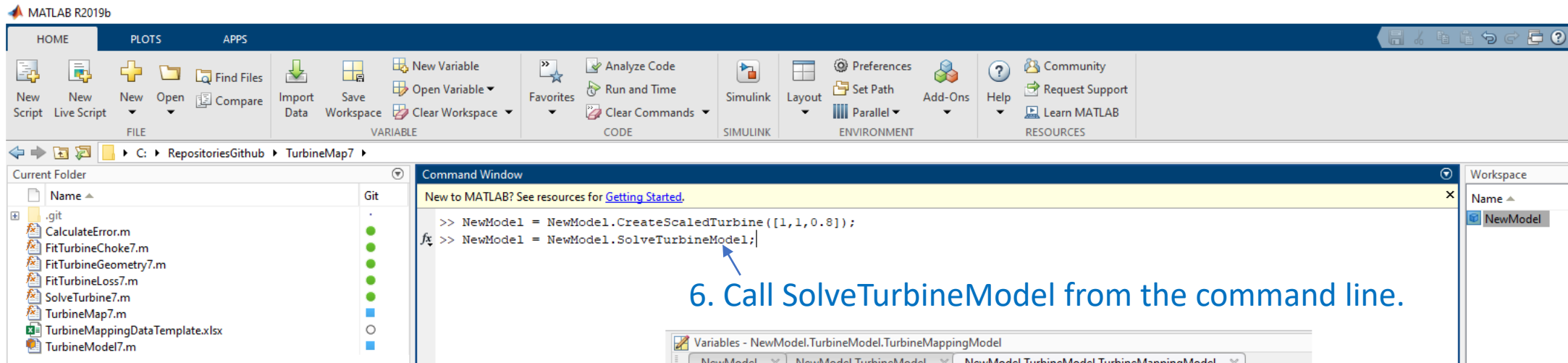


The Variables window shows the structure of `NewModel.TurbineMapData`. It is a table with 4 rows and 5 columns. The first three rows are 'Training', 'Validation', and 'NewScale'. The 'NewScale' row is highlighted with a blue arrow pointing to it from the text below.

Fields	TurbineMap	Data Type	GeometryInput	TurbineData
1	'C:\Users\rm57...	'Training'	[0.0495,0.0454,0.03...	1x1 struct
2	'C:\Users\rm57...	'Validation'	[0.0495,0.0454,0.03...	1x1 struct
3	'NewScale'	'ScaledMap'	[0.0495,0.0454,0.02...	1x1 struct
4				

A new row will be added to "TurbineMapData"

Scaling a Turbine Map



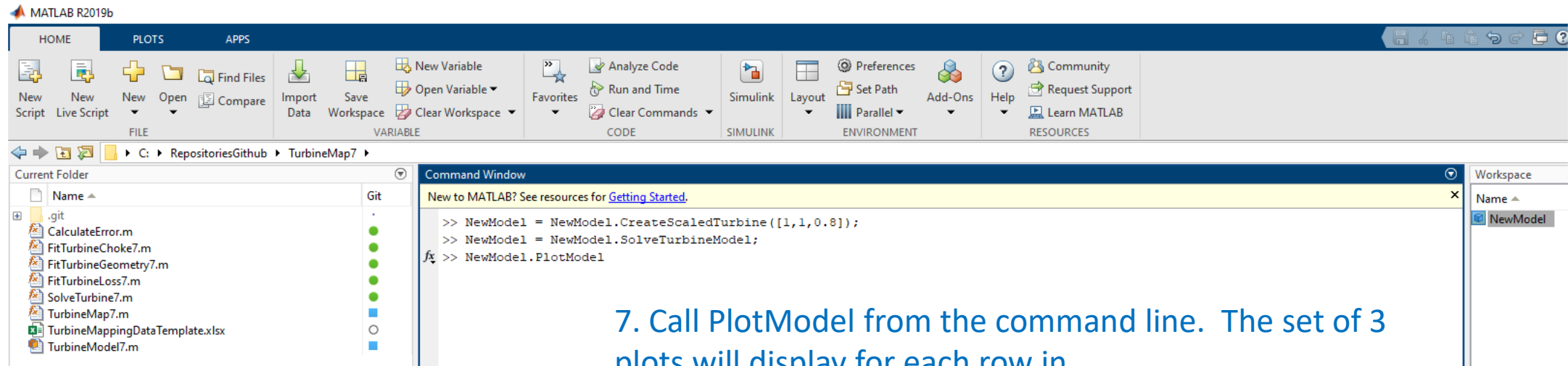
6. Call SolveTurbineModel from the command line.

Variables - NewModel.TurbineModel.TurbineMappingModel

Fields	TurbineMap	DataType	ScaleFactors	ModelOutput	ModelError	ModelExtended
1	'C:\Users\rm57...	'Training'	[1,1,1,1,1,1]	42x8 double	2x9 table	1470x8 double
2	'C:\Users\rm57...	'Validation'	[1,1,1,1.1935,1,1...	47x8 double	2x9 table	1689x8 double
3	'NewScale'	'ScaledMap'	[1,1,1,0.8000,1,1...			1419x8 double
4						
5						

A new row will be added to "TurbineModel.TurbineMappingModel"

Plot the Scaled Turbine Map



7. Call PlotModel from the command line. The set of 3 plots will display for each row in TurbineModel.TurbineMappingModel – 9 plots total for the example shown (3 for training data, 3 for validation data, 3 for scaled map)