香港建造學院 | HONG KONG INSTITUTE OF CONSTRUCTION

Certificate in Building Information Modelling (BIM) Data Management with Dynamo

建築信息模擬 Dynamo 數據管理證書

Chapter 1-7

Lecture
講義

ION
Foridea
Tech Manager

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Chapter. 1
Introduction to Dynamo

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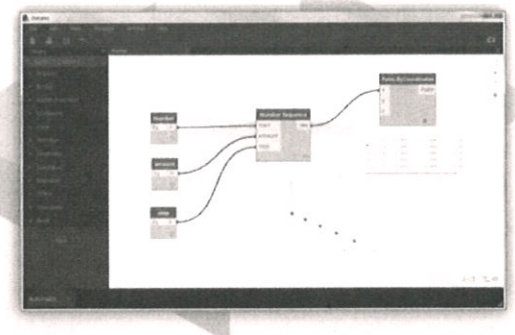
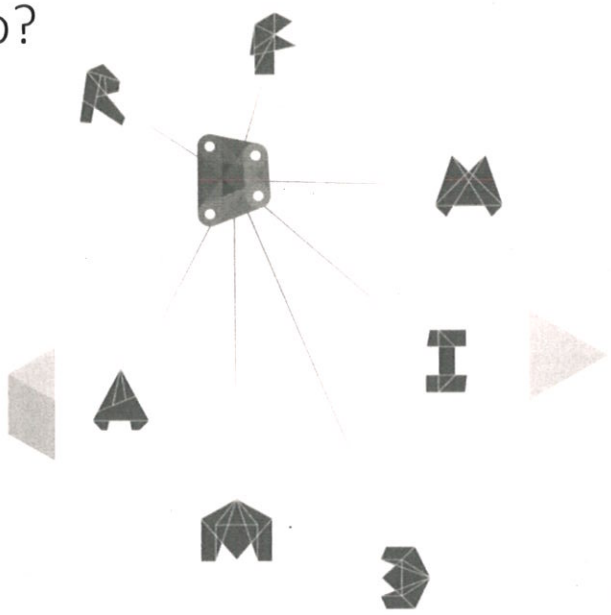
What is Dynamo?

- Open Source Visual Programming
- Full access to data and APIs
- Can perform complex calculations
- No programming experience needed



Where do I use Dynamo?

- Dynamo Sandbox
- Dynamo for Revit
- Dynamo Studio
- Dynamo for Civil 3D



Where does Dynamo apply?

GEOMETRY

DATA PROCESSING

AUTOMATION

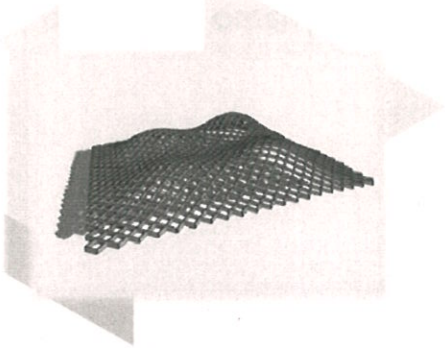
Possible Application

GEOMETRY

DATA PROCESSING

AUTOMATION

Generation and study of generative / parametric geometry and complex structures, which would not be feasible with the native tools in Revit



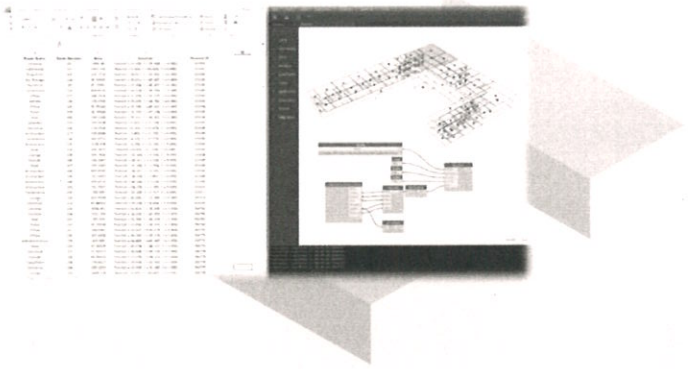
Possible Application

GEOMETRY

DATA PROCESSING

AUTOMATION

Reading, analysis, manipulation, filling of BIM attributes / Excel link



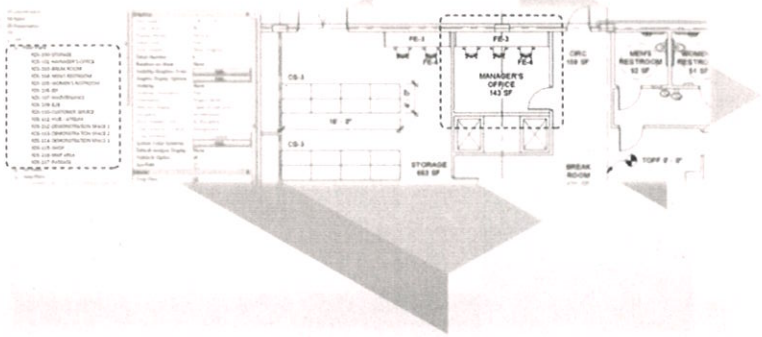
Possible Application

GEOMETRY

DATA PROCESSING

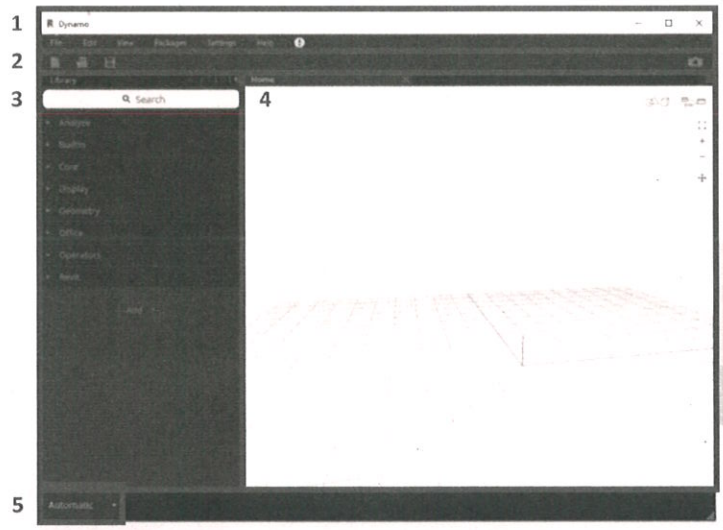
AUTOMATION

Direct access to all functions on the Revit programming interface



Let's start playing with Dynamo!

UI Tour



- 1: Menus
- 2: Toolbar
- 3: Library
- 4: Workspace
- 5: Execution Bar

Keyboard shortcuts

- 1: Ctrl + W: Create new note
- 2: Ctrl + G: Group selected nodes
- 3: Ctrl + U: Ungroup
- 4: Ctrl + B: Switch between node view and 3d view

Ch1. Introduction to Dynamo

Exercise 1

In this exercise, you will learn about parametric mass in Revit. You will learn to edit and modify Revit element parameters in Dynamo.

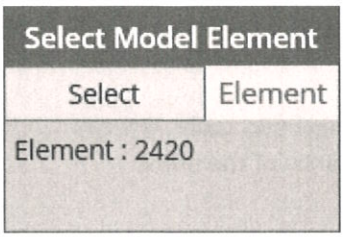
1. Select the mass and you will see the parameters listed in the Properties table. You can change the value of different parameters to change the appearance of the mass.
2. Link Revit Model with Dynamo.
3. Set element parameter
4. Add an integer slider to change the **Lift Up**.
5. Replace String node with Get family parameter
6. Copy the whole set of nodes to below and change the parameter of the second set to **Inside Offset**
7. Create a list containing family parameters and the value
8. Add more parameters to the list by copying the previous
9. Set constrain to maintain the model form

Revit Dynamo Training Notes

Useful Nodes

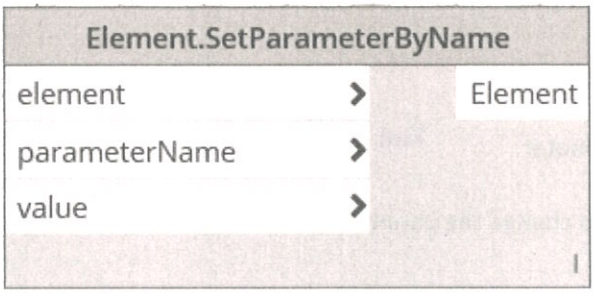
Select Model Element

+(S) = Window select

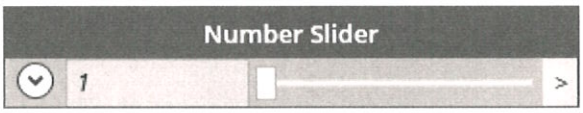


Element.SetParameterByName

(加新 parameter)



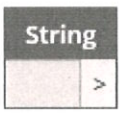
Number Slider



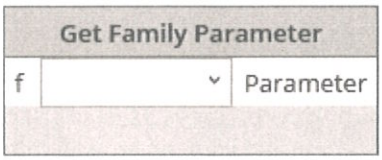
String = Name

大細楷重要

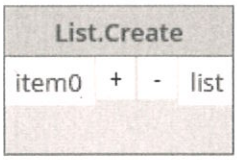
空格



Get family Parameter



List.Create



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Chapter. 2
Dynamo Listings, Adaptive families

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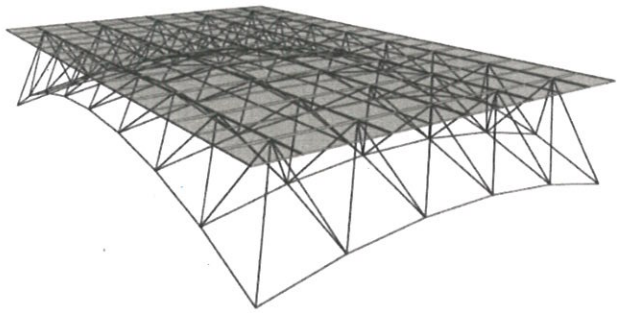
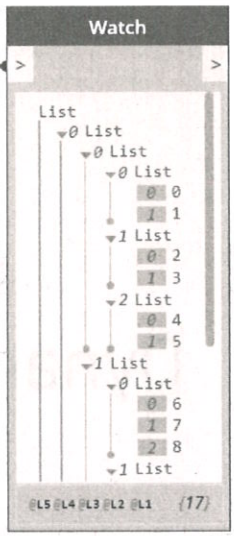
Adaptive families

- Adaptive components
- Takes multiple insertion points
- Changes according to the insertion points



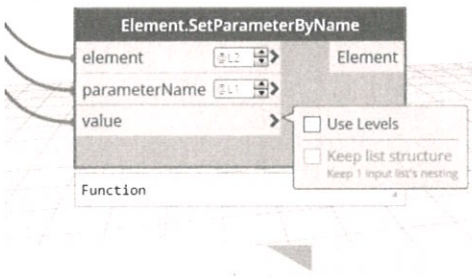
Dynamo Listings

- Zero-Based Indices
- Nodes' input and output



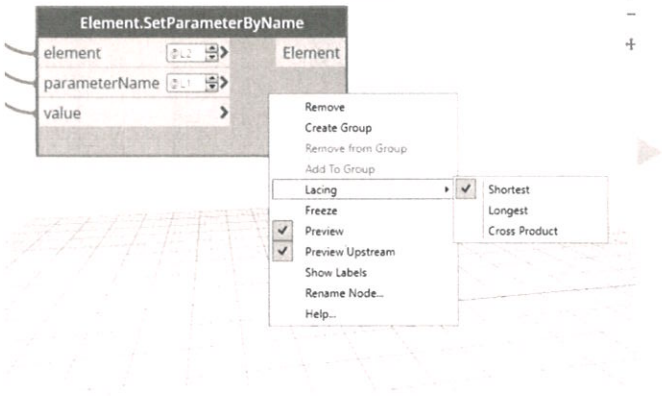
Listing levels

- Select different level of the list for input
- Navigate to the desired output value



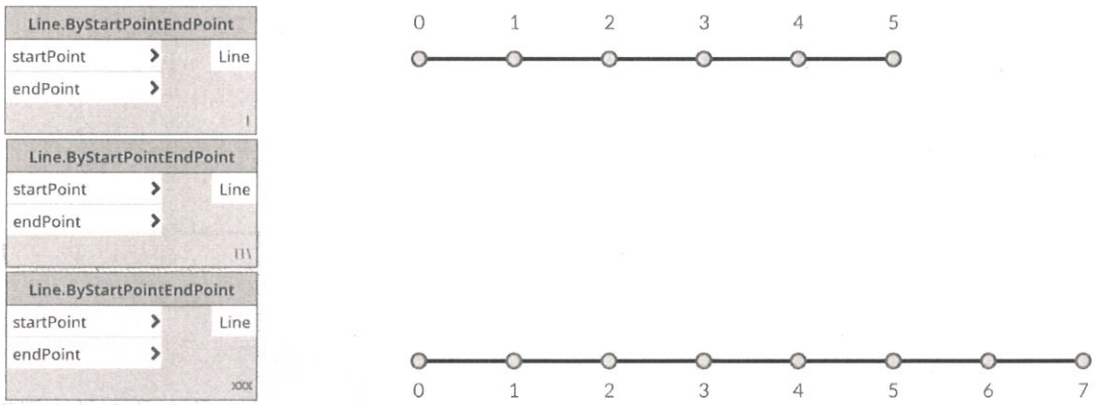
Lacing

- Shortest, Longest, Cross Product

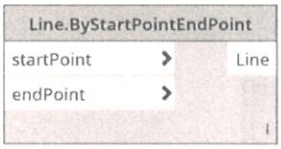


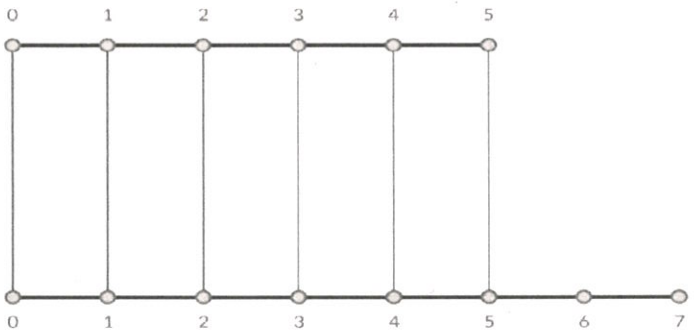
Lacing

- Say we have a node that create segments between points…

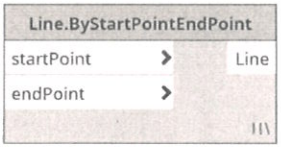


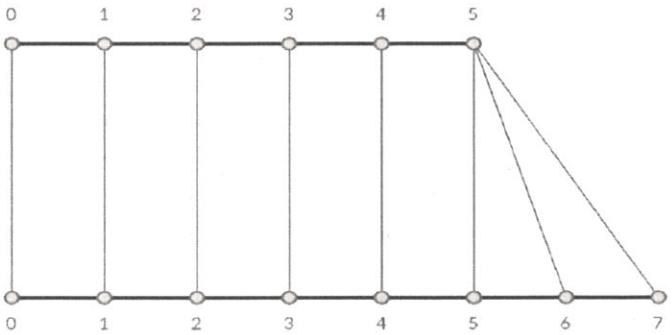
Shortest



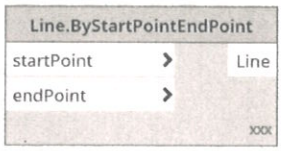


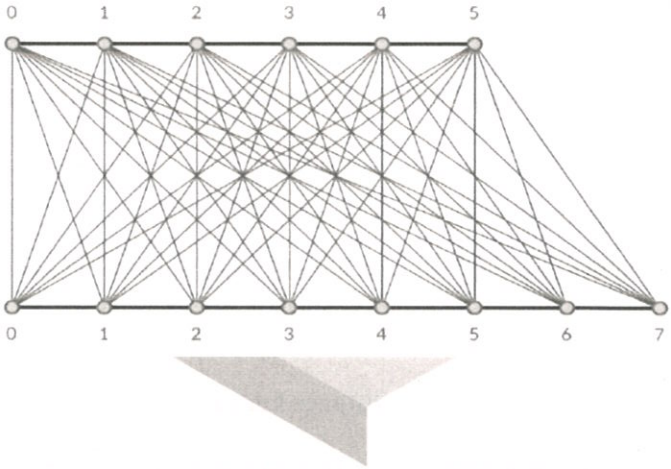
Longest





Cross Product





Ch2. Dynamo Listings, Adaptive family

Exercise 1

In this exercise, you will learn to create structural framings in revit with dynamo.

1. Link the two revit model lines with Dynamo
2. Divide the two curves into equal segments with points
3. Create lines between the two curve with the points
4. Create Structural framings by the lines generated.

Exercise 2

In this exercise, you will learn to place panel families in Revit with Dynamo.

1. Link the face in revit with Dynamo
2. Create equal-distanced points on two edges
3. Subdivide the surface into grids for panel placement with the points
4. Add the family type to the script and link the parameters with the grids created
5. Place family instances in model with the grid points created

Exercise 3

In this exercise, you will learn to place adaptive families referring model geometry in Revit with Dynamo.

1. Link the mass and the model line with Dynamo
2. Get the polysurface from the mass
3. Create equal-distanced planes on the model line
4. Get the intersection points of the planes and the mass polysurface
5. Place adaptive families using the point sets

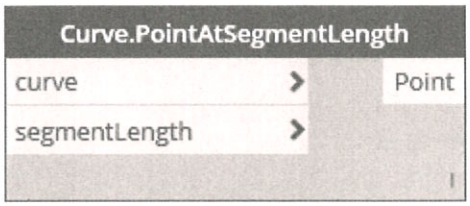
Exercise 4

In this exercise, you will learn to manipulate elevation of level elements in revit.

1. Link revit level with Dynamo
2. Set elevation with a slider

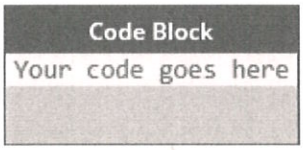
Useful Nodes

Curve.PointAtSegmentLength

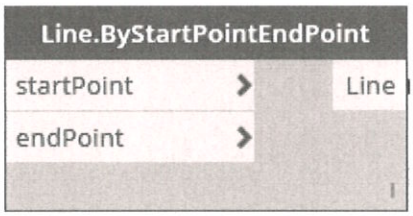


Range

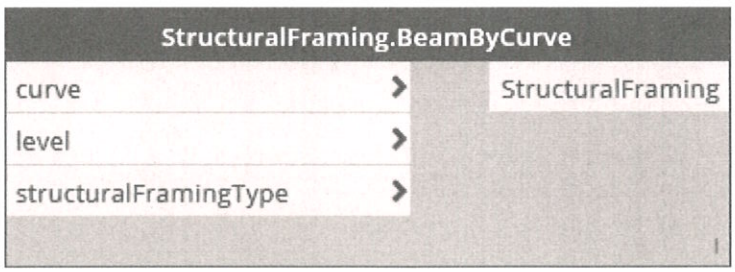
Code Block



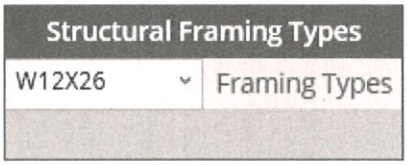
Line.ByStartPointEndPoint



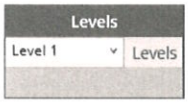
StructuralFraming.BeamByCurve



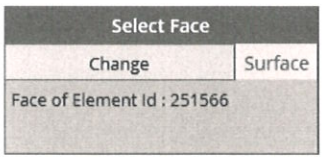
Structural Framing Types



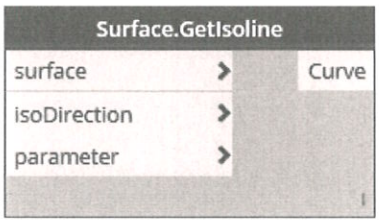
Levels



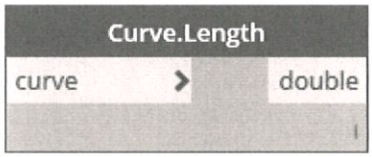
Select Face



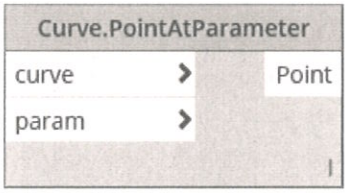
Surface.GetIsoline



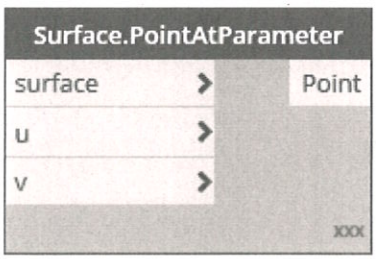
Curve.Length



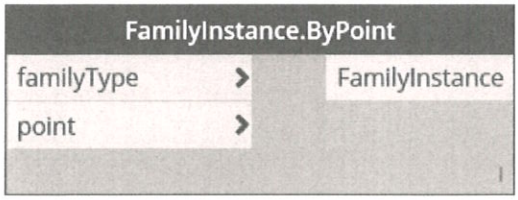
Curve.PointAtParameter



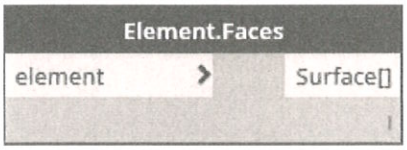
Surface.PointAtParameter



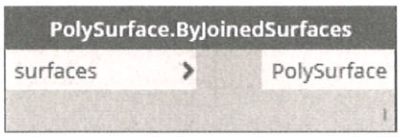
FamilyInstance.ByPoint



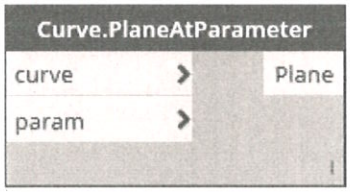
Element.Faces



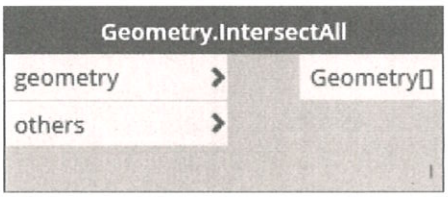
PolySurface.ByJoinedSurfaces



Curve.PlaneAtParameter

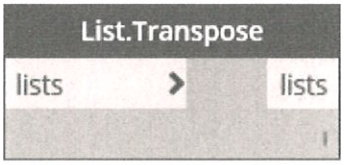


Geometry.IntersectAll

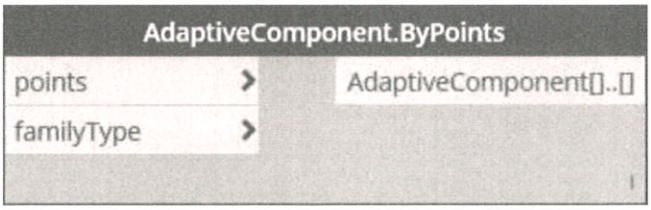


List.GetItemAtIndex

List.Transpose



AdaptiveComponent.ByPoints



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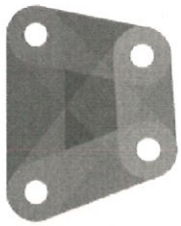

Chapter. 3
Dynamo Geometries

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Geometries in Dynamo

- Geometry Types
- Abstract Types

Data Type Hierarchy							
Abstract Types			Geometry Types				
Defines Location + Orientation	Defines Position + Volume	Defines Relationships	Model Elements				
Vector	Bounding Box	Topology	Point	Curve	Surface	Solid	Mesh
• Vector • Plane • Coordinate System	• Bounding Box	• Vertex • Edge • Face	• XYZ Coordinate • UV Coordinate	• Line • Polygon • Arc • Circle • Ellipse • NURBS Curve • PolyCurve	• NURBS Surface • Polysurface	• Cuboid • Sphere • Cone • Cylinder	• Mesh

Geometry type

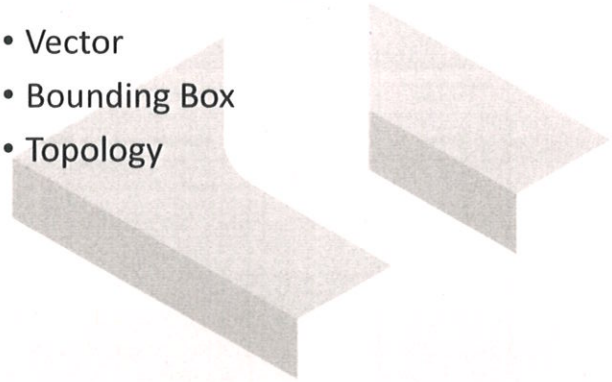
- Point
- Curve
- Surface
- Solid
- Mesh

Geometry Types				
Model Elements				
Point	Curve	Surface	Solid	Mesh
• XYZ Coordinate • UV Coordinate	• Line • Polygon • Arc • Circle • Ellipse • NURBS Curve • PolyCurve	• NURBS Surface • Polysurface	• Cuboid • Sphere • Cone • Cylinder	• Mesh

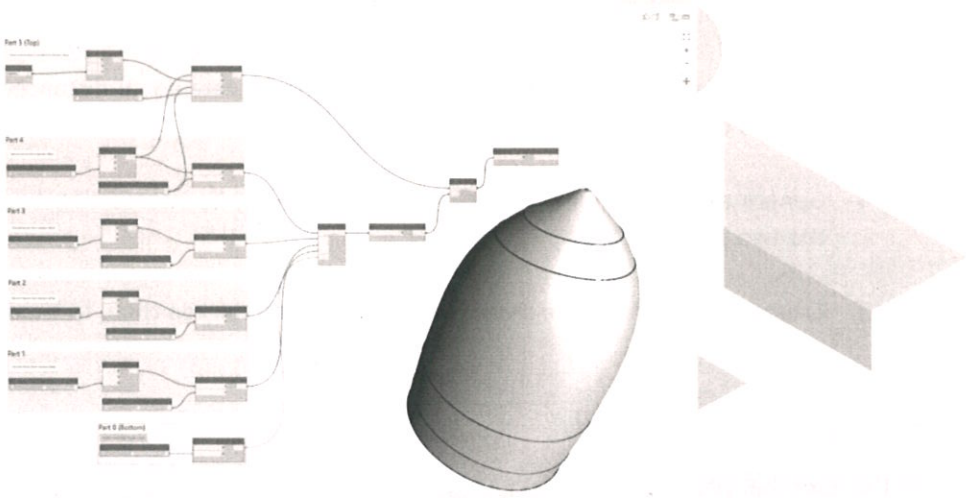
Abstract type

Abstract Types		
Defines Location + Orientation	Defines Position + Volume	Defines Relationships
Vector	Bounding Box	Topology
• Vector • Plane • Coordinate System	• Bounding Box	• Vertex • Edge • Face

- Vector
- Bounding Box
- Topology



Parametric Designs



Ch3. Dynamo Geometry

Exercise 1

In this exercise, you will learn to manipulate revit geometry element and create geometry elements based on revit model.

1. Link revit element with Dynamo
2. Get bounding box of the geometry
3. Get the front surface of the bounding box and generate equal-distanced planes along two sides of the surface
4. Generate cross section curves of the revit geometry by intersecting it with the planes along the two direction.
5. Create surfaces from the cross section curves and thicken them to become solid geometries

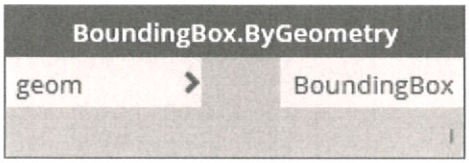
Exercise 2

In this exercise, you will learn to import geometries generated in Dynamo into revit model, or export the geometries into SAT file.

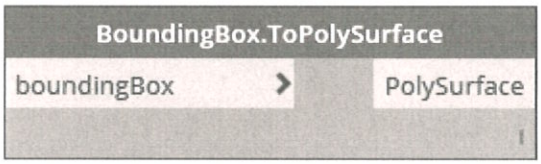
1. Export the geometries generated in Exercise 1 to the set file path as SAT file
2. Import the geometries into revit model as instances

Useful Nodes

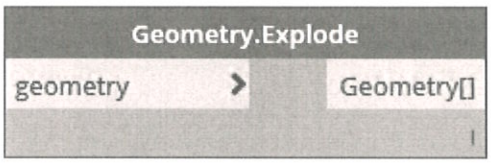
BoundingBox.ByGeometry



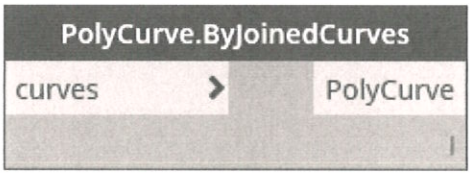
BoundingBox.ToPolySurface



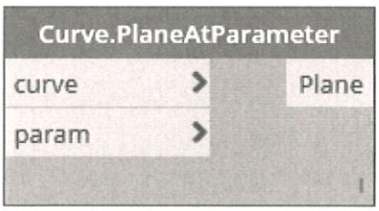
Geometry.Explode



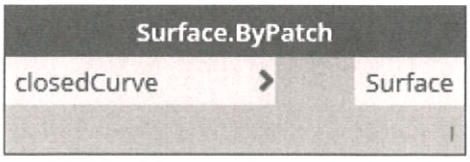
Polycurve.ByJoinedCurves



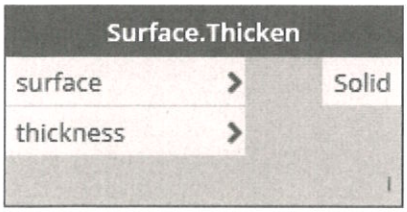
Curve.PlaneAtParameter



Surface.ByPatch

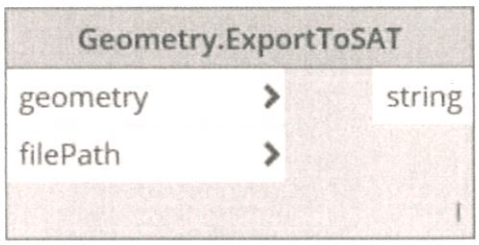


Surface.Thicken

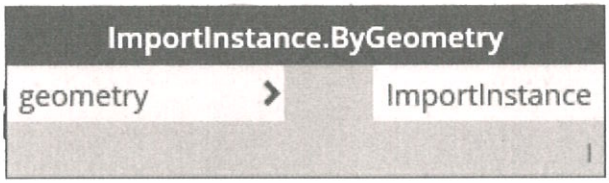


Flatten

Geometry.ExportToSAT



ImportInstance.ByGeometry



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Chapter. 4
Data Structure in Revit

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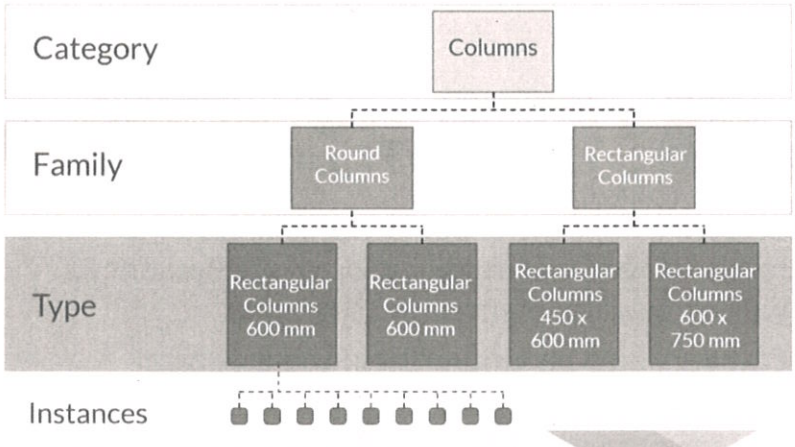
Revit Hierachy



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Revit Hierachy

Furniture

Table

Medium Table

Table 213

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Revit Hierachy

Category will control behaviour and options related to placement and modification of an element as well as how the element is scheduled

Category also be influential in the graphical appearance of elements

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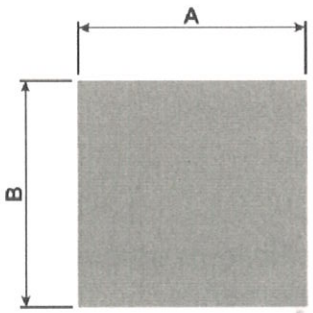
Revit Hierachy

Family



The family contains the basic geometric form and all logic in the form of parametric controls such as *Size = A x B* and *Colour = grey*

Any changes at a family level will affect all types and instances of this element

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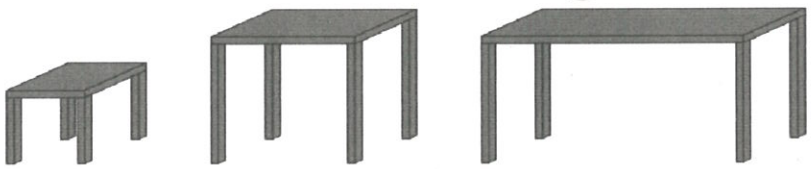
Revit Hierachy

Small **Medium** **Large**



Types are pre-defined values for the available parametric fields, saved under a given name
Any change to a type parameter will affect all instances of this same type

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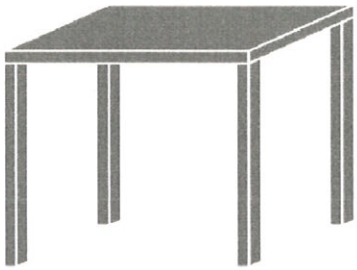
Revit Hierachy



ID: 324781

Item # 324 in room 37 on the second floor

Instances properties affect a specific item uniquely without impact on other similar elements

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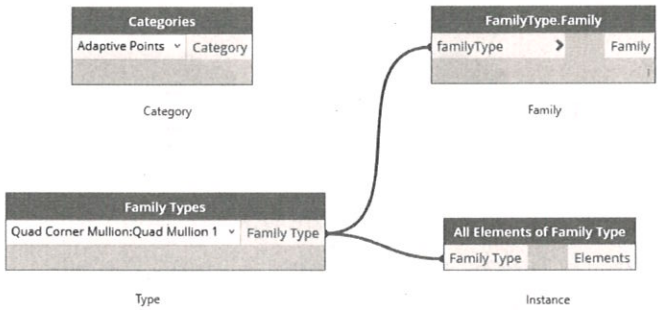
In Dynamo



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Chapter. 4
Dynamo Custom Nodes

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What are Custom nodes?

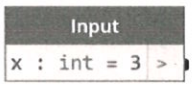
- A node constructed by nesting nodes
- Function like normal nodes
- Can be saved externally as .dyf

Custom nodes

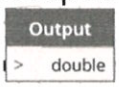
Built-in nodes

Inside Custom nodes

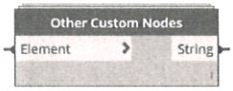
- Input nodes



- Output nodes



- Other Custom nodes



Why use custom nodes?

- Pros
  - Saves time for repeating nodes
  - Easy to share
- Cons
  - May not suit different version of Dynamo
  - Difficult to control the version of custom nodes

Ch4. Data Structure in Revit, Custom Nodes

Exercise 1

In this exercise, you will learn to import SAT file into Dynamo for investigation.

1. Import the SAT file with an **ImportInstance.BySATFile** node
   This should directly create the geometry in revit model

2. Import the SAT file with a **Geometry.ImportFromSAT** node
   This should open the SAT file in Dynamo for edit without importing into revit model

Exercise 2

In this exercise, you will learn to read data from excel spreadsheets and use the data to create geometry and further utilize it for other purposes.

1. Import the excel file and extract data in the spreadsheet as string

2. Use the custom node **Excel to Point** to create points from the data

3. Copy the nodes to create four points for each corner of the geometry

4. Create surfaces between each four points after rearranging the list to the correct format

5. Use the same set of points to place adaptive components in the revit model

Exercise 3

In this exercise, you will learn to read image in Dynamo and recreate it in revit model.

1. Start with the script you created in Exercise 2, import a jpg image into Dynamo

2. Override the adaptive componenet panels by the color from the jpg image

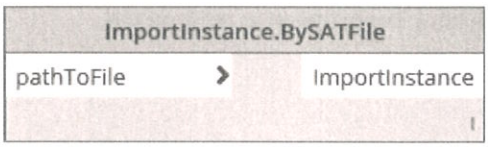
3. Link the extrusion value of the adaptive components with the brightness of the jpg image

4. Try importing another image file to test the script

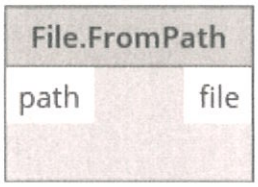
Useful Nodes

Geometry.ImportFromSAT

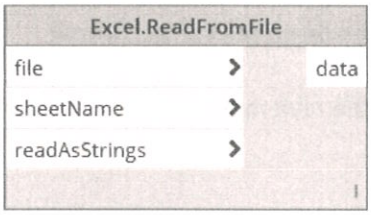
ImportInstance.BySATFile



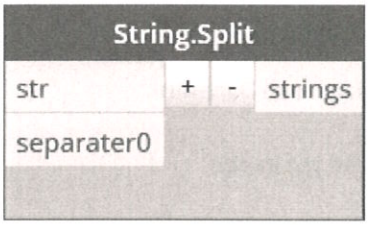
File.FromPath



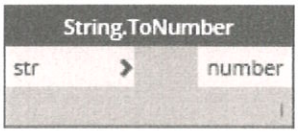
Excel.ReadFromFile



String.Split



String.ToNumber



Polygon.ByPoints

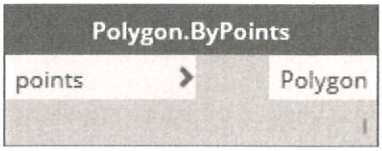
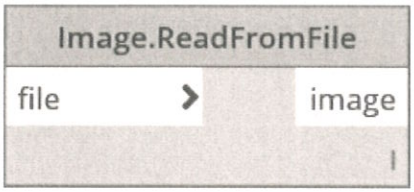
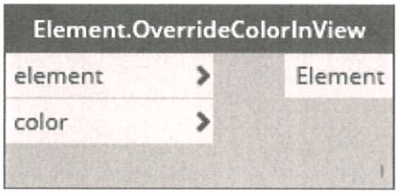


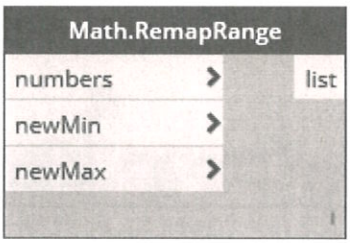
Image.ReadFromFile



Element.OverrideColorInView



Math.RemapRange



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Chapter. 5
Data Visualization using dynamo

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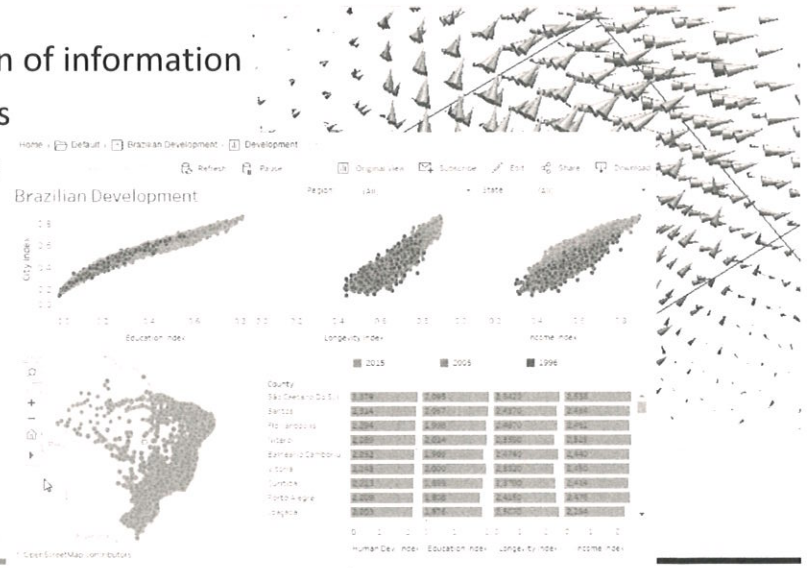
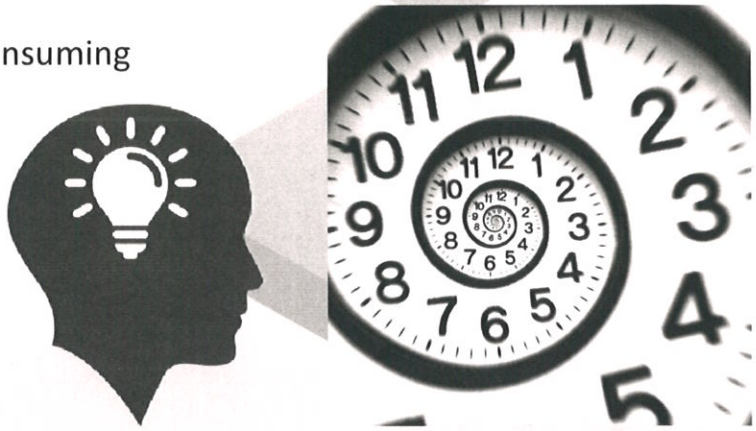
Data Visualization

- Graphical representation of information
- Charts, graphs and maps
- Shapes, colors and sizes



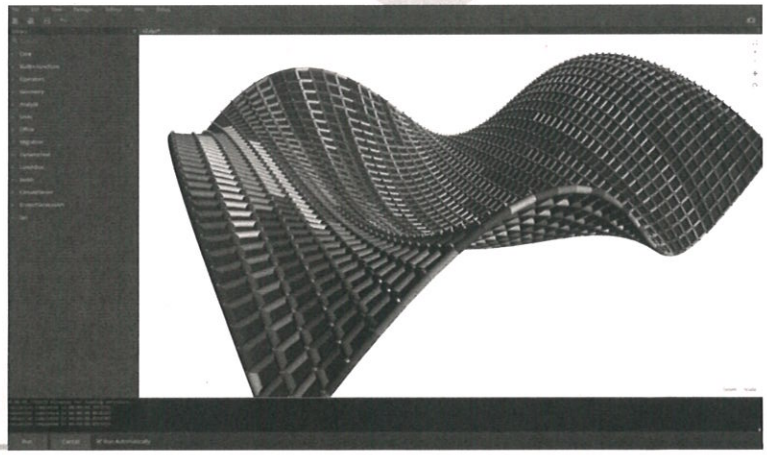
Pros and Cons for Visualization

- Manage and Analyze data
- Straightforward graphics
- BUT could be resource consuming



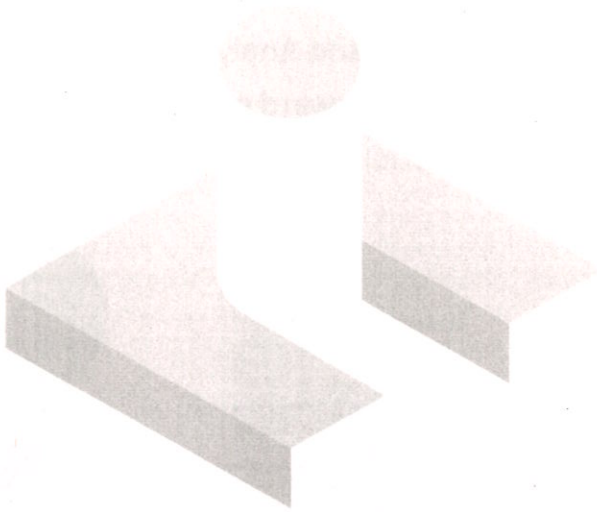
Visualizing with Dynamo

- Quick and accurate visualization
- Dynamic model
- Easily customized



What we can do with Dynamo?

- Override colour in Revit
- Change parameters in Revit
- Export spreadsheet
- Get creative!



Ch5. Data Visualization

Exercise 1

In this exercise, you will learn to link data or properties from the revit model with Dynamo and visualize them in the form of color into revit model.

1. Start from the script created in last lecture, get the surface area of each small surfaces created from Surface.ByPatch

2. Map the range of the changing area into a color range, then override the color onto the according adaptive component panel

3. Extract the deviation of each surface instead of the area, visualize the result and see the difference

Exercise 2

In this exercise, you will learn to export the analyzed data from Dynamo to Excel.

1. Start from the script created in Exercise 1, export the deviation data directly to the excel file

2. Extract the Element Id for each adaptive component panel and export the data after aligning them with the deviation value accordingly

3. Number each adaptive component panel and align the number into the excel file

Exercise 3

In this exercise, you will learn to utilize the Sun setting in revit to visualize the solar orientation of revit model in Dynamo.

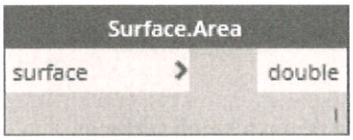
1. Start from the script created in last lecture, first set up the sun path in revit

2. Read the sun direction in the revit model, find out the deviation of each panel in the direction of the sun

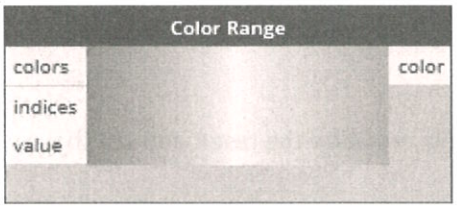
3. Visualize the deviation onto the revit model

Useful Nodes

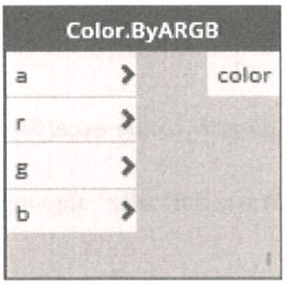
Surface.Area



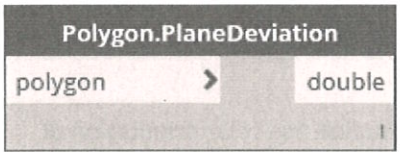
Color Range



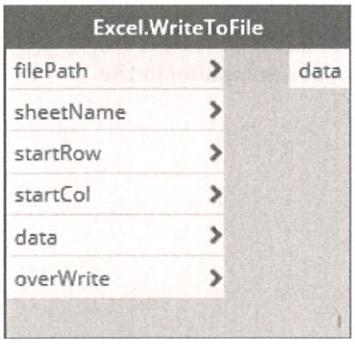
Color.ByARGB



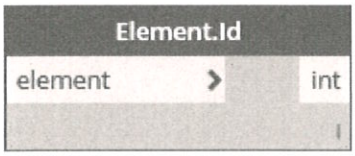
Polygon.PlaneDeviation



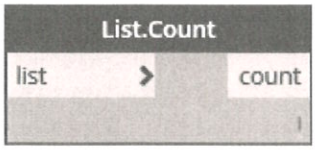
Excel.WriteToFile



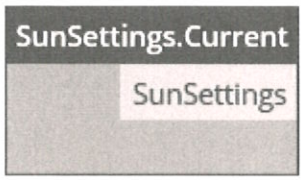
Element.Id



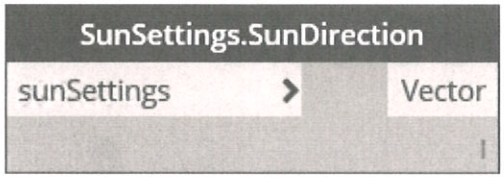
List.Count



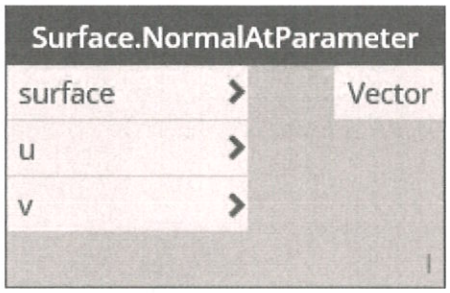
SunSettings.Current



SunSettings.SunDirection



Surface.NormalAtParameter



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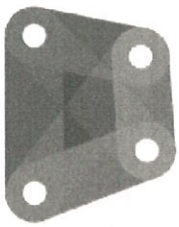

Chapter. 6
Advanced Code Blocks

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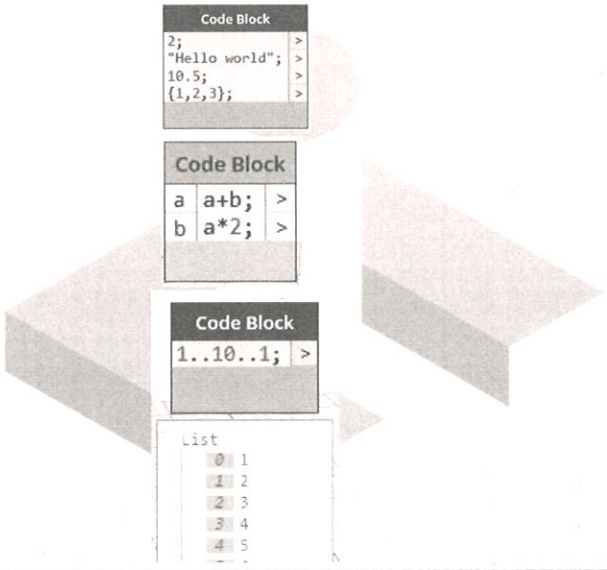
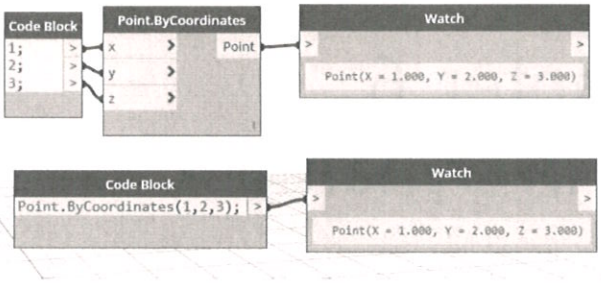
We used code blocks for...

- Inputs
- Formulas
- Number ranges

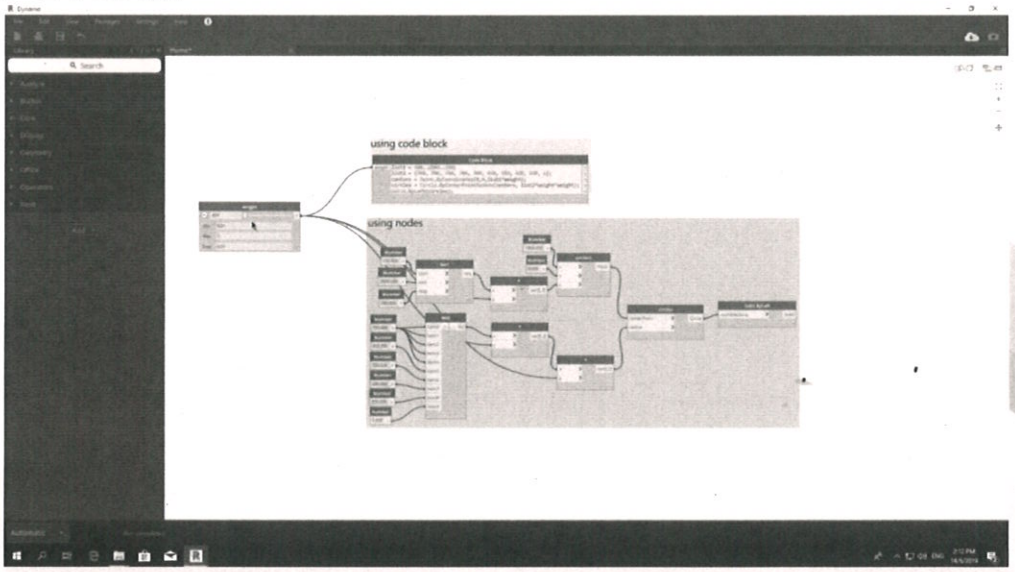


But we can also do...

- Design Scripts replacing simple nodes



Or even...



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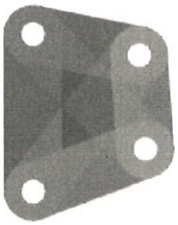

Chapter. 6
Python in Dynamo

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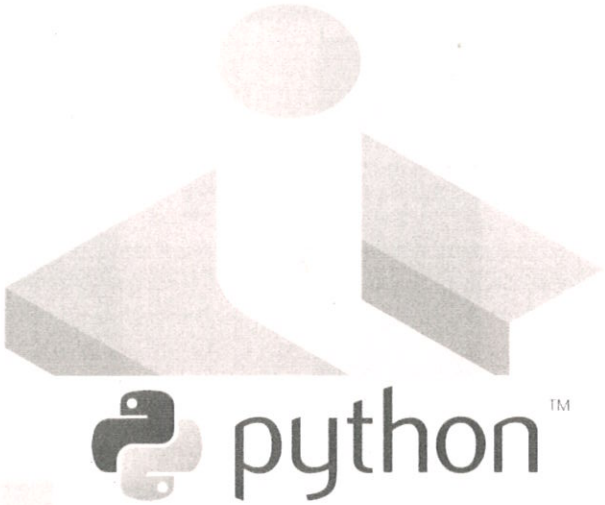
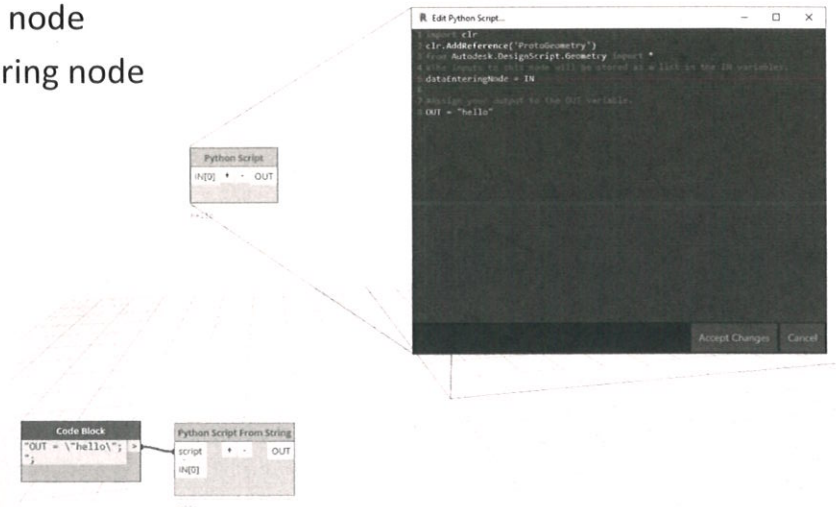
Python

- Highly readable language
- Easy to learn
- Widely used in different area



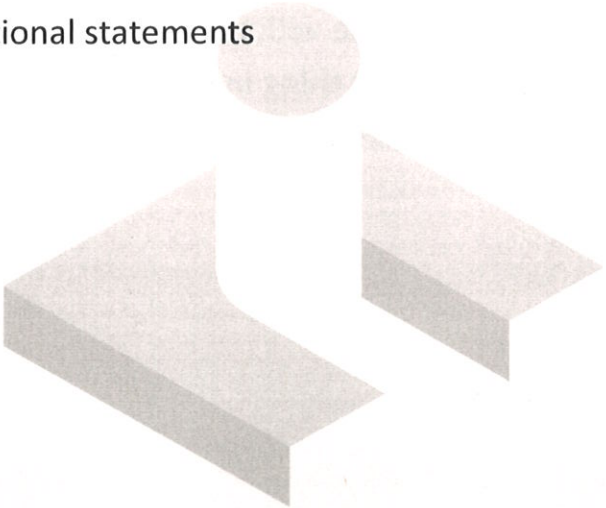
Using python code in Dynamo

- Use the Python Script node
- Python Script From String node



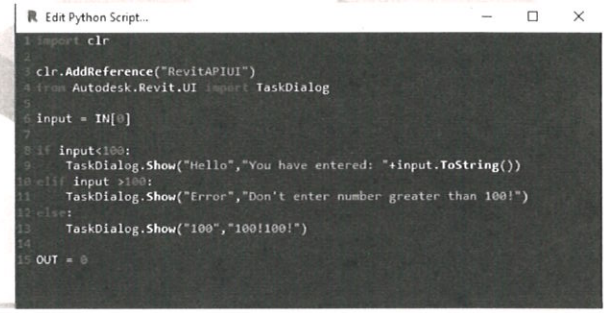
Why go back to coding?

- More capable in looping and conditional statements
- More flexible and customizable
- Handy if used correctly



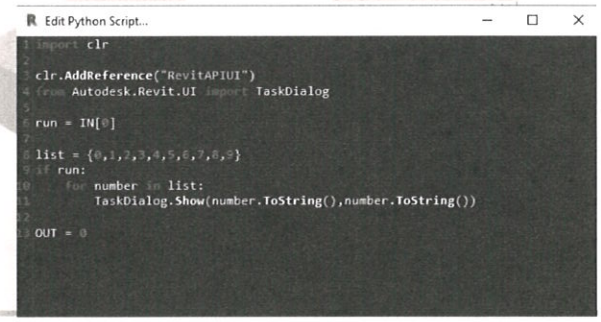
Basic program logic – If/If-else/If-else-if

- Conditional statement that checks from top to bottom
- if **[the condition]**:
  [do something]
  elif **[the next condition]**:
  [do something else]
  else:
  [do something else]



Basic program logic – for loop

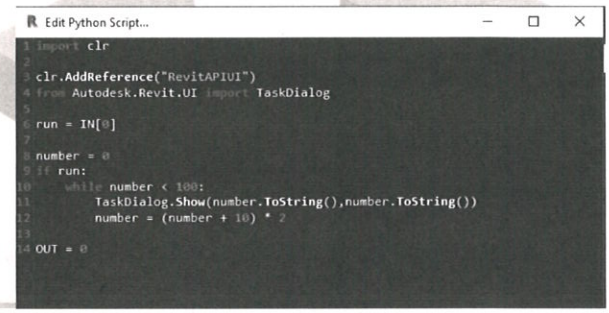
- Repeat the action for a specific range
- for **[each thing in the list]** in **[the list]**:
  [do something]



Basic program logic – while loop

- Repeat the action if a certain condition is fulfilled
- while **[the condition]**:

  [do something]



Ch6. Code Blocks, Python Scripts

Exercise 1

In this exercise, you will learn to use code blocks in an advanced way to simplify the code and speed up the script building.

1. Open the Script used in Exercise 2 in Chapter 4
2. Try replace inputs and formulas with code blocks
3. Try replace nodes with code blocks
4. Try replace series of nodes with single code block
5. Define Function out of a code block
6. Replace part of the old script with code blocks using the newly written function

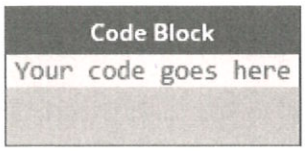
Exercise 2

In this exercise, you will learn to implement python nodes in Dynamo as conditional statement.

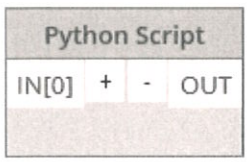
1. Open the Script used in Exercise 3 in Chapter 5
2. Add a python node which changes its output value depending on whether the input number is greater than 0.85
3. Connect the python script node in the Dynamo script so it only generates surfaces when the deviation value is greater than 0.85
4. Apply the same conditioning to placing adaptive component in the original script

Useful Nodes

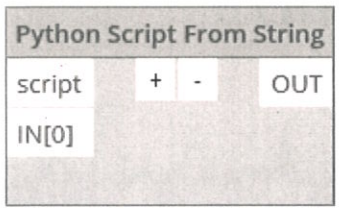
Code Block



Python Script



Python Script From String



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Chapter. 7
Packages in Dynamo

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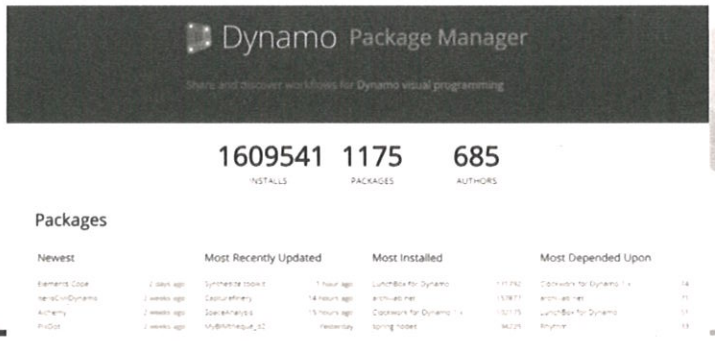
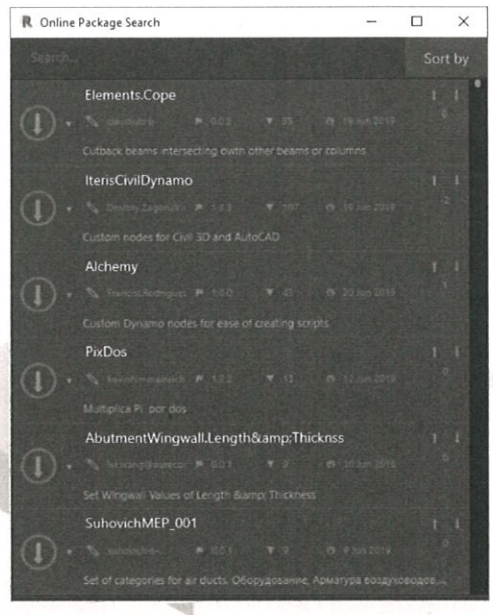
What are Packages?

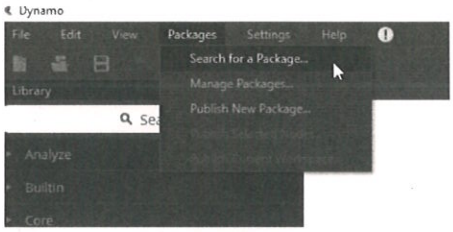
- Organized collections of custom nodes
- Extends Dynamo functionality
- Easy to manage, publish and install

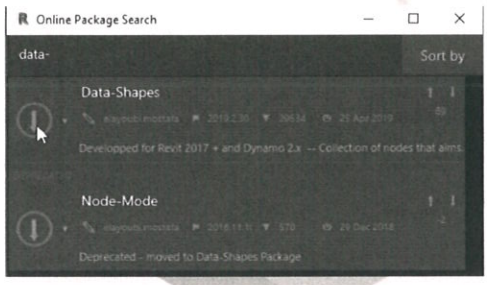




How do I get them?

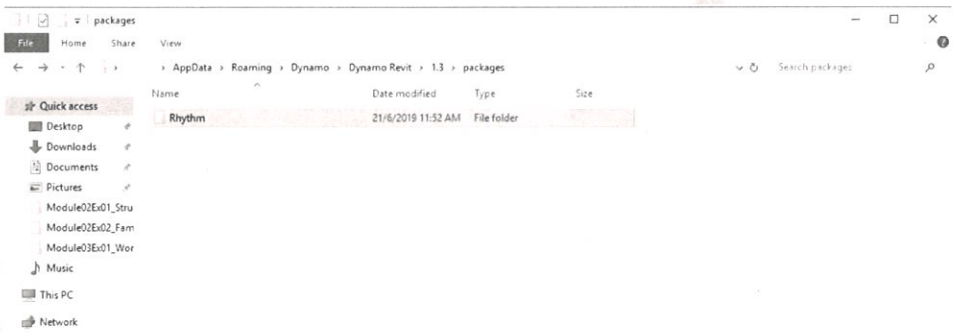
- From the package manager in Dynamo





How do I get them?

- Or put package folder directly at the Dynamo directory

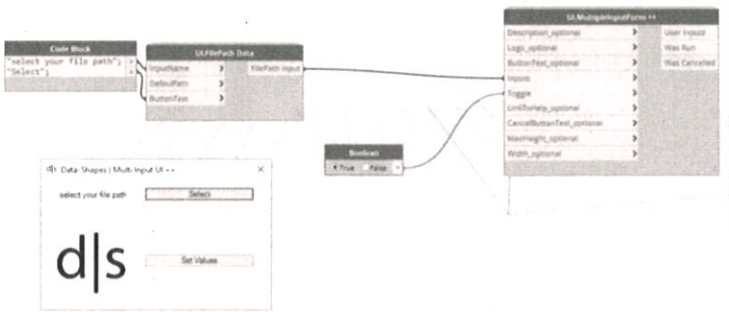


Some useful packages

- Archi-lab.net by Konrad Sobon
- Bakery by Luke Johnson
- Clockworks by andydandy
- Dynaworks by Gytaco
- Rhythm by j0hnp
- Spring Nodes by dimeter.ven
- Data-shapes by elayoubi.mostafa

Data-shapes

- Add user interface to Dynamo scripts
- Works better with Dynamo player
- Better selection mechanism



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Chapter. 7
Dynamo Player

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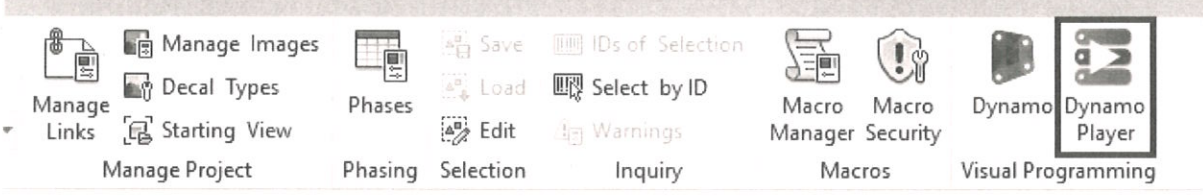
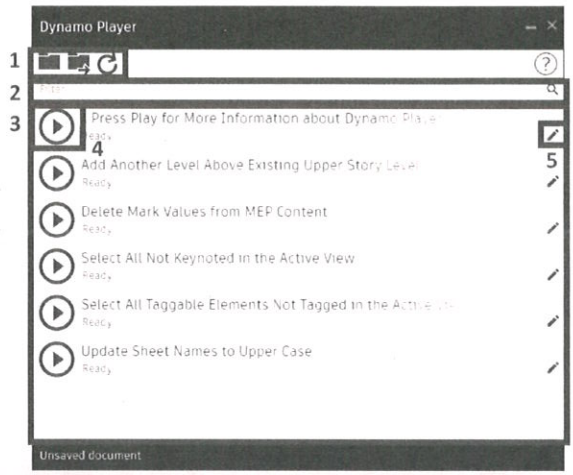
Dynamo player

- Run Dynamo scripts from list
- Without opening the script
- Included in Revit since 2017.1



Dynamo player



- 1: Folder navigation
- 2: Search/Filter
- 3: Scripts
- 4: Play script
- 5: Edit script

Ch7. Dynamo Packages, Dynamo Player

Exercise 1

In this exercise, you will learn to find and install packages in dynamo, and manage packages installed.

1. In Dynamo, locate the "Package" tab and click "Search for a Package..."
2. Type in keywords to search for the desired package. You will need the "Data-Shapes" package for the following exercises
3. Download and install the package. Make sure you selected the version 2019.2.9 for the package

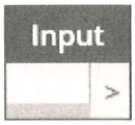
Exercise 2

In this exercise, you will learn to apply the Data-shapes package to the scripts you created previously in the course.

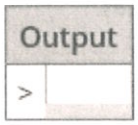
1. Run the Script for Exercise 1 in Chapter 2 in Dynamo player
2. Open the file the script, replace the Select model element nodes into single UI input from the data-shapes package
3. Add a Boolean switch to toggle the UI block
4. Change the default settings of the UI block
5. Save the script and run the script again from Dynamo player
6. Run the Script for Exercise 2 in Chapter 4 in Dynamo player
7. Open the script, replace the string node storing the file path to a UI block to browse file path from
8. Test again the script in Dynamo player
9. Do the same to other scripts that uses string node to store file path

Useful Nodes

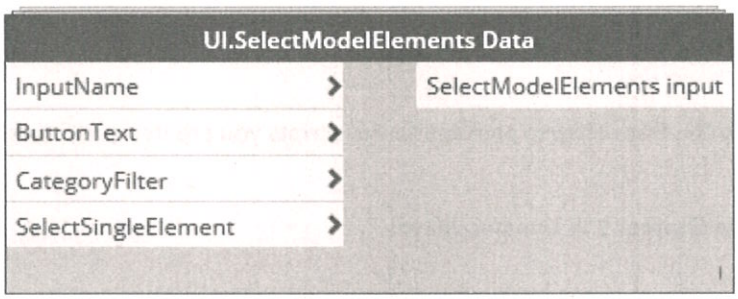
Input



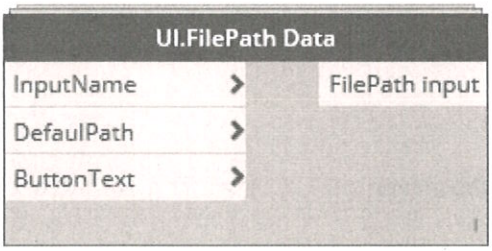
Output



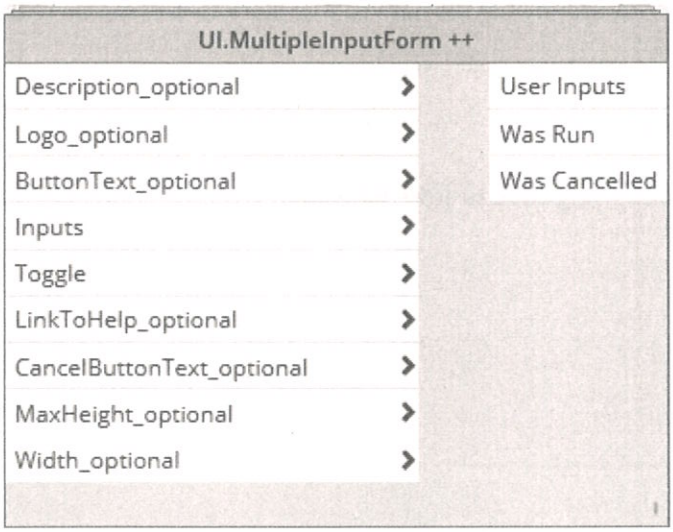
UI.SelectModelElements Data



UI.FilePath Data



UI.MultipleInputForm ++



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