

468512

# Unlock the Hidden Super Powers of Dynamo

Tadeh Hakopian  
HMC Architects

## Learning Objectives

Learn how Dynamo can use machine learning to perform path analysis and generative design.

Learn how to connect your Dynamo script to web APIs and access information for online databases.

Learn how to create specialized geometry formations with Topologic and other packages to expand modeling capability.

Learn how to document your scripts by exporting your files to GitHub for anyone to use online with special nodes.

## Description

Dynamo for a long time has been the go-to tool of Revit users to quickly script solutions to time-consuming routine problems. However, there is much more that Dynamo can do beyond scripting. There is a whole world to explore with packages and integrations which you may not be aware of. See what is possible with AI, geometry manipulation, coding, generative design in Autodesk software, and document updates, as well as accessing web APIs with Dynamo. If you think you know Dynamo, then you've only scratched the surface. Check out this class to see the true potential of Dynamo and visual scripting.

## Speaker(s)

[Add your bio(s). Photos are not required, but you can add one if you choose.]



## About the speaker

### Tadeh (Todd-A) Hakopian



Tadeh leverages BIM, VDC and Design Technology to provide his teams with impactful tools for project success. He has over 8 years of experience in the AEC field developing methods and practices to enhance project outcomes. With a background in Architecture he has worked with designers, engineers and contractors in all phases of building design and construction. Over the years he has been a part of large, complex projects in Commercial, Sports, Education, Healthcare and Residential sectors. His current focus is on design automation, data insights in projects and comprehensive workflows that come full circle in planning project life cycles. He is an active speaker at conferences and his local community meetups. Current Professional Goals Help move the AEC profession into new horizons using value driven solutions and innovative research.

Disclaimer:

This is a starting off point to learn more

For more information please check out the referenced links

Sections:

Geometry

GIS / Maps

Text Coding in Dynamo

Machine Learning

Web API

Github docs

External software integration

Cross platform integration

# GEOMETRY POWERS



## TITLE

DynaShape

## WHAT IS IT

Open-source Dynamo plugin for constraint-based form finding, optimization and physics simulation

## ORIGIN

Long Nguyen

## REPO

<https://github.com/LongNguyenP/DynaShape>

## USE CASE

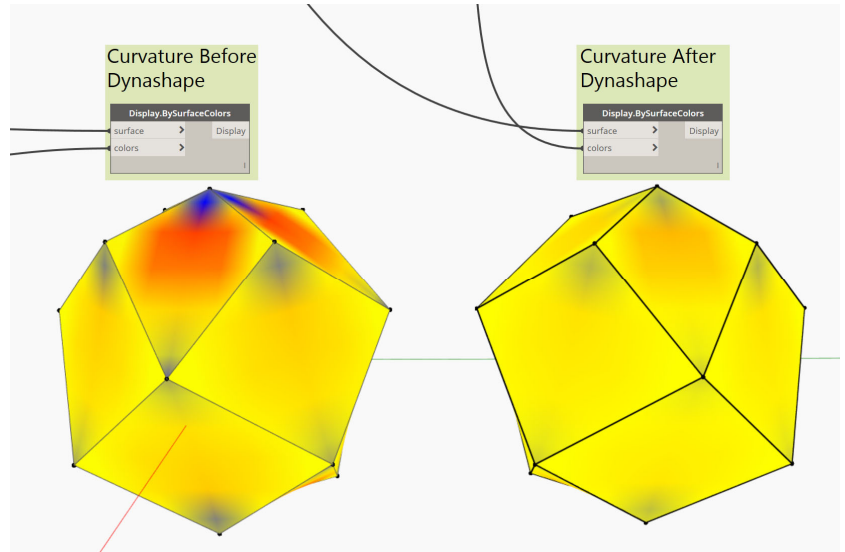
DynaShape is a Dynamo package for constraint-based form finding, optimization and physics simulation. The core algorithm is based on ShapeUp 85. This provides an important theoretical foundation by formally describing how different geometric constraints can be defined in a unified and extensible framework, how they can be solved/optimized simultaneously and under what conditions the solution can be guaranteed.

## MORE INFORMATION

<https://forum.dynamobim.com/t/dynashape/11666>

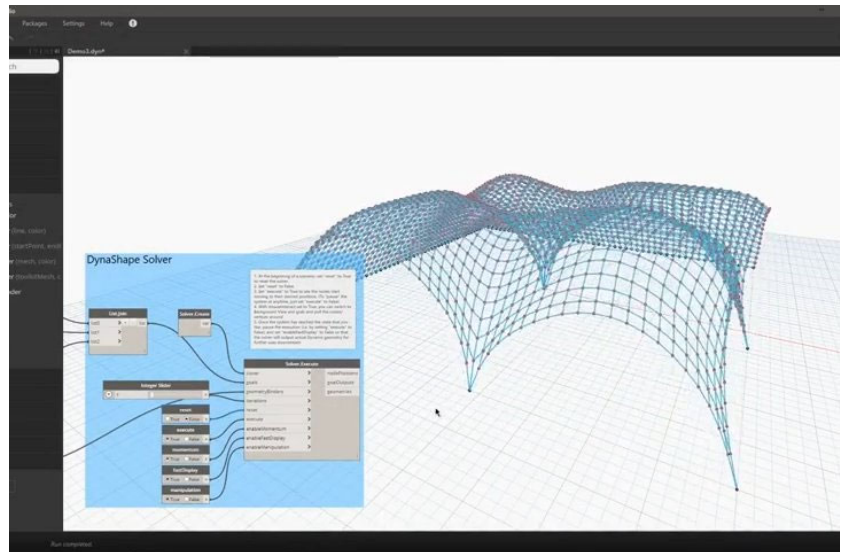
## Refine shape geometry

Dynashape can help you optimize geometry so the shapes match what you want instead of compromising into 'close enough' forms



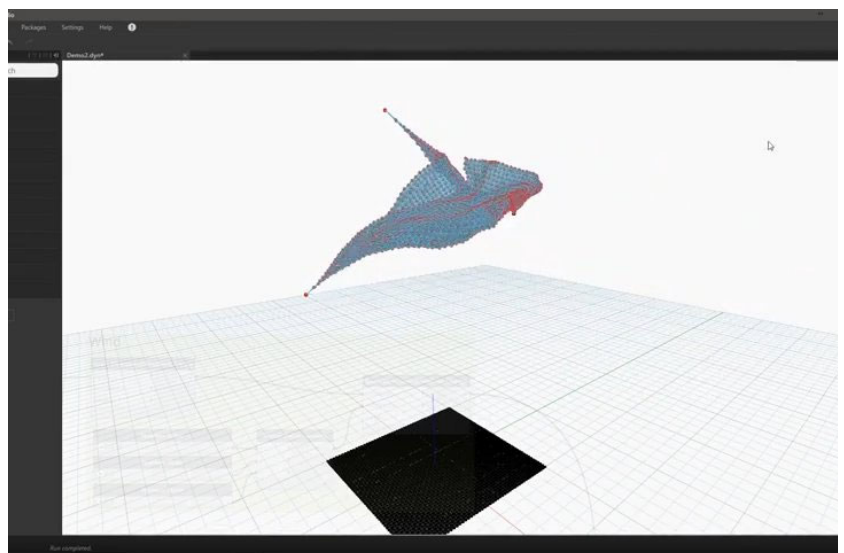
## Diagrid Catenary arches

Create elegant forms with finite control



## Drape fold

Create fluid shapes!





## TITLE

Topologic

## WHAT IS IT

Topologic is a software modelling library enabling hierarchical and topological representations of architectural spaces, buildings and artefacts through non-manifold topology.

## ORIGIN

Dr. Wassim Jabi and the Topologic Team

## REPO

<https://github.com/NonManifoldTopology/Topologic>

## USE CASE

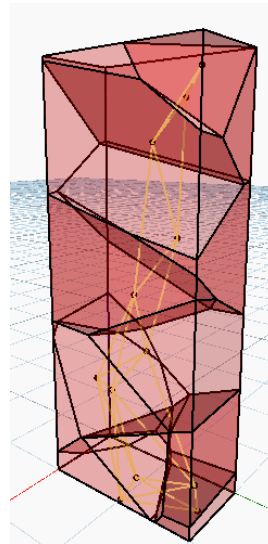
Topologic can be used to support energy modelling - say dimensioning the windows on different sides of a hospital to avoid summer overheating Topologic can be be used to plot paths such as fire egress routes, the least disruptive route for a new service pipe or the most congested location in a city layout

## MORE INFORMATION

<https://topologic.app/learning/>

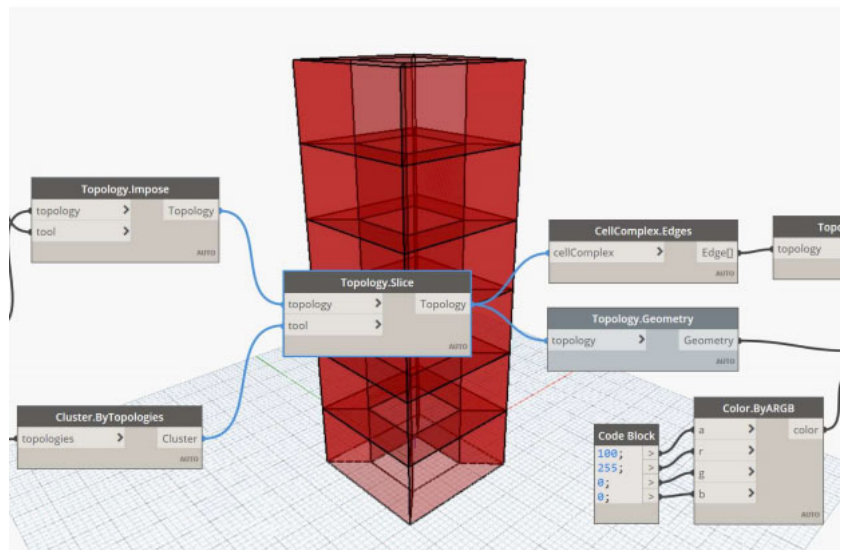
## Voronoi

Create geometry that use faces and shells to explore space configuration in ways regular Dynamo or Revit modeling is unable to do



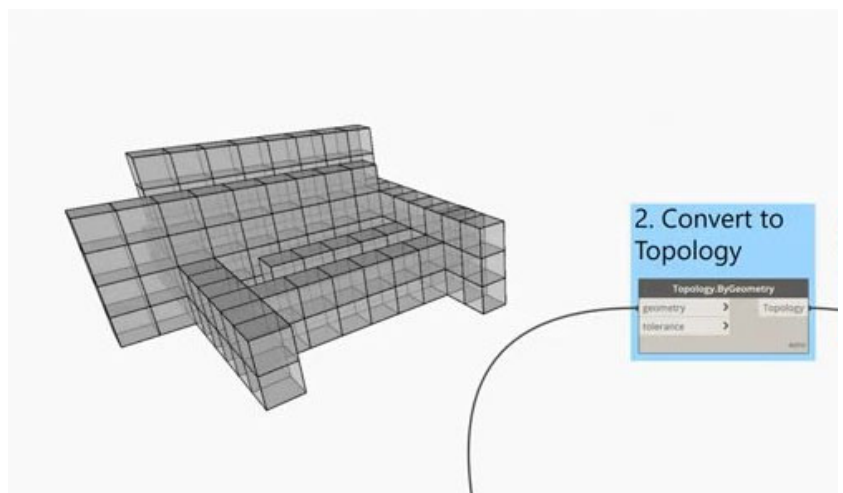
## Cell Complex

A non-manifold (non-folding) set of cells is a complex. All you need to know is new modeling capabilities are opened up by using topologic tools like complexes



## Space Integration

Organize spaces in an interconnected system to test geometry optimization



## TITLE

Project Refinery

## WHAT IS IT

An Autodesk generative design beta for the architecture, engineering and construction industry that gives users the power to quickly explore and optimize their Dynamo designs

## ORIGIN

Autodesk

## REPO

<https://www.autodesk.com/campaigns/refinery-beta>

<https://dynamobim.org/refinery-toolkit/>

## USE CASE

Generative design is used to provide practitioners the ability to quickly explore, optimize, and make informed decisions to complex design problems. Think of generative design software as an assistant that helps with creating, testing, and evaluating options. This approach is especially useful when you have many variations to consider in order to access a few optimized results. Refinery can accelerate design exploration providing a selection of optimized results based on the user input and preferences.

## MORE INFORMATION

<https://www.autodesk.com/autodesk-university/article/Design-Automation-Generative-Design-AEC-2020>

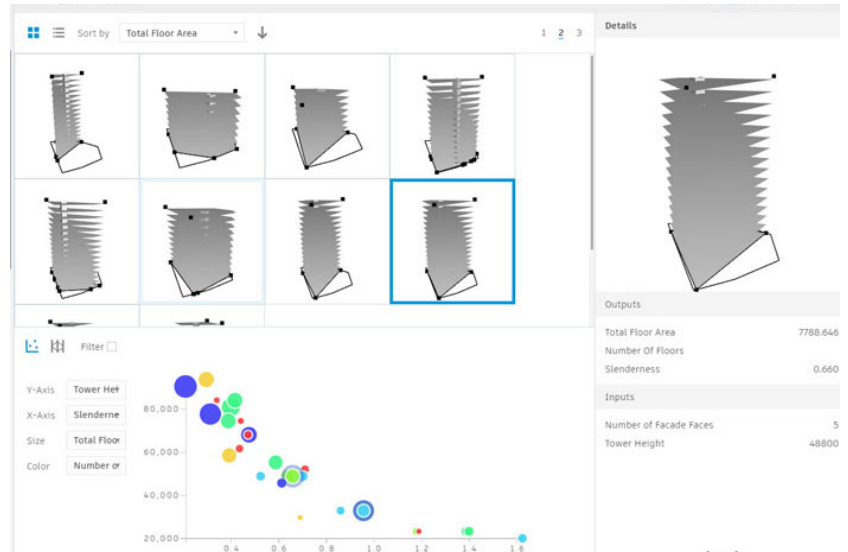
[https://www.youtube.com/watch?](https://www.youtube.com/watch?v=F3dlYANY4zo&feature=youtu.be&t=5290&ab_channel=SwissDataScienceCenter)

[v=F3dlYANY4zo&feature=youtu.be&t=5290&ab\\_channel=SwissDataScienceCenter](https://www.youtube.com/watch?v=F3dlYANY4zo&feature=youtu.be&t=5290&ab_channel=SwissDataScienceCenter)

<https://www.generativedesign.org/>

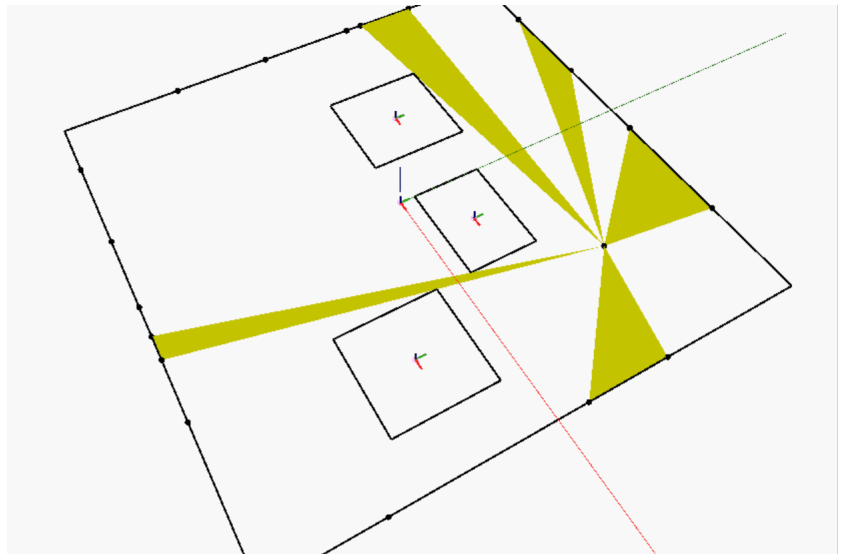
## Assess Design Metrics

Refinery lets you set inputs and outputs to generate different options for design compositions. Then you can see where the iterations line up in charts to further refine (get it, refine?) to continue making new options to narrow down results to an ideal size.



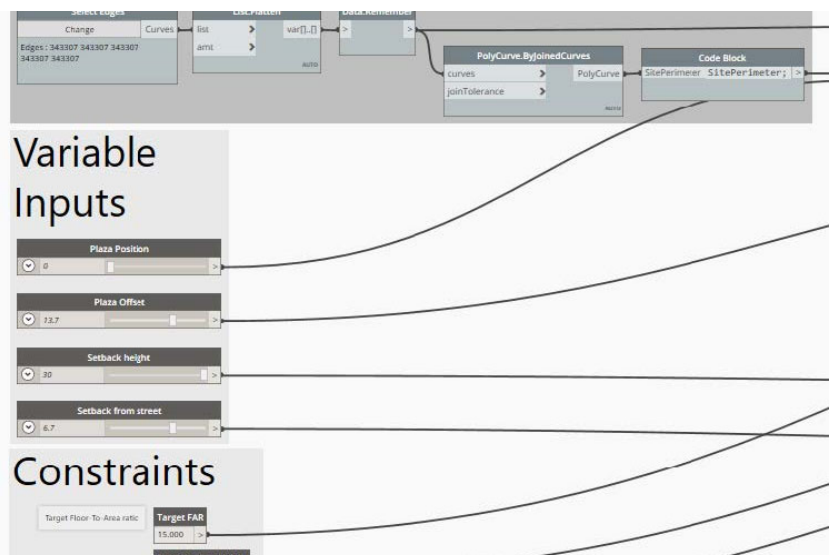
## Study spaces with environmental analysis

Sight lines inside a floor or outside in the urban landscape can be assessed in real time. Find an optimized result for your planning



## Set inputs and constraints with Dynamo

Use the Refinery Beta to connect your inputs and constraints to Dynamo for further refinement and control



# GIS / LOCATION POWERS



## TITLE

DynaMaps

## WHAT IS IT

View extension and node package which provides the most straightforward workflow to get site data into Dynamo

## ORIGIN

Mostafa El Ayoubi

## REPO

<https://github.com/MostafaElAyoubi/Data-shapes>

## USE CASE

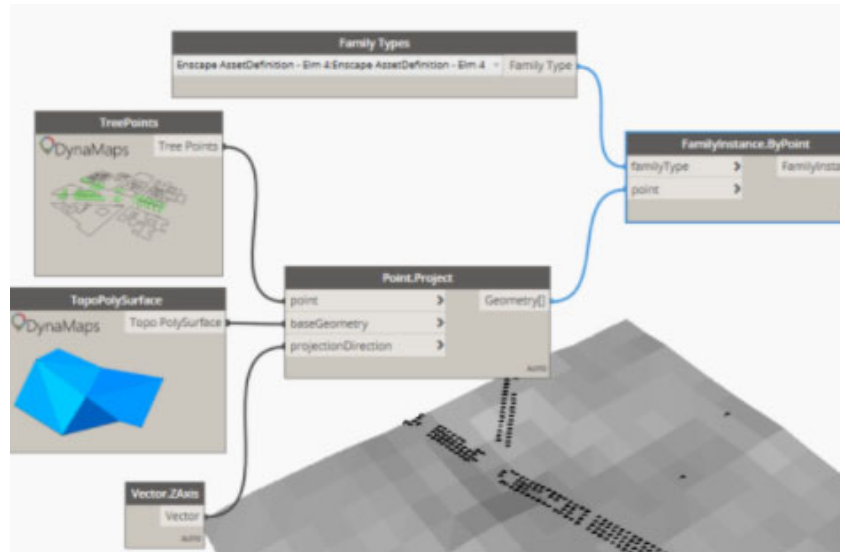
Placing site content like buildings and topography into your Revit model with the DynaMaps package nodes. Load and create site model data into Revit without having to link files and rebuild content yourself.

## MORE INFORMATION

<https://dynamobim.org/dynamaps/>

## Package nodes for GIS data load

DynaMaps has a full suite of nodes including a view extension to load all the geometry into your model.



## Load model elements into Revit

Automatically from the GIS and map content. Revit can then load the topography and building massing directly into your model





## TITLE

GIS2BIM

## WHAT IS IT

Access GIS content from online database and load them into your Revit model with Dynamo nodes

## ORIGIN

Maarten Vroegindeweij

## REPO

<https://github.com/DutchSailor/GIS2BIM>

## USE CASE

GIS2BIM is a collection of custom nodes for the Dynamo visual programming environment. It imports 2D and 3D GIS-information to Autodesk Revit-models.

## MORE INFORMATION

<https://github.com/DutchSailor/GIS2BIM/wiki/Workflows>

<http://dutchrevitblog.blogspot.com/>

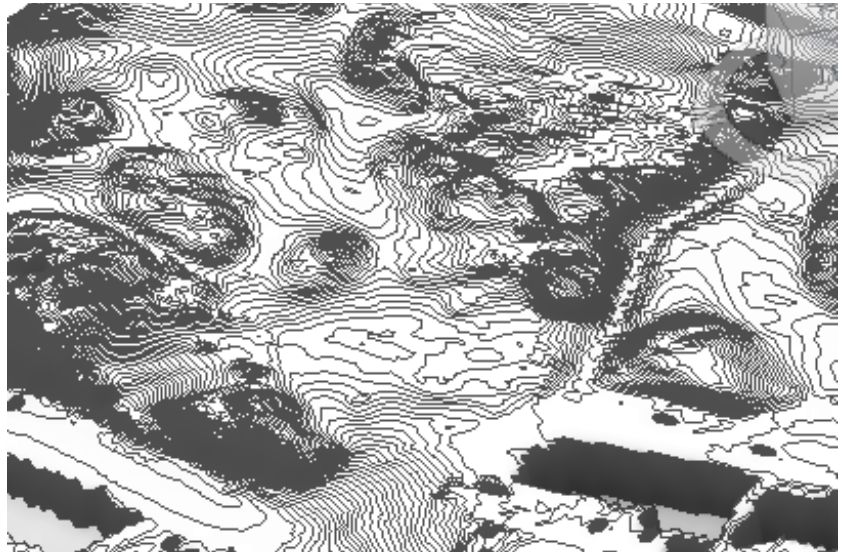
## Mass Geometry

Urban layouts can quickly be generated and added to your model



## Landscapes

Large scale Topography can be added to Revit models for large site design projects



## TITLE

Google Maps in Dynamo

## WHAT IS IT

Add Google map images into your documents

## ORIGIN

Konrad Sobon

## REPO

<https://github.com/ksobon/archilab>

## USE CASE

Take the Google maps API and get it into your model with a special node package from Archi-lab. Classic use of Dynamo that cuts down time and complexity of a task with a simple script and information that can be immediately used on your projects.

## MORE INFORMATION

<https://archi-lab.net/google-maps-static-api-in-dynamo/>



# CODING POWERS



## TITLE

DesignScript

## WHAT IS IT

DesignScript is a novel language for exploratory design useful for compacting scripts and customizing functions in Dynamo

## ORIGIN

Dynamo Team

## REPO

<https://github.com/DynamoDS/designscript-archive>

## USE CASE

DesignScript enables a 'soft transition' between visual data flow programming and text based scripting by implementing a series of intermediate programming techniques. This provides a gentle learning curve which allows the gradual introduction of more advanced programming concepts and notation. DesignScript enables the pragmatic world of design automation and production to be connected to the world of computer science and algorithmic thinking.

## MORE INFORMATION

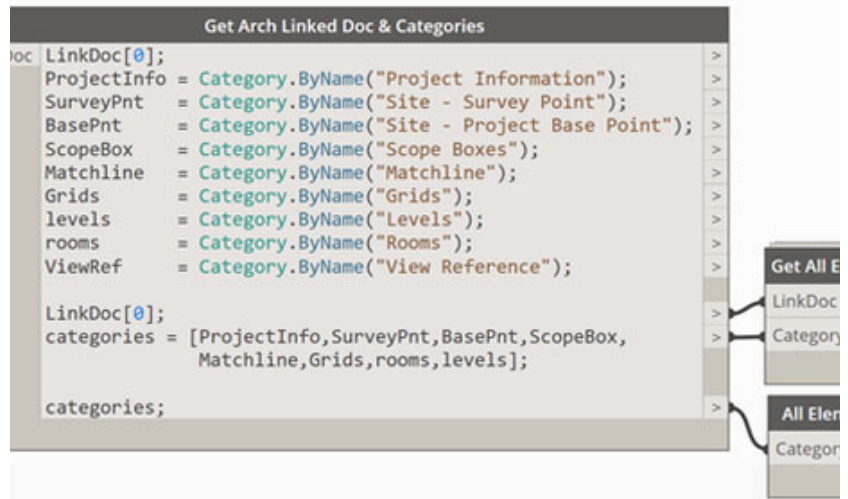
[https://primer.dynamobim.org/07\\_Code-Block/7-2\\_Design-Script-syntax.html](https://primer.dynamobim.org/07_Code-Block/7-2_Design-Script-syntax.html)

<https://dynamobim.org/wp-content/links/DesignScriptGuide.pdf>

<http://www.designscript.io/>

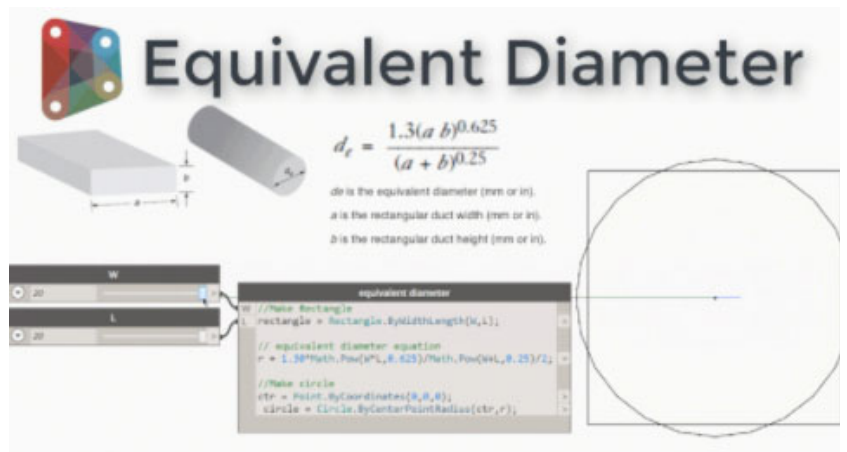
Easy to read functions

Create custom functions and logic for  
Dynamo so you can expand what is possible  
with your graphs



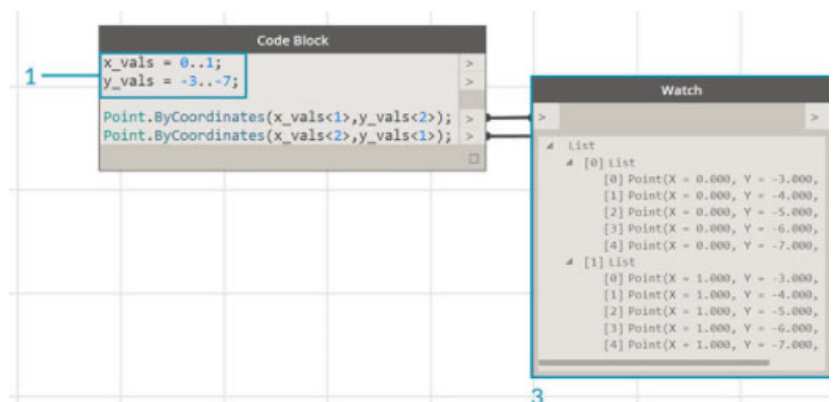
Math!

Get formulas in your script that can allow  
sophisticated functions in an easy-to-read  
format for anyone to experiment with



Formulas

Shrink your scripts so they're no a mess  
of nodes and wires





## TITLE

Zero Touch Nodes

## WHAT IS IT

Using C# code directly into your Dynamo Scripts

## ORIGIN

Dynamo Team

## REPO

<https://github.com/DynamoDS>

## USE CASE

Zero-Touch Importing refers to a simple point-and-click method for importing C# libraries. Dynamo will read the public methods of a .dll file and convert them to Dynamo nodes. You can use Zero-Touch to develop your own custom nodes and packages, and to import external libraries into the Dynamo environment.

## MORE INFORMATION

[https://primer.dynamobim.org/11\\_Packages/11-5\\_Zero-Touch.html](https://primer.dynamobim.org/11_Packages/11-5_Zero-Touch.html)

<https://developer.dynamobim.org/03-Development-Options/3-4-zerotouch-nodes.html>

<https://github.com/DynamoDS/Dynamo/wiki/Zero-Touch-Plugin-Development>

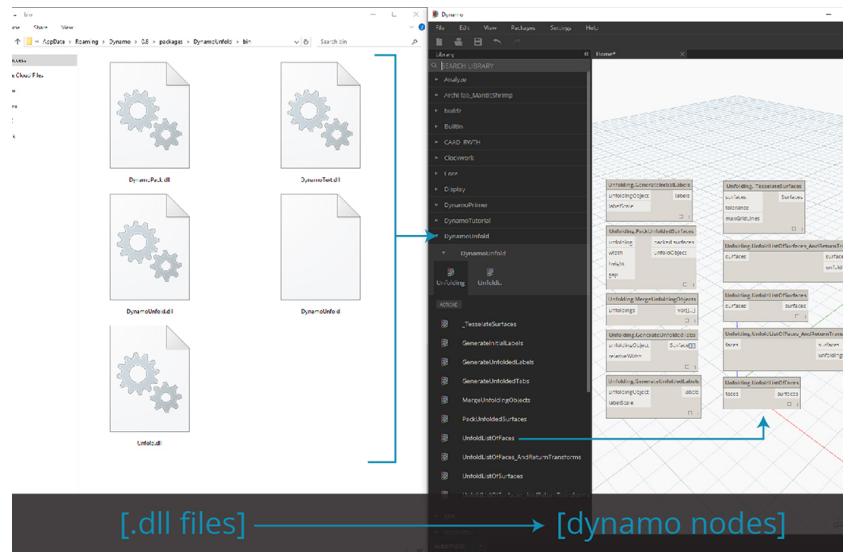
Zero Touch relies on the C# script

Autodesk provides a lot of Revit documentation in C# so finding documentation is easy if you know the language



Create custom .dll files for distribution

Packages can be made of .dll files for custom nodes



## TITLE

Python Node

## WHAT IS IT

Using Python code directly into your Dynamo Scripts

## ORIGIN

Dynamo Team

## REPO

<https://github.com/DynamoDS>

## USE CASE

The plan behind the Dynamo Project is to widen the scope of platform implementation. As Dynamo adds more programs to the platform, users will gain access to platform-specific APIs from the Python scripting environment. While Revit is the case study for this section, we can anticipate more chapters in the future which offer comprehensive tutorials on scripting in other platforms. Additionally, there are many IronPython libraries accessible now which can be imported into Dynamo!

## MORE INFORMATION

[https://primer.dynamobim.org/10\\_Custom-Nodes/10-5\\_Python-Revit.html](https://primer.dynamobim.org/10_Custom-Nodes/10-5_Python-Revit.html)

<https://github.com/Amoursol/dynamoPython>

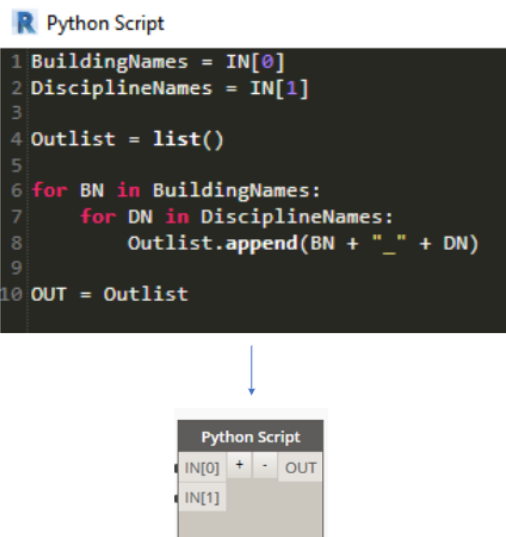
## Python3 Engine

With the Cpython implementation coming with Dynamo 2.8 you can now import popular Python3 packages for data science and visualization



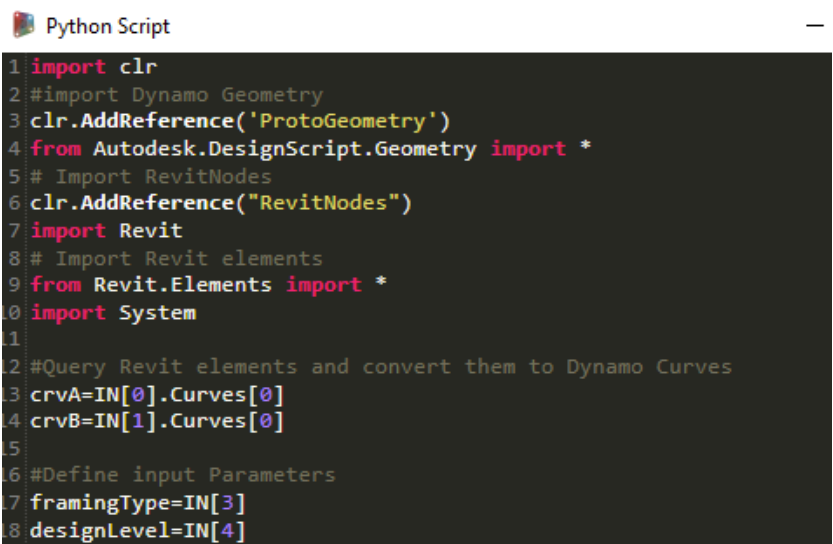
## Compacting scripts

Another option for consolidating scripts is Python coding. Loops and conditional statements can make script management much easier. Plus you can create custom nodes for packages



## Create a Template

Between a custom template and external text editor tools you can optimize your script and save time



## TITLE

Algorithms in Dynamo

## WHAT IS IT

New improvements to the Dynamo software

## ORIGIN

Dynamo Team and Developer Community

## REPO

<https://github.com/DynamoDS>

## USE CASE

The use of algorithms provides a number of benefits. One of these benefits is in the development of the procedure itself, which involves identification of the processes, major decision points, and variables necessary to solve the problem. Developing an algorithm allows and even forces examination of the solution process in a rational manner. Identification of the processes and decision points reduces the task into a series of smaller steps of more manageable size. Problems that would be difficult or impossible to solve wholesale can be approached as a series of small, solvable subproblems. The required specification aids in the identification and reduction of subconscious biases. By using an algorithm, decision making becomes a more rational process.

## MORE INFORMATION

<https://www.referenceforbusiness.com/encyclopedia/A-Ar/Algorithms.html>

<https://dynamobim.org/occupancy/>

## With DesignScript

Create your own functions and formulas in Designscript like KMeans algorithms

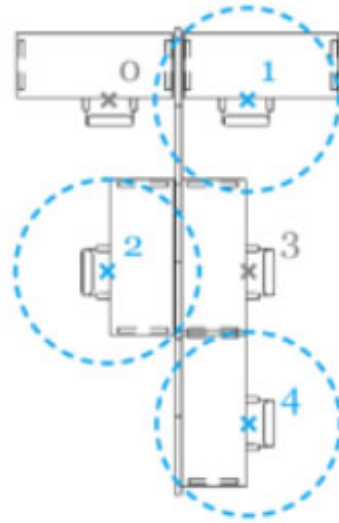
**Code Block**

```

1 // Central point of a bounding box
2 // as projected to the specified z-height
3 def BoundingBoxCenter(bbox:var, z:var)
4 {
5     minPt = BoundingBox.MinPoint(bbox);
6     maxPt = BoundingBox.MaxPoint(bbox);
7     x = (maxPt.X + minPt.X)/2;
8     y = (maxPt.Y + minPt.Y)/2;
9     return = Point.ByCoordinates(x, y, z);
10 };
  
```

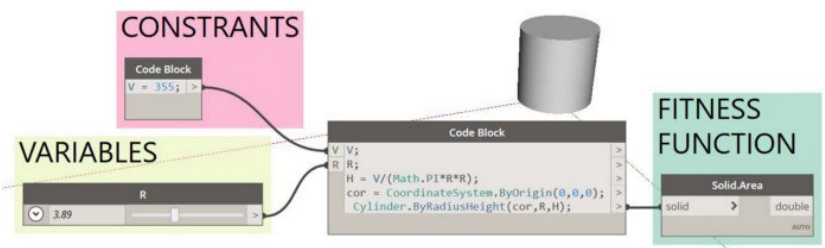
## Occupancy Planner

Sort distances between people with Algorithm based calculations



## Fitness Functions

Cross over of Design Script and Refinery toolkit to solve problems like optimized shapes per function algorithm inputs



## TITLE

DynaWeb

## WHAT IS IT

package providing support for interaction with the internet

## ORIGIN

Radu Gidei

## REPO

<https://github.com/radumg/DynaWeb>

## USE CASE

DynaWeb was designed as a package to make other packages, so it provides building blocks enabling you to build Dynamo integrations with just about any web service out there. After making DynaSlack & DynAsana, it became clear that writing a ZeroTouch-based package for every web service I or the community would want to integrate with was simply not scalable or sustainable, no matter how much code was re-used. DynAsana is an abstracted DynaSlack and DynaWeb is an even more abstracted & modularised DynAsana.

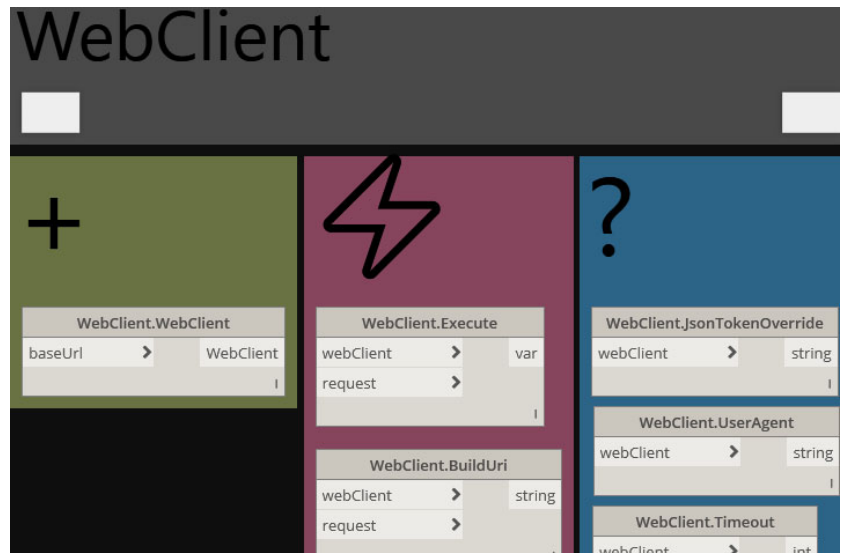
## MORE INFORMATION

<https://radumg.github.io/DynaWeb/>

<https://www.bim42.com/2020/07/dynaweb-1>

## Web API pack

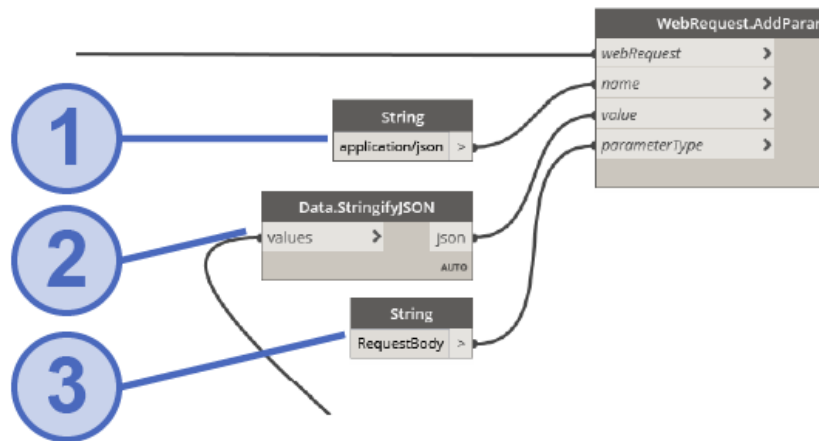
Use one package to connect Web services to your BIM models.



## Connect with Web Services

Fully connected to the Dynamo environment for web inputs and outputs

## Add the body to the request



## JSON Format

JavaScript Object Notation (JSON) is an open standard file format for data exchange commonly used in web services. This includes being able to exchange BIM data to a central database.

```
{
  "id": "rec05Tz0sAsrWLXD4",
  "fields": {
    "Code": "201",
    "Material": "Steel",
    "Width": 915,
    "Height": 2134,
    "Fire Rating": "3/4 Hours",
    "Level": "02 - Floor",
    "Frame Finish": "Polyester powder coated",
    "Doorstop": "Floor mounted door stop"
  },
  "createdTime": "2020-06-26T14:50:25.000Z"
}
```



# UPGRADES



## TITLE

Dynamo 2.8 And Beyond!

## WHAT IS IT

New improvements to the Dynamo Core software expanding the future of the software

## ORIGIN

Dynamo Team

## REPO

<https://github.com/DynamoDS/Dynamo/releases>

## USE CASE

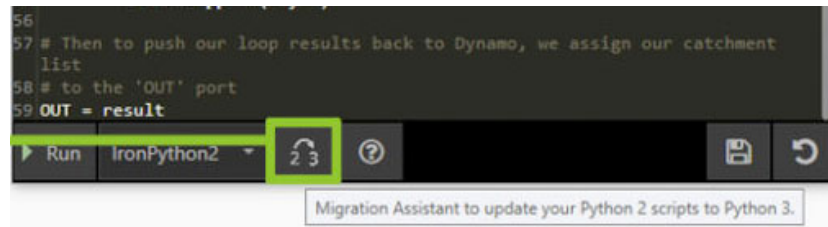
A slew of new features to improve and streamline the Python 3 experience, including better messaging, a migration assistant, more in-product help, whitespace characters, the ability to print to the Dynamo console, recognition of any potential missing IronPython2.7 engine native inside the Workspace References extension, a few targeted improvements to Geometry that allow greater control for the graph author on PolyCurves and NurbsCurves, as well as a respectable amount of bug and crash fixes that all make a much more stable and consistent Dynamo.

## MORE INFORMATION

<https://dynamobim.org/dynamo-core-2-8-release/>

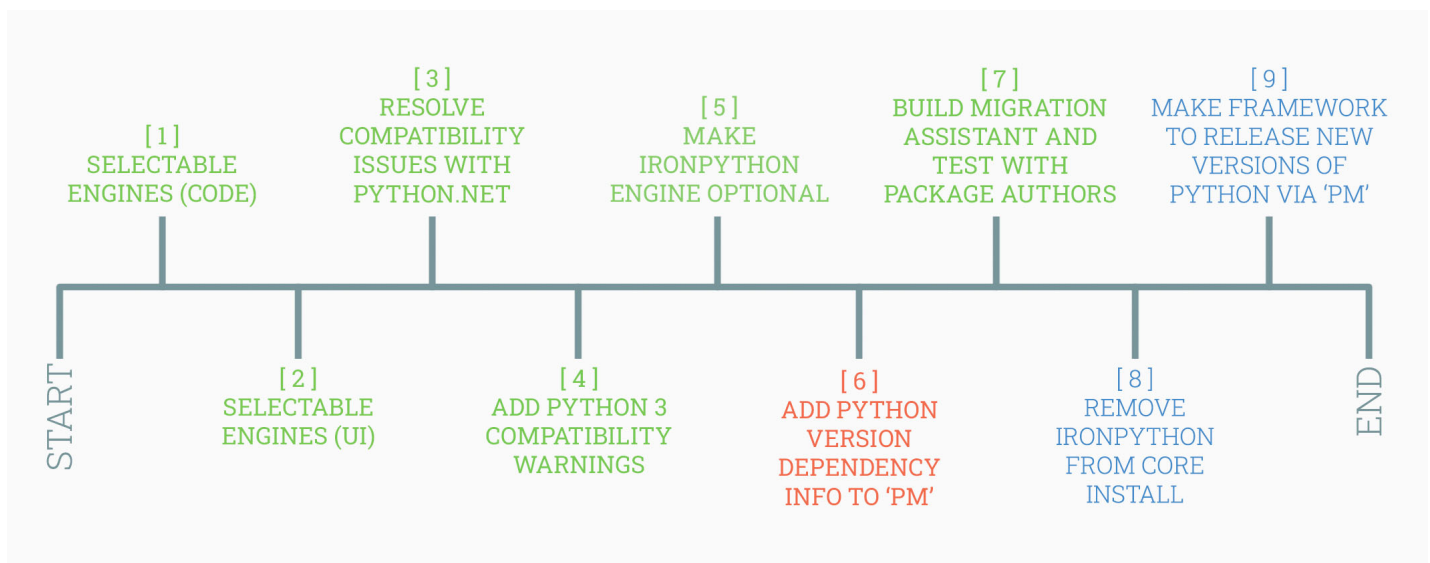
## Python3 Engine support

Enter the world of Python3 which is the standard for Python coders. You are no longer restrained to IronPython's Python2x implementation. That's a big deal.



## The Roadmap

A lot of ground has been covered and more progress will come to improve the Dynamo core product. Talk to the Dynamo team and let them know what you want to see more of!



## TITLE

Data Science Packages with Cpython

## WHAT IS IT

Access popular python3 libraries with the Cpython interpreter

## ORIGIN

Dynamo Team

## REPO

<https://github.com/DynamoDS>

## USE CASE

Simplifying workflows requiring data extractions from a model to analysis

## MORE INFORMATION

<https://dynamobim.org/dynamo-core-2-8-release/>

<https://jupyter.org/>

<https://numpy.org/>

## Use Jupyter Notebooks

open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more.



## Use Numpy Package

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays



## Import packages

The way you access all this enhanced horsepower is through imports on your code. Now supported with Dynamo 2.8

```
Python Script
1 # Load the Python Standard
2 import sys
3 import clr
4 import random
5 import numpy as np
6 #import pandas as pd
```

## TITLE

DynaHub

## WHAT IS IT

Dynamo Extension to interact with GitHub. Enable Dynamo to pull graphs from GitHub + version control

## ORIGIN

Andrea Tassera

## REPO

<https://github.com/Dre-Tas/DynaHub>

## USE CASE

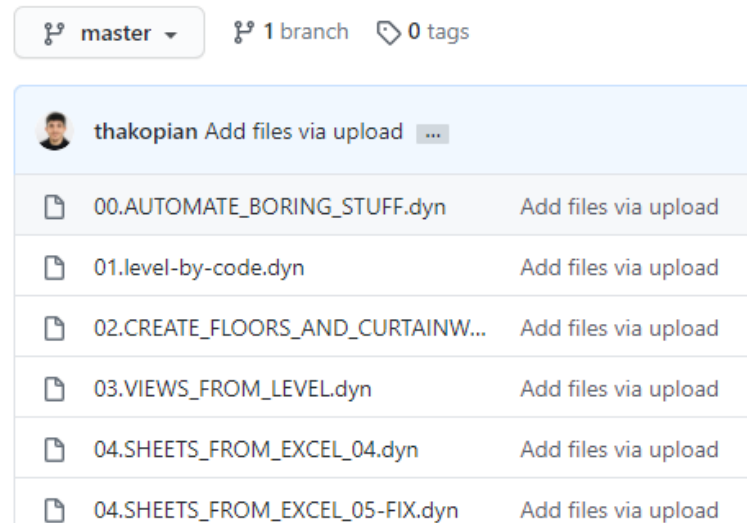
GitHub is widely used in software engineering for facilitating collaboration and consistency of code over time. However, it has never been applied in computational design. DynaHub—an open-source Dynamo extension that connects Dynamo to GitHub—bridges a gap by letting you push and pull automations and packages from a centralized and accessible repository. Any user or organization, through their GitHub account, can use the Dynamo scripts stored in their own repository, knowing that they are using the most recent and validated version.

## MORE INFORMATION

<https://www.autodesk.com/autodesk-university/class/Dynamo-GitHub-DynaHub-Adopting-New-Innovative-Repository-Dynamo-Content-2019#handout>

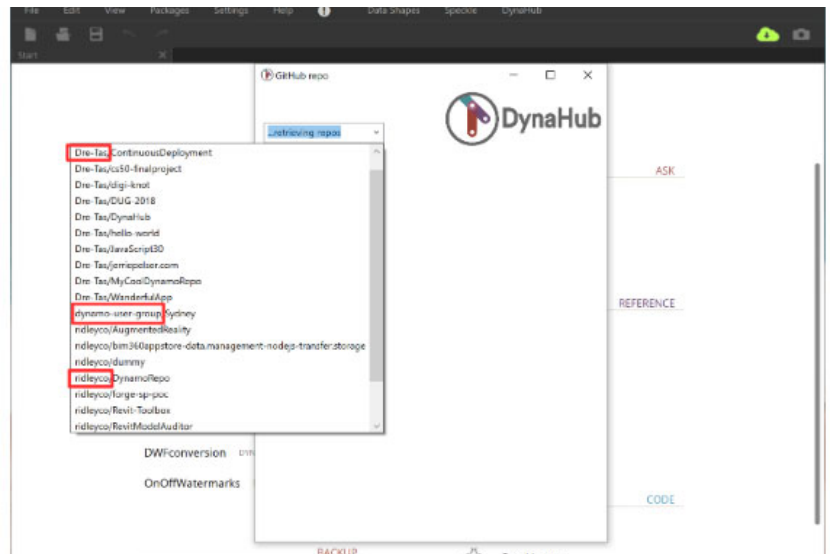
## Store your files on Github

Upload your scripts onto Github. It's free and is a convenient place for Dynamo script files and related assets like text code in Python and C#



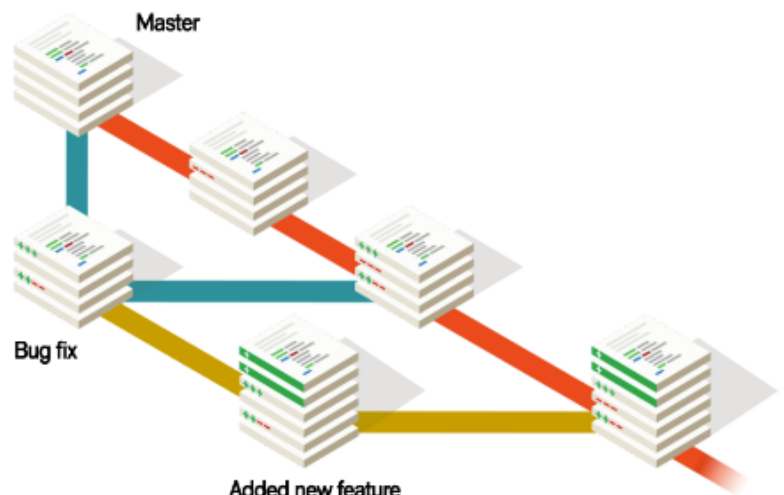
## Open them with Dynahub

Login through Github through the Dynahub view extension. Now you can access all your files from a Github repo to open on your computer



## Distribute them to your Group

Github uses Git for Tracking versions of the code so you can review who edited the files. As your Dynamo content gets more complex and more people contribute to the scripts tracking the changes becomes critical





# ROGUE POWERS



## TITLE

Hypar

## WHAT IS IT

platform for designing, generating, and sharing building systems

## ORIGIN

Hypar Team

## REPO

<https://github.com/hypar-io>

## USE CASE

Platform to generate, visualize and analyze buildings to make better decisions faster. You can easily add your own processes and expertise so you don't start from square one with each new project.

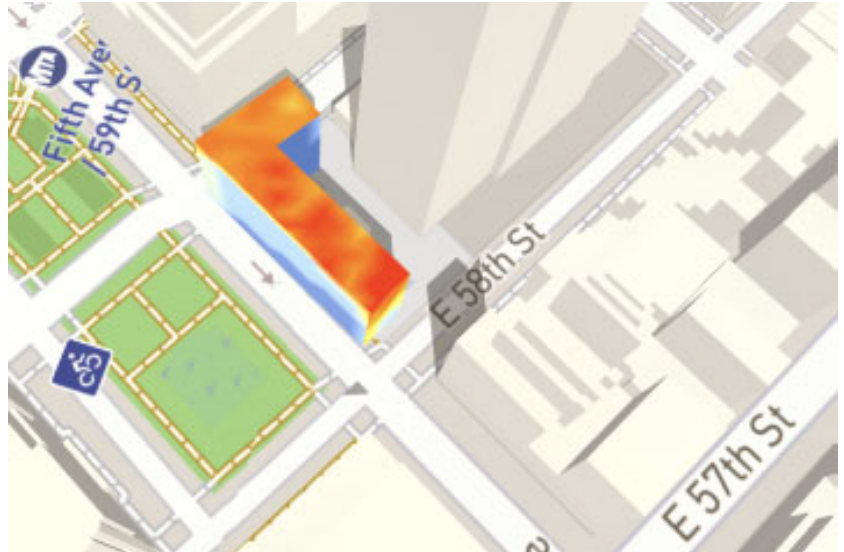
Quickly generate proposals by combining different building systems that intelligently interact. Include analysis and simulation tools created by industry experts to predict and drive performance. Take designs from concept to construction, system by system.

## MORE INFORMATION

<https://www.autodesk.com/autodesk-university/class/White-Blank-Page-MEP-Conceptual-Design-Dynamo-and-Hypar-2019#presentation>

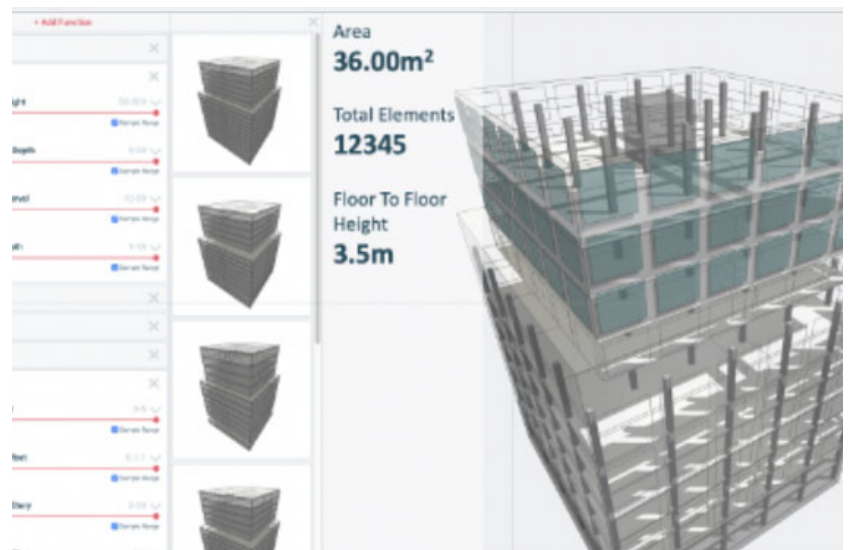
## Site Analysis

Hypar has its own site context tools to use on their own or with your scripts



## Custom Optioneering

Create your own generative design system for inputs as you see fit



## TITLE

Proving Grounds

## WHAT IS IT

Enterprise customization with open source tools

## ORIGIN

Proving Grounds team

## REPO

<https://provingground.io/tools/>

## USE CASE

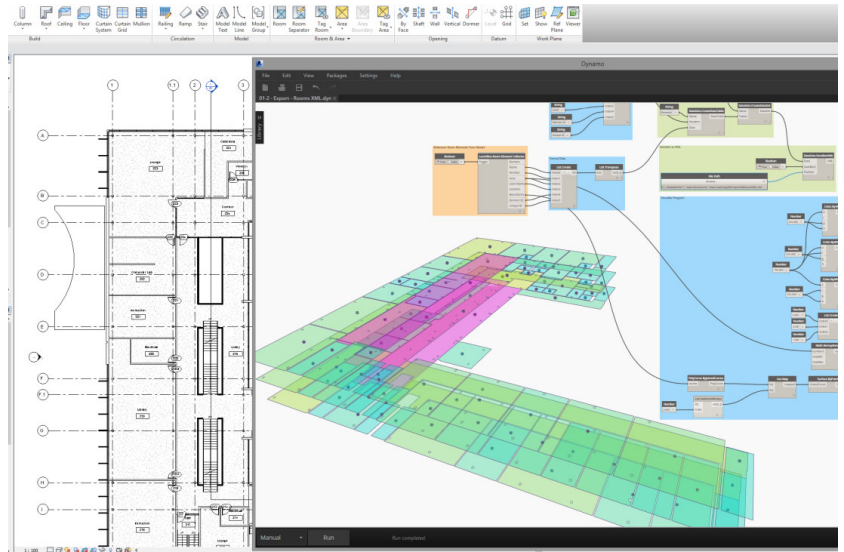
The plugins include new component nodes for managing data and geometry for activities such as generative form making, paneling, rationalization, and interoperability

## MORE INFORMATION

<https://provingground.io/tools/>

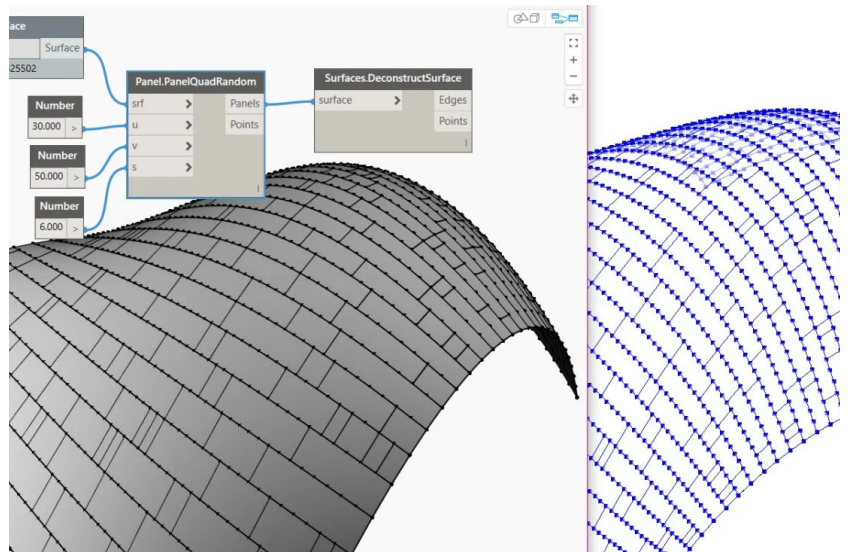
## Space Data

Collect Data from your models



## Dynamo Package

Proving Grounds has full support for Dynamo



## TITLE

TestFit IO

## WHAT IS IT

A generative design and co-creation tool that allows a user to get a site TestFit in seconds for multifamily development.

## ORIGIN

TestFit team

## REPO

<https://blog.testfit.io/testfit-home>

## USE CASE

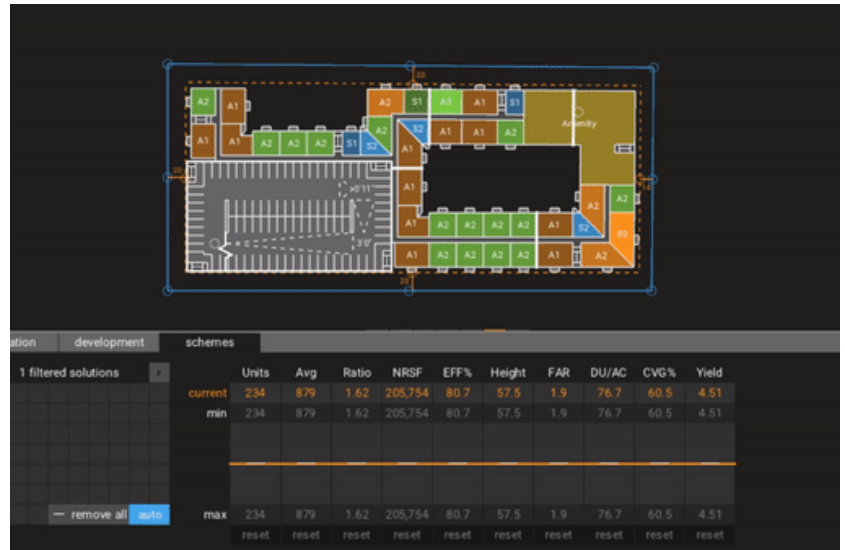
TestFit users are architects, brokers, contractors, developers, or anyone wanting to do feasibility studies.

## MORE INFORMATION

<https://provingground.io/tools/>

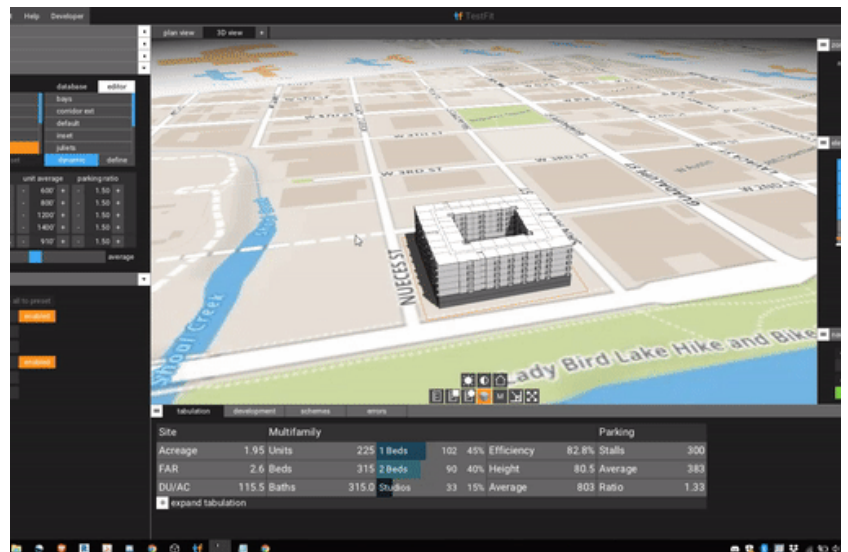
## Unit Analysis

Create on the fly floor plans with rationalized egress



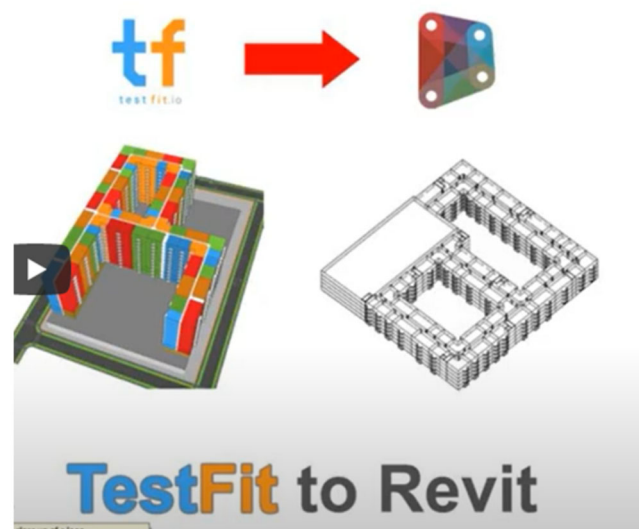
## Site Planning

## Check sites in the urban context



## Dynamo Package

## Full support for Dynamo





## TITLE

PyRevit

## WHAT IS IT

Rapid Application Development (RAD) Environment for Autodesk Revit

## ORIGIN

Ehsan Iran-Nejad

## REPO

<https://github.com/eirannejad/pyRevit>

## USE CASE

pyRevit (with lowercase py) is a Rapid Application Prototyping (RAD) environment for Autodesk Revit. It helps you quickly sketch out your automation and addon ideas, in whichever language that you are most comfortable with, inside the Revit environment and using its APIs. It also ships with an extensive set of powerful tools that showcase its capabilities as a development environment.

## MORE INFORMATION

<https://www.youtube.com/c/pyRevit/playlists>

<https://www.notion.so/pyRevit-bd907d6292ed4ce997c46e84b6ef67a0>

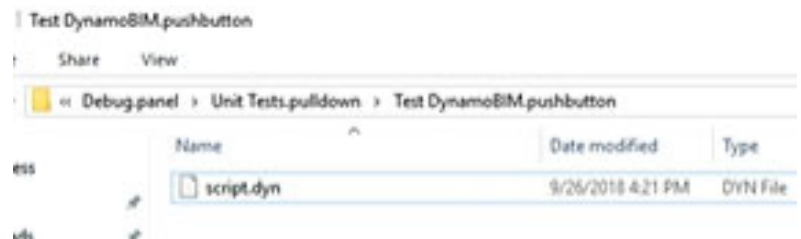
## SAMPLE 1

pyRevit makes adding tools for Revit easy and is a good follow up to your Dynamo development. Once you feel like a workflow in Dynamo has broader application across teams then software like pyRevit can make it a deployable tool.



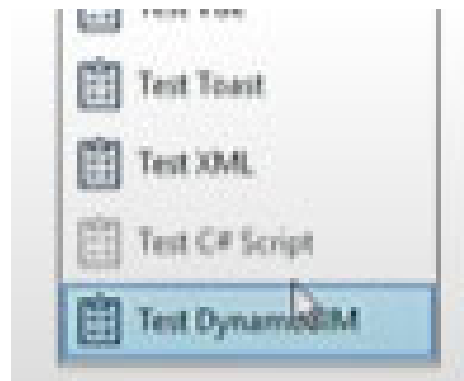
## SAMPLE 2

You can launch Dynamo scripts through PyRevit.



## SAMPLE 3

Between the built in tools, Prototyping new tools and distributing Dynamo scripts you can have a lot of capabilities released with PyRevit. It's a great addition to any Dynamo user's toolset.



# THE NEW HEROES



## TITLE

Integrations

## WHAT IS IT

New improvements to the Dynamo Core software for cross-platform support

## ORIGIN

Dynamo Team

## REPO

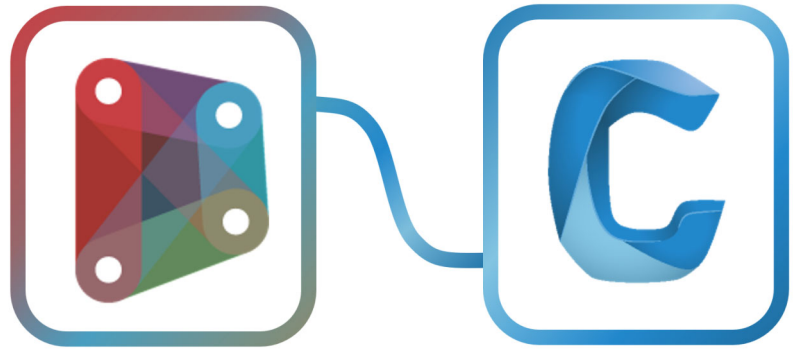
<https://github.com/DynamoDS>

## USE CASE

Visual scripting available on many software platforms

## Dynamo and Other Software

Dynamo is not just Revit. The software lets you integrate with many different tools! You can even connect with other completely non-Autodesk software if you want to



## Expansion

Soon the same Dynamo platform will be available to many more Autodesk products expanding the super powers even more!



DYNAMO  
SANDBOX



FORMIT



DYNAMO  
REVIT



DYNAMO  
STUDIO



Civil 3D



ADVANCE  
STEEL

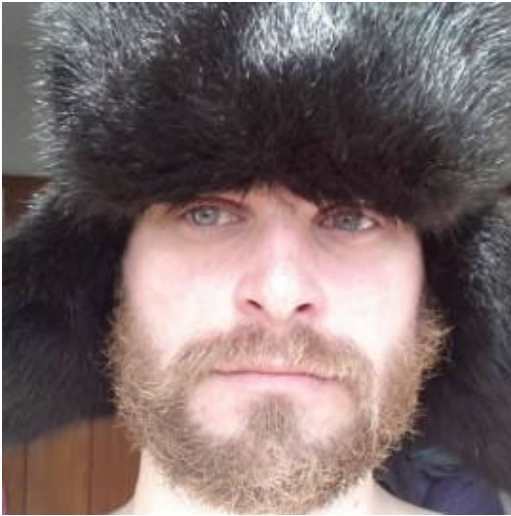


ALIAS  
DESIGN

More coming soon!

A very special thanks to the Dynamo Team at Autodesk for improving their product and supporting the community

Not all heroes wear capes



## Everyday heroes

All the workhorse packages, Contributors and the Dynamo team who are the real heroes!

### List of packages

<https://www.autodesk.com/autodesk-university/class/Dynamo-Packages-Have-You-Tried-These-Yet-2018#presentation>

- Archi-lab
- Bang!
- Parametric Monkey
- Clockwork
- Data-Shapes
- Juggernaut
- Lunchbox
- Monocle
- Rhythm
- Springs
- Simplex
- And Many More!

TITLE



## Tadeh Hakopian Contact Information:

Twitter: [https://twitter.com/tadeh\\_hakopian](https://twitter.com/tadeh_hakopian)

Linkedin: <https://www.linkedin.com/in/thakopian/>

Github: <https://github.com/thakopian>



