

Take Your Coding to the Next Level

Evolving Your Developer Tech Tools

By Tadeh Hakopian

April 14, 2021



YourDesk University
Learning With AEC Tech Experts

WHAT ARE WE TALKING ABOUT?

- This talk is about how to get started with coding practices for people who don't know much about it
- All the main steps to start use open source tech tools including learning resources
- Anything else is beyond the scope of this talk
- But feel free to ask questions ☺



ABOUT ME

- Tadeh Hakopian
- (Todd-A) (Ha-co-pea-on)
- Design Technologist and Developer
- Background in Architecture
- Experience in Architecture, Engineering and Construction disciplines with BIM and VDC workflows
- Course Author and Speaker for BIM, Dynamo and Coding content



ABOUT HMC DIGITAL PRACTICE



Nancy Reyes

Interim Digital Practice / BIM Technology Director



Cody Winchester

Lead Technology Trainer



Noah Kelly

Design Technology Manager



Tadeh Hakopian

BIM Technologist



Sara Cabal

Content Manager



Jan-Paul Kneski

BIM Manager



Brittney Holmes

Design Technologist



Tifani Grant

Technology Trainer

CAN YOU BECOME A CODER?

- ✓ Do you like to think through problem solving
- ✓ Are you interested in visual script code
- ✓ Do you find yourself reading through posts to solve problems
- ✓ Does long term projects with iterative updates sound like something that would work for you?



CAN YOU BECOME A CODER?

If any applies to you then you too can code!

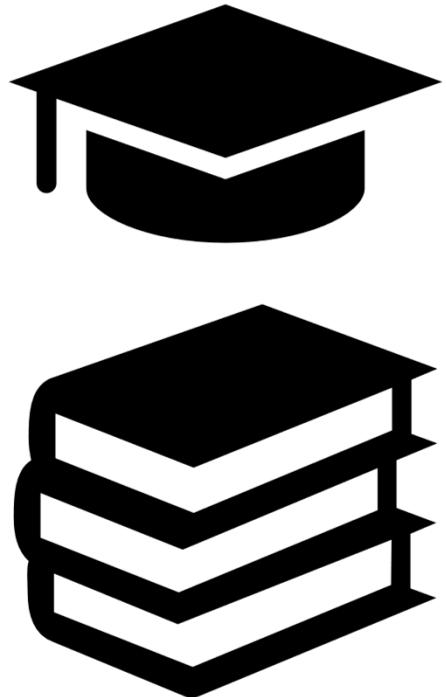


IMPORTANT PARTS

Get out of your comfort zone



There's always something you can learn

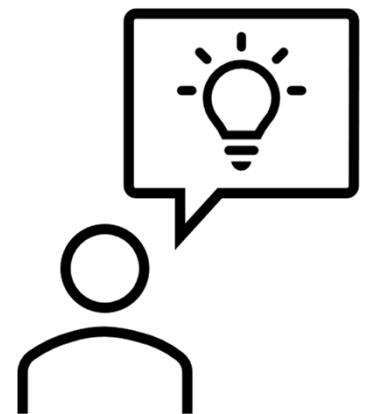


Just try something

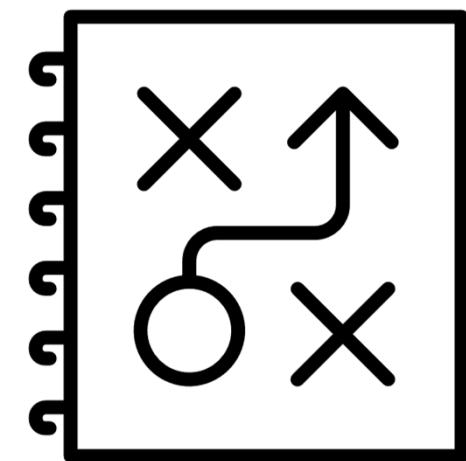


FIRST STEP – WHAT'S YOUR END GOAL?

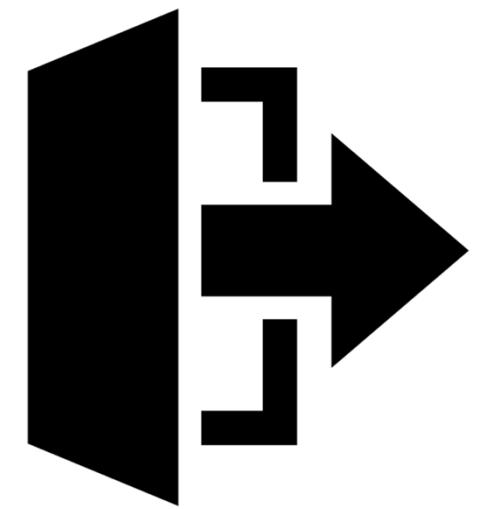
What interests you?



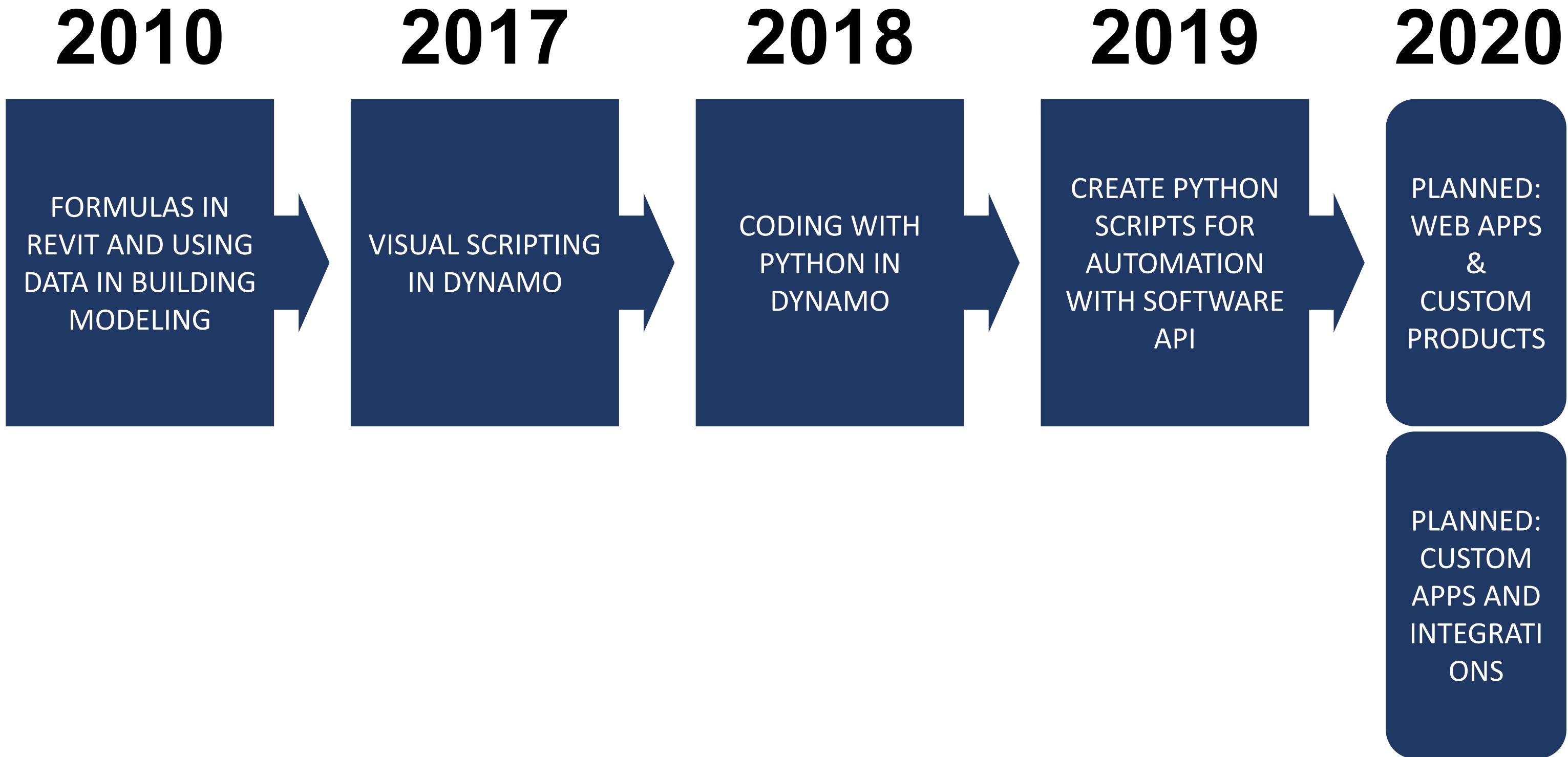
Which problems do you want to solve?



What is the best way to deliver these solutions?

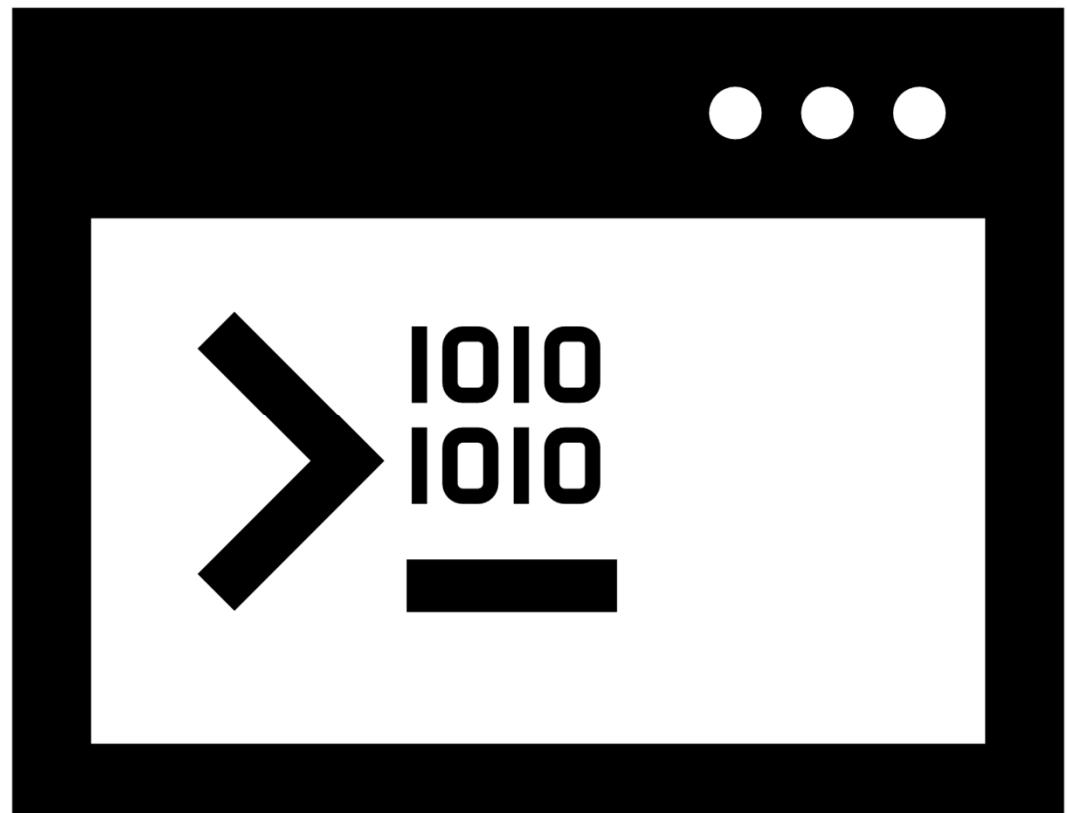


MY DEVELOPER PATH



WHAT DOES CODING LOOK LIKE?

- Most Coding is straight forward
- You add lines of text to instruct the computer to complete a process
- Then execute that code in a script to perform the process
- A good chunk of your time is understanding the right problem to solve then debugging the code so it runs correctly



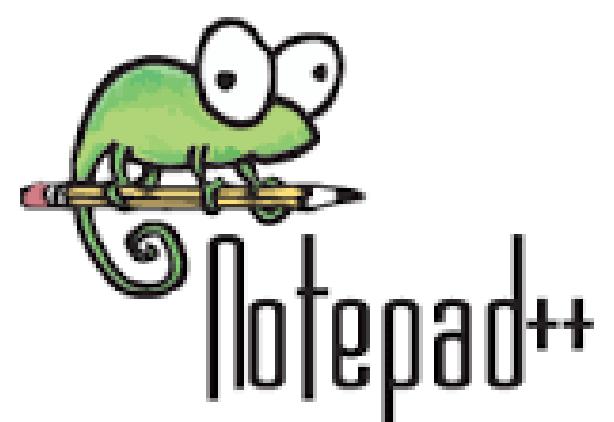
GET AN EDITOR!

- If you can't write code then you can't do much
- Text editors are helpful to write and format code
- You can type all your code on Windows Notepad but that sucks
- They include helpful auto-complete, error checking and debug systems
-
- Text editors can also run code and create virtual environments to deploy code

```
1 /*  
2  * Off-canvas mobile menu navigation  
3  */  
4  
5 .button__mobile-menu {  
6  position: relative;  
7  padding: 0;  
8  border: none;  
9  background: transparent;  
10 color: white;  
11 font-size: 18px;  
12  
13 @include respond-to($break-mobile-header) {  
14   display: none;  
15 }  
16  
17 &:after {  
18   content: "";  
19   display: inline-block;  
20   vertical-align: bottom;  
21   height: 25px;  
22   width: 30px;  
23   background-repeat: no-repeat;  
24   background-position: center;  
25   background-size: 20px;  
26   background-image: url(../images/svg/icon-nav.svg);  
27   margin-left: 5px;  
28  
29   .layout__hero-wrapper & {  
30     background-image: url(../images/svg/icon-nav-shadow.svg);  
31     background-size: 30px;  
32     background-position: center bottom;  
33   }  
34  
35  
36 &.js-overlay--mobile-menu-active:after {  
37   margin-left: 0;  
38   background-size: 20px;  
39   background-position: center 20px;
```

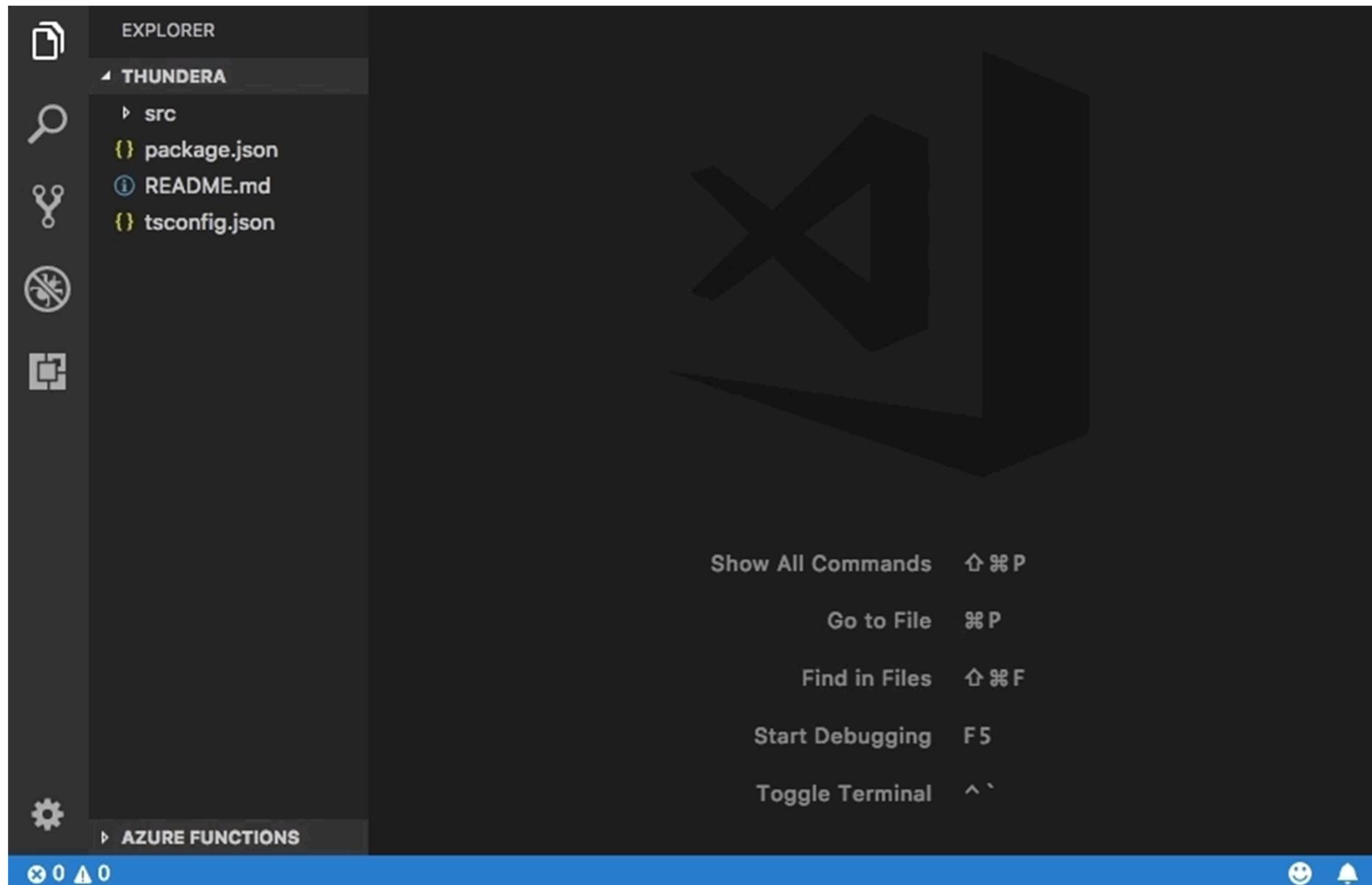
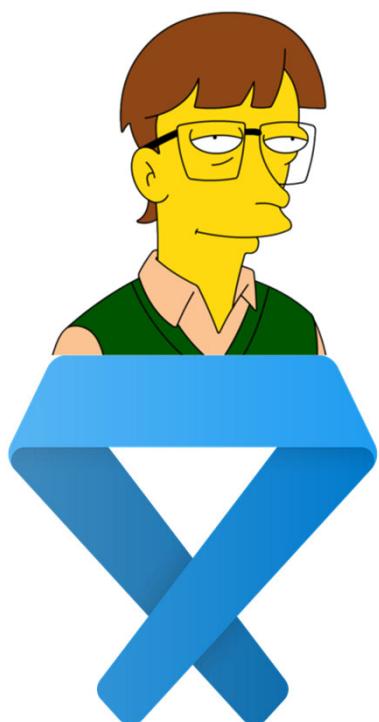
GET AN EDITOR!

- There are a lot of editors out there which to choose from
- Vim
- Sublime Text
- Atom
- Gnat
- Brackets
- VS Code
- Notepad++
- Regular Notepad
- Maybe 20-30 more out there...



VS CODE

- VS Code is simple and easy to pick up
- Becoming an industry standard
- Lots of add in support which is nice
- <https://code.visualstudio.com/>



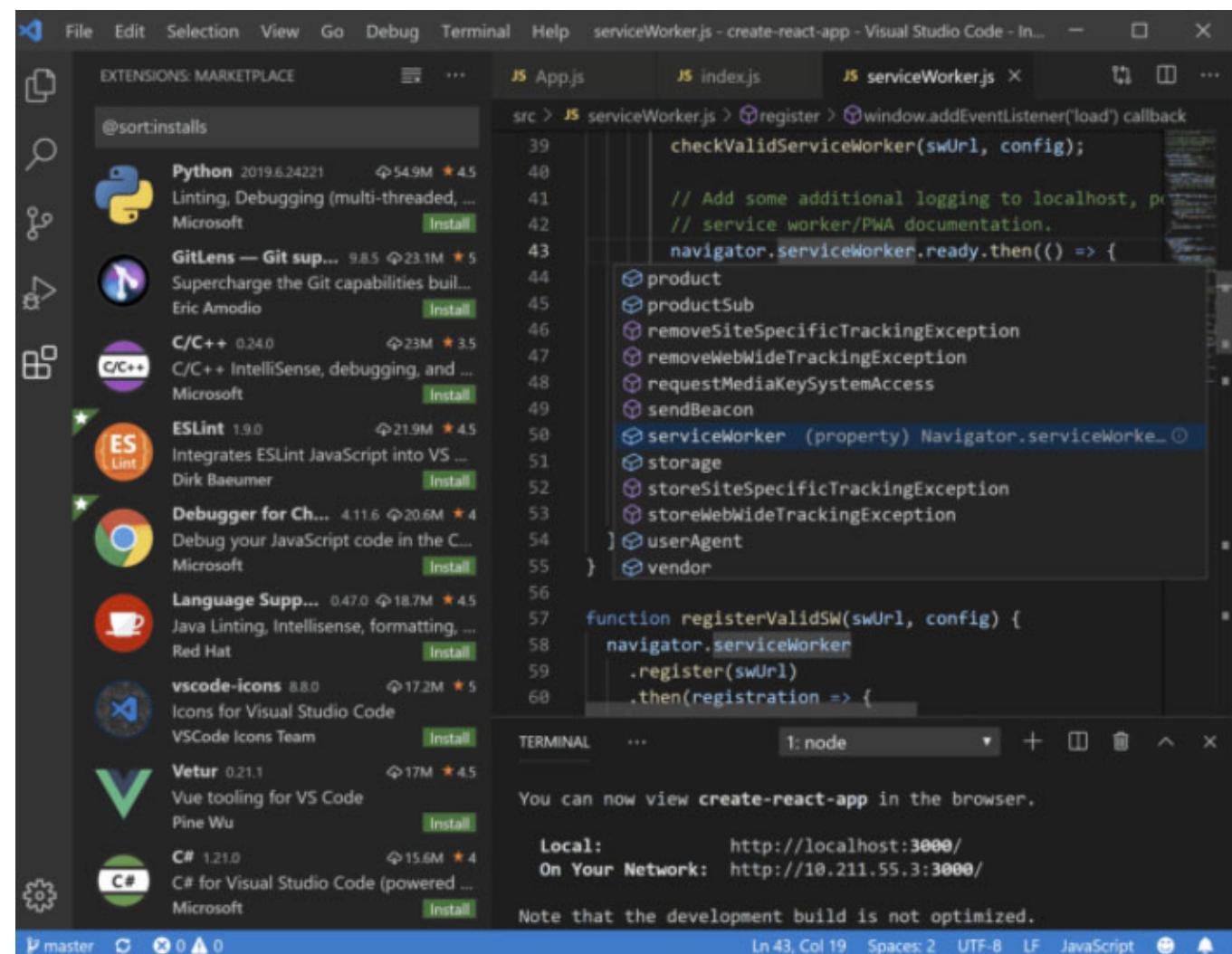
FOLDER STRUCTURE

- Locate your files in a convenient folder location
- Nothing special just someplace where your code is organized consistently
- Some notes -
<https://www.bryanbraun.com/2017/08/29/how-i-organize-the-code-folder-on-my-computer/>

This PC > Windows (C:) > 0_LOCAL_LENOVO > CODING > PYTHON					
	Name	Date modified	Type	Size	
+_02	VS CODE_JUPYTER_TESTS.ipynb	1/5/2021 3:47 PM	IPYNB File	0 KB	
TS	VS CODE_JUPYTER_TESTS.txt	1/5/2021 3:46 PM	Text Document	0 KB	
Files					

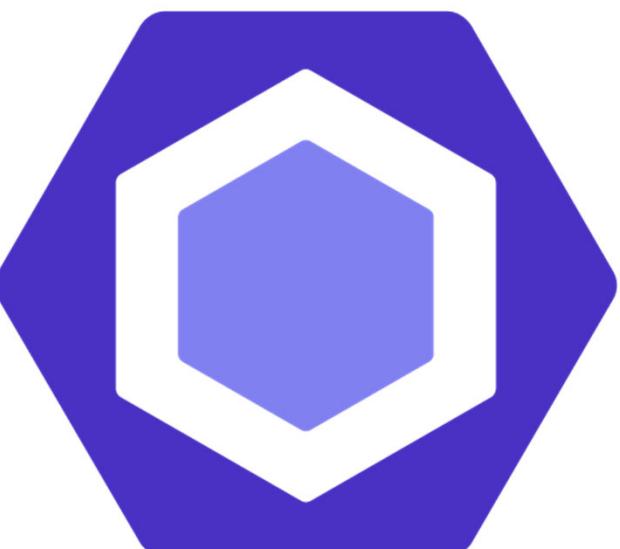
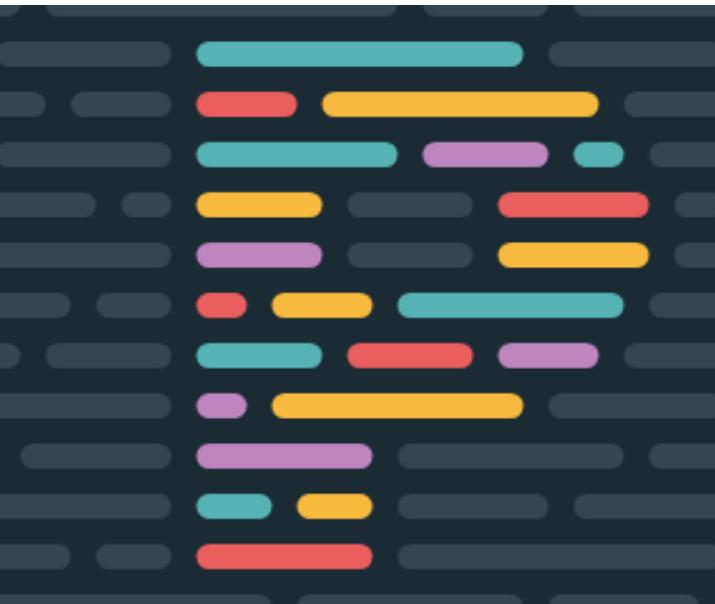
EXTENSIONS

- Helps you get things done
 - Plus installs the programming languages through VS code if this is the only IDE you want to use
 - VS Code has a lot:
 - Python
 - JavaScript
 - Java
 - C#
 - Forge
 - Jupyter
 - Formatters



LINTERS, ADD INS, FORMATTING

- Get to know your IDE Extensions!
- Linter – helps you catch errors
- Prettier – format your code
- Emmet – Add your HTML quickly
- Jupyter Notebooks – Write code snippets and data frames
- Many more but these are good starters



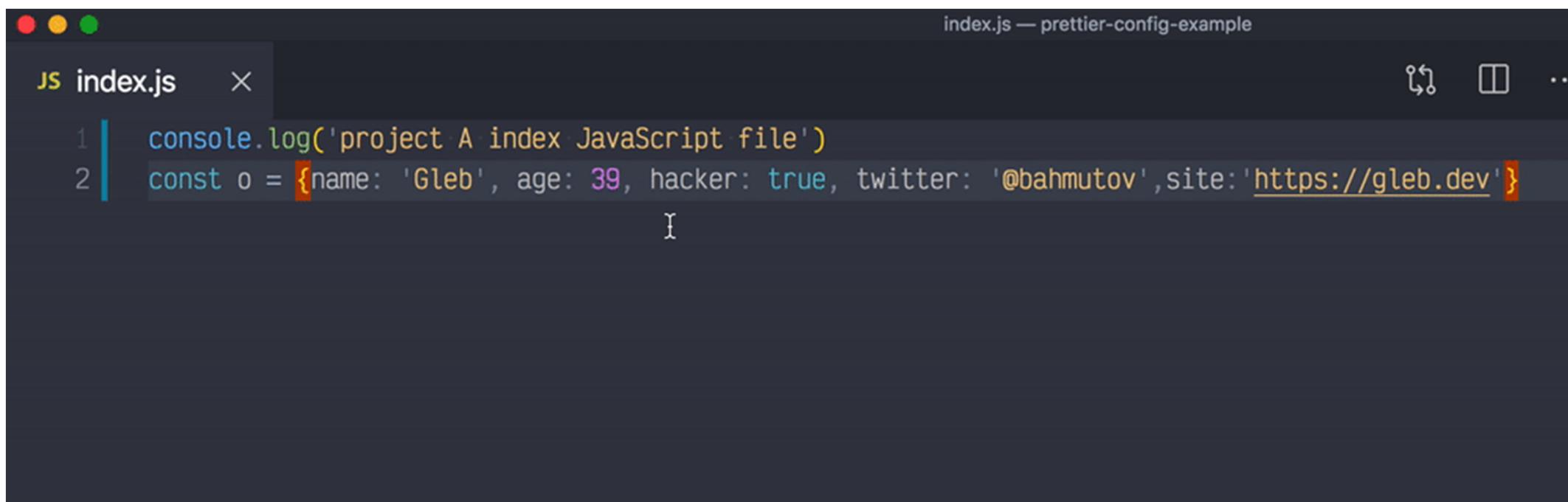
EMMET

```
1 <!DOCTYPE html>           Tab
2 <html lang="en">
3 <head>
4   <meta charset="UTF-8">
5   <title>Document</title>
6 </head>
7 <body>
8
9 </body>
10 </html>
```

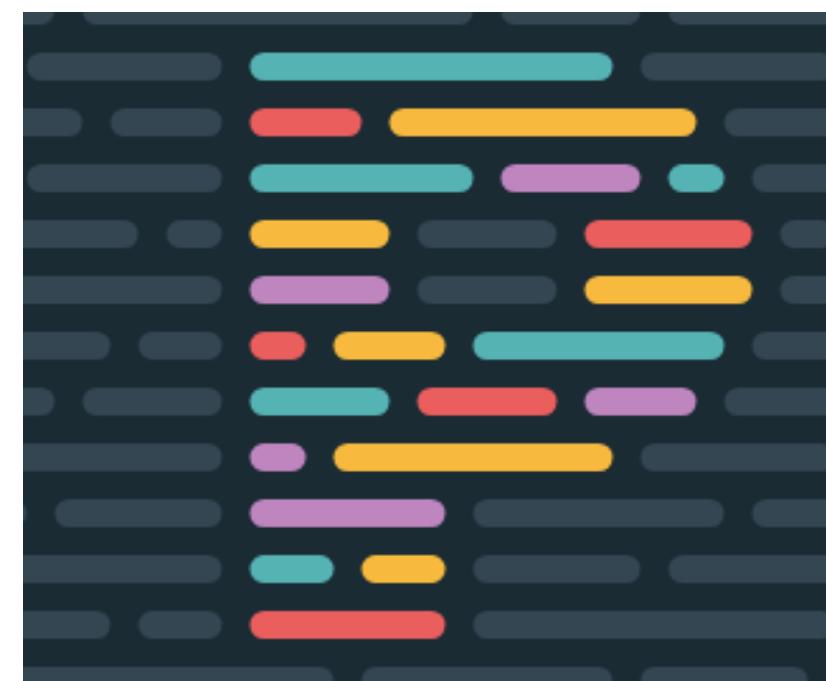


- Add your HTML content quickly
- ! - enters the HTML body and doctype as a shortcut
- <https://docs.emmet.io/>

PRETTIER

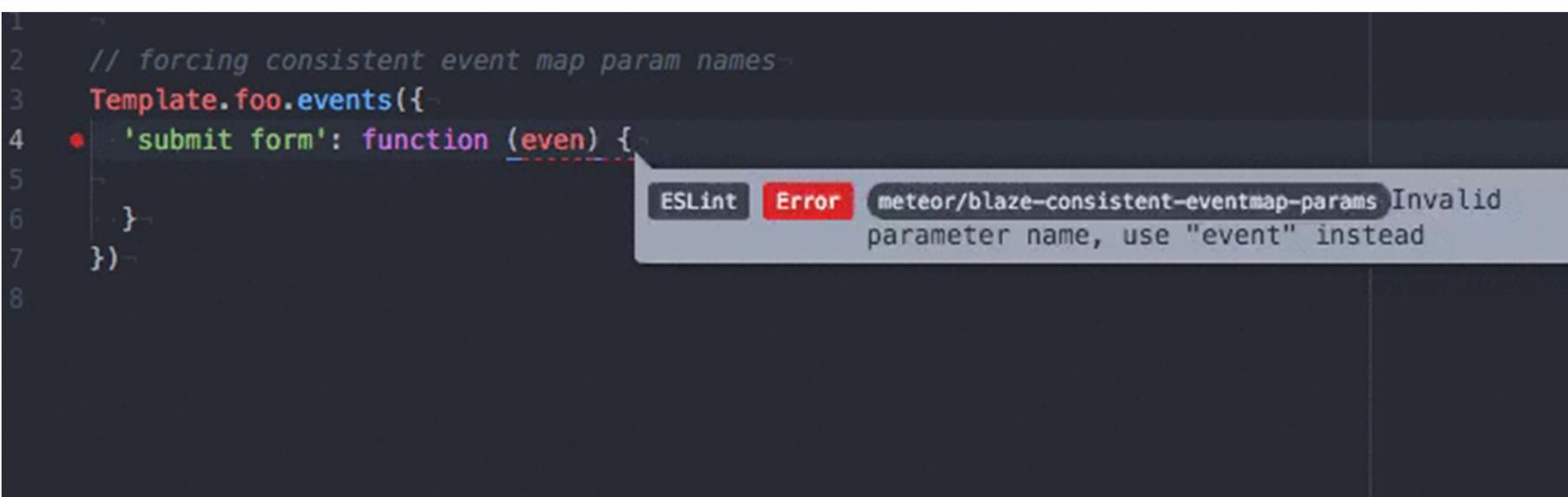


```
index.js — prettier-config-example
JS index.js ×
1  console.log('project A index JavaScript file')
2  const o = {name: 'Gleb', age: 39, hacker: true, twitter: '@bahmutov', site:'https://gleb.dev'}
```



- Formats your JavaScript code
- Makes it easier to read your text
- <https://prettier.io/>

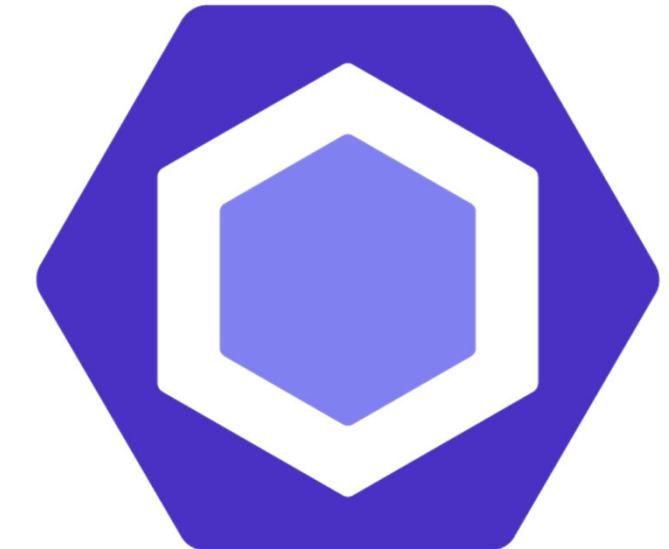
ESLINT



A screenshot of a code editor showing a ESLint error. The code is:

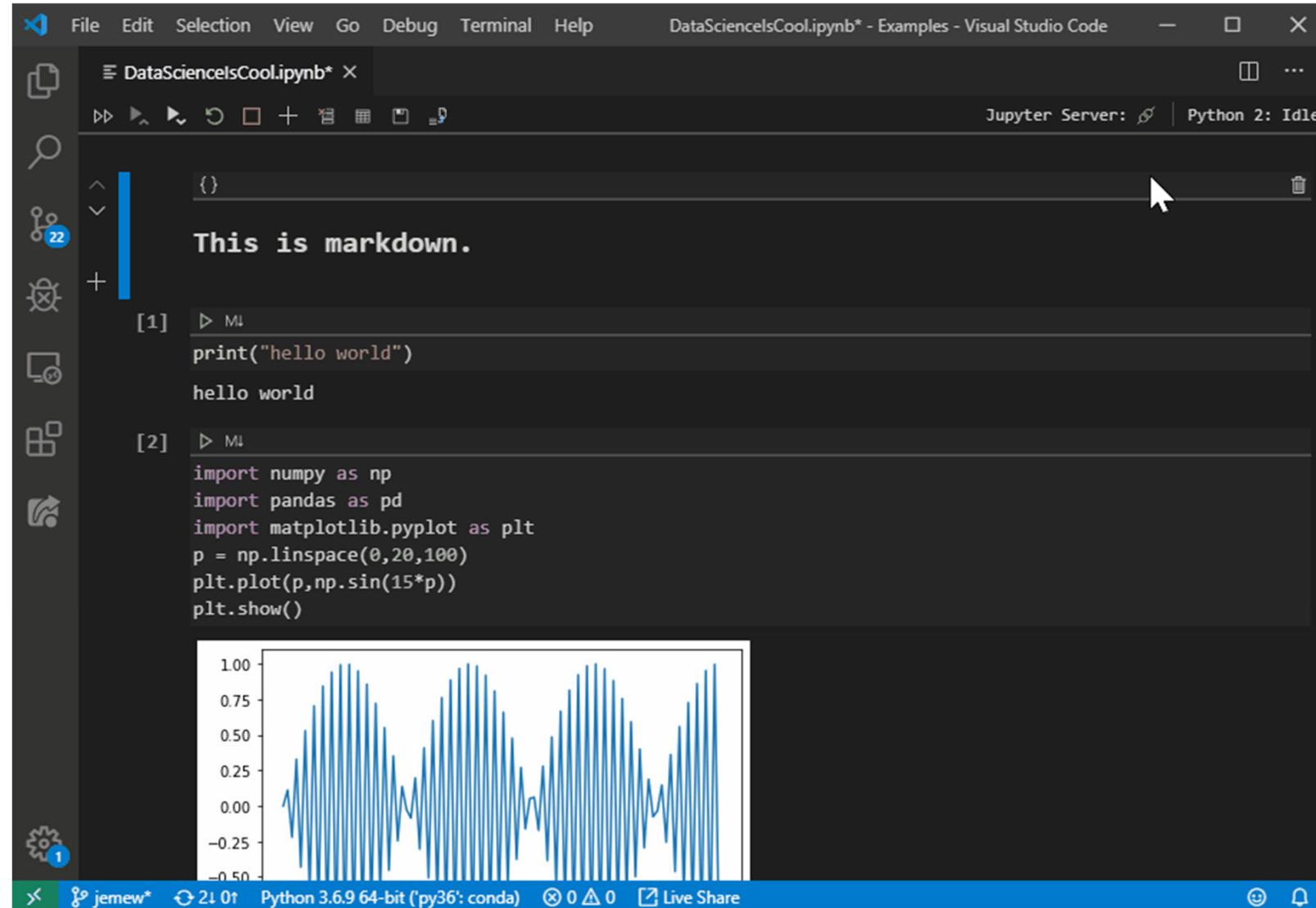
```
1 // forcing consistent event map param names
2 Template.foo.events({
3   'submit form': function (even) {
4     ...
5   }
6 })
7 }
```

The word 'even' is underlined with a red dashed line, indicating an error. A tooltip appears with the text: ESLint Error meteor/blaze-consistent-eventmap-params Invalid parameter name, use "event" instead.



- Helps you review code errors
- Kind of like a spell checker for your programming
- Different versions exist for different programming languages
- <https://eslint.org/>

PRETTIER



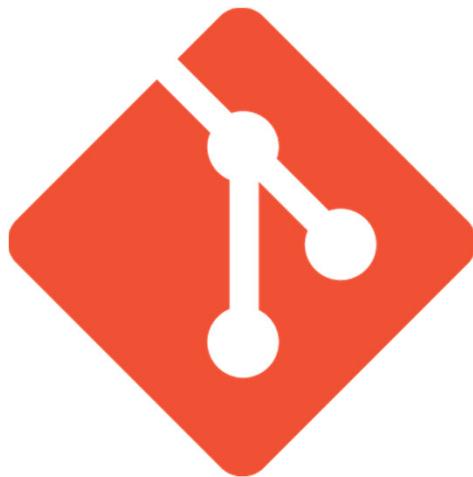
The screenshot shows a Visual Studio Code window displaying a Jupyter notebook file named "DataSciencsCool.ipynb". The notebook interface includes a toolbar at the top with icons for file operations, search, and other functions. Below the toolbar, there are two code cells. Cell [1] contains the Python code `print("hello world")` and its output "hello world". Cell [2] contains Python code to import numpy, pandas, and matplotlib, and then plots a sine wave. The resulting plot is displayed below the code in the notebook.



- Great for data science and reviewing snippets of code
- <https://jupyter.org/>

GIT AND VERSION CONTROL

- Version Control also known as source control, is the practice of tracking and managing changes to software code
- Part of software tools that help software teams manage changes to source code over time
- Sharing code base with a group after you have a working version available
- Git system is popular with many services supporting this version control protocol
- More explanations here -
<https://www.atlassian.com/git/tutorials/what-is-version-control>

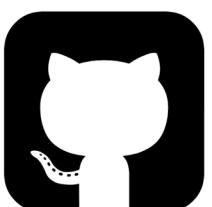


git

Systems based on Git protocol

 Bitbucket

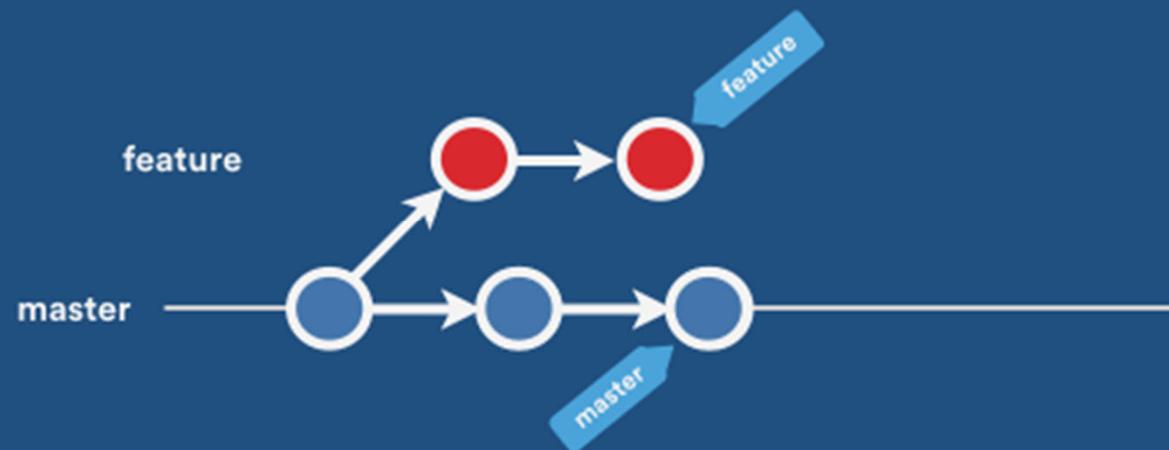
 GitLab

 Github

 CircleCI

What is a merge?

A process that unifies the work done in two branches



GIT AND VERSION CONTROL

- Git Protocol stages code updates and makes them ready to commit to the working base
- Git flow
- Git commands
- Cheat sheet - <https://education.github.com/git-cheat-sheet-education.pdf>

The Git commands that I use the most:

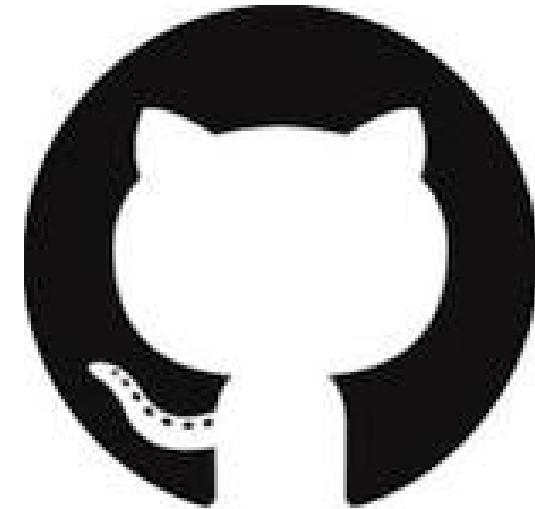
- add
- commit
- checkout
- branch
- reset
- revert
- merge
- rebase
- pull
- Push
- Status
- log

Branch and Merge

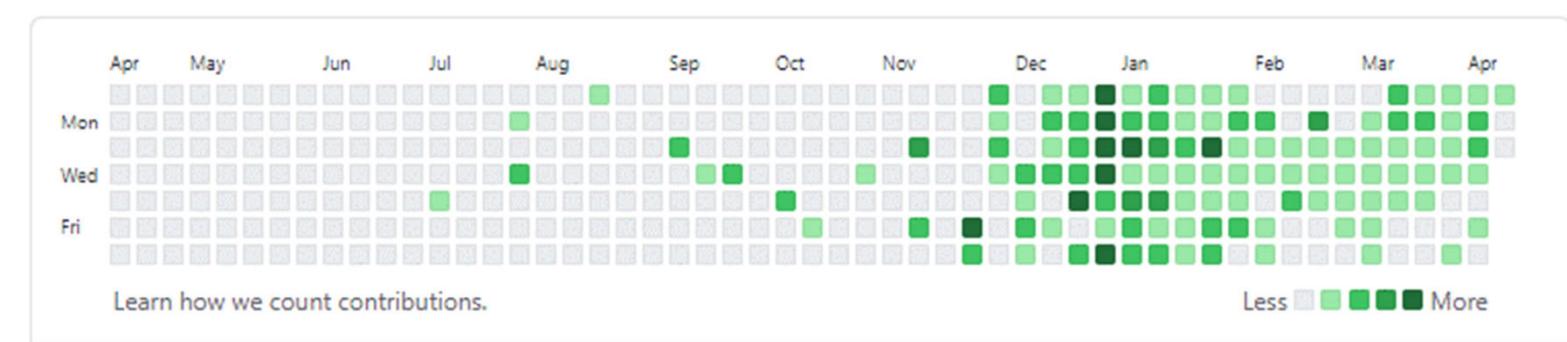


SHARE YOUR CODE

- Github is an online repository for versions of your code
- Create a profile and share your code
- Or release a specific public version of code while you test the working code
- Easy to use and can host wikis and most file types for anyone to access
- Quickstart guide:
<https://docs.github.com/en/github/getting-started-with-github/quickstart>



247 contributions in the last year



2021

2020

2019

WHICH CODING LANGUAGE TO CONTINUE WITH?

WEB TOOLS

WINDOWS / .NET TOOLS

DATA / ML / AI

JavaScript

C#

Python



ROADMAP – WEB DEVELOPMENT

- Web Development
- Everything is online and everything is a web tool
- If you want to make web tools then you have to learn about modern web frameworks and languages
- There are easy steps and hard steps but there are lots of steps
- Constantly changing environment but high growth

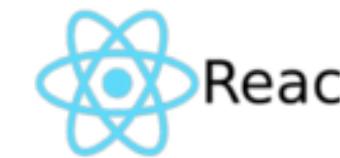


WEB TECH STACKS – DIFFERENT ENDS

Front End



Or



BACKBONE.JS

Back End

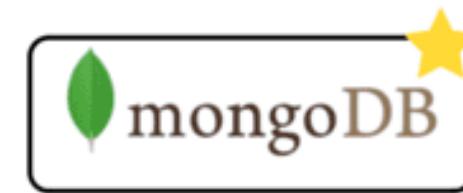


Or



KeystoneJS

Database



Or



WEB TECH STACKS – FRONT END

- Front end is what the user sees when they visit a site
 - Frameworks makes it easier to create one
 - There are a lot of frameworks!
 - React, Angular and Vue are the most popular
 - Just about all of them use JavaScript as a base
 - <https://medium.com/dailyjs/a-realworld-comparison-of-front-end-frameworks-2020-4e50655fe4c1>

CHOOSE YOUR CHARACTER!

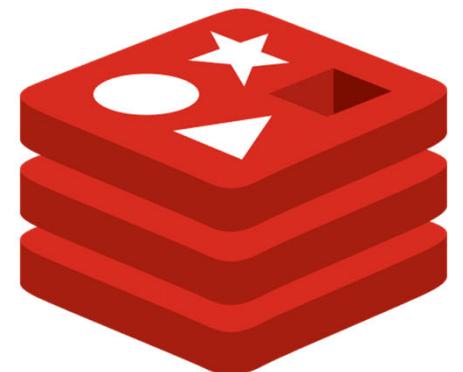


WEB TECH STACKS – BACK END



- Back end is what manages the site operations that a user doesn't see
- The bigger and more complex your site the more important back end becomes
- Lots of variety with languages and frameworks – depends on what you are comfortable with

WEB TECH STACKS – DATABASES



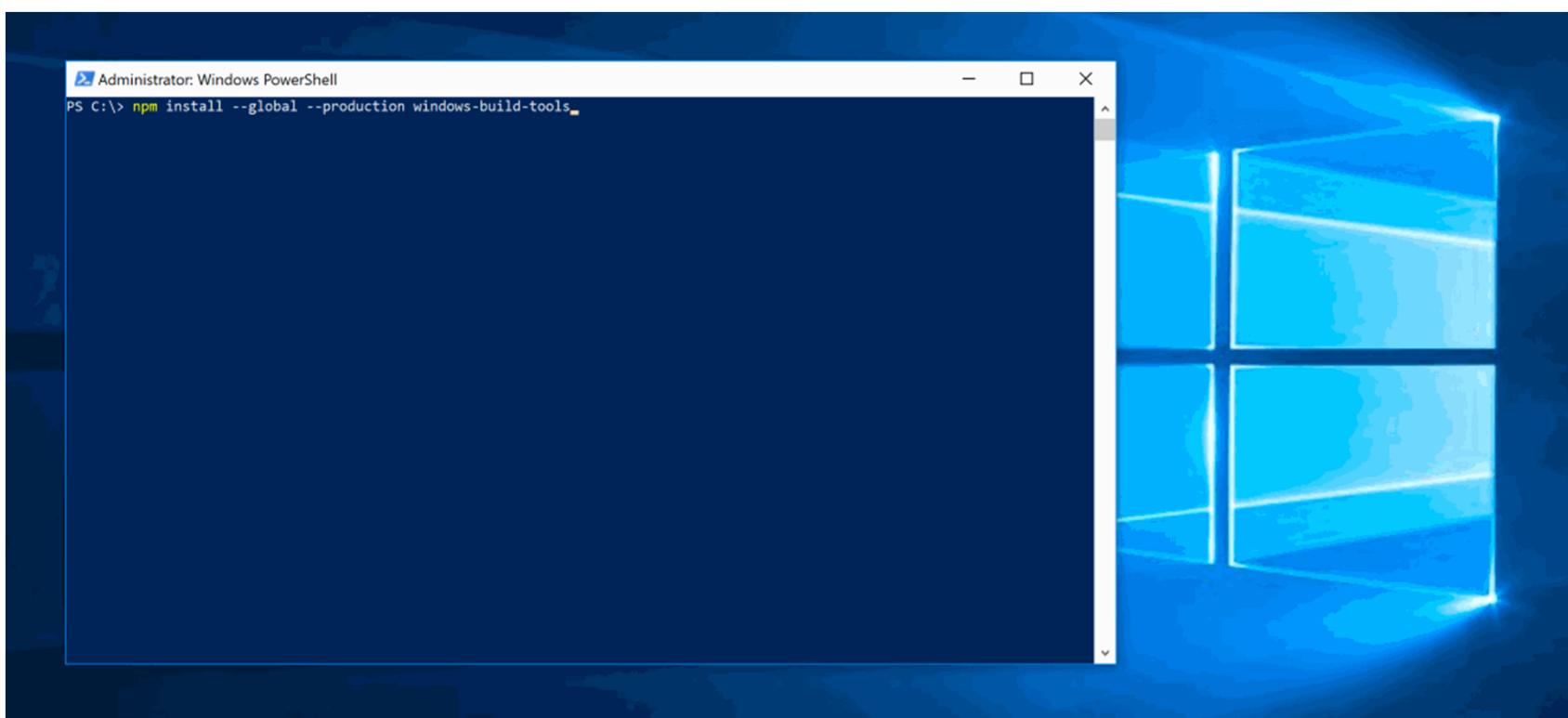
redis



- Database systems store information for your applications
- You can know a lot or very little about databases depending on your projects
- Main types are SQL and NoSQL – <https://www.ibm.com/cloud/blog/sql-vs-nosql>

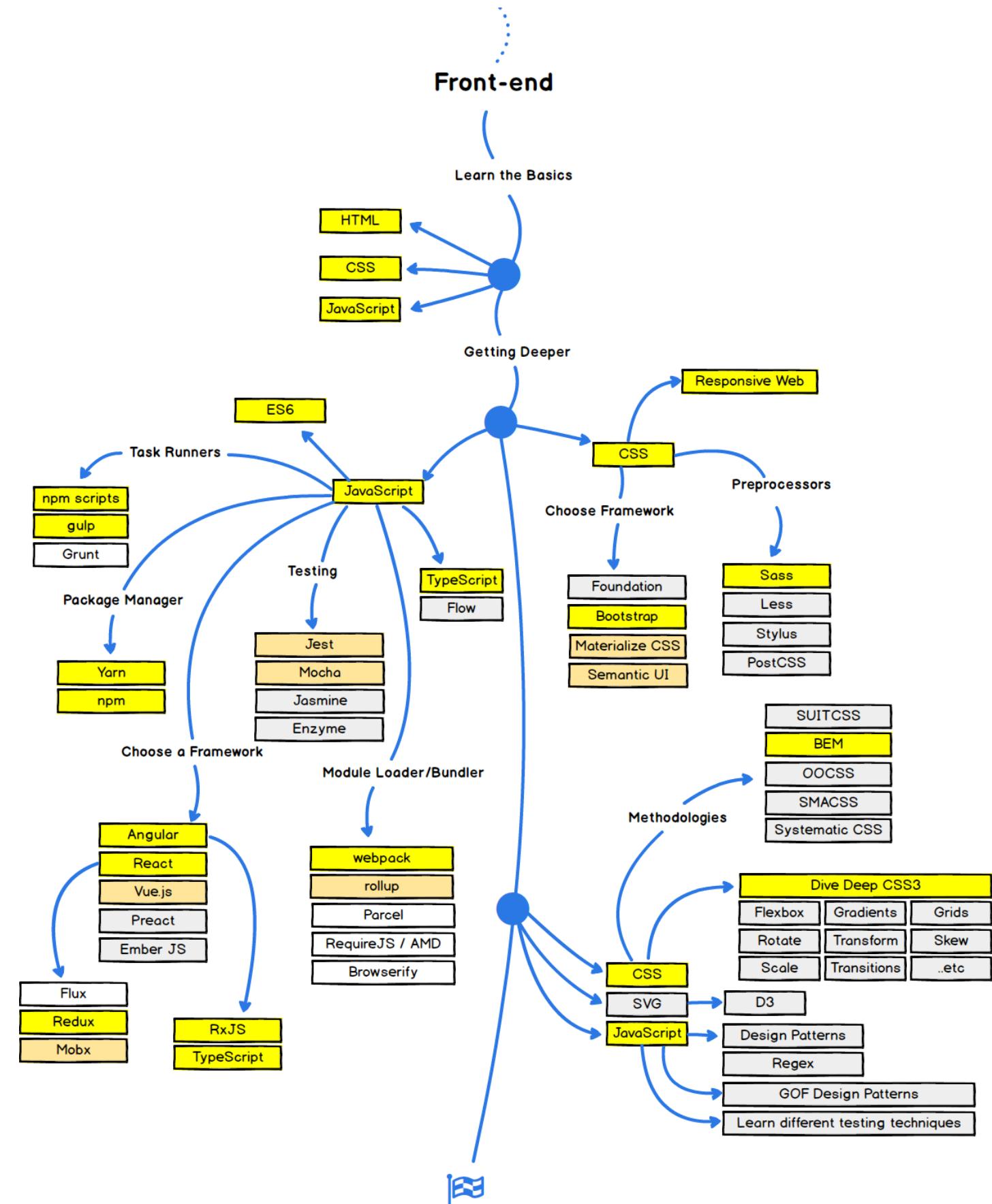
WEB TECH STACKS – NPM

- NPM is the 800 pound gorilla of the JavaScript world
- Has a lot of useful packages to install
- Get used to installing things
- <https://www.npmjs.com/>



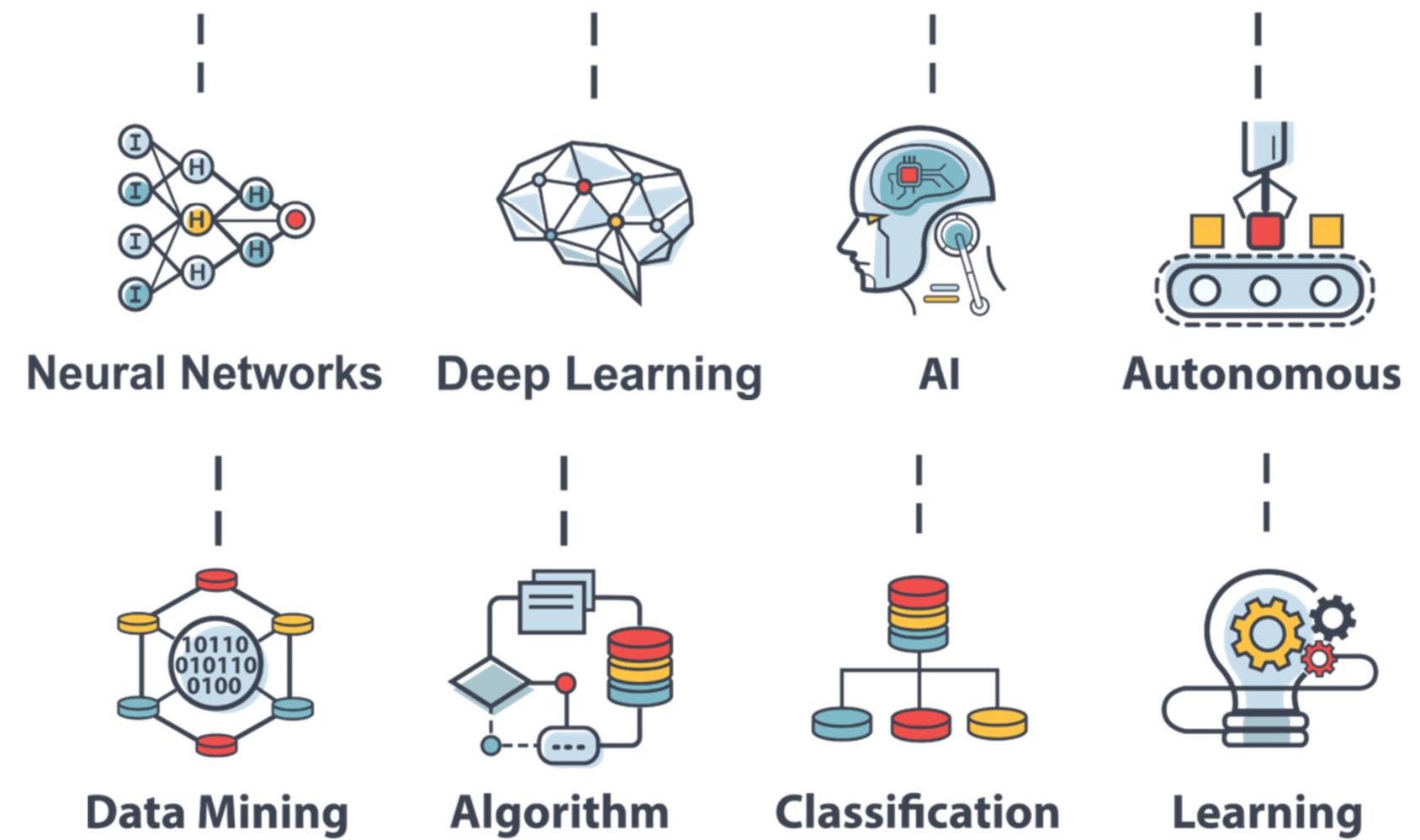
ROADMAPS

- If you want to learn in more detail then follow a lesson plan or roadmap
- Web development, Data Science, App development and other tech stacks all have learning curves
- Find an existing roadmap or make your own
- Check out some examples here –
- <https://roadmap.sh/>



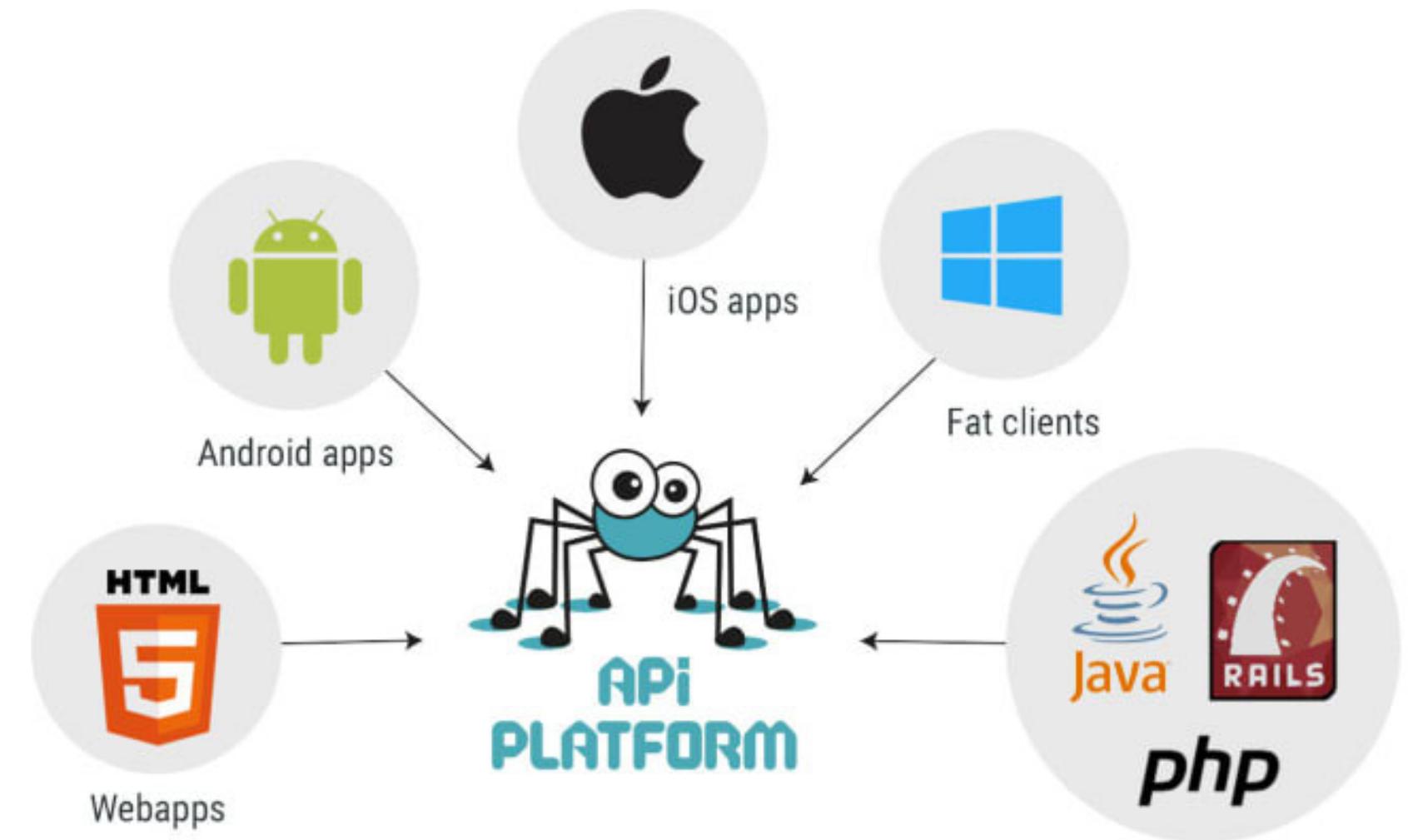
ROADMAP - DATA ENGINEERING

- Machine Learning and AI
- Basically get the computer CPU to do the thinking work for you
- Not one path though there is a lot of variety
- Can get started on large or small scale
- Python heavy scenario which is a good thing



ROADMAP – SCRIPTS AND INTEGRATIONS

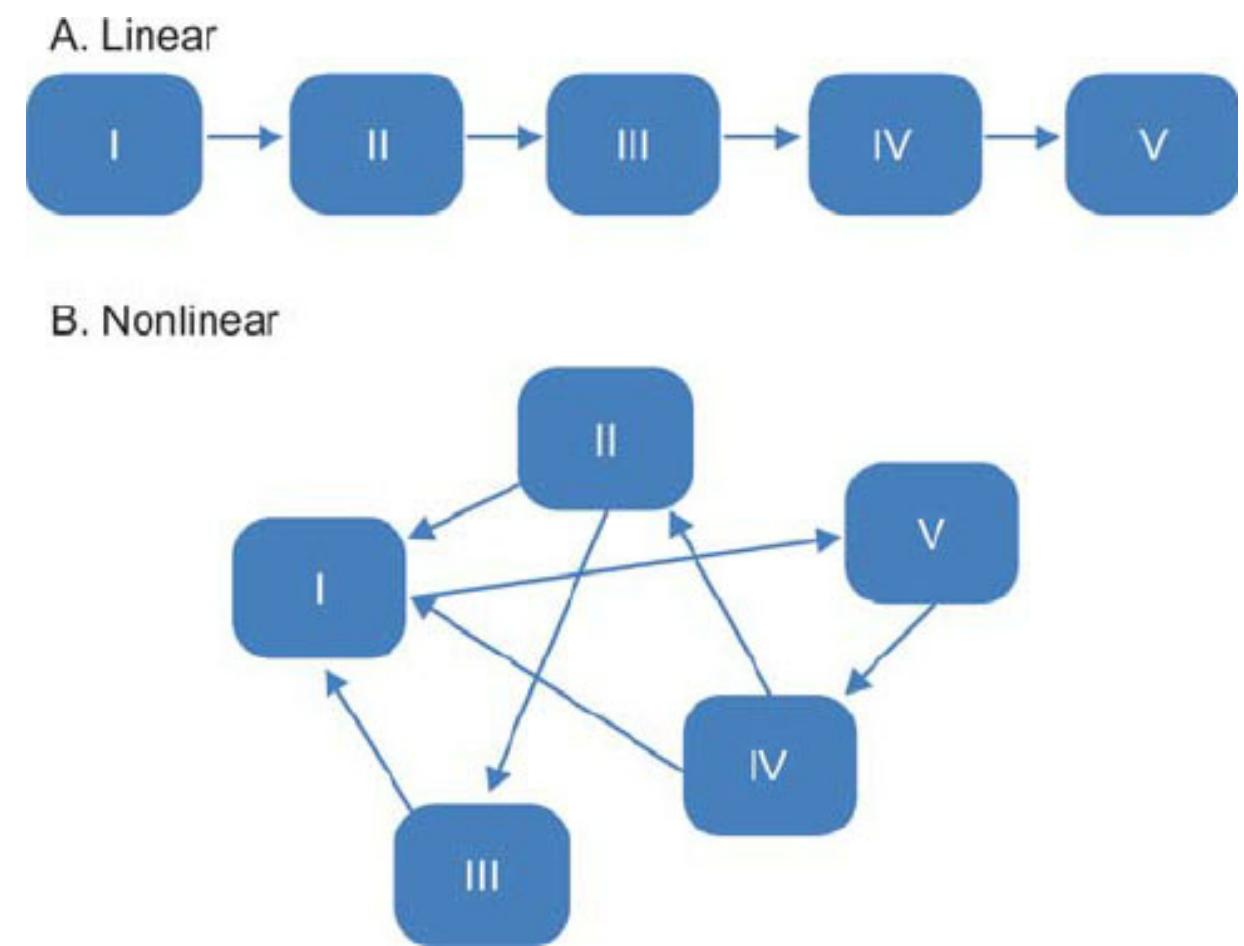
- Scripting
- Not interested in being a full time professional software development?
There's always scripting!
- Most software you use has an API that can provide access to the functions of the platform and you can automate tasks
- Just knowing enough to script is extremely useful and pays dividends for any work you do



PROBLEM SOLVING & LEARNING STYLES

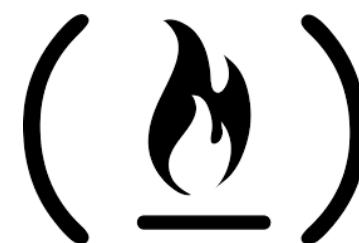


Linear and Non-Linear



LEARNING RESOURCES

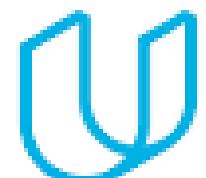
- There are many free resources to start coding on any language you want to learn
- If you are a beginner then any of these are a good start for the basics
- Code Academy
- Edx
- Udemy
- Pluralsight
- SoloLearn
- Treehouse
- FreeCodeCamp
- Udacity
- And Many more....



PLURALSIGHT



treehouse



UDACITY

NEED HELP? – ASK THE INTERNET!

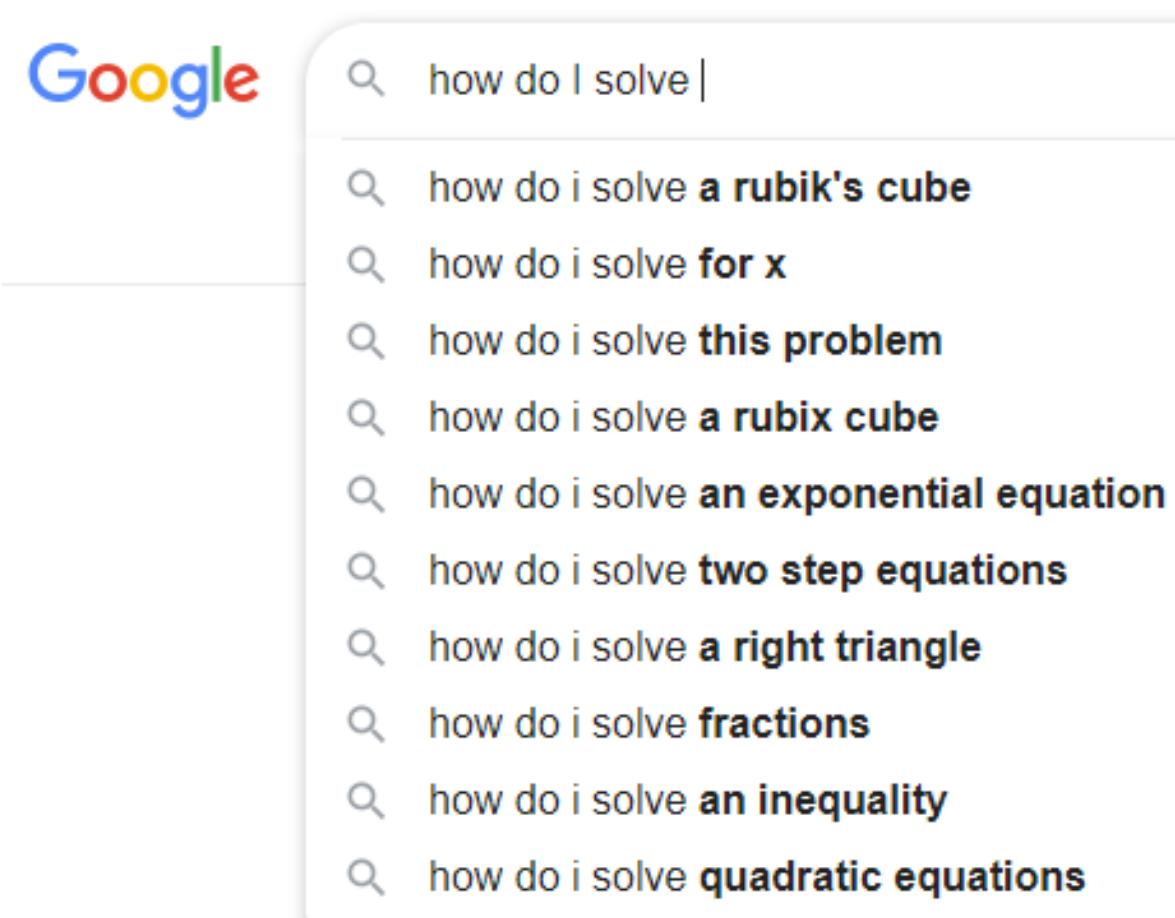
- Ask questions with keywords to get the results you need
- Stack Overflow – First place to ask for help on actual code problems
- Reddit – Lots of subreddits on many coding languages that can provide support on your issues
- Quora – Question and Answer site for general and specific tech problems

Quora



NEED HELP? – ASK THE INTERNET!

- Or just ask Google
- Google is your friend



SUPER POWERS FOR SUPER USERS

20 lines (16 sloc) | 471 Bytes

```
1 # Enable Python support and load DesignScript library
2 import clr
3 clr.AddReference('ProtoGeometry')
4 from Autodesk.DesignScript.Geometry import *
5 clr.AddReference('RevitNodes')
6 from Revit.Elements import *
7
8 famtype = IN[0]
9 pbc = Point.ByCoordinates(0,0,0)
10 output = []
11
12 for x in range(0, 100, 20):
13     for y in range(0, 100, 20):
14         for z in range(0, 100, 20):
15             pbc = Point.ByCoordinates(x,y,z)
16             col = FamilyInstance.ByPoint(famtype,pbc)
17             output.append(col)
18
19 OUT = output
```



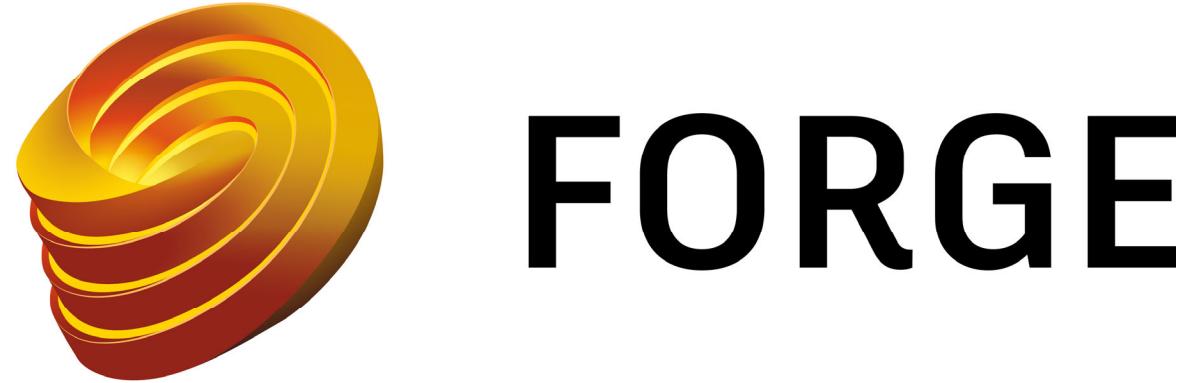
R PS - XYZ matrix Family PY

```
1 # Enable Python support and load DesignScript library
2 import clr
3 clr.AddReference('ProtoGeometry')
4 from Autodesk.DesignScript.Geometry import *
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15             pbc = Point.ByCoordinates(x,y,z)
16             col = FamilyInstance.ByPoint(famtype,pbc)
17             output.append(col)
18
19 OUT = output
```



SOFTWARE PROJECTS BY PEOPLE FROM AEC

Forge from Autodesk



Hypar



Layer by Zach Soflin



Testfit



PYREVIT

- pyRevit is a Rapid Application **Prototyping** (RAD) environment for Autodesk Revit
- Open source project for creating **custom add ins for Revit**
- Created so you **don't need to know any C#** to create add ins to Revit
- Big un-blocker for people of non-CS backgrounds in Architecture
- Possible due to IronPython, RPS and RPW projects from other contributors

PyRevit By Ehsan



PYREVIT

API calls in C# requires SDK kit to run in .NET

PyRevit takes the calls and can write them in Python code to create custom applications

Allows for editing in the Revit model environment based on custom tools

The screenshot shows the Revit API Docs website. The navigation bar includes links for 2015, 2016, 2017, 2017.1, 2018, and Code Samples. The main content area is titled "ElementParameterFilter Class". It includes sections for Members, Examples, and See Also. A detailed description states: "A filter used to match elements by one or more parameter filter rules." Below this are Syntax sections for C#, Visual Basic, and Visual C++. The C# section contains the following code:

```
public class ElementParameterFilter : ElementSlowFilter
```

The screenshot shows a Python script titled "Advanced Collection of Data: Collects all the walls of height 10". The script imports Autodesk.Revit.DB and uses PyRevit utilities to time the process. It creates an ActiveUIDocument, gets the document, and defines a parameter provider for height. It then creates a numeric equality rule for height, sets it as the filter for an ElementParameterFilter, and collects all walls from the document. Finally, it sets the selected element IDs in the active document's selection. The code is as follows:

```
"""Advanced Collection of Data: Collects all the walls of height 10"""

__author__ = 'Ehsan Iran-Nejad'

# for timing
from pyrevit.coreutils import Timer
timer = Timer()

# ...

import Autodesk.Revit.DB as DB

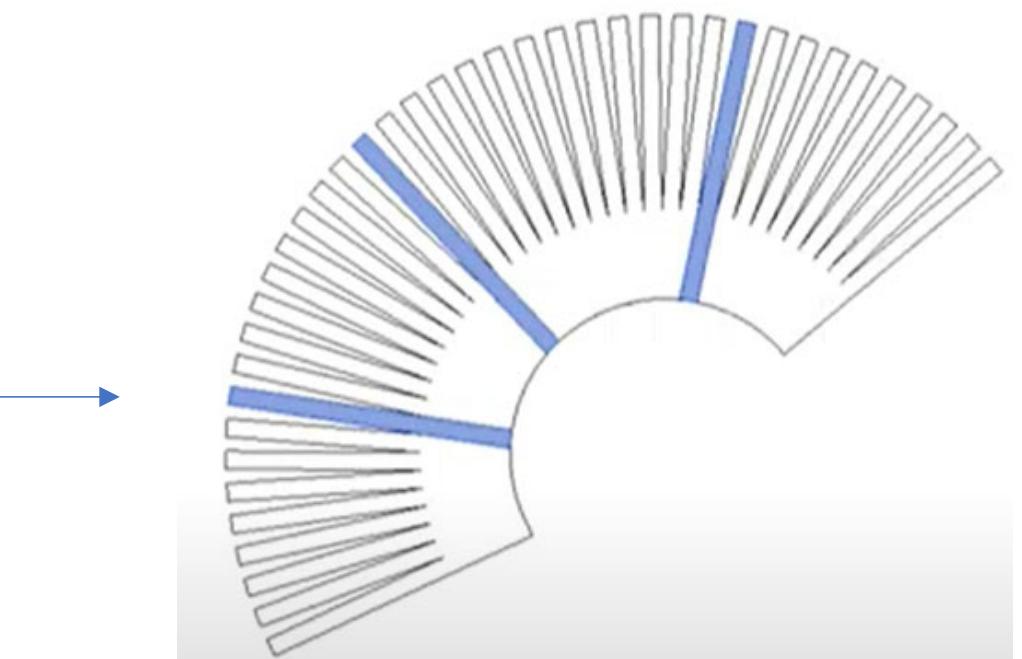
doc = __revit__.ActiveUIDocument.Document
uidoc = __revit__.ActiveUIDocument

height_param_id = DB.ElementId(DB.BuiltInParameter.WALL_USER_HEIGHT_PARAM)
height_param_prov = DB.ParameterValueProvider(height_param_id)
param_equality = DB.FilterNumericEquals()
height_value_rule = DB.FilterDoubleRule(height_param_prov,
                                         param_equality,
                                         10.0,
                                         1E-6)
param_filter = DB.ElementParameterFilter(height_value_rule)

walls = DB.FilteredElementCollector(doc) \
    .WherePasses(param_filter) \
    .ToElementIds()

uidoc.Selection.SetElementIds(walls)

# for timing
endtime = timer.get_time()
print(endtime)
# ...
```



BLENDER AND BLENDER BIM

Blender 3D



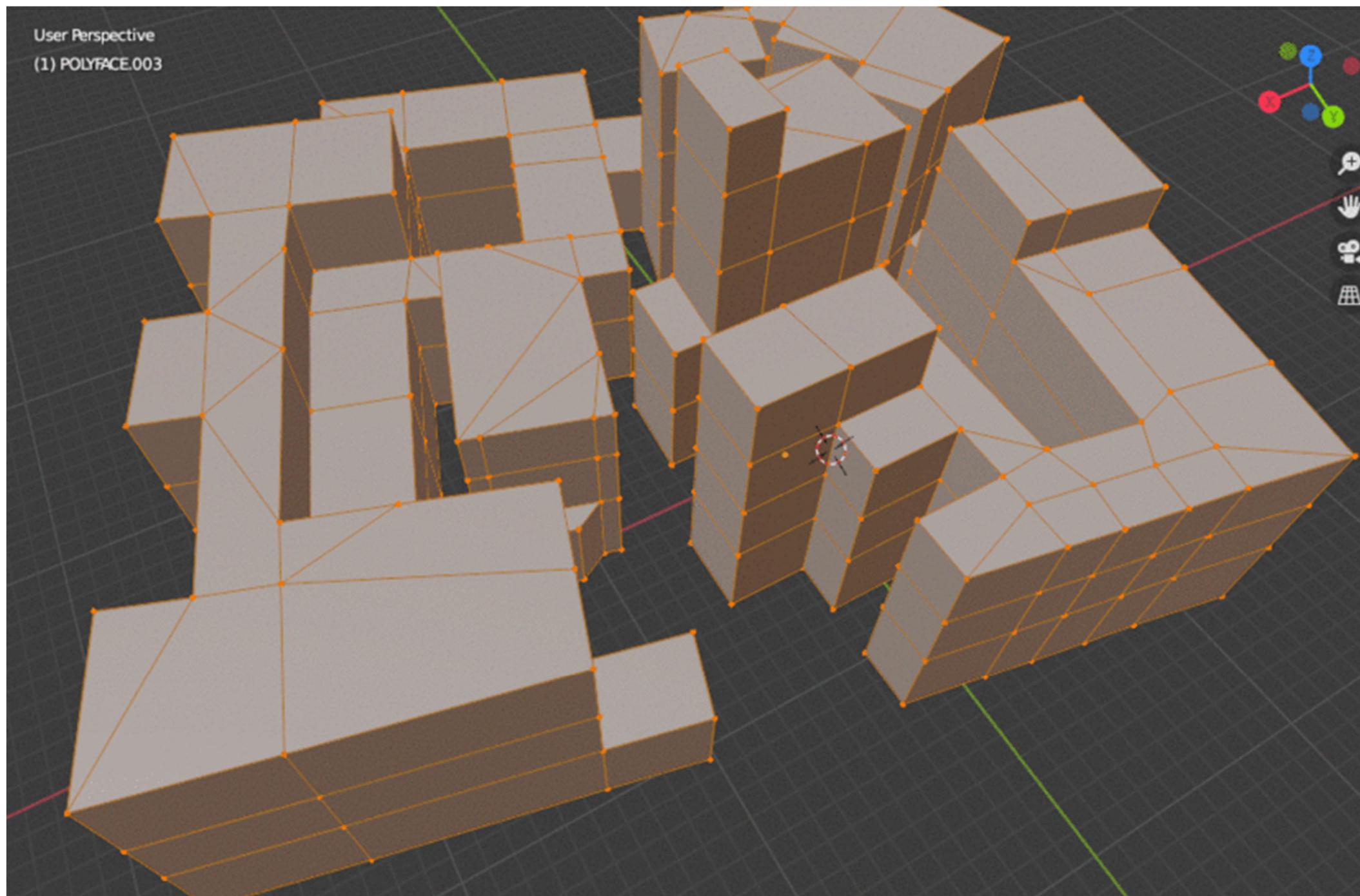
blender

BlenderBIM by
Dion Moult



BLENDERBIM
ADD-ON

BLENDER BIM



Source: brunopostle

https://community.osarch.org/discussion/comment/2489/#Comment_2489

BLENDER GENERATIVE TOWER DESIGN

- From Blender to BIM to design



Source: UH Studio

https://www.youtube.com/watch?v=4LGw1g5sGEo&feature=emb_logo&ab_channel=UHStudio

BLENDER BIM BRIDGING THE GAP

- BlenderBIM makes the Blender geometry **writable to a BIM format** for parametric element modeling
- Add on allows data with **IFC file format** which is interchangeable with many BIM software like Revit or Archicad
- Provides a future where designers can use **open source tools** outside of enterprise suites
- Check out more -
<https://community.osarch.org/discussion/283/bim-modeling-using-greasepencil#latest>



BLENDERBIM ADD-ON

IfcOpenShell

the open source ifc toolkit and geometry engine

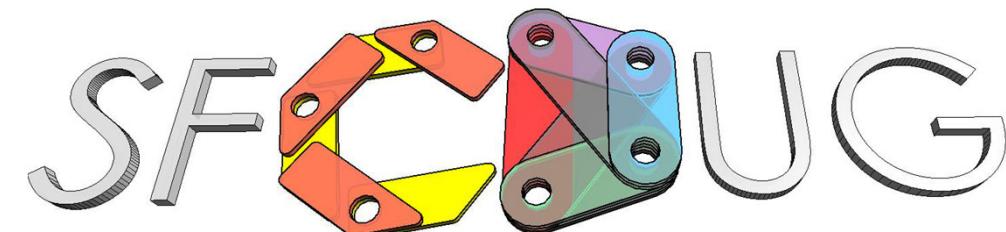


JOIN GROUPS AND HACKATHONS

- There are many groups to follow that provide workshops, training guides, hackathons and events
- Find them locally or online and connect with the people there
- Ideally connect with some meetup groups with real tech professionals where you can meet and talk shop
- Hackathons are some of the best places to learn coding on the fly – usually with support from experienced developers



CORE
studio



HOW LONG DOES IT TAKE?

- However you are never really going to stop coding
- The programming environment always changes and you have to keep up to date
- Get used to learning new things and trying them out
- The ride never ends...

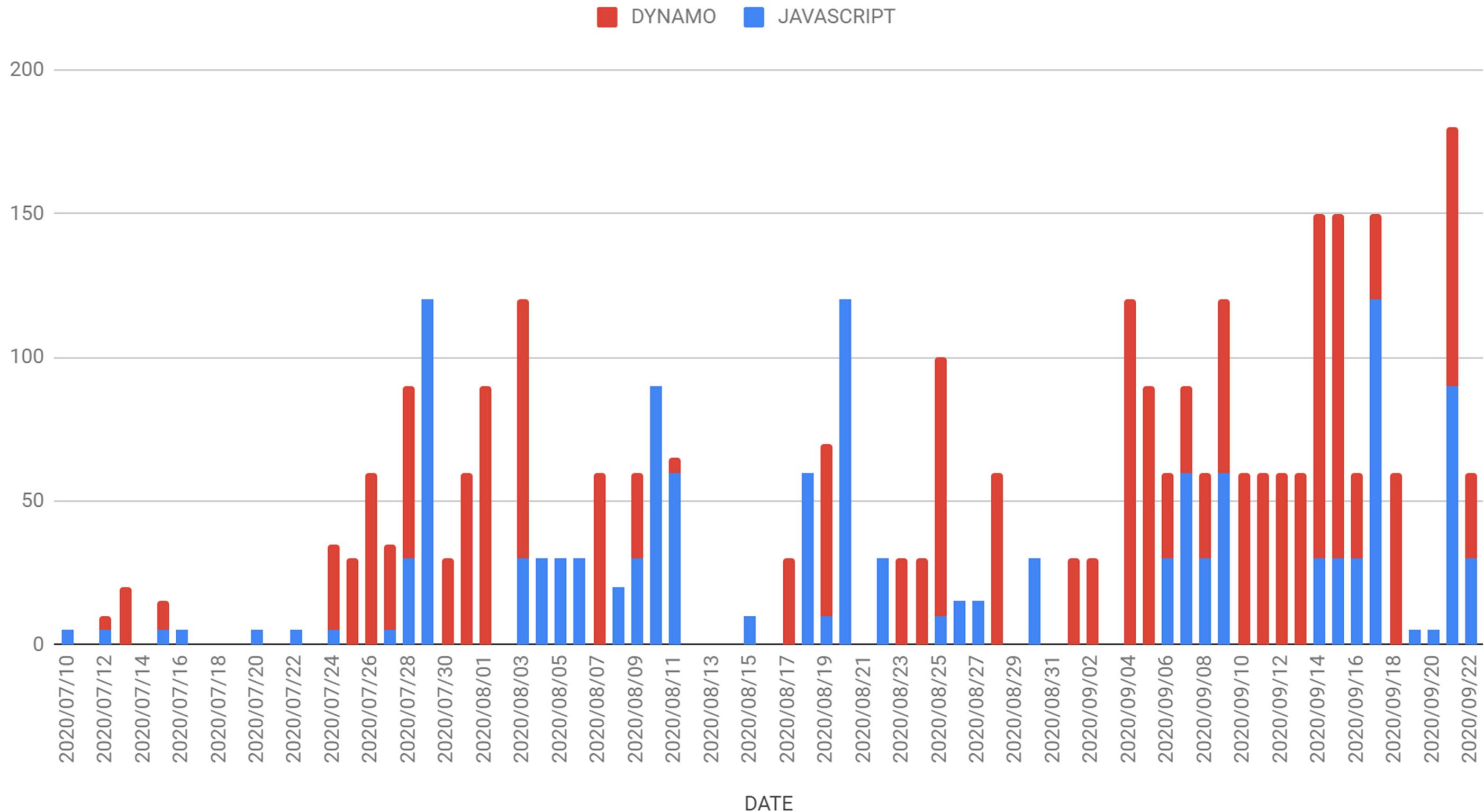


HOW LONG DOES IT TAKE?

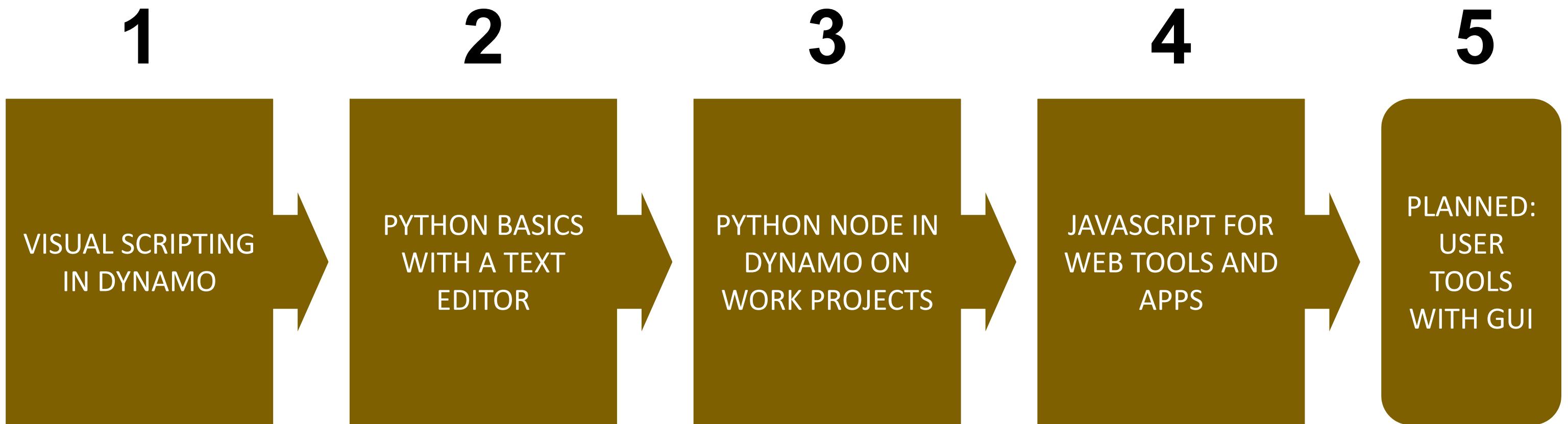
- Becoming capable of writing code on your own on a regular basis can take time but most people can do it
- Speed of learning depends on how much time you put in
- How often you code (daily is best)
- If you're working on real projects
- Keep a journal of time spent coding
- More than zero effort put into the work every day to see progress

LEARNING METHOD	TIME TO LEARN CODING
Self-Study	6 – 12 months
College Degree	4+ years
Coding Bootcamp	3 – 6 months

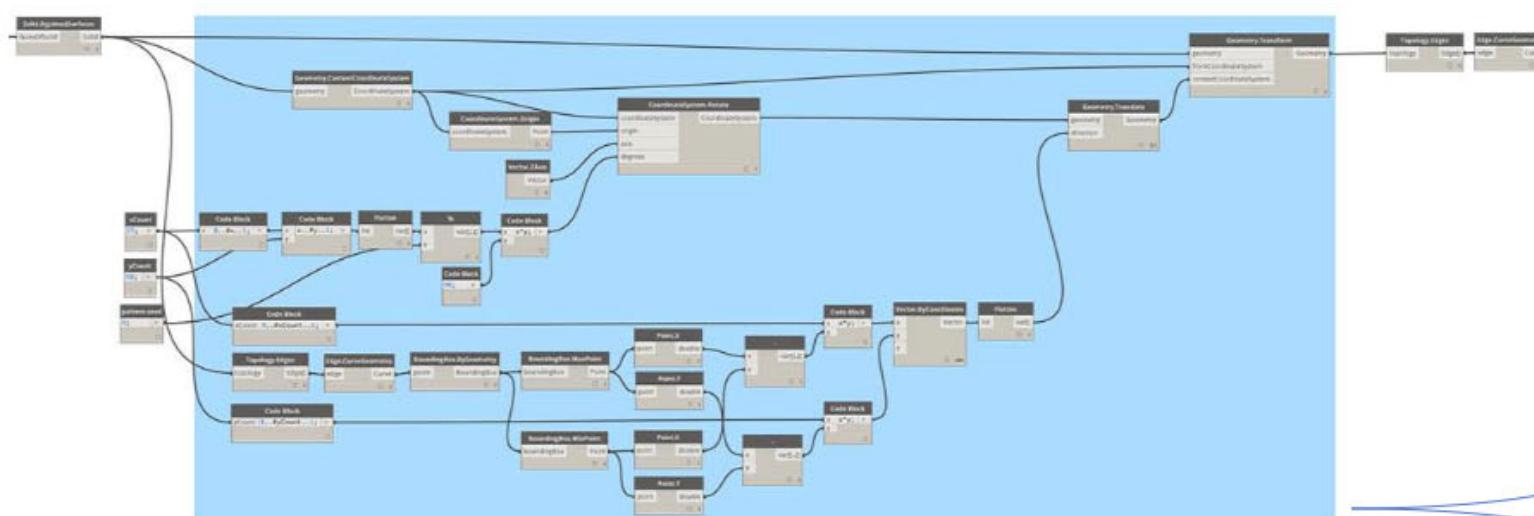
MORE THAN ZERO MINUTES



CREATE YOUR OWN PROJECTS - MY LEARNING PATH



MY EXAMPLES



```
import clr
clr.AddReference('ProtoGeometry')
from Autodesk.DesignScript.Geometry import *

solid = IN[0]
seed = IN[1]
xCount = IN[2]
yCount = IN[3]

solids = []

yDist = solid.BoundingBox.MaxPoint.Y-solid.BoundingBox.MinPoint.Y
xDist = solid.BoundingBox.MaxPoint.X-solid.BoundingBox.MinPoint.X

for i in xRange:
    for j in yRange:
        fromCoord = solid.ContextCoordinateSystem
        toCoord =
fromCoord.Rotate(solid.ContextCoordinateSystem.Origin,Vector.ByCoordinates
(0,0,1),(90*(i+j%val)))
        vec = Vector.ByCoordinates((xDist*i),(yDist*j),0)
        toCoord = toCoord.Translate(vec)
        solids.append(solid.Transform(fromCoord,toCoord))

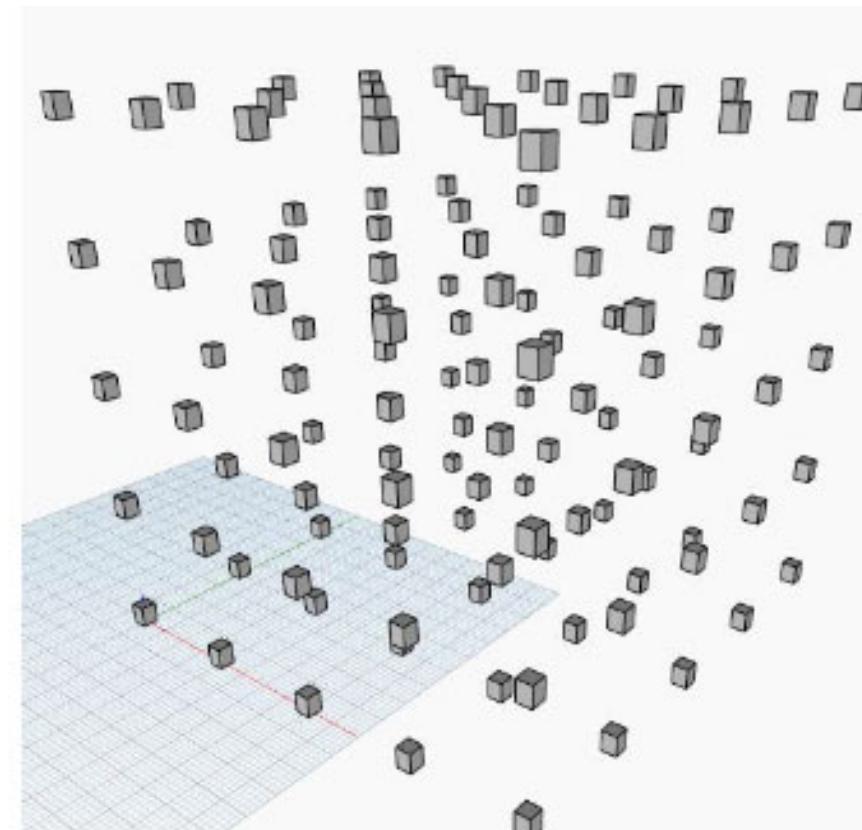
OUT = solids
```

MY EXAMPLES

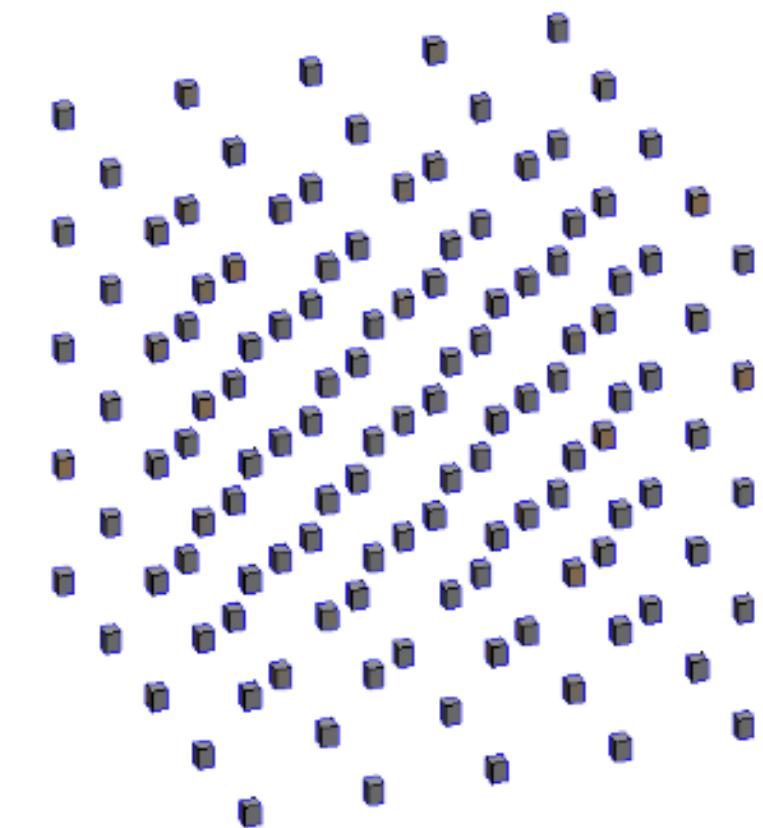
Python in Dynamo

```
R PS - XYZ matrix Family PY
1 # Enable Python support and load DesignScript library
2 import clr
3 clr.AddReference('ProtoGeometry')
4 from Autodesk.DesignScript.Geometry import *
5 clr.AddReference('RevitNodes')
6 from Revit.Elements import *
7
8 famtype = IN[0]
9 pbc = Point.ByCoordinates(0,0,0)
10 output = []
11
12 for x in range(0, 100, 20):
13     for y in range(0, 100, 20):
14         for z in range(0, 100, 20):
15             pbc = Point.ByCoordinates(x,y,z)
16             col = FamilyInstance.ByPoint(famtype,pbc)
17             output.append(col)
18
19 OUT = output
```

Solids in Dynamo



Elements in Revit



Exploring Python Nodes in Dynamo from Autodesk University

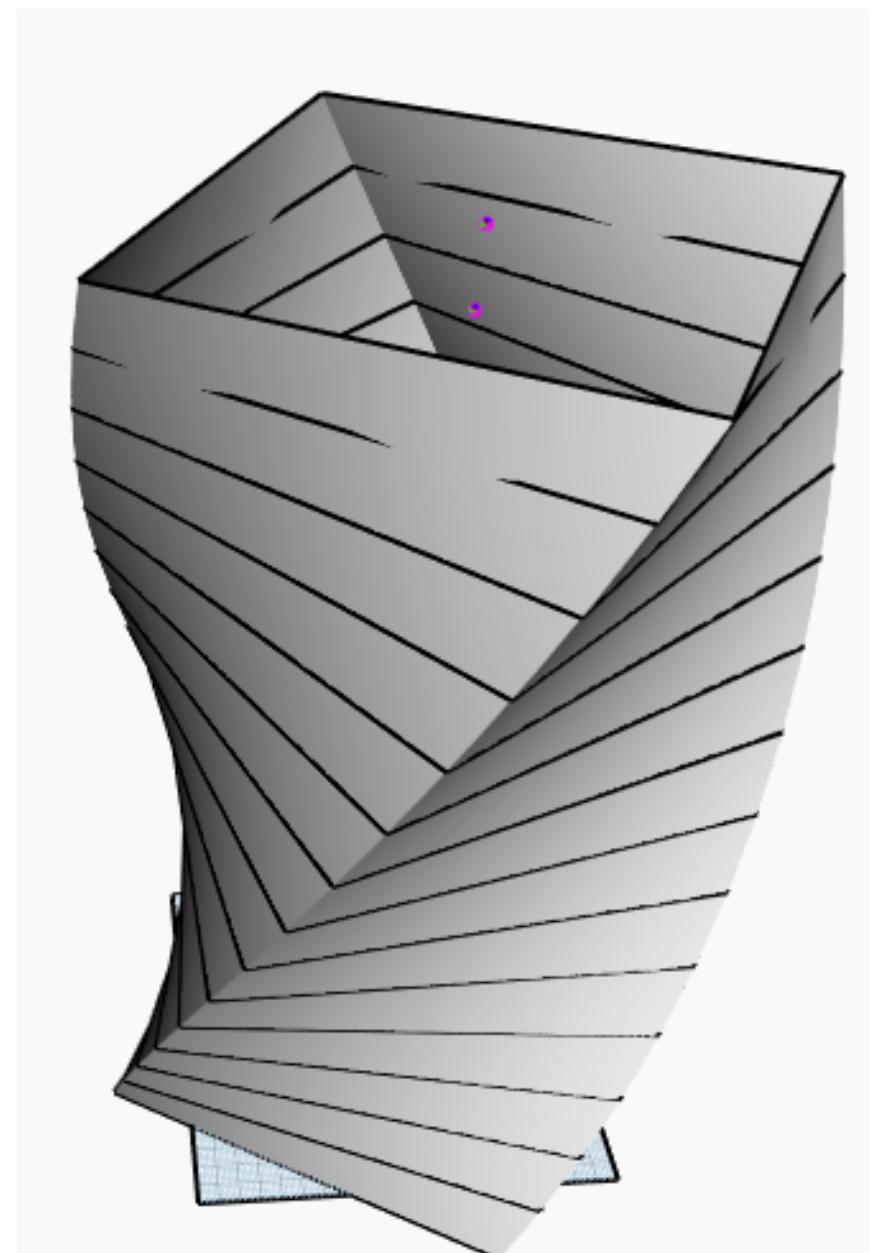
<https://www.autodesk.com/autodesk-university/class/Exploring-Python-Nodes-Dynamo-2019#presentation>

DYNAMO

- Makes it easier to modify the **design beyond** what you can do with the default nodes

R Python Script

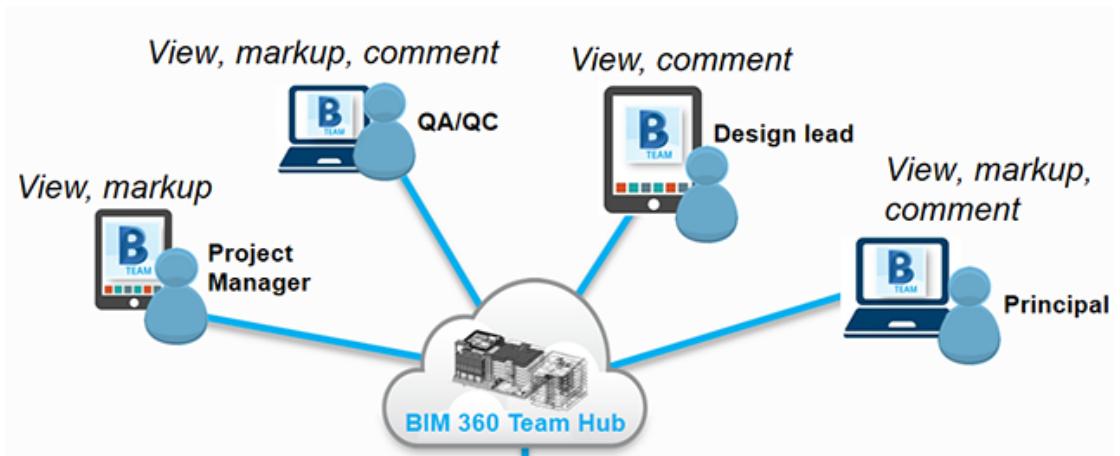
```
1 # Enable Python support and load DesignScript library
2 import clr
3 clr.AddReference('ProtoGeometry')
4 from Autodesk.DesignScript.Geometry import *
5 clr.AddReference('RevitNodes')
6 from Revit.Elements import *
7
8 #cs = IN[0]
9 width = 100
10 length = 100
11 rect = Rectangle.ByWidthLength(width,length)
12 origin = Point.Origin()
13 axis = Vector.ZAxis()
14 degree = IN[0]
15
16 #degfloat = [float(i) for i in degree]
17 #degfloat = map(float, degree)
18 degfloat = [float(i) for i in degree]
19
20 GeoRo = Geometry.Rotate(rect,origin,axis,degfloat)
21
22 # output element based on the variable you assigned
23 OUT = GeoRo
```



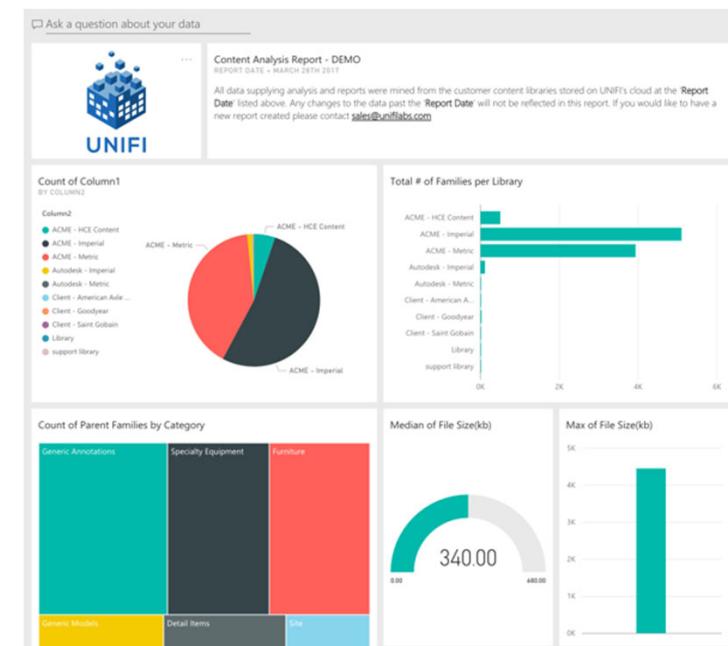
MY EXAMPLES



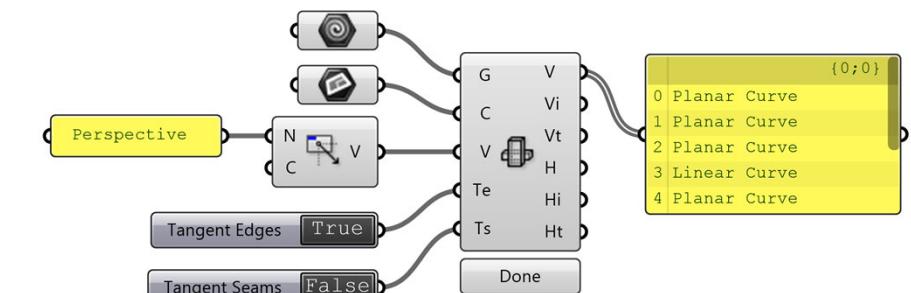
Cloud Native Teams



Data Driven Design



Analysis Tools



PARKING LOT GENERATOR WITH HYPAR



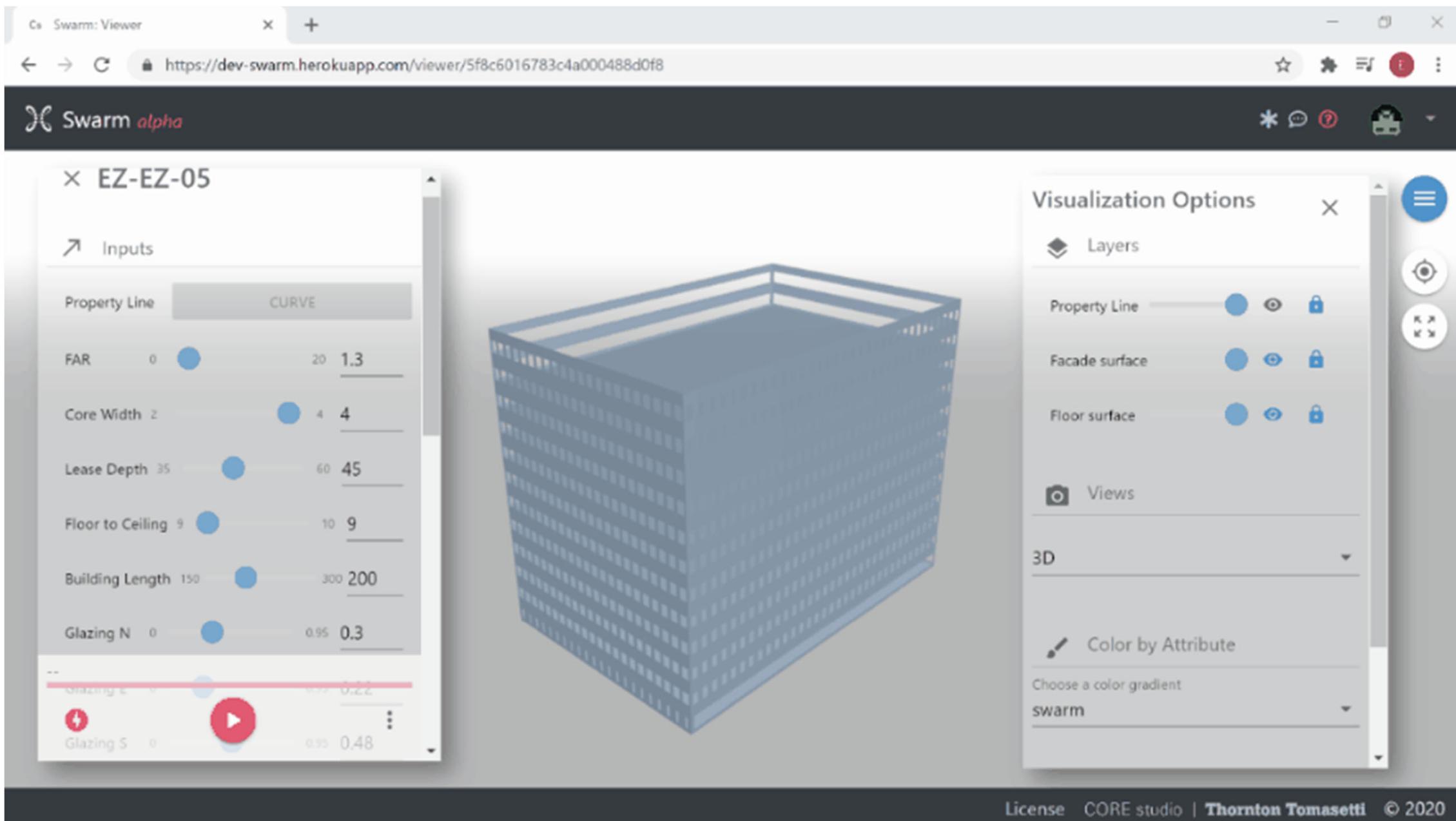
- HMC project with Hypar ACE platform to develop a parking lot generator app
- Brittney Holmes with Grasshopper background was able to work with Hypar to develop this tool
- Check it out -
<https://twitter.com/HyparAEC/status/1309522176014536705?s=20>



EMBODIED CARBON CALCULATOR



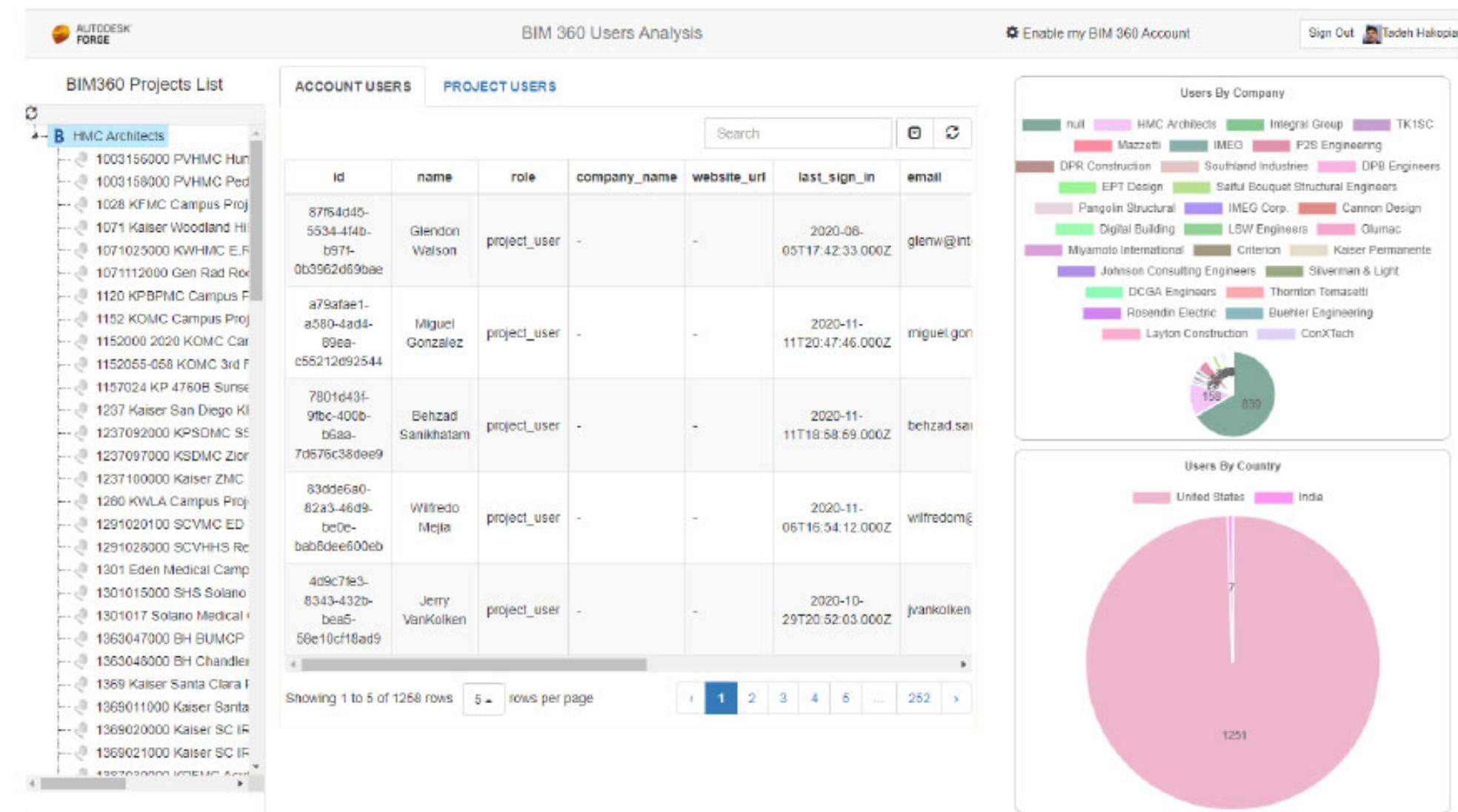
- AEC Hackathon project using open source tools
- Group effort in 2 days with people from HMC and other companies
- BHoM, Swarm, Vue and Grasshopper system
- Check it out - [Swarm: Viewer \(dev-swarm.herokuapp.com\)](https://dev-swarm.herokuapp.com/)
- Repo - [GitHub - lukegehron/EZ-EC: AEC Tech Hackathon - Embodied Carbon Tool](https://github.com/lukegehron/EZ-EC-AEC-Tech-Hackathon-Embodied-Carbon-Tool)

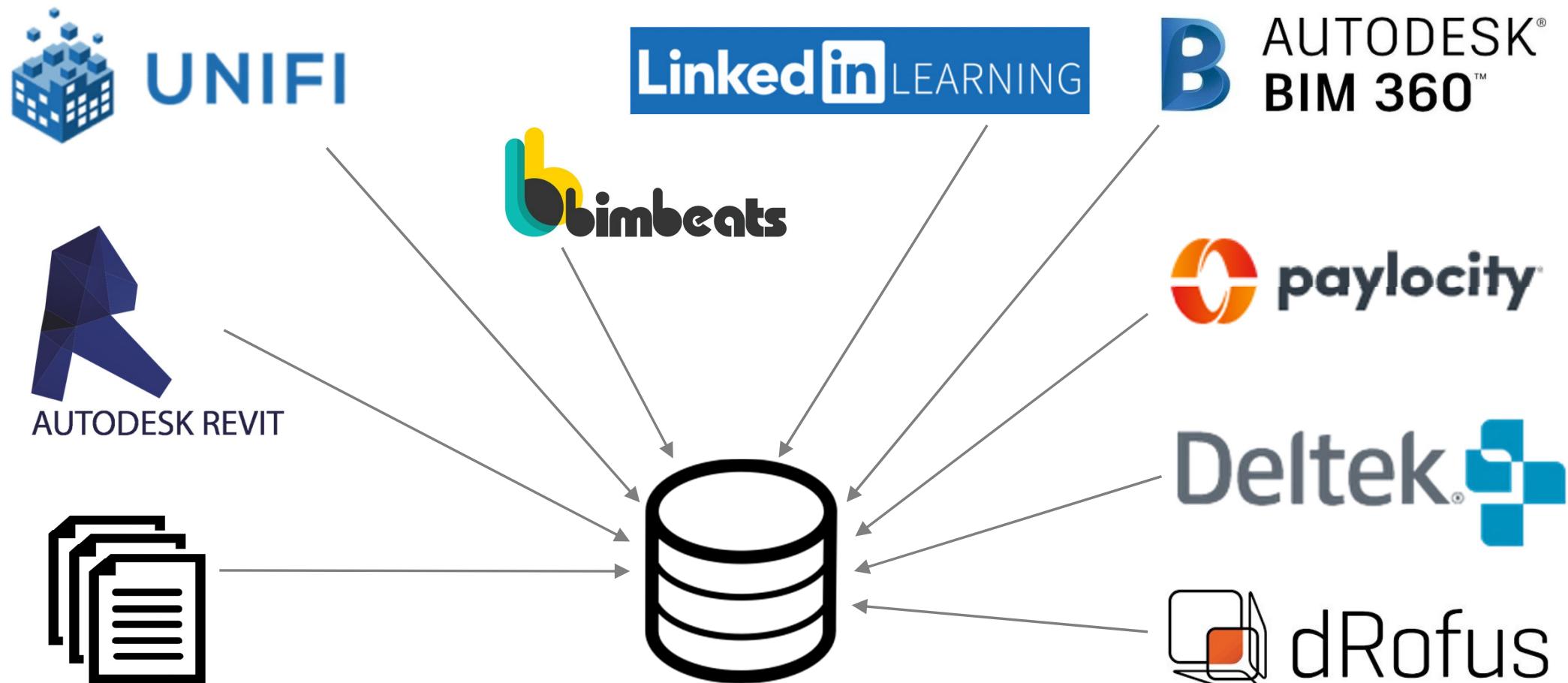


FORGE TV VIEWER

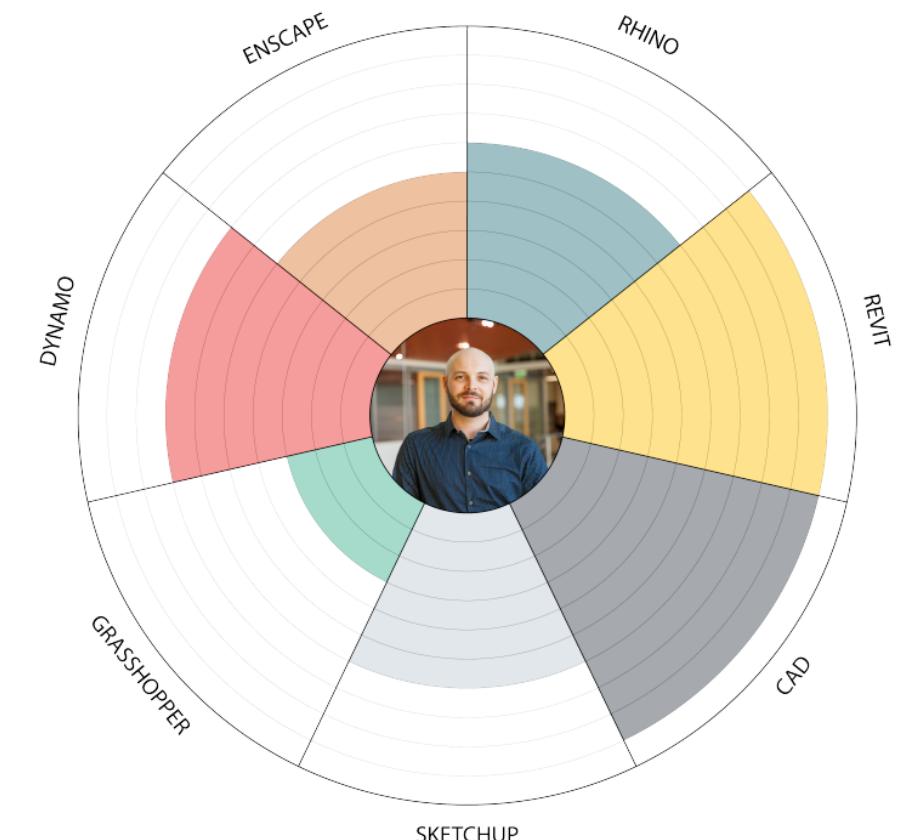
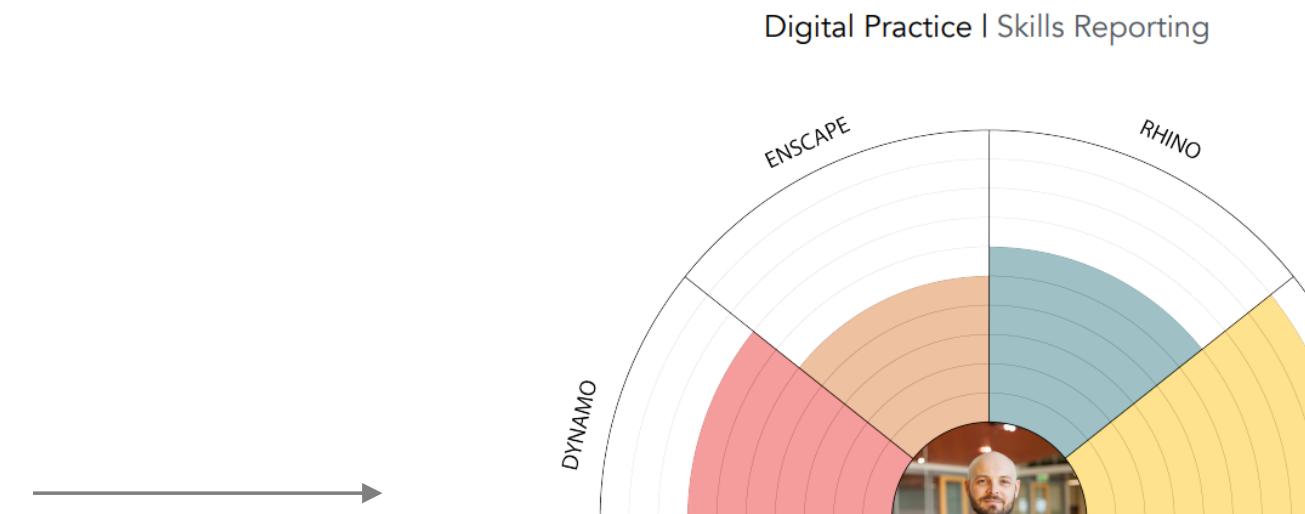
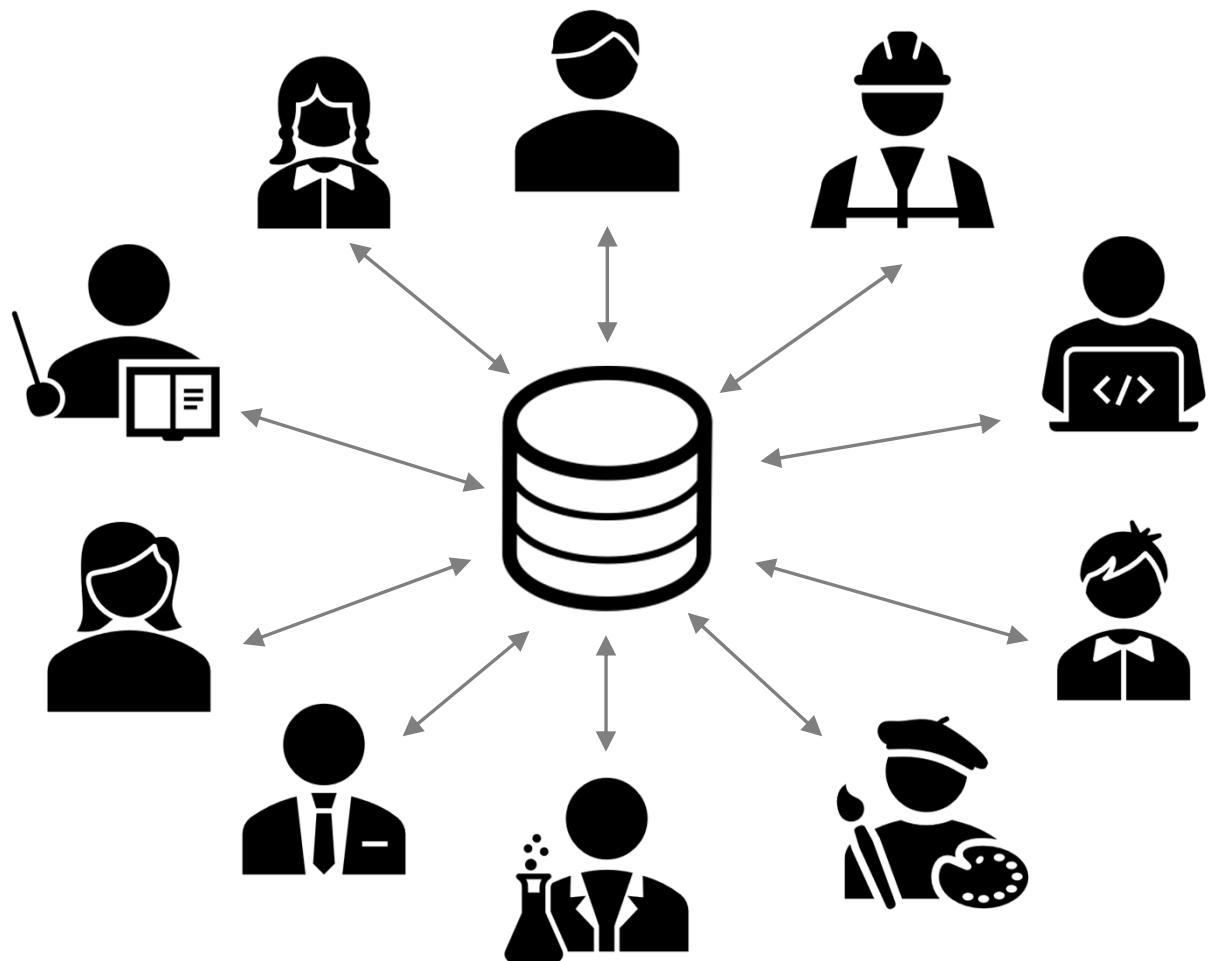


- HMC project Autodesk Forge to create a dashboard viewer of BIM 360 content
- Tadeh Hakopian, Janek Kneski and Forge team developed the app in a few hours
- Check it out -
<https://forgetv.herokuapp.com/>
- Repo -





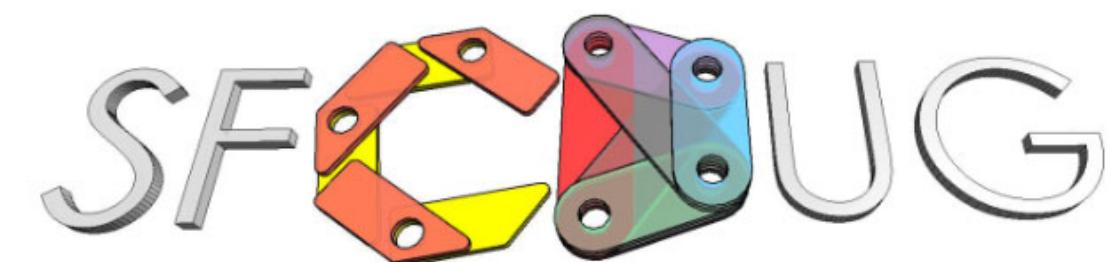
DATABASE CREATION



WHO TO FOLLOW



pyRevit blog

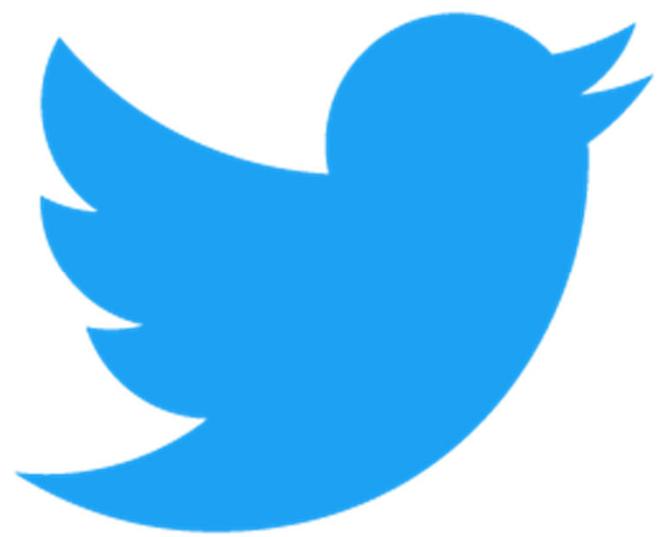


ADDITIONAL LEARNING



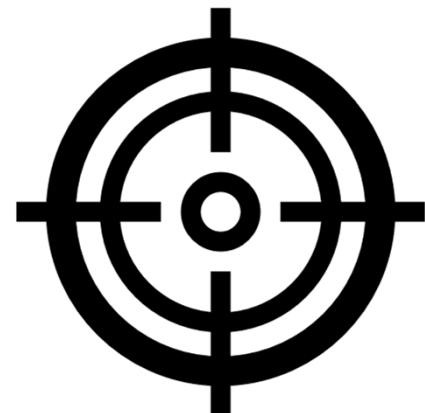
PEOPLE TO FOLLOW

- Ehsan Iran-Nejad - @eirannejad
- Ian Keough - @ikeough
- Jose Oliveira - @TugaBIM
- Sol Amour - @solamour
- Gavin Crump - @thebimguru
- Thomas Mahon - @Thomas__Mahon
- Wassim Jabi - @wassimj
- Gui Talarico - @gtalarico
- Lisa Marie Mueller - @lm2_me
- Find More on the interwebs!

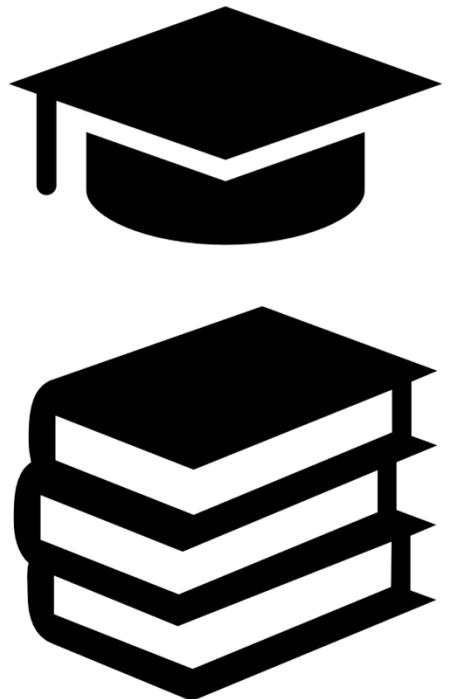


IMPORTANT PARTS, AGAIN

Get out of your comfort
zone
(start trying out something
you like)



There's always something
you can learn
(groups and hackathons)



Just try something
(and share it with everyone)



THAT'S IT! GET GOING! THANKS!

- **Tadeh's Contacts:**
 - Twitter - @tadeh_hakopian
 - Linkedin - <https://www.linkedin.com/in/thakopian/>
 - Github Decks - <https://github.com/thakopian/Presentations>
 - Email – thakopian@gmail.com
- **YourDesk site:**
 - <https://yourdeskuniversity.com/>



ADDITIONAL LEARNING

- Dynamo Primer -
https://primer.dynamobim.org/10_Custom-Nodes/10-4_Python.html
- Dynamo Forums - <https://forum.dynamobim.com/>
- Autodesk University - <https://www.autodesk.com/autodesk-university/au-online?query=PYTHON>
- LinkedIn Learning -
<https://www.linkedin.com/learning/dynamo-for-revit-python-scripting-2/jumping-into-python-and-dynamo>
- YouTube Channels (Danny Bentley) -
<https://www.youtube.com/channel/UC1Dx-jGyRbvHzZ8ZyGWF5w>
- Automate the boring stuff with Python -
<https://automatetheboringstuff.com/>
- Python Cheat Sheet -
<https://forum.dynamobim.com/t/how-to-install-python-modules-in-dynamo-core-runtime-2-8-0/52922/7>
- Revit API Docs - <https://www.revitapidocs.com/code/>
- Dynamo Python Gitbook -
<https://dynamopythonprimer.gitbook.io/dynamo-python-primer/>
- Dynamo Github Repo -
<https://github.com/DynamoDS/DynamoRevit/issues/1881>
- Dynamo 2.8 release notes -
<https://dynamobim.org/dynamo-core-2-8-release/>
- Python modules to run in Dynamo 2.8 -
<https://forum.dynamobim.com/t/how-to-install-python-modules-in-dynamo-core-runtime-2-8-0/52922>

CONTRIBUTORS AND OPEN SOURCE PROJECTS

- **Special Thanks to:**
- Gui Talarico (Revit API docs, Revit Python Wrapper)
- Ehsan Iran-Nejad (pyRevit)
- Dimon Moult (Blender BIM)
- Mostapha Sadeghipour Roudsari (Ladybug Tools)
- Dynamo Team
- Pattern Language - <https://www.patternlanguage.com/>
- Dynamo - https://primer.dynamobim.org/10_Custom-Nodes/10-4_Python.html
- Grasshopper - <https://developer.rhino3d.com/guides/rhinopython/your-first-python-script-in-grasshopper/>
- Revit Python Shell - <https://github.com/architecture-building-systems/revitpythonshell>
- Revit Python Wrapper - <https://revitpythonwrapper.readthedocs.io/en/latest/>
- Revit API docs - <https://www.revitapidocs.com/>
- PyRevit - <https://www.notion.so/pyRevit-bd907d6292ed4ce997c46e84b6ef67a0>
- BlenderBIM - <https://blenderbim.org/>
- ifcOpenShell - <http://ifcopenshell.org/>
- Ladybug tools - <https://www.ladybug.tools/>