AI-Assisted Design

DM II Week 5

DES 212| Winter Term 2 | 2026 | 3 Credits

Instructor: Xun Liu

Content

Machine Learning
Generative AI
Generative AI – Visual Applications
Beyond Visual

Machine Learning

Rule: Y = 2X - 1

Input X = 4

Output Y = ?

Input	X =	-1,	0,	1,	2,	3,	4
Output	Y =	-3,	-1,	1,	3,	5,	?

Input	X =	-1,	0,	1,	2,	3,	4
Output	Y =	-3,	-1,	1,	3,	5,	?

$$(Y = 2X - 1)$$

Input: image



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Output: Assign image to one of a fixed set of categories

cat
bird
deer
dog
truck

```
def classify_image(image):
  # Some magic here?
  return class_label
```

Unlike e.g. sorting a list of numbers,

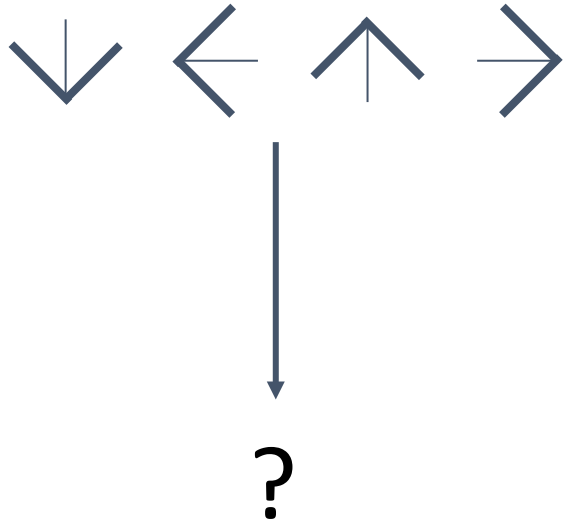
no obvious way to hard-code the algorithm for recognizing a cat, or other classes.



Find edges

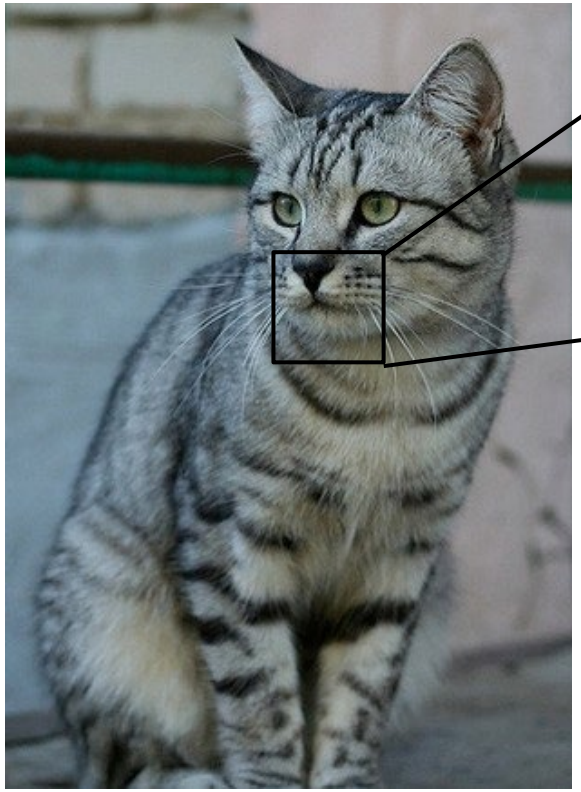


Find corners



?

John Canny, “A Computational Approach to Edge Detection”, IEEE TPAMI 1986



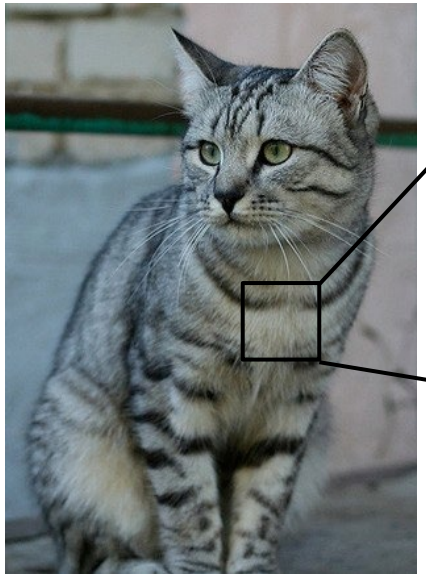
This image by Nikita is licensed under CC-BY 2.0

```
[[105 112 108 111 104  99 106  99  96 103 112 119 104  97  93  87]
 [ 91  98 102 106 104  79  98 103  99 105 123 136 110 105  94  85]
 [ 76  85  90 105 128 105  87  96  95  99 115 112 106 103  99  85]
 [ 99  81  81  93 120 131 127 100  95  98 102  99  96  93 101  94]
 [106  91  61  64  69  91  88  85 101 107 109  98  75  84  96  95]
 [114 108  85  55  55  69  64  54  64  87 112 129  98  74  84  91]
 [133 137 147 103  65  81  80  65  52  54  74  84 102  93  85  82]
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 [115 114 109 123 150 148 131 118 113 109 100  92  74  65  72  78]
 [ 89  93  90  97 108 147 131 118 113 114 113 109 106  95  77  80]
 [ 63  77  86  81  77  79 102 123 117 115 117 125 125 130 115  87]
 [ 62  65  82  89  78  71  80 101 124 126 119 101 107 114 131 119]
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 [ 87  65  71  87 106  95  69  45  76 130 126 107  92  94 105 112]
 [118  97  82  86 117 123 116  66  41  51  95  93  89  95 102 107]
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 [123 107  96  86  83 112 153 149 122 109 104  75  80 107 112  99]
 [122 121 102  80  82  86  94 117 145 148 153 102  58  78  92 107]
 [122 164 148 103  71  56  78  83  93 103 119 139 102  61  69  84]]
```

What the computer sees

An image is just a big grid of numbers between [0, 255]:

e.g. 800 x 600 x 3 (3 channels RGB)



```
[[105 112 108 111 104  99 106  99  96 103 112 119 104  97  93  87]
 [ 91  98 102 106 104  79  98 103  99 105 123 136 110 105  94  85]
 [ 76  85  90 105 120 105  87  96  95  99 115 112 106 103  99  85]
 [ 99  81  81  93 120 131 127 100  95  98 102  99  96  93 101  94]
 [106  91  61  64  69  91  88  85 101 107 109  98  75  84  96  95]
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 [133 137 147 103  65  81  80  65  52  54  74  84 102  93  85  82]
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 [125 133 148 137 119 121 117  94  65  79  80  65  54  64  72  98]
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 [ 87  65  71  87 106  95  69  45  76 130 126 107  92  94 105 112]
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 [164 146 112  80  82 120 124 104  76  48  45  66  88 101 102 109]
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 [122 164 148 103  71  56  78  83  93 103 119 139 102  61  69  84]]
```

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All pixels change when the camera moves!

Maine Coon



This image is free for for use under the Pixabay License

Ragdoll



This image is CC0 public domain

American Shorthair



This image is CC0 public domain



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This image is CC0 1.0 public domain



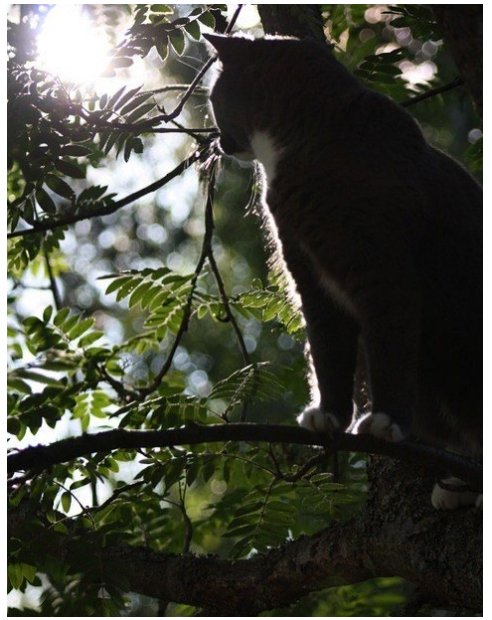
This image is CC0 1.0 public domain



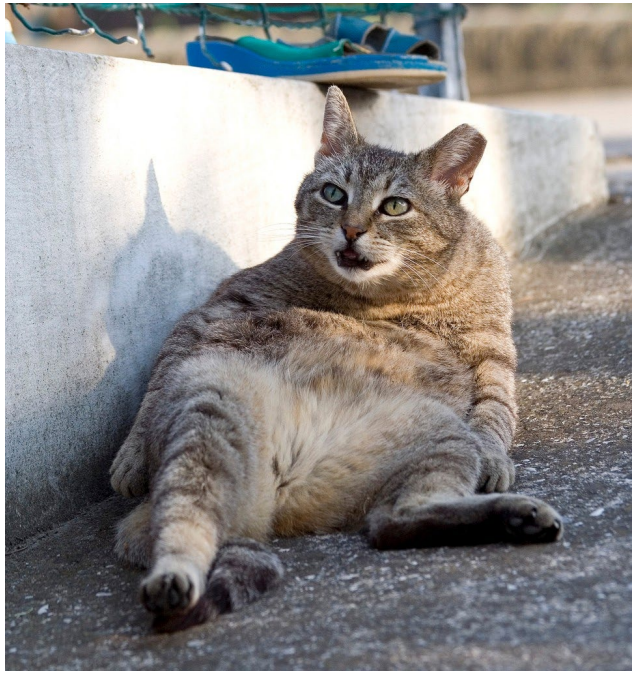
This image is CC0 1.0 public domain



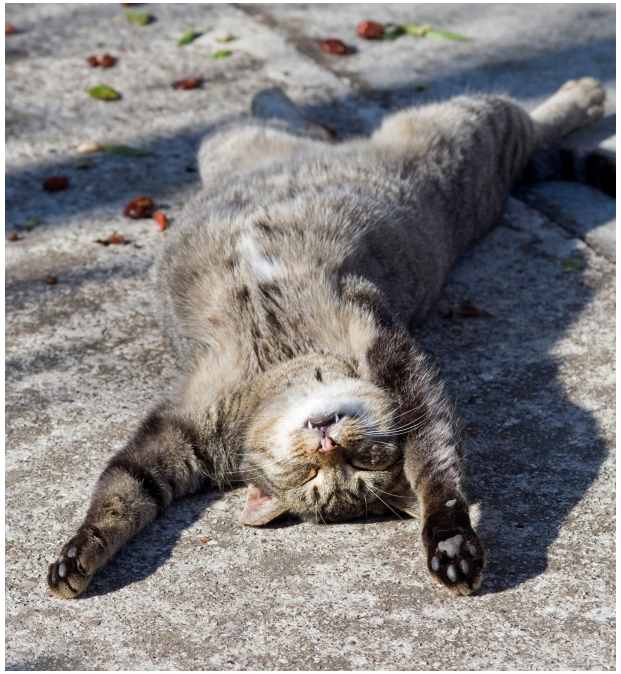
This image is CC0 1.0 public domain



This image is CC0 1.0 public domain



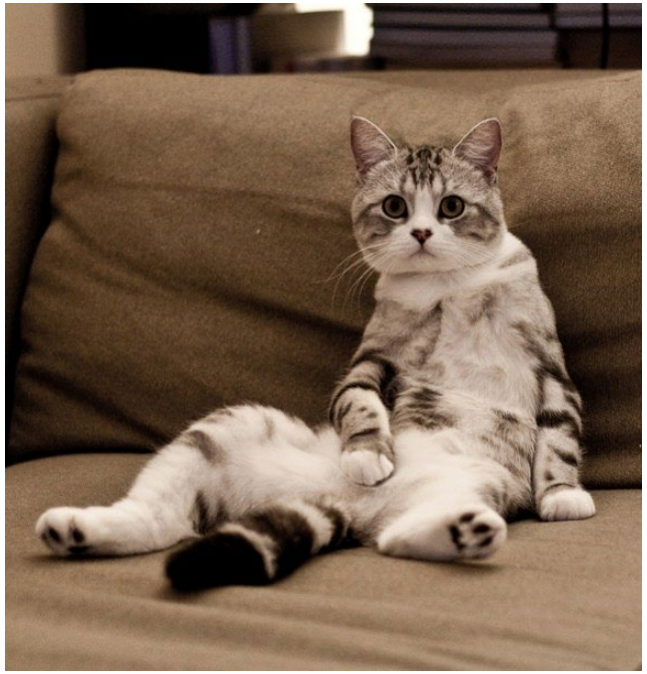
This image by Umberto Salvagnin is licensed under CC-BY 2.0



This image by Umberto Salvagnin is licensed under CC-BY 2.0



This image by sare bear is licensed under CC-BY 2.0



This image by Tom Thai is licensed under CC-BY 2.0



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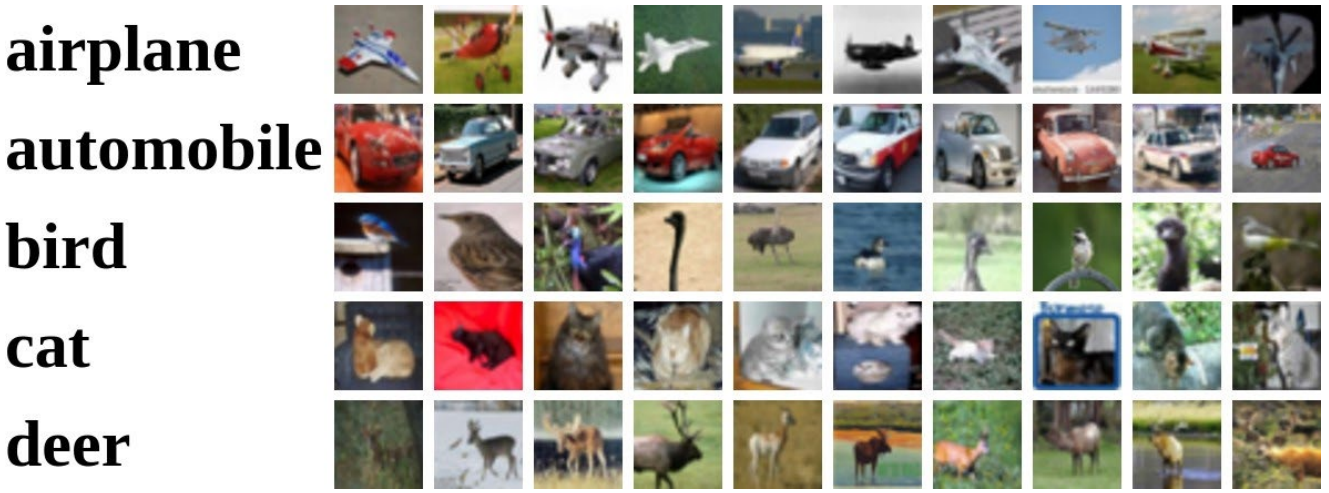
This image by jonsson is licensed under CC-BY 2.0

1. Collect a dataset of images and labels
2. Use Machine Learning to train a classifier
3. Evaluate the classifier on new images

```
def train(images, labels):
  # Machine learning!
  return model
```

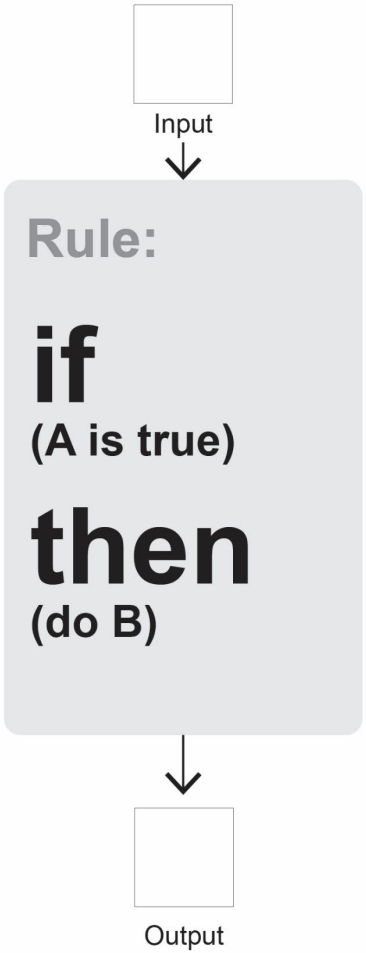
```
def predict(model, test_images):
  # Use model to predict labels
  return test_labels
```

Example Training Set

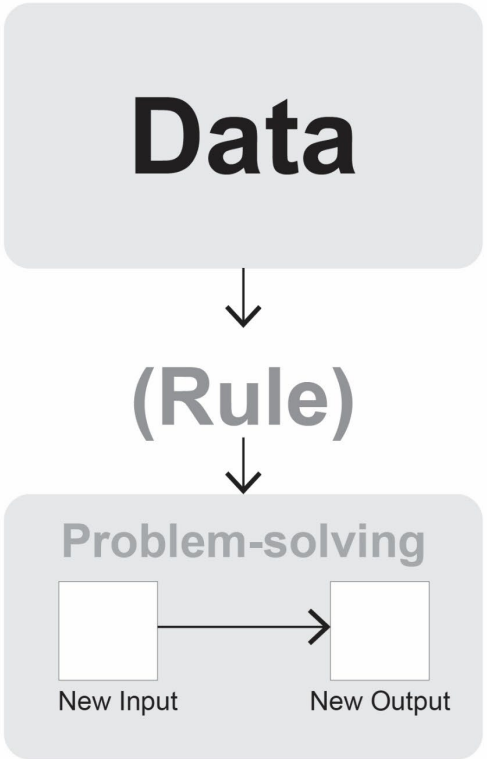


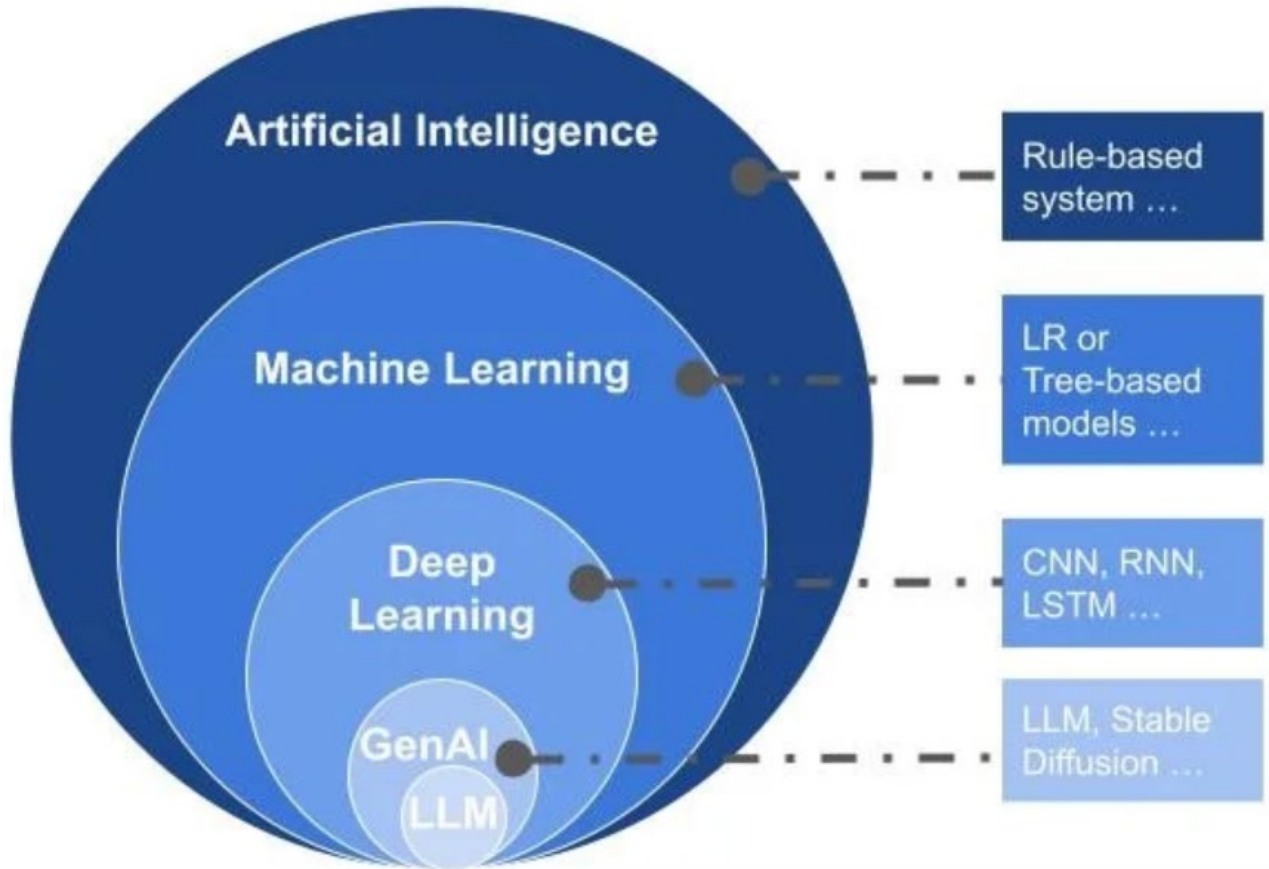
Credit: EECS 498.008 / 598.008: Deep Learning for Computer Vision. UMich. By Justin Johnson

Rule-based Approach



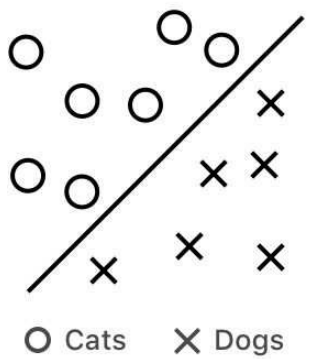
Machine Learning Approach



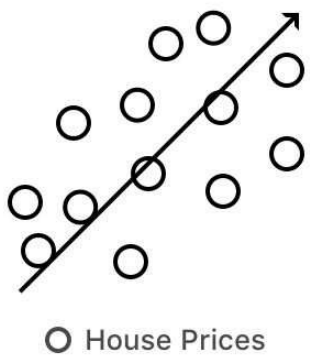

Artificial Intelligence
Machine Learning
Deep Learning
GenAI
LLM
Rule-based system …
LR or Tree-based models …
CNN, RNN, LSTM …
LLM, Stable Diffusion …

SUPERVISED LEARNING

Classification

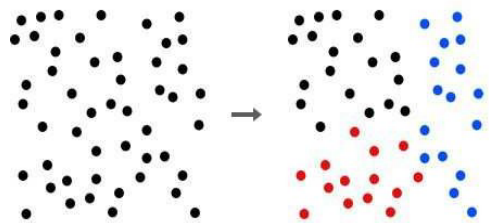


Regression



UNSUPERVISED LEARNING

Clustering



Association

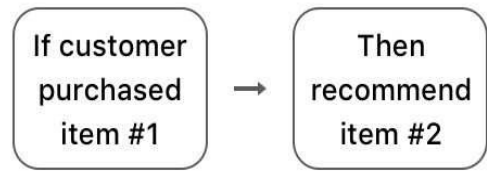
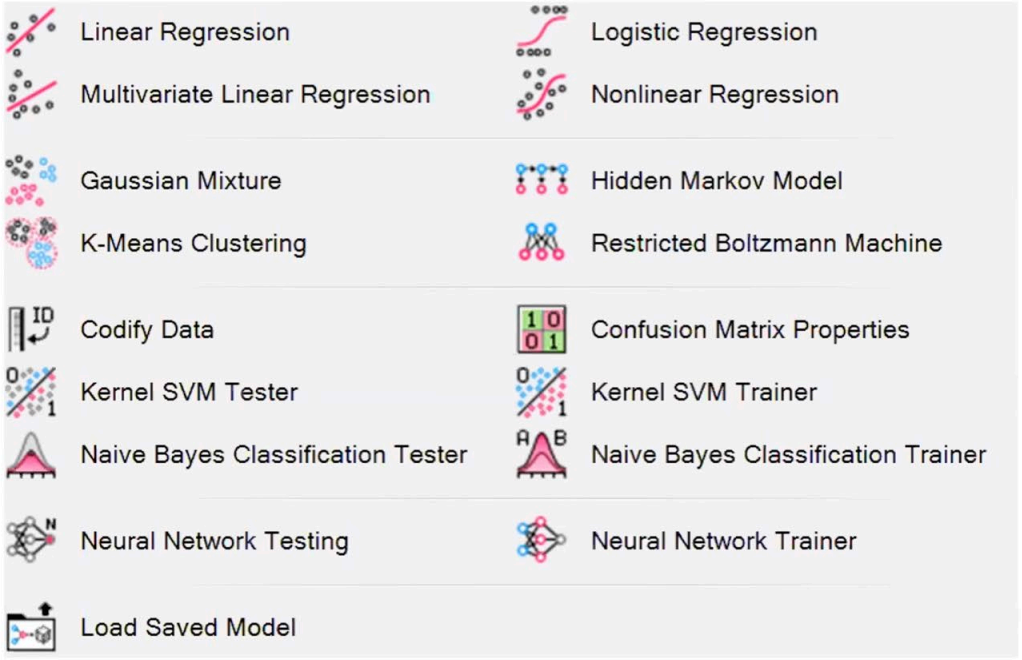
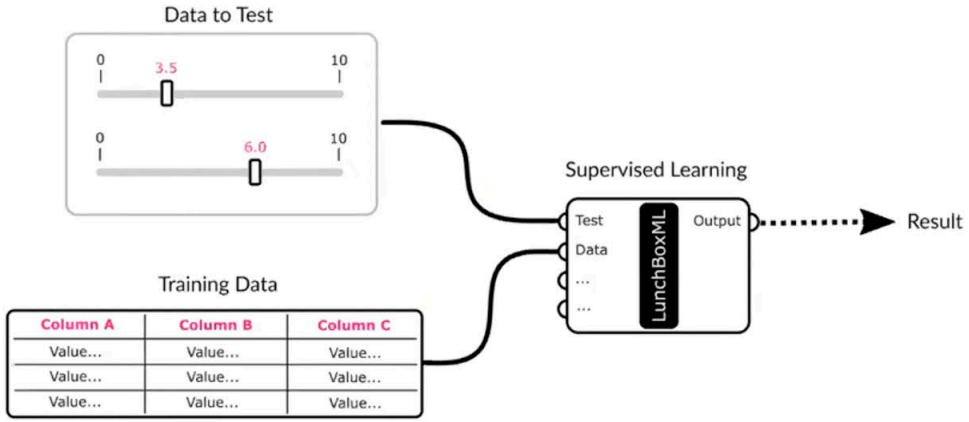


Image: https://uxdesign.cc/an-intro-to-machine-learning-for-designers-5c74ba100257

Implementing Machine Learning in GH (Lunchbox)





LunchBoxML

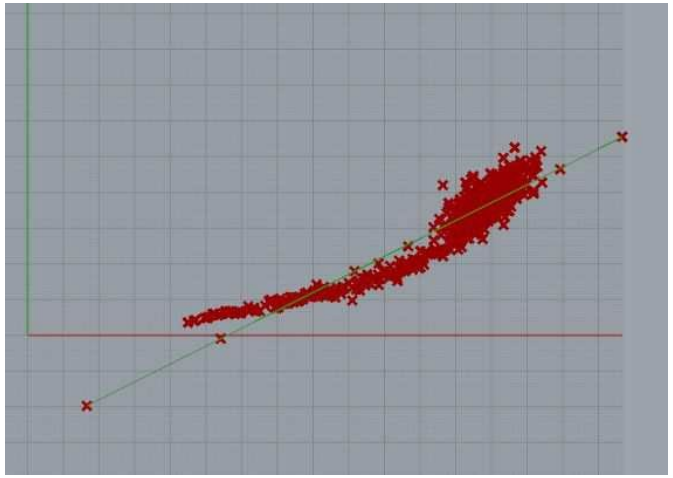
Grasshopper components that expose general-purpose ML solvers

proving ground

Implementing Machine Learning in GH (Lunchbox)
Regression Tools

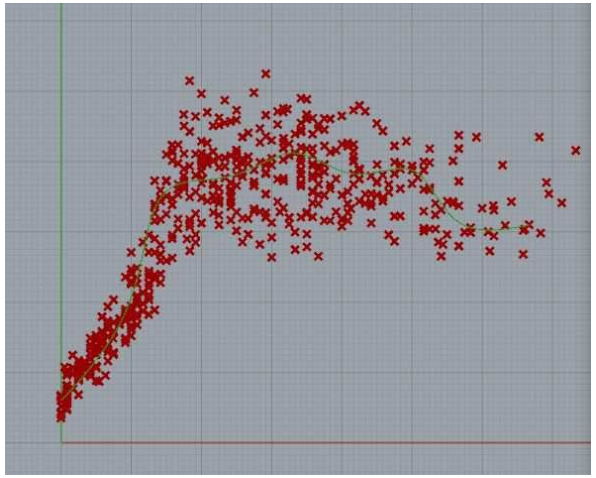
Liner

Height and Weight



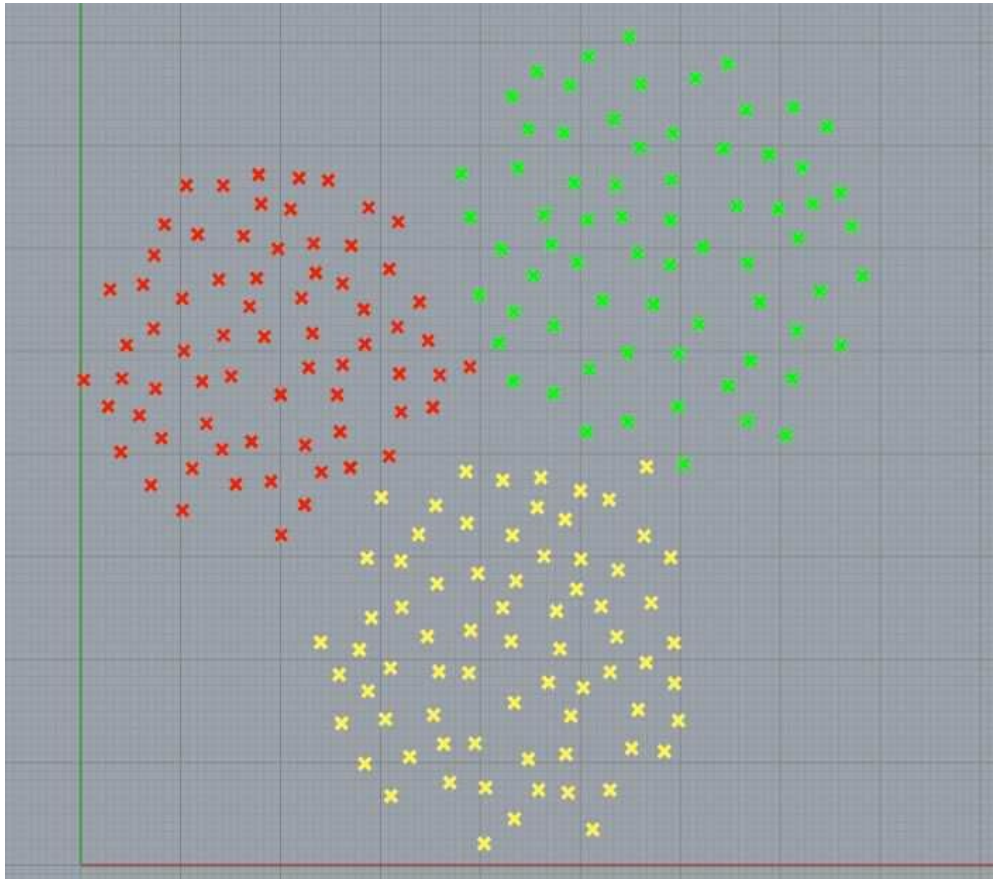
Not Liner

Age and Weight



Demo :
https://www.lynda.com/Grasshopper-tutorials/Introduction-machine-learning/797729/2800195-4.html

Implementing Machine Learning in GH (Lunchbox)
Clustering Tools



Demo :https://www.lynda.com/Grasshopper-tutorials/Introduction-machine-learning/797729/2800195-4.html

Implementing Machine Learning in GH (Lunchbox)
Clustering Tools

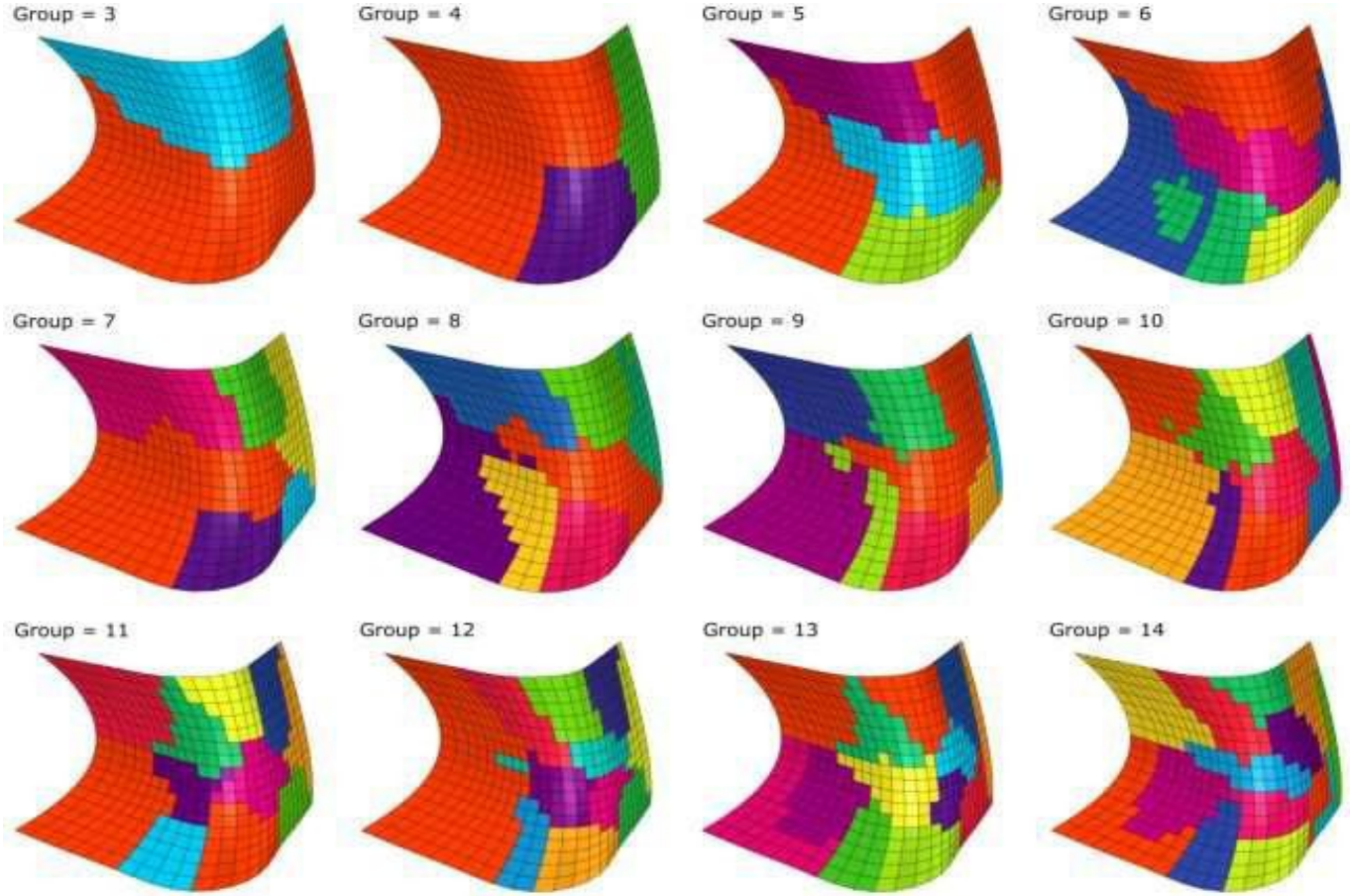


Image: https://provingground.io/2018/10/29/aec-tech-2018-lunchboxml-workshop-examples/

Implementing Machine Learning in GH (Lunchbox)
Feature Detection

Point scan data (stone work)



Gaussian mixture (sorted attributes)

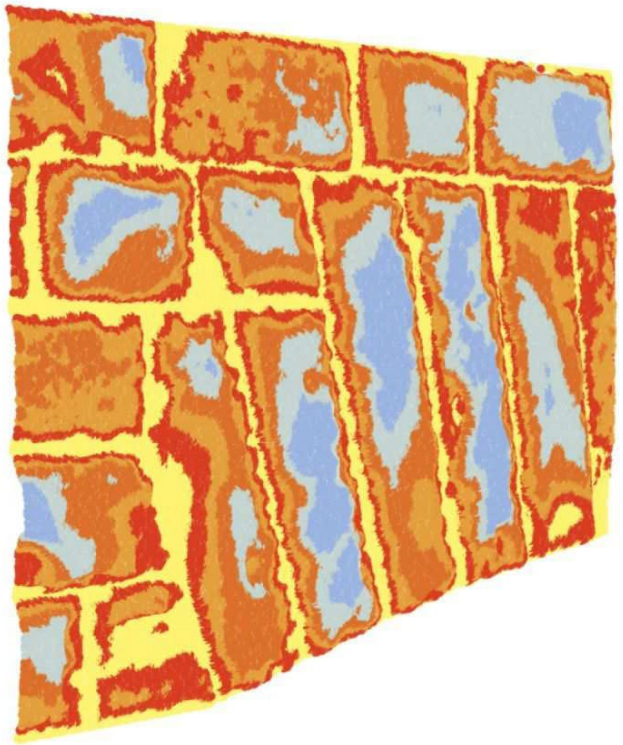
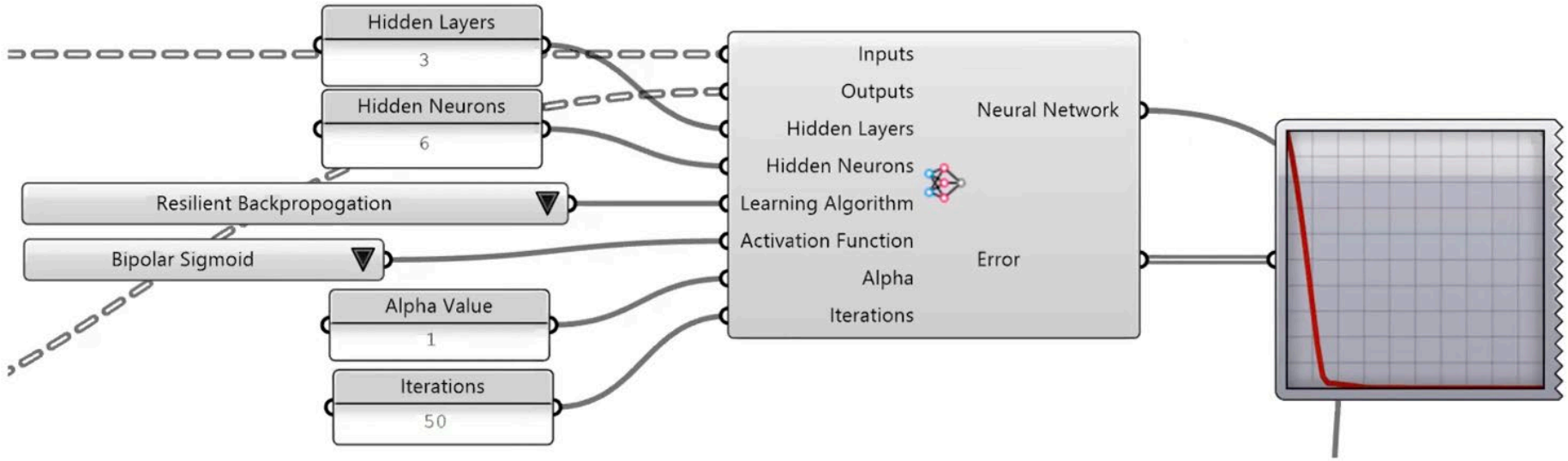


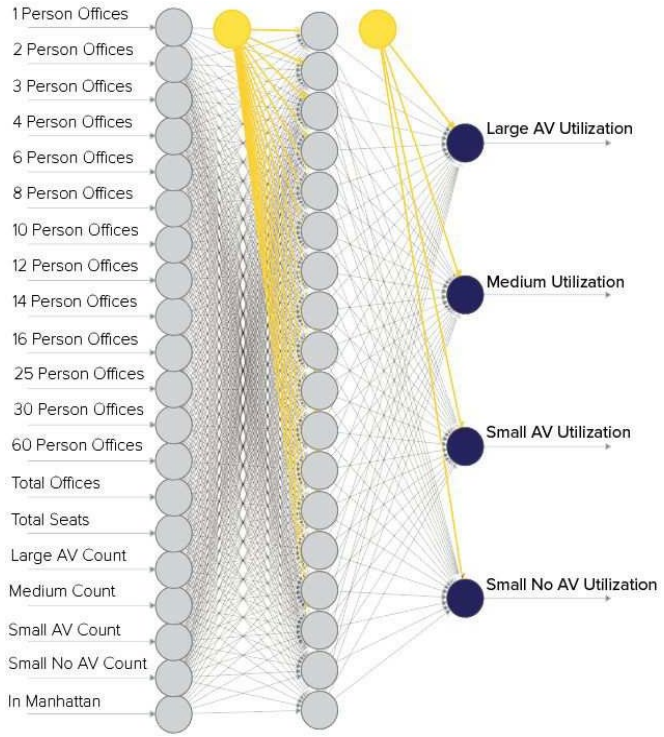
Image: https://provingground.io/2018/10/29/aec-tech-2018-lunchboxml-workshop-examples/

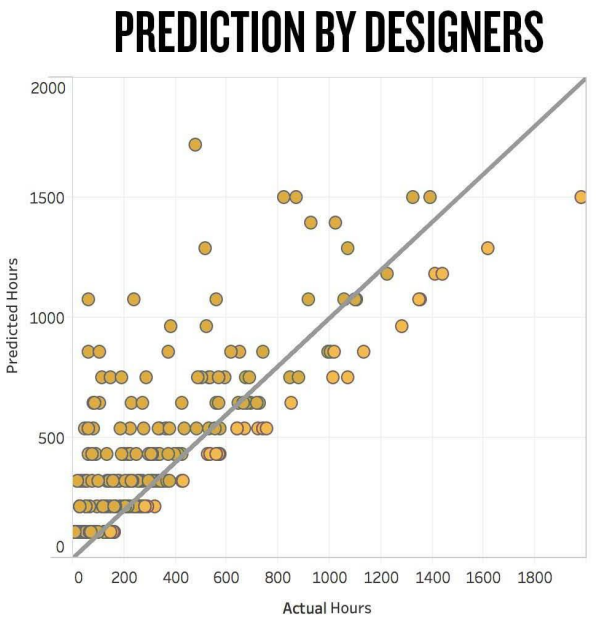
Implementing Machine Learning in GH (Lunchbox)

Classification Tools: Neural Network



Implementing Machine Learning in GH (Lunchbox)
Classification Tools: Neural Network





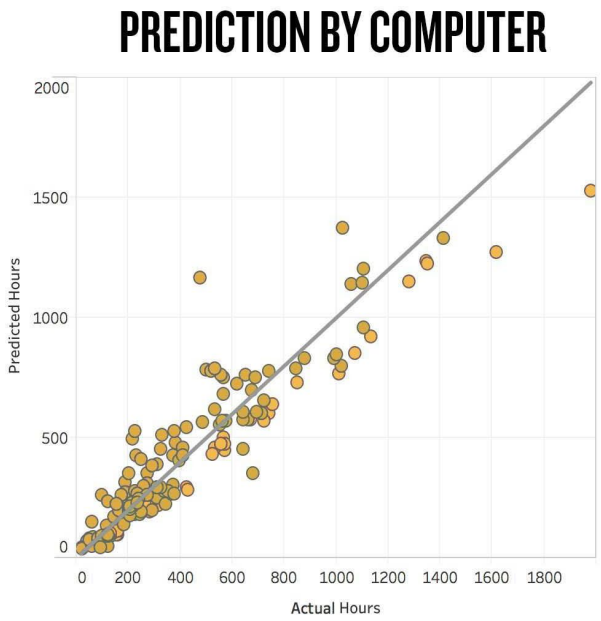


Image: https://provingground.io/2018/10/29/aec-tech-2018-lunchboxml-workshop-examples/

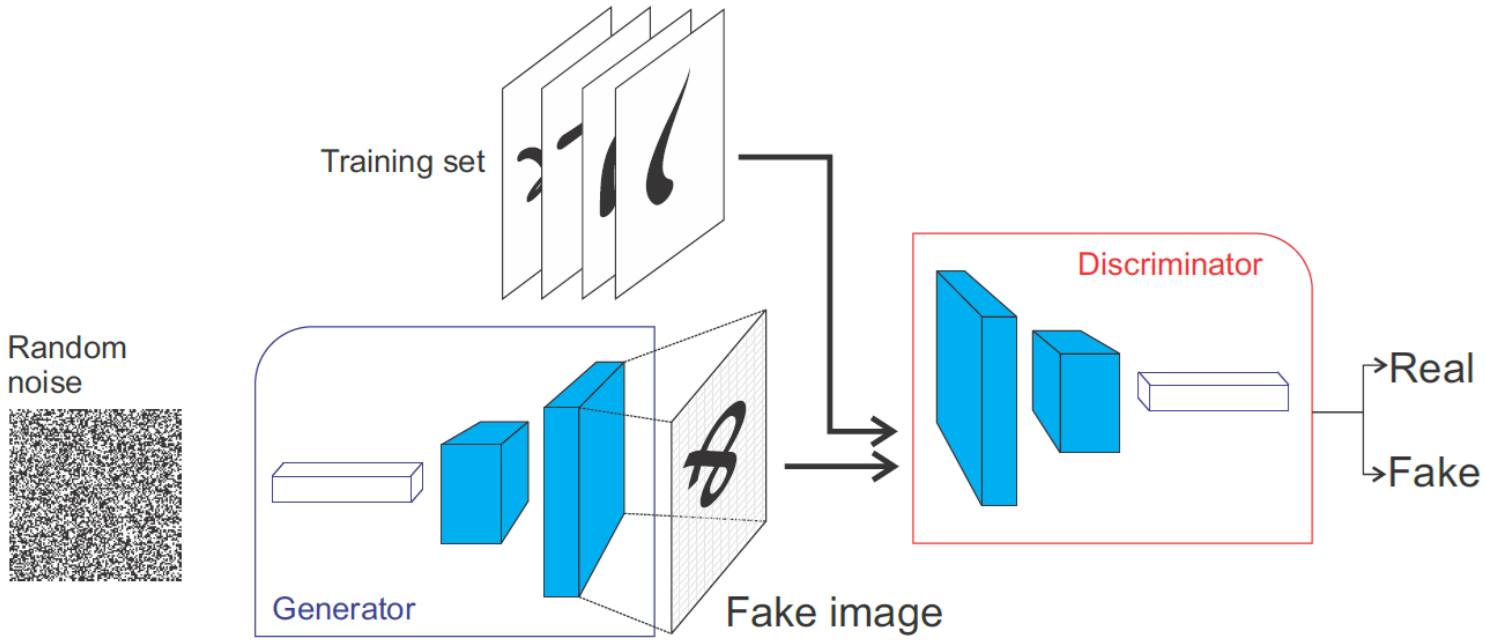
Generative AI





https://lambdalabs.com/blog/stylegan-3/

Generative Adversarial Networks (GANs) - 2014



Ian Goodfellow, 2014

Generative Adversarial Networks (GANs) - 2014



Ian Goodfellow's Twitter

“ThisXdoesnotexist” - 2018



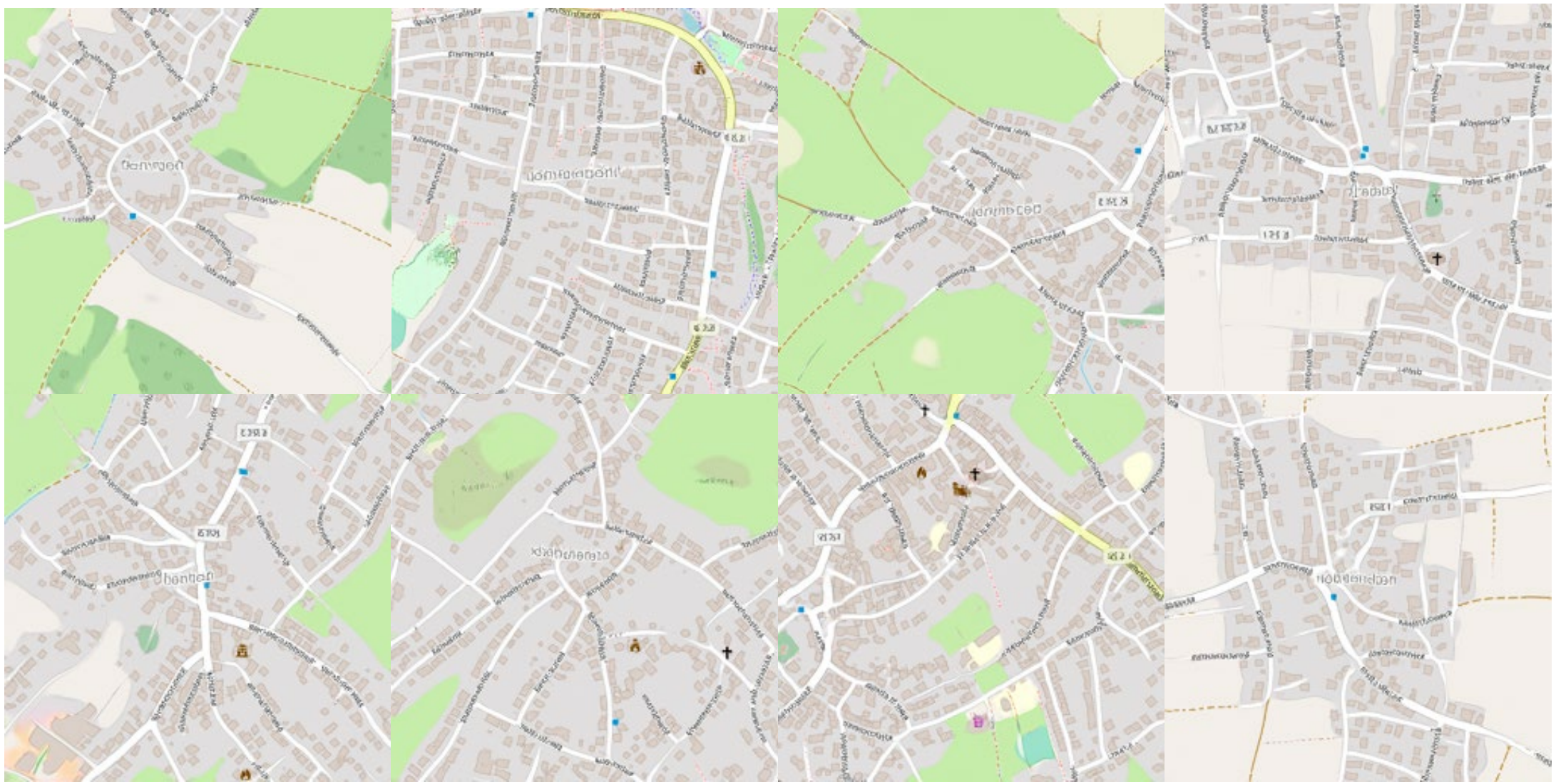
https://thispersondoesnotexist.com/

“ThisXdoesnotexist” - 2018



http://thiscitydoesnotexist.com/

“ThisXdoesnotexist” - 2018



http://thismapdoesnotexist.com/

“ThisXdoesnotexist” - 2018



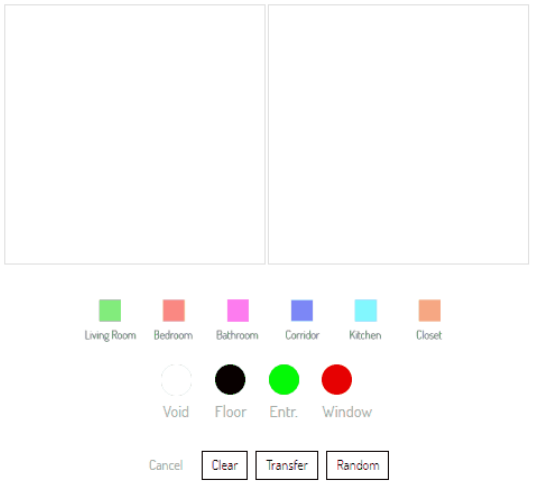
https://thisartworkdoesnotexist.com/

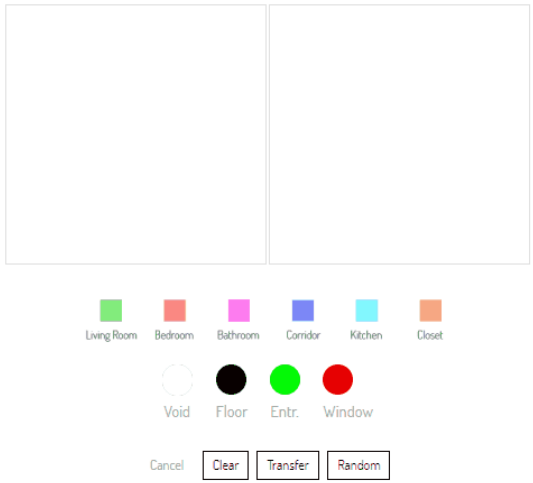
“ThisXdoesnotexist” - 2018



Robert A. Gonsalves, 2021.” GANscapes: Using AI to Create New Impressionist Paintings”

ArchiGAN- 2019

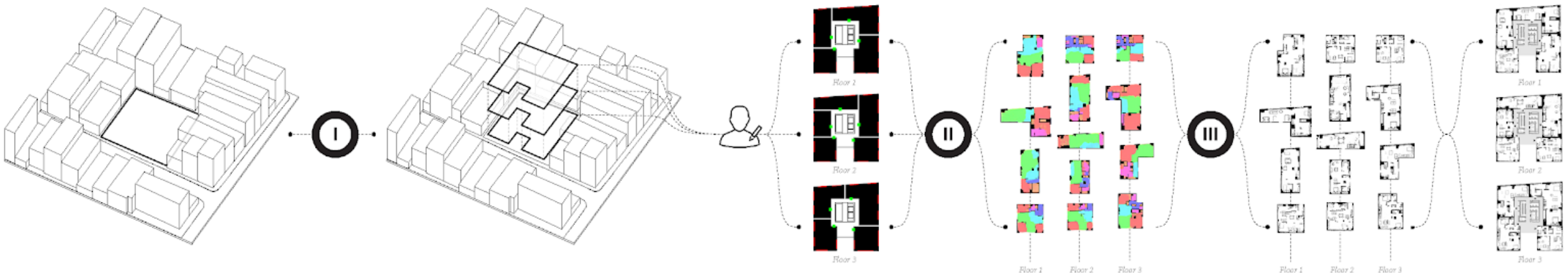






Chaillou, Stanislas. "Archigan: Artificial intelligence x architecture

ArchiGAN- 2019



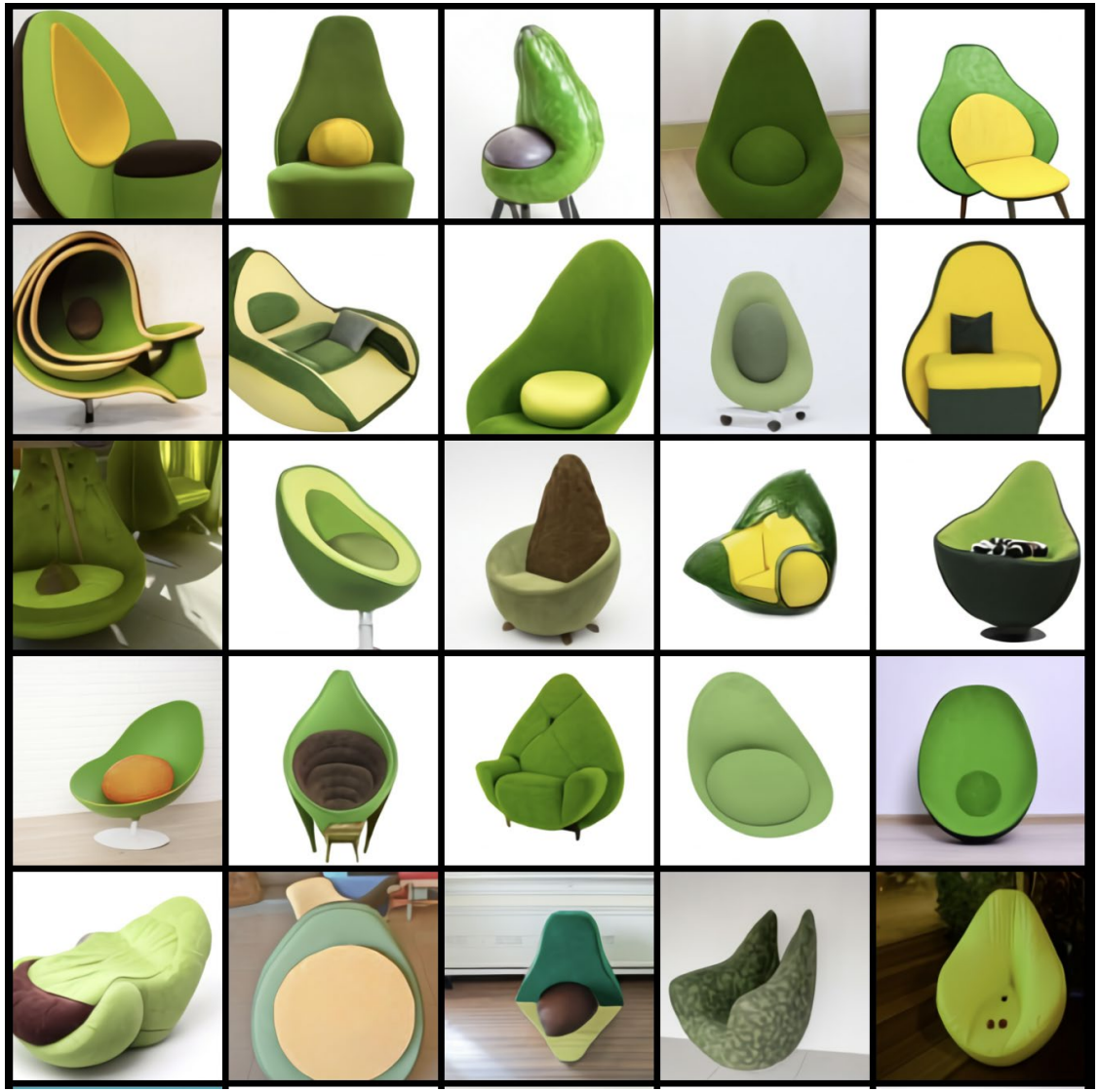
Chaillou, Stanislas. "Archigan: Artificial intelligence x architecture

Text to Image: 2021 Jan

Input Text:

“An armchair in shape of an avocado”

AI-generated images:



Jan 2021. https://openai.com/blog/dall-e/

Text to Image: 2021 Jan

Input Text:

“A snail made of sharp”

AI-generated images:



https://openai.com/blog/dall-e/

Text to Image: 2021 Jan

Input Text:

“A stained glass window with an image of a blue strawberry”

AI-generated images:

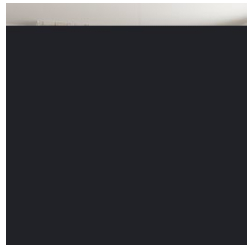


https://openai.com/blog/dall-e/

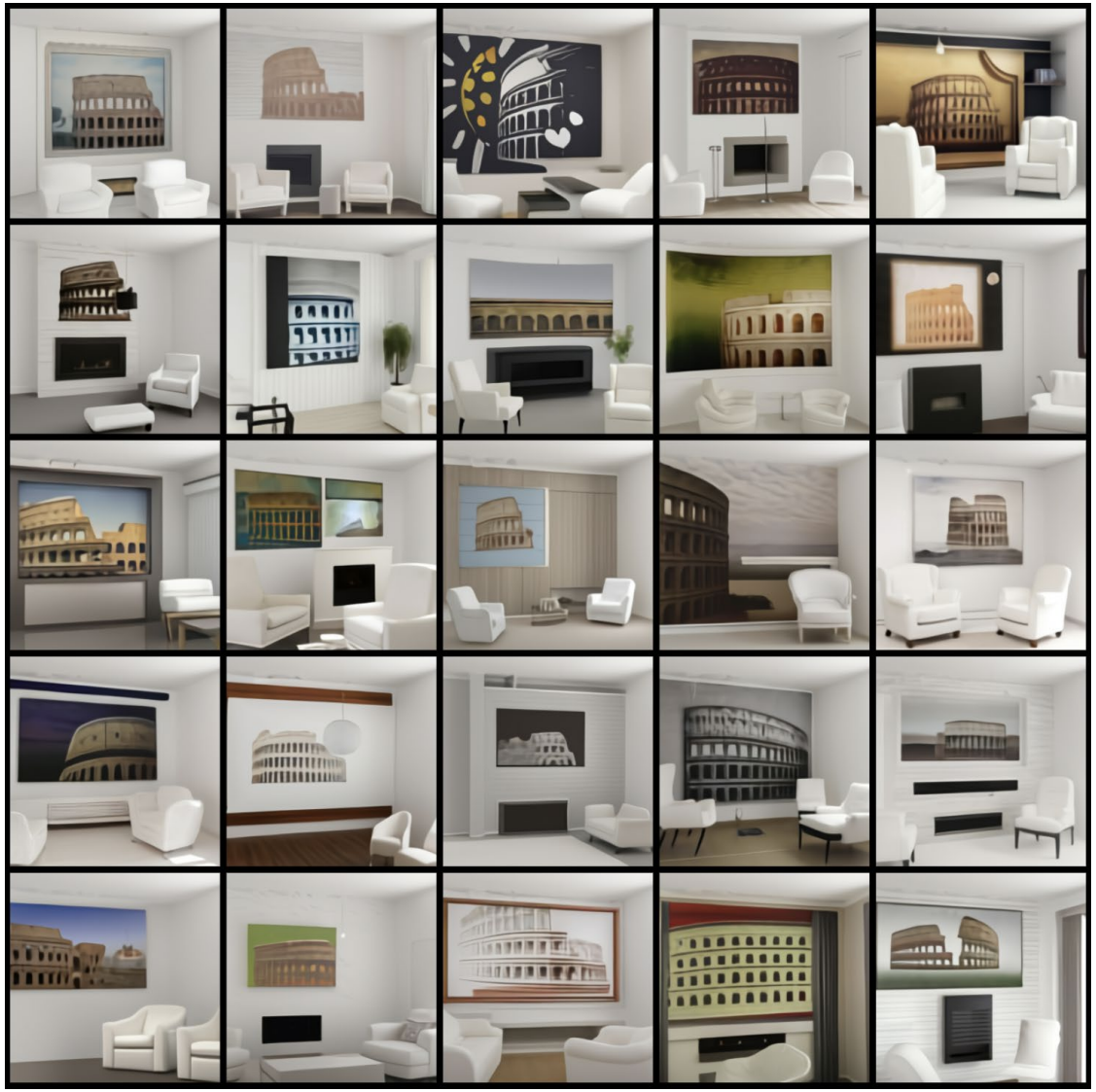
Text to Image: 2021 Jan

Input Text:

“A living room with two white armchairs and a painting of the colosseum. The painting is mounted above a modern fireplace.”



AI-generated images:



https://openai.com/blog/dall-e/

Generative AI
Visual Applications

“AI, like electricity, is a General-purpose technology.”

by Dr. Andrew Ng (Founder & CEO of DeepLearning.AI)

AI Tools for Visual













Visual Tools

1. Conceptualization

Text-to-Image (T2I)

Sketch-to-Image (S2I)

Contextual Image Editing

Aesthetic Style Transfer

Interactive Real-Time Rendering

2. Assisting Workflow

Drawing/Diagrammatic Style Reference

Generate 2D Assets (Material, Entourage)

3. High-Fidelity Rendering

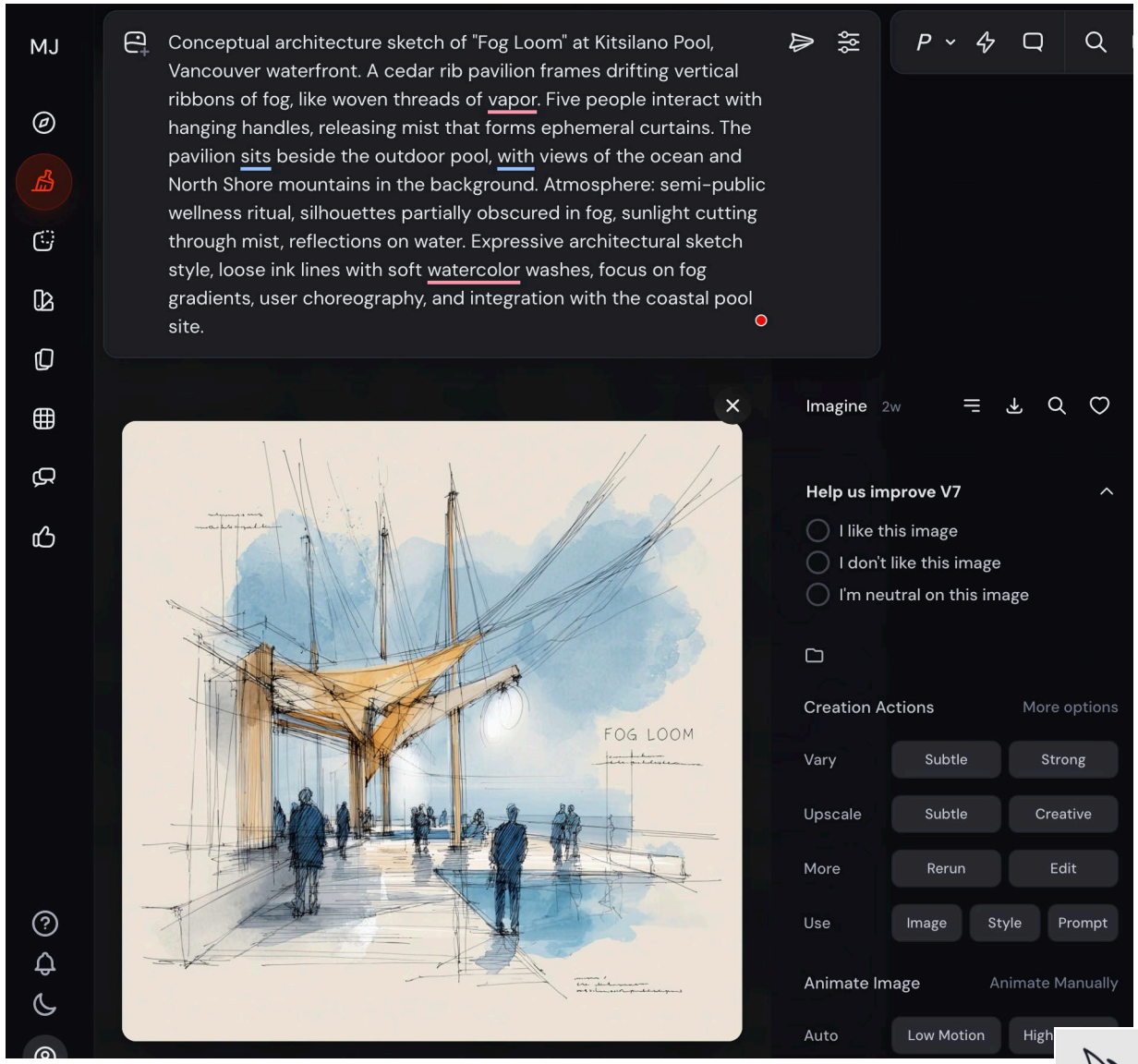
Conversational Image Refinement

Semantic Material Adjustment

Atmospheric Control

Upscaling and Enhancement

Post-Processing



Midjourney

Visual Tools

1. Conceptualization

- Text-to-Image (T2I)
- Sketch-to-Image (S2I)
- Contextual Image Editing
- Aesthetic Style Transfer
- Interactive Real-Time Rendering

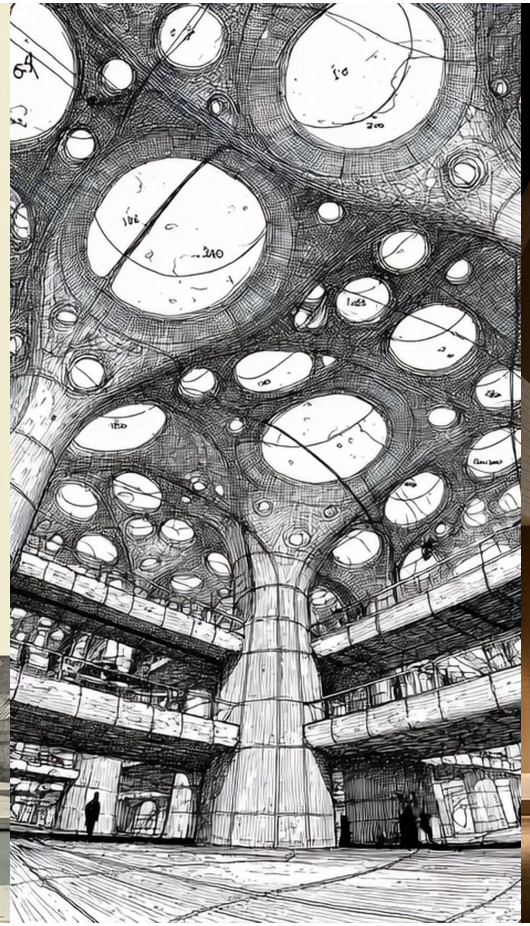
2. Assisting Workflow

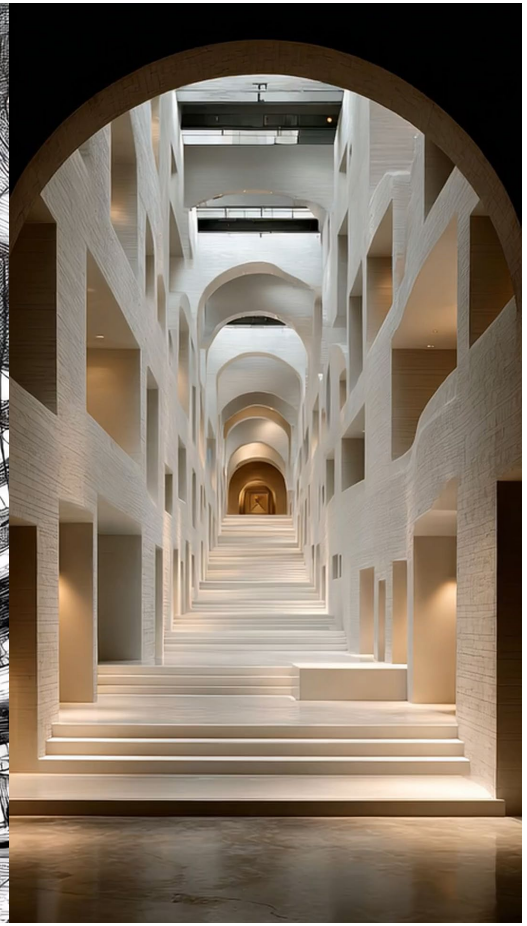
- Drawing/Diagrammatic Style Reference
- Generate 2D Assets (Material, Entourage)

3. High-Fidelity Rendering

- Conversational Image Refinement
- Semantic Material Adjustment
- Atmospheric Control
- Upscaling and Enhancement
- Post-Processing







Midjourney

Visual Tools

1. Conceptualization

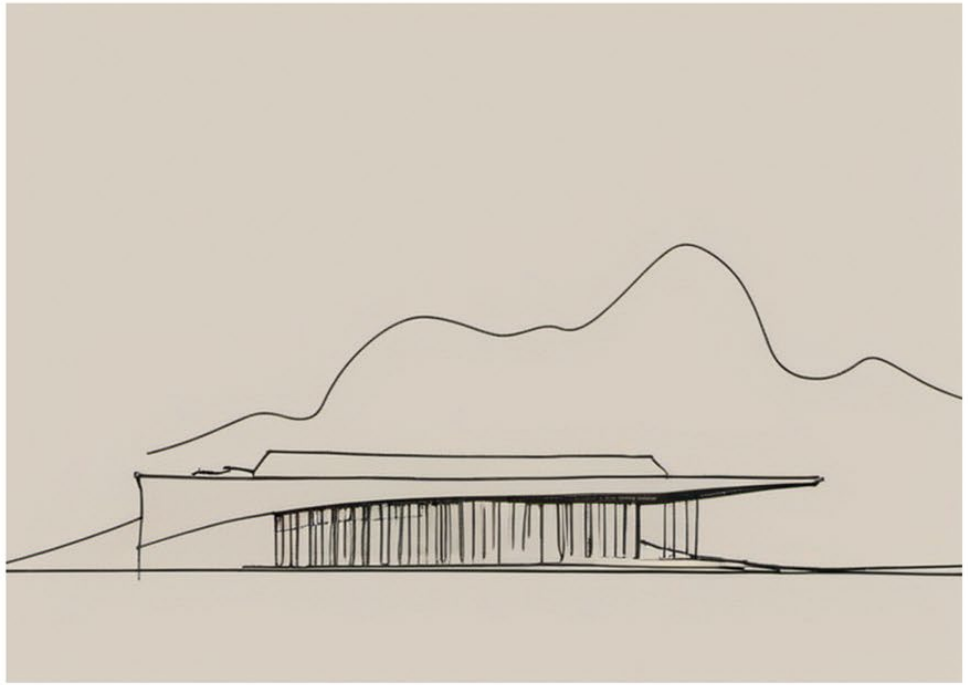
- Text-to-Image (T2I)
- Sketch-to-Image (S2I)
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Stable Diffusion

With ControlNet

Visual Tools

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A photorealistic architectural rendering of a modern, terraced residential complex situated on a gentle slope, as depicted in the provided sketch. The buildings feature clean lines, expansive glass windows, and warm, light-colored concrete facades with wooden accents on the balconies and eaves. Each unit has a private balcony or terrace with lush, minimalist plantings. The scene is set during a clear, warm afternoon with soft, natural light, creating a serene and inviting atmosphere. Show a paved pathway leading along the front of the complex, with some subtle landscaping like low shrubs and small trees to enhance the setting. Emphasize the harmony between the contemporary design and the natural slope of the land.





Gemini | Nano Banana

Visual Tools

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Input



output

Stable Diffusion

With **ControlNet**

Visual Tools

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Gemini | Nano Banana

Visual Tools

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D5 Render

Visual Tools

1. Conceptualization

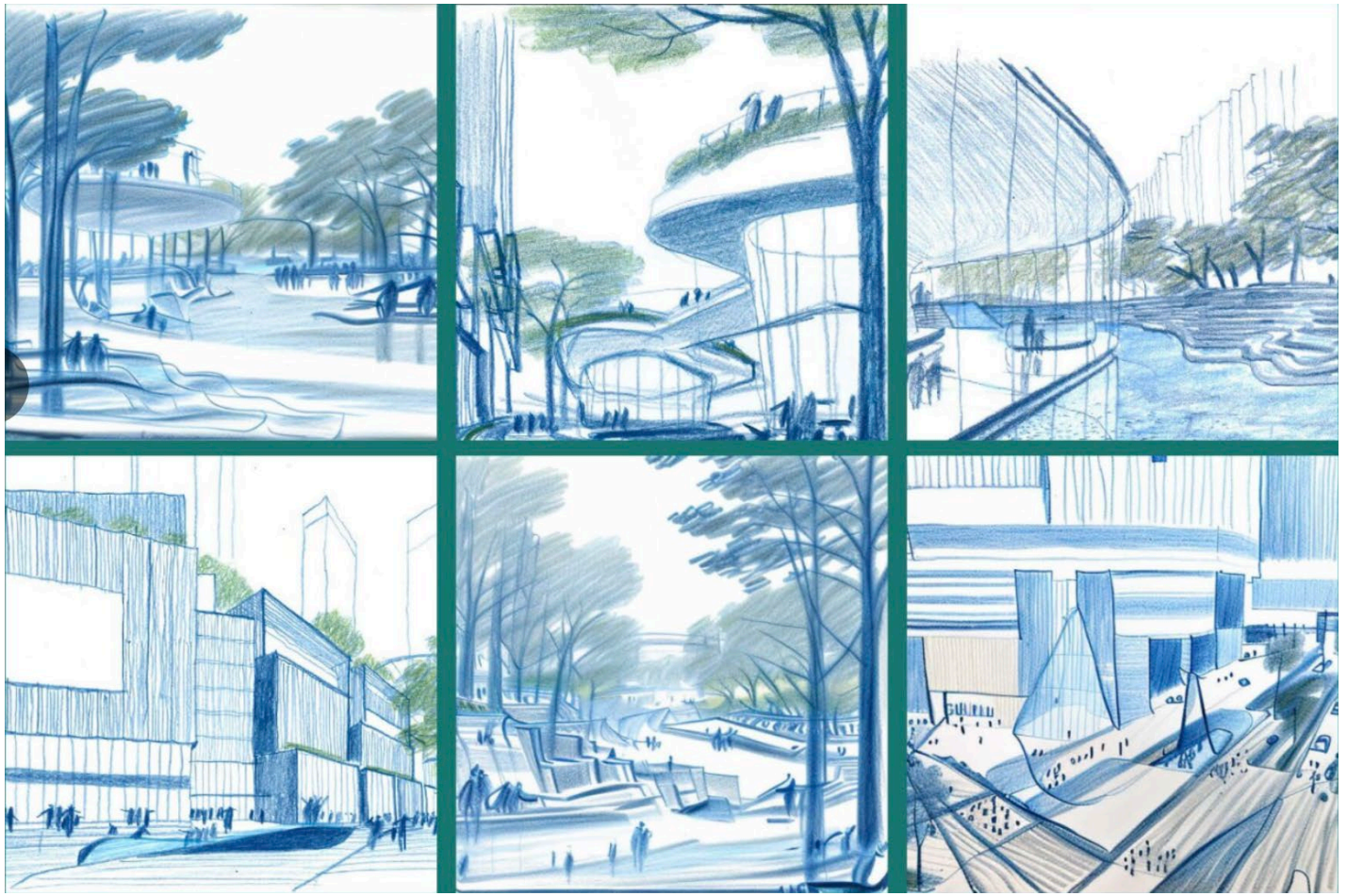
- Text-to-Image (T2I)
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Stable Diffusion

With ControlNet

SWA AI Fellowship. Shi Chen, Yaxin Cao, Wenjing Fang & Yeqing "Jerry" Shang

Visual Tools

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- Post-Processing



Touch Designer
+ Stream Diffusion

Visual Tools

1. Conceptualization

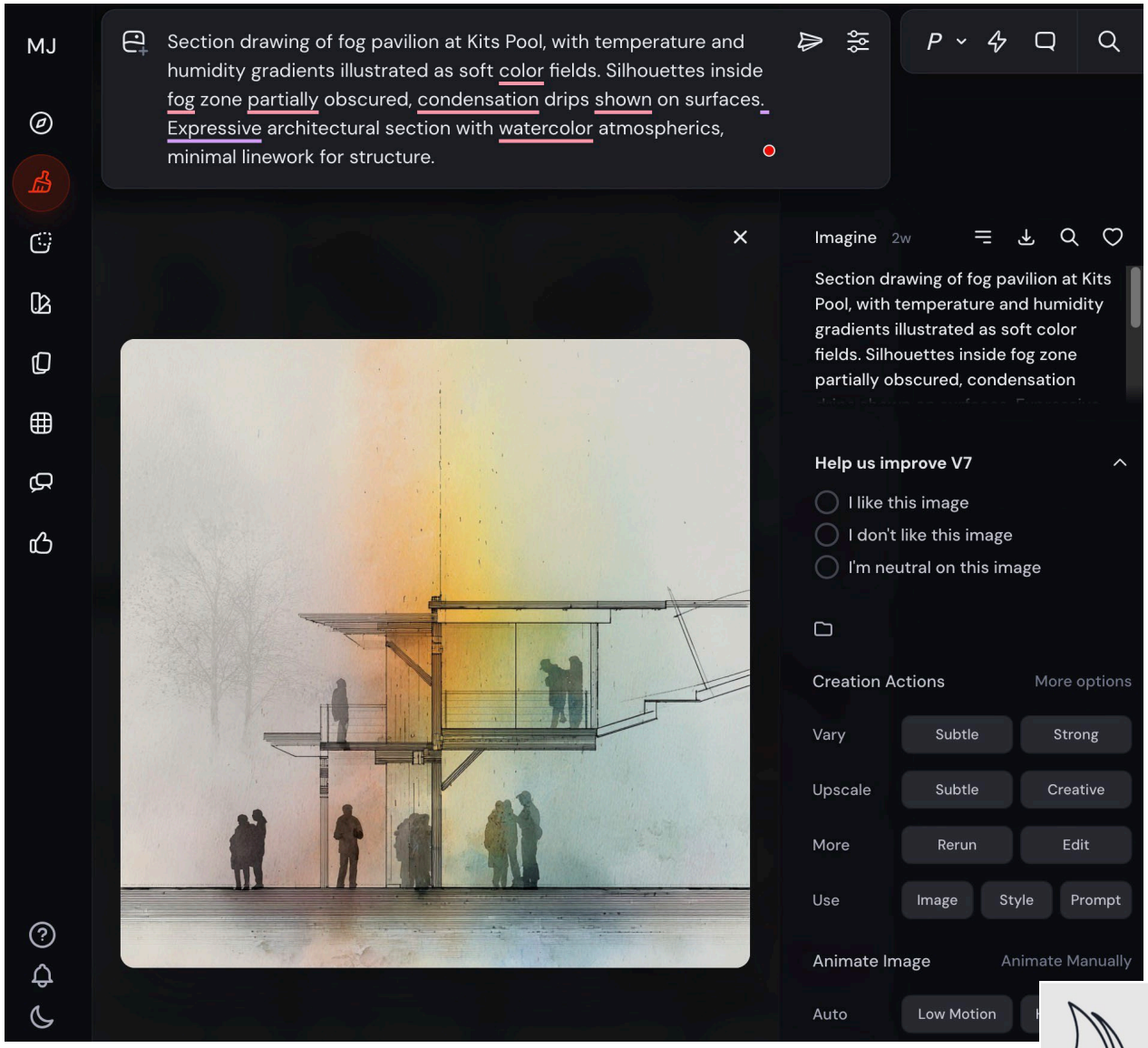
- Text-to-Image (T2I)
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- Contextual Image Editing
- Aesthetic Style Transfer
- Interactive Real-Time Rendering

2. Assisting Workflow

- Drawing/Diagrammatic Style Reference
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3. High-Fidelity Rendering

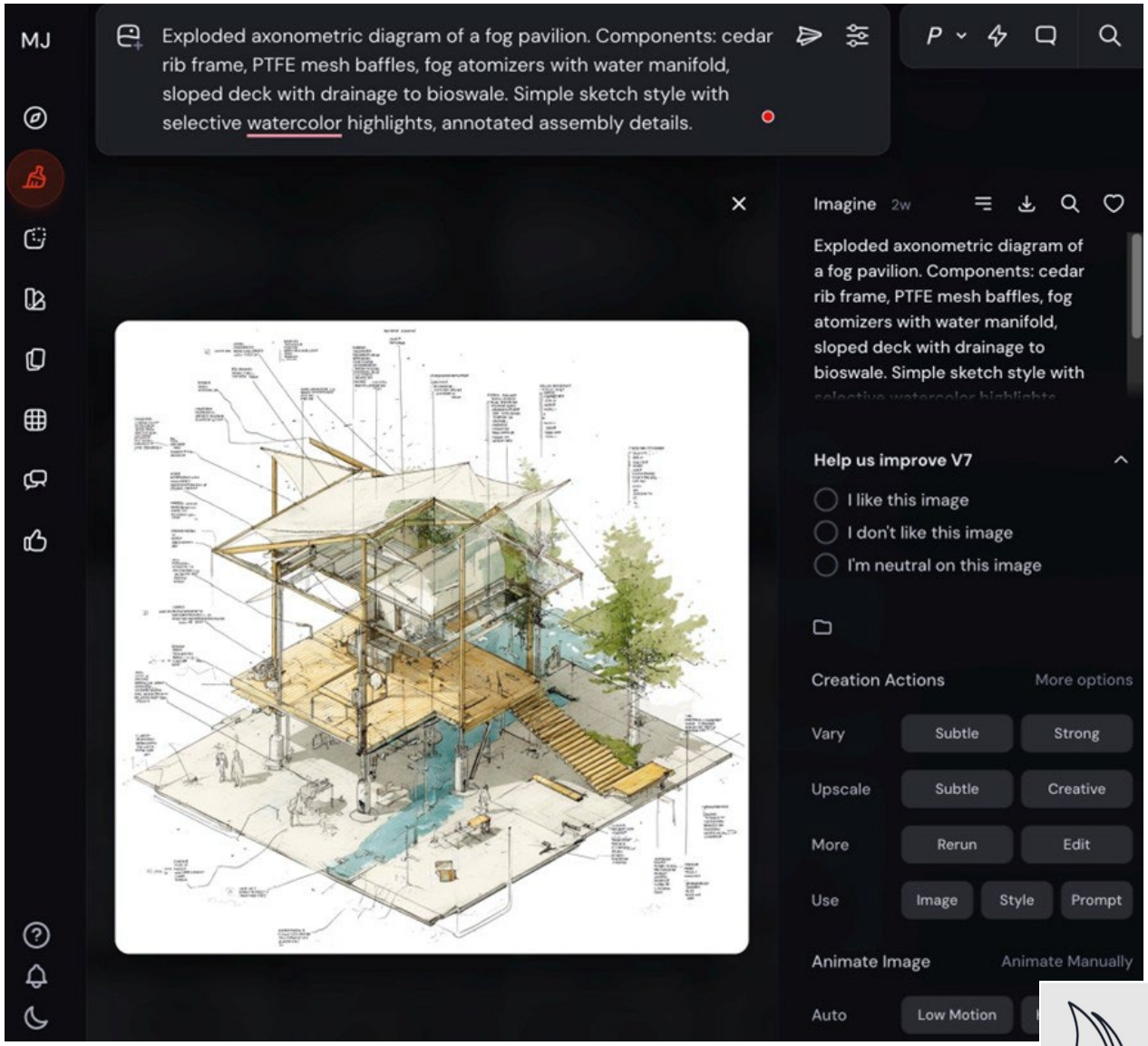
- Conversational Image Refinement
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Midjourney

Visual Tools

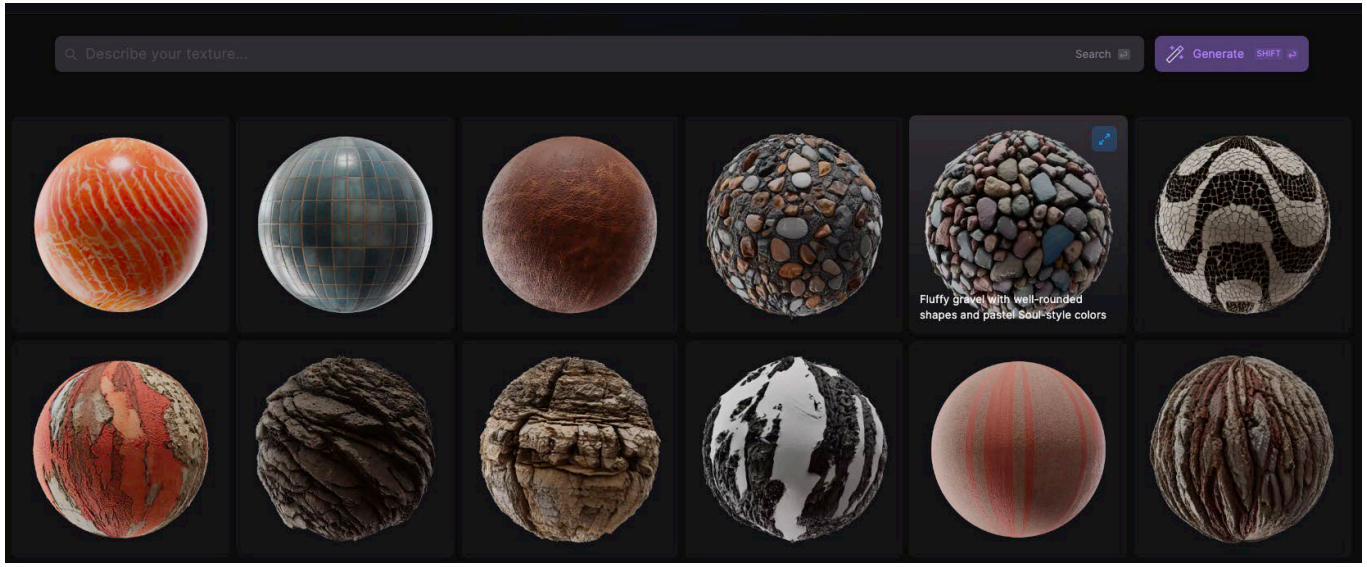
1. Conceptualization
   - Text-to-Image (T2I)
   - Sketch-to-Image (S2I)
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Midjourney

Visual Tools

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Midjourney

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Midjourney

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Midjourney

Visual Tools

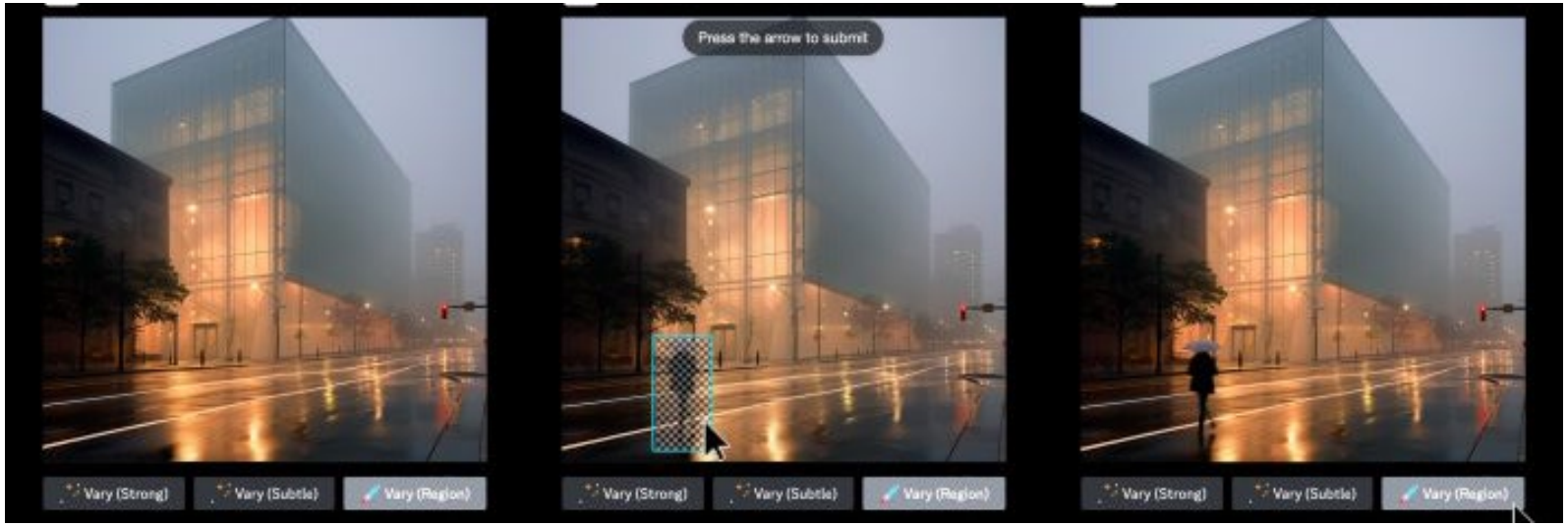
1. Conceptualization
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Original Image

Visual Tools

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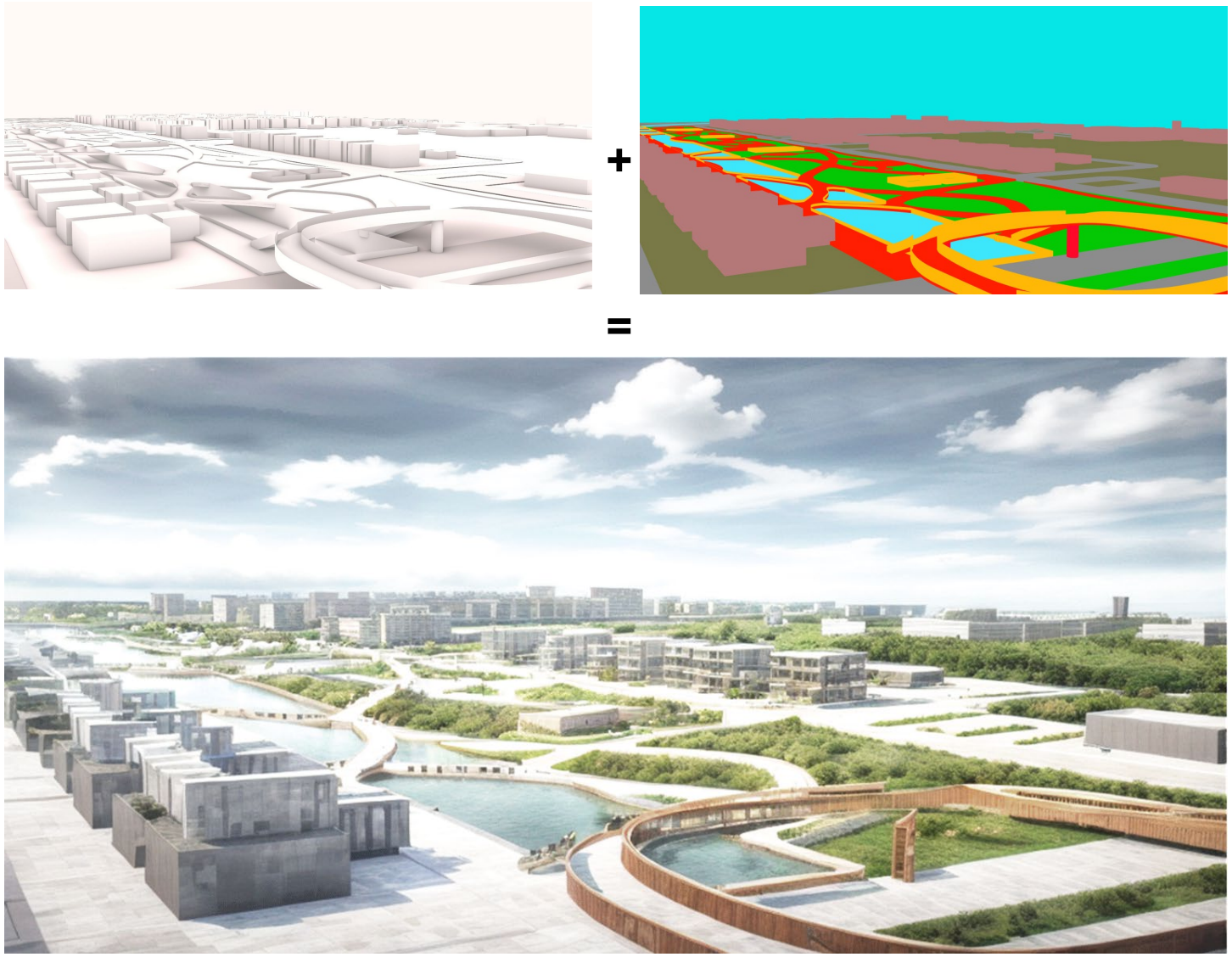


Inpainting

Midjourney

Visual Tools

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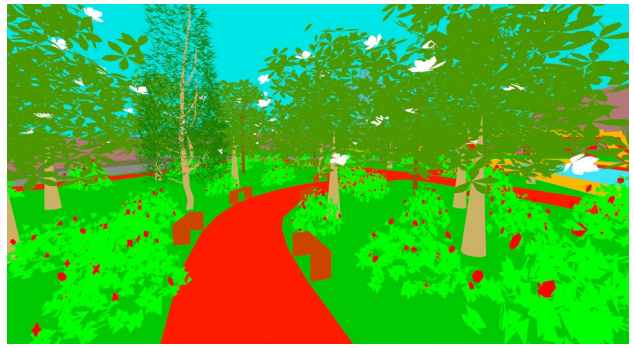


Visual Tools

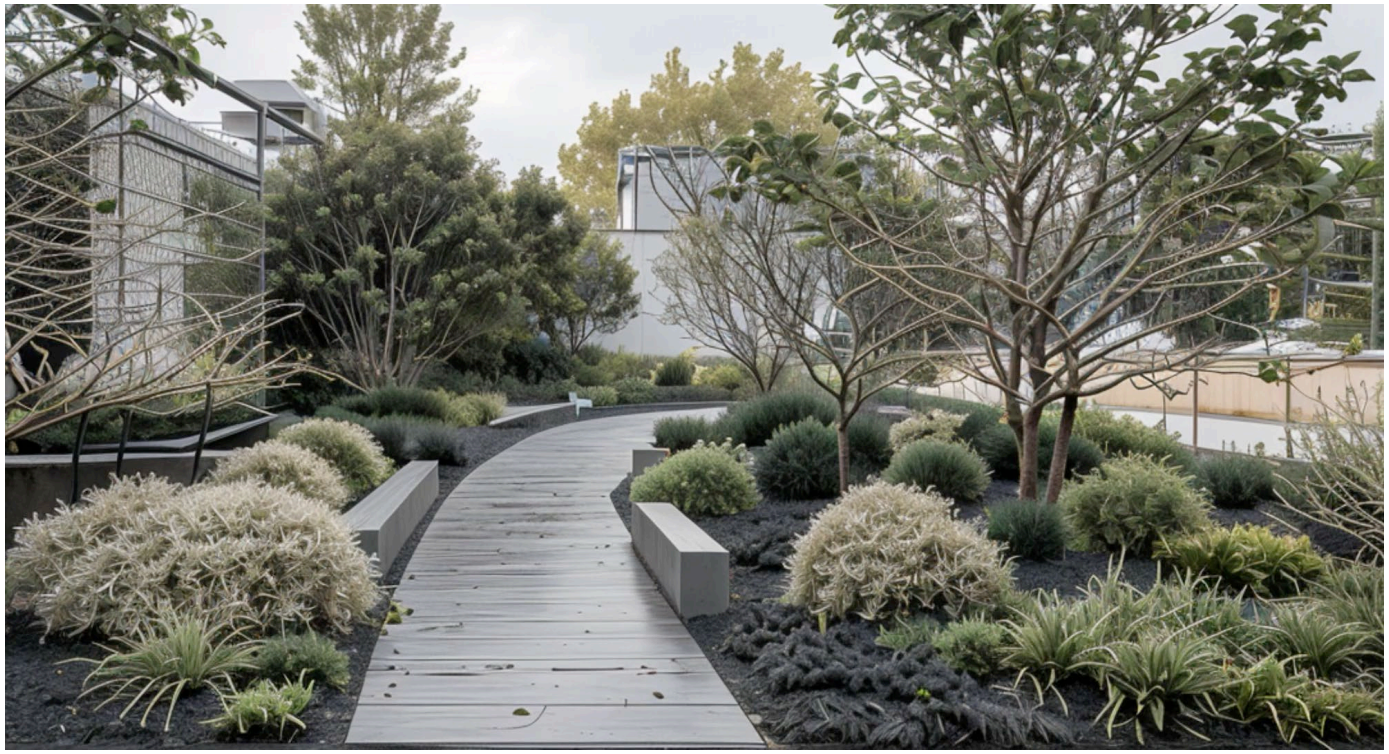
1. Conceptualization
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+



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Visual Tools

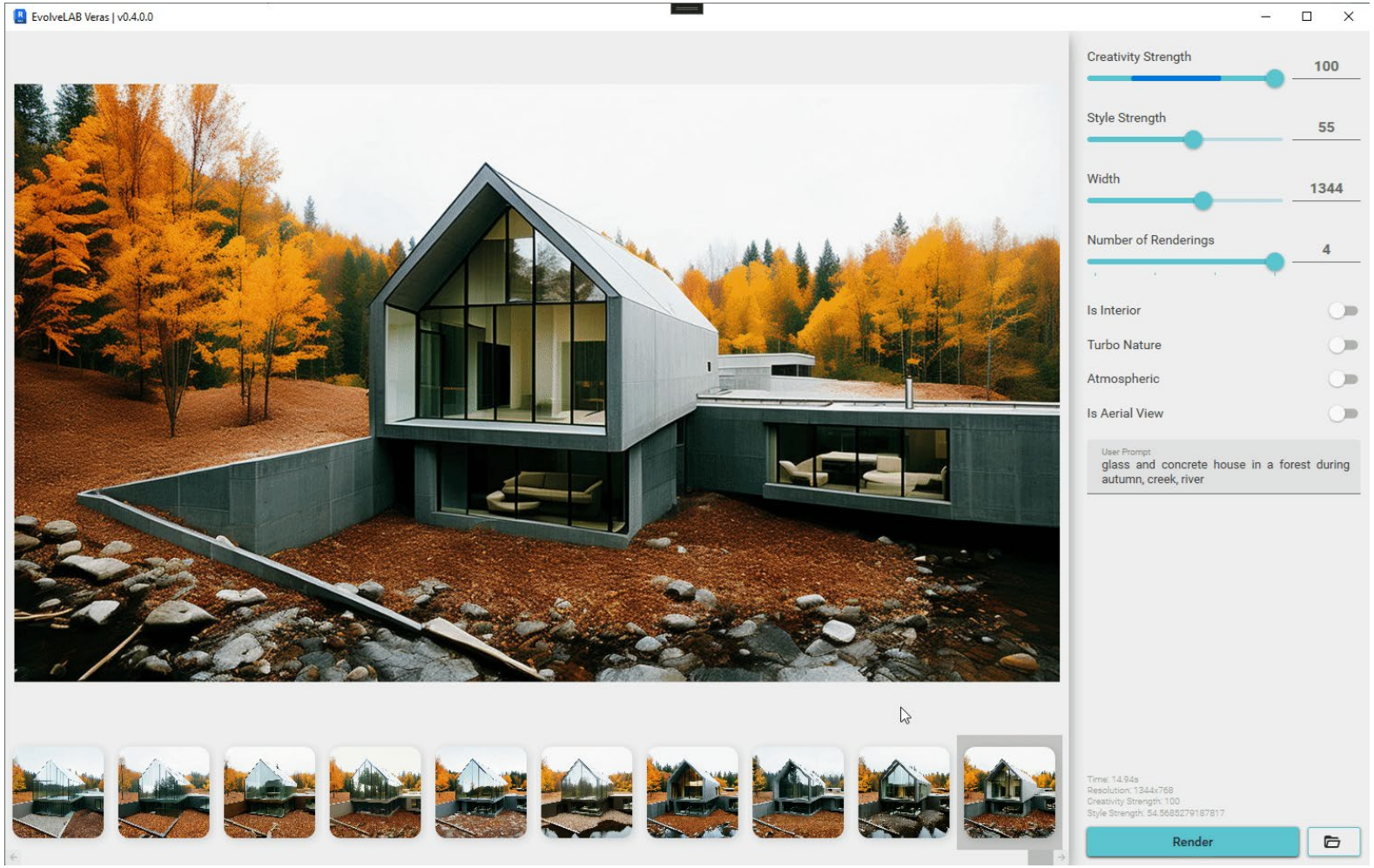
1. Conceptualization
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Evolvelab Veras for Revit

Visual Tools

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Evolvelab Veras for Revit

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Stable Diffusion

Visual Tools

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Stable Diffusion

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Stable Diffusion

Visual Tools

1. Conceptualization

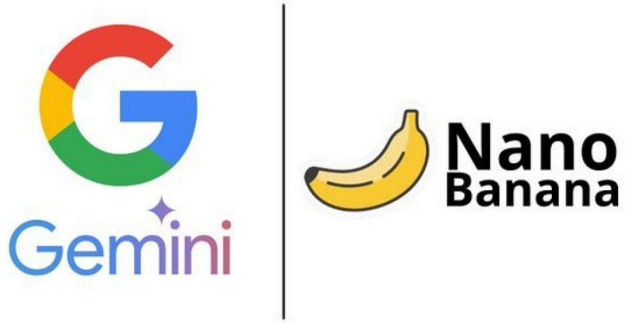
- Text-to-Image (T2I)
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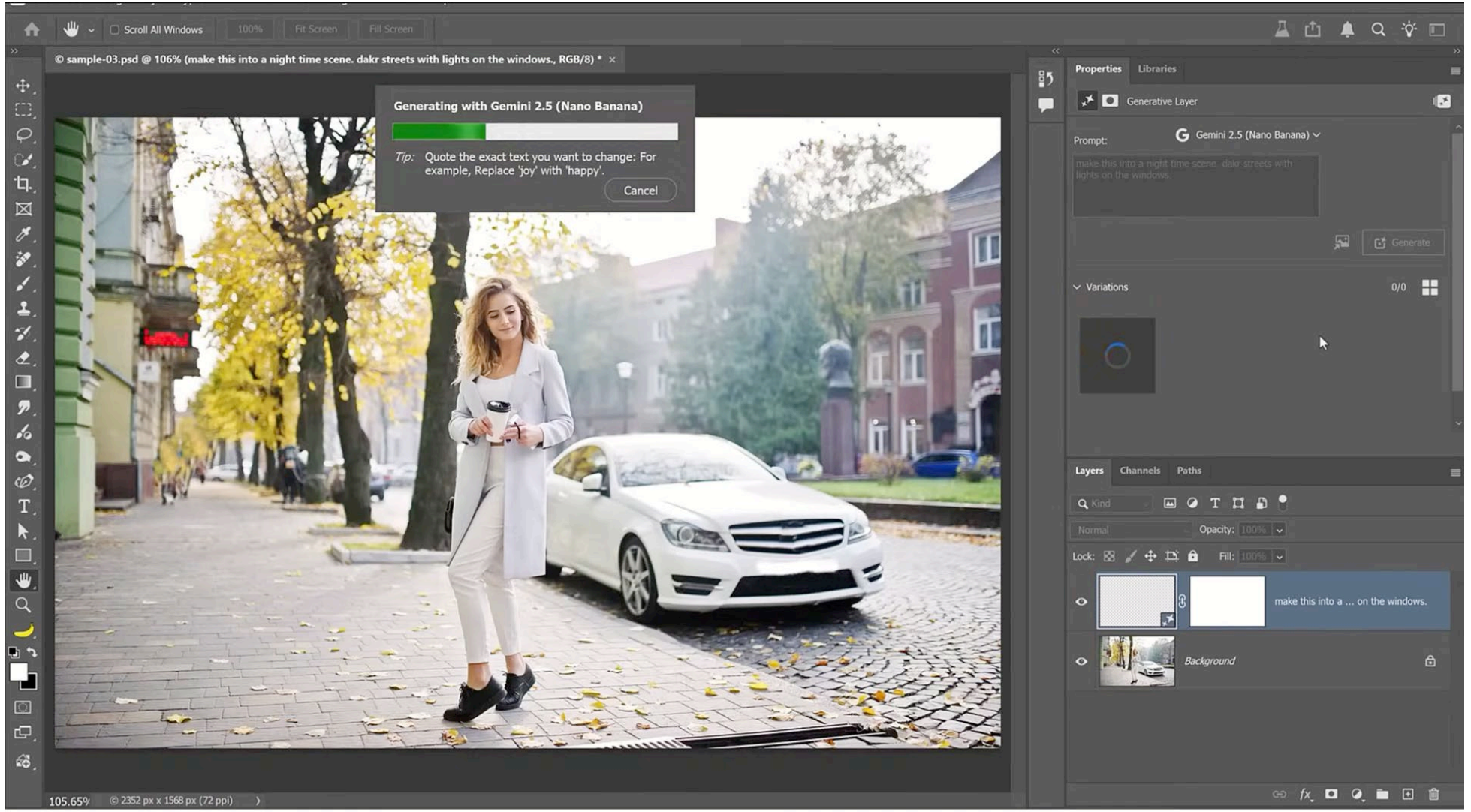
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Photoshop Beta

2025.09

Credit: Photoshop Training Channel



Nano Banana



Nano Banana (Google Gemini 2.5)

2025.08

Credit: Urban Decoders

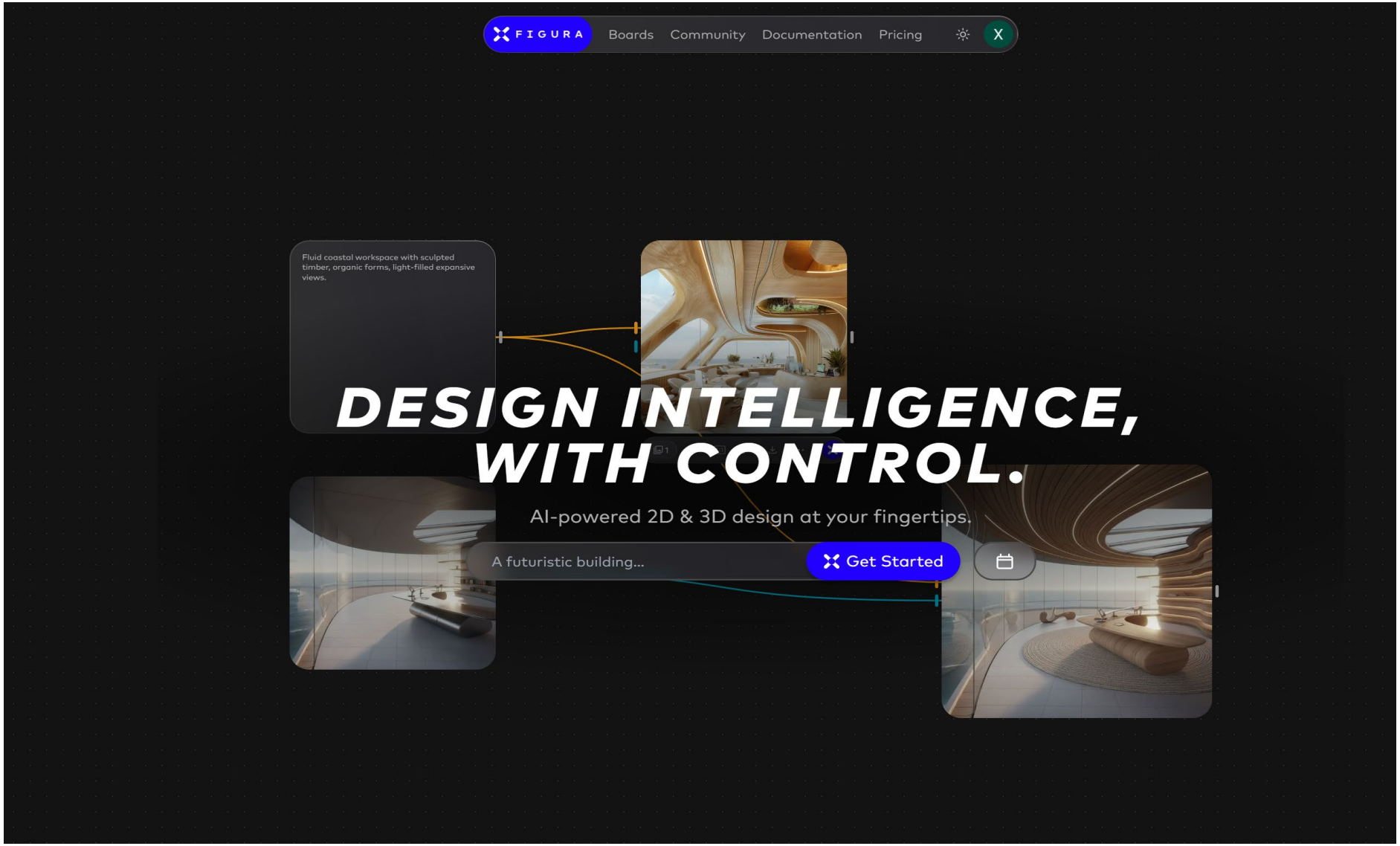
Plan to 3D

Nano Banana (Google Gemini 2.5)

2025.08

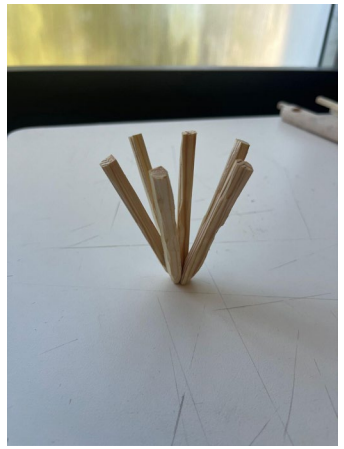
Credit: Land Space Architecture

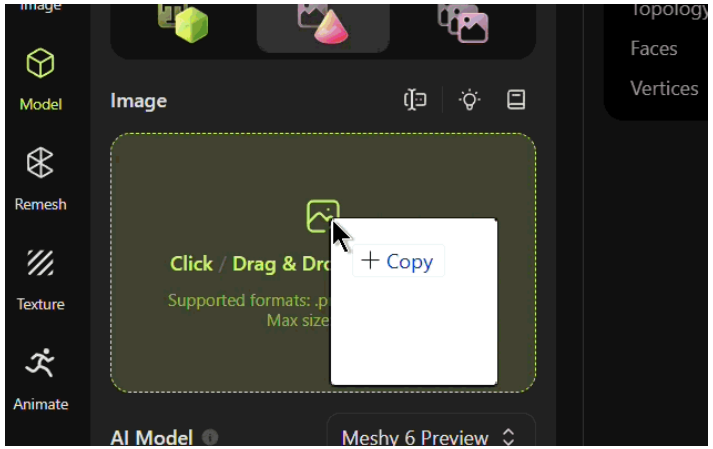
Node-based: xfigura.ai



Beyond Visual

3D Models - Mesh





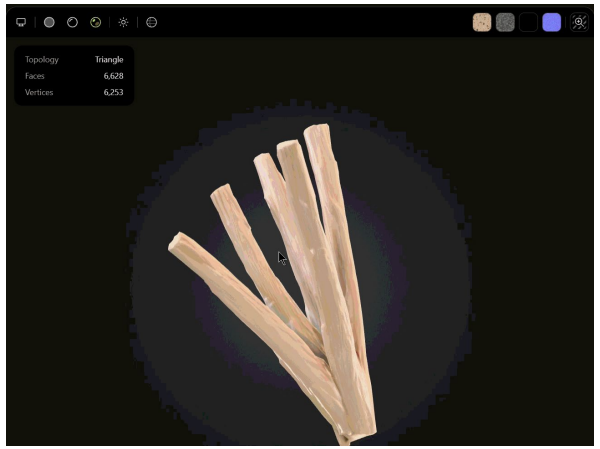
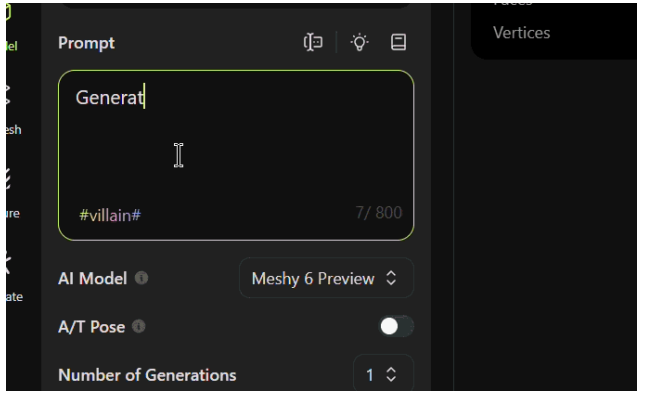


Photo to 3D





Existing Image to 3D



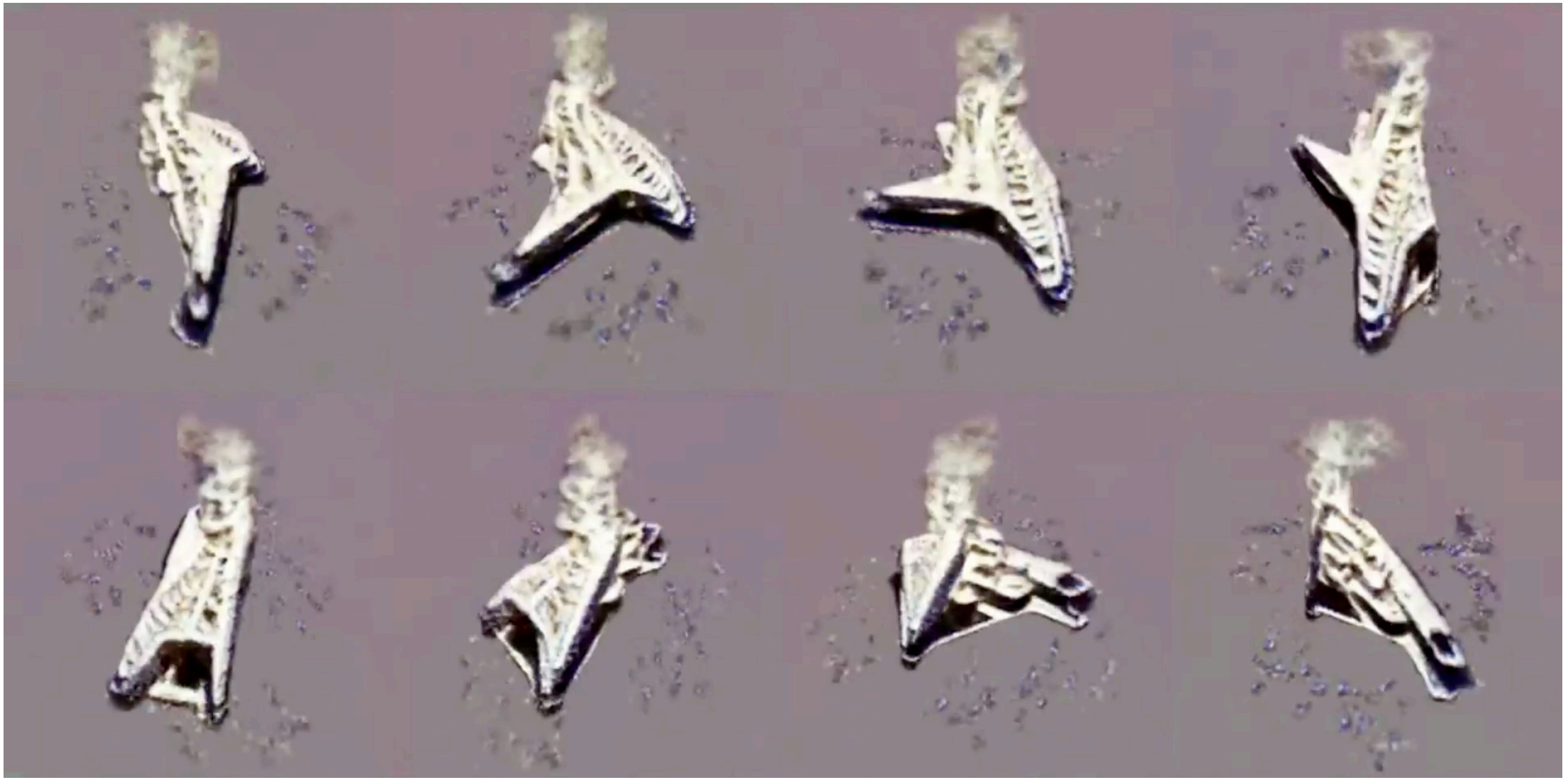


Text to 3D

Meshy.ai TRIPO Tencent Hunyuan

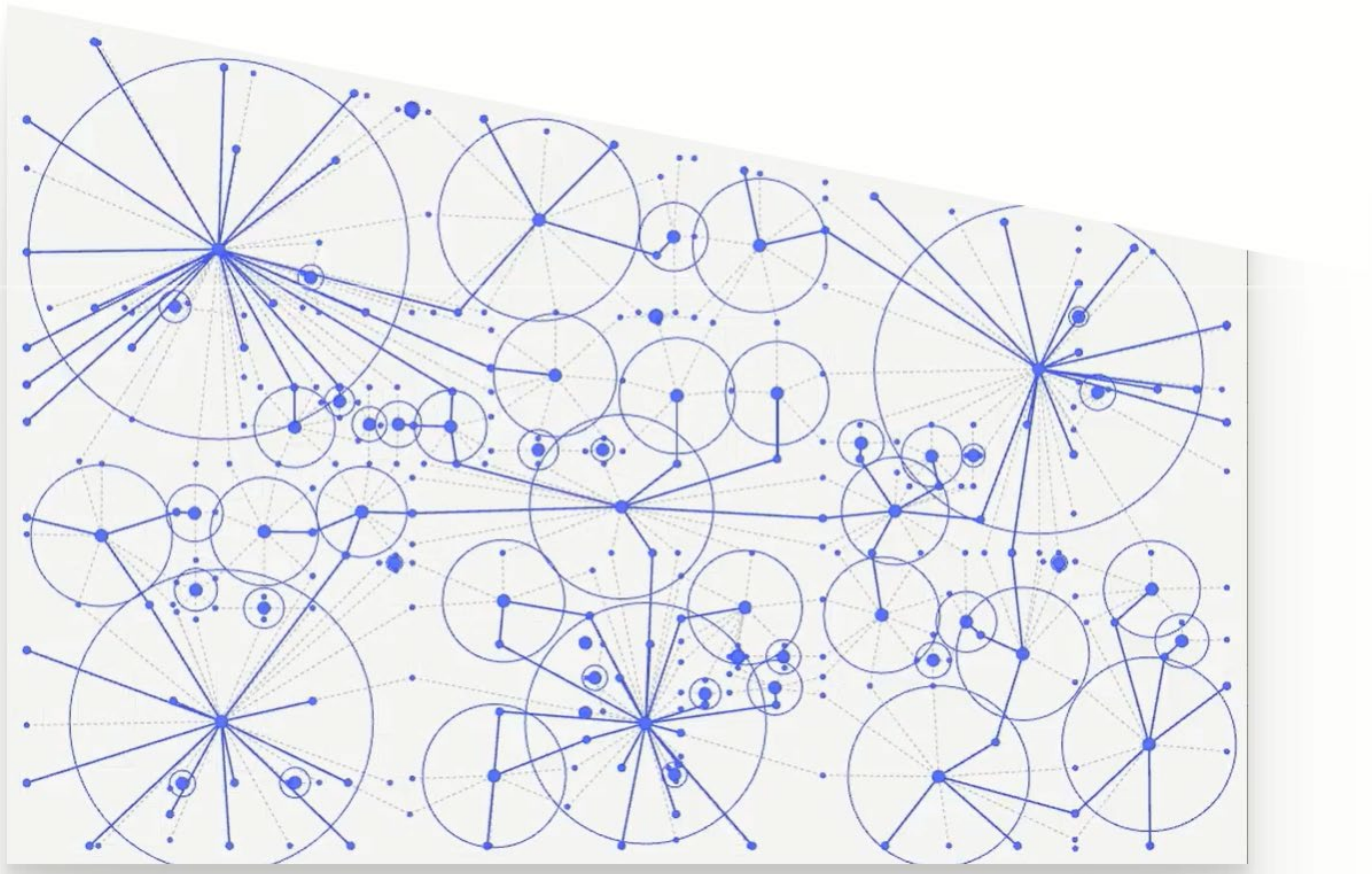
Students:Ewen Hall
UBC ARCH540 Instructor: Xun Liu

3D Models – Point Cloud



Credit: Immanuel Koh, fine-tuned Text-to-3D diffusion model based on Zaha Hadid Architects' past projects

Plan Layout

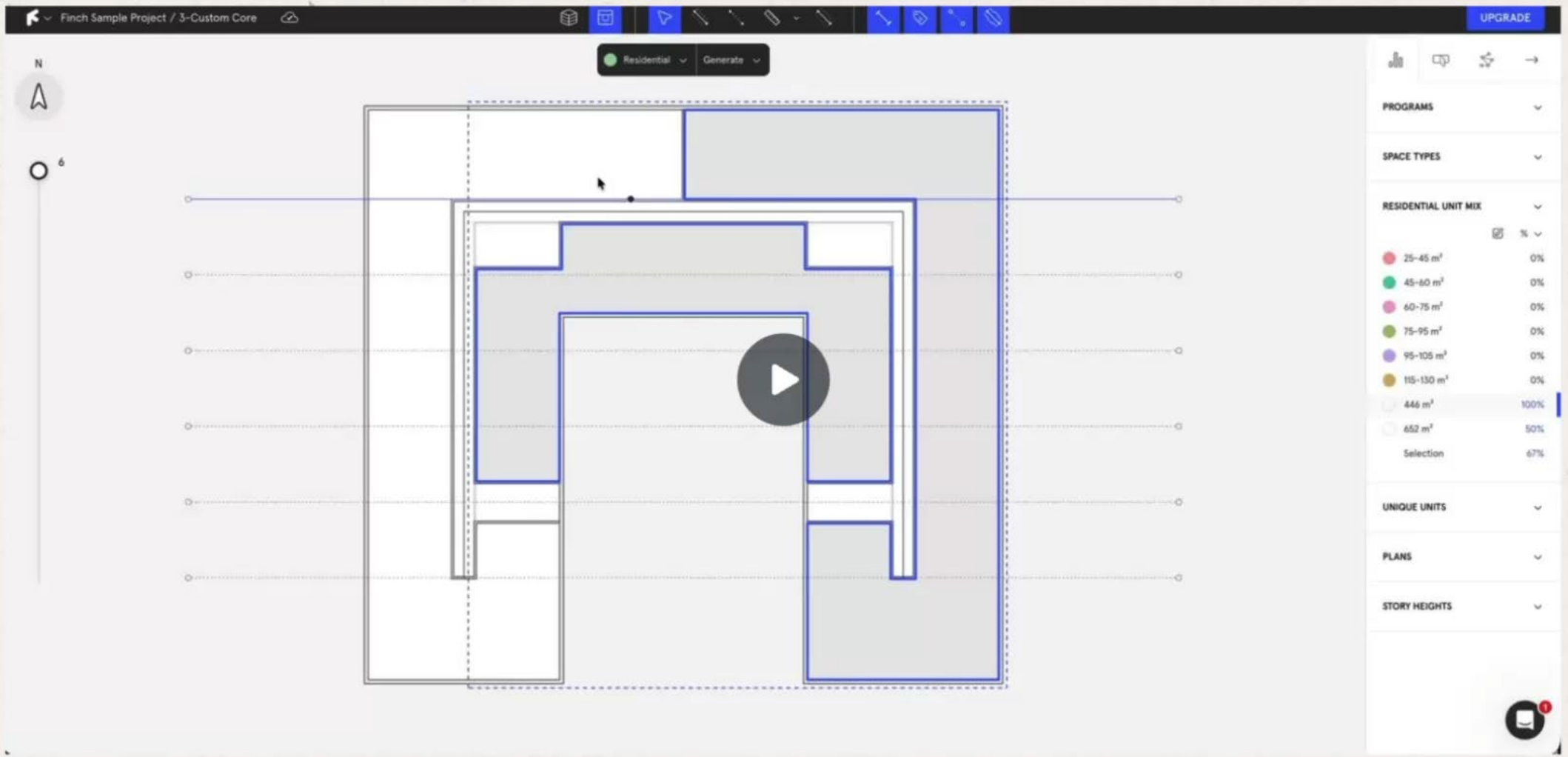


Finch

Credit: finch3d.com

FINCH3D - step 2

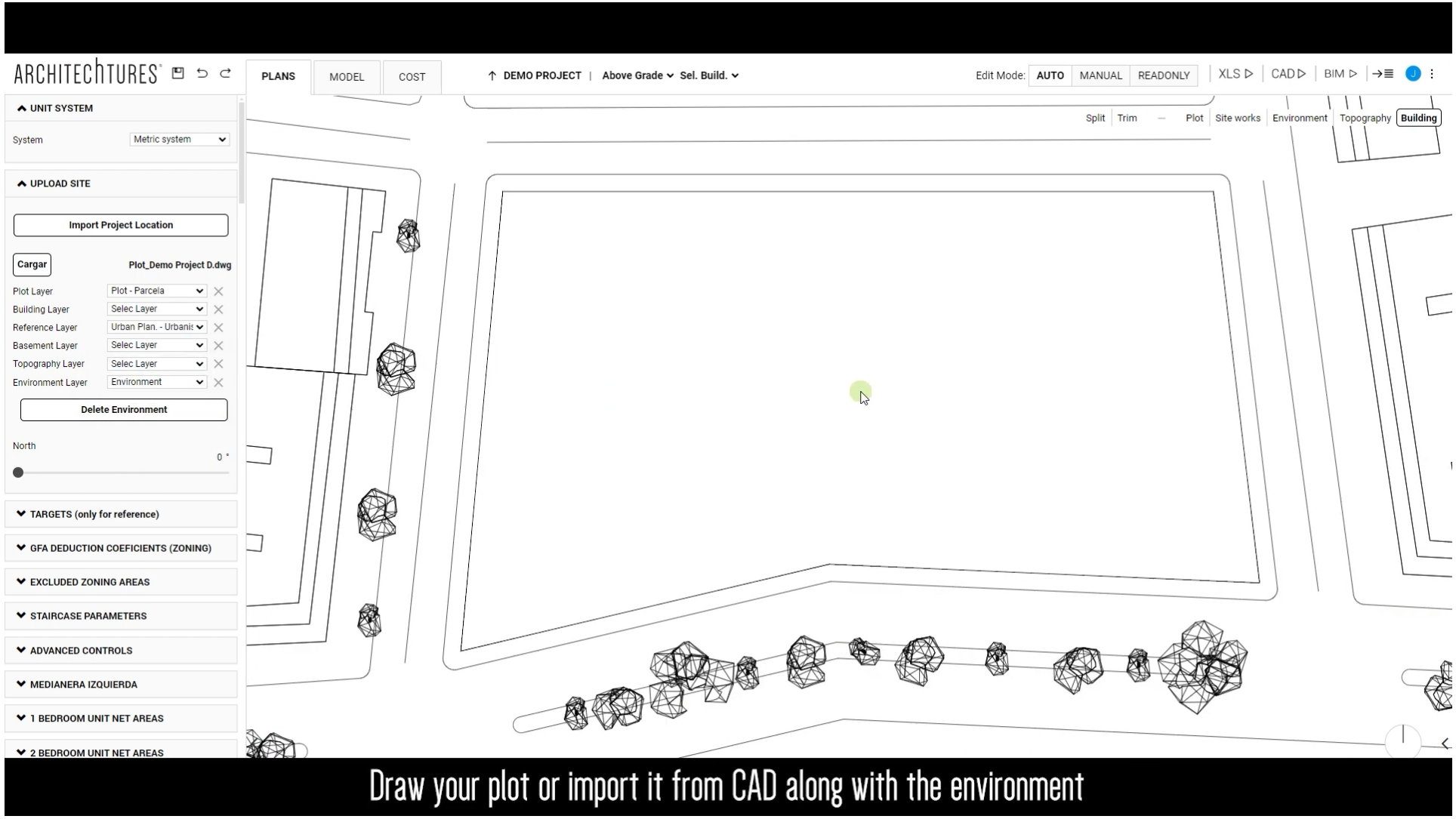
Floor Plate



2X speed
In real time: 01:08

Credit: Jonathan Chu

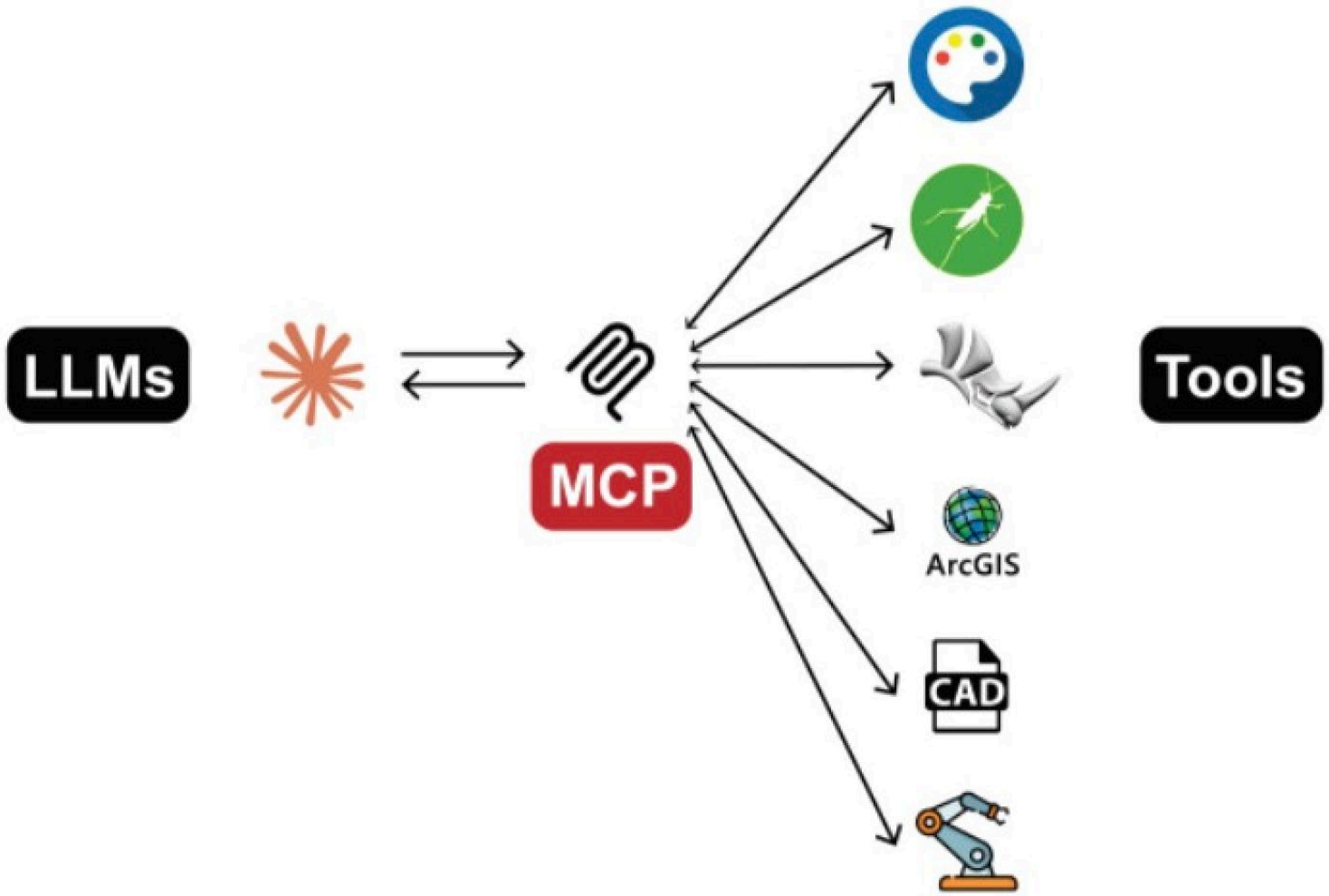
Plan Layout



ARCHITECHTURES

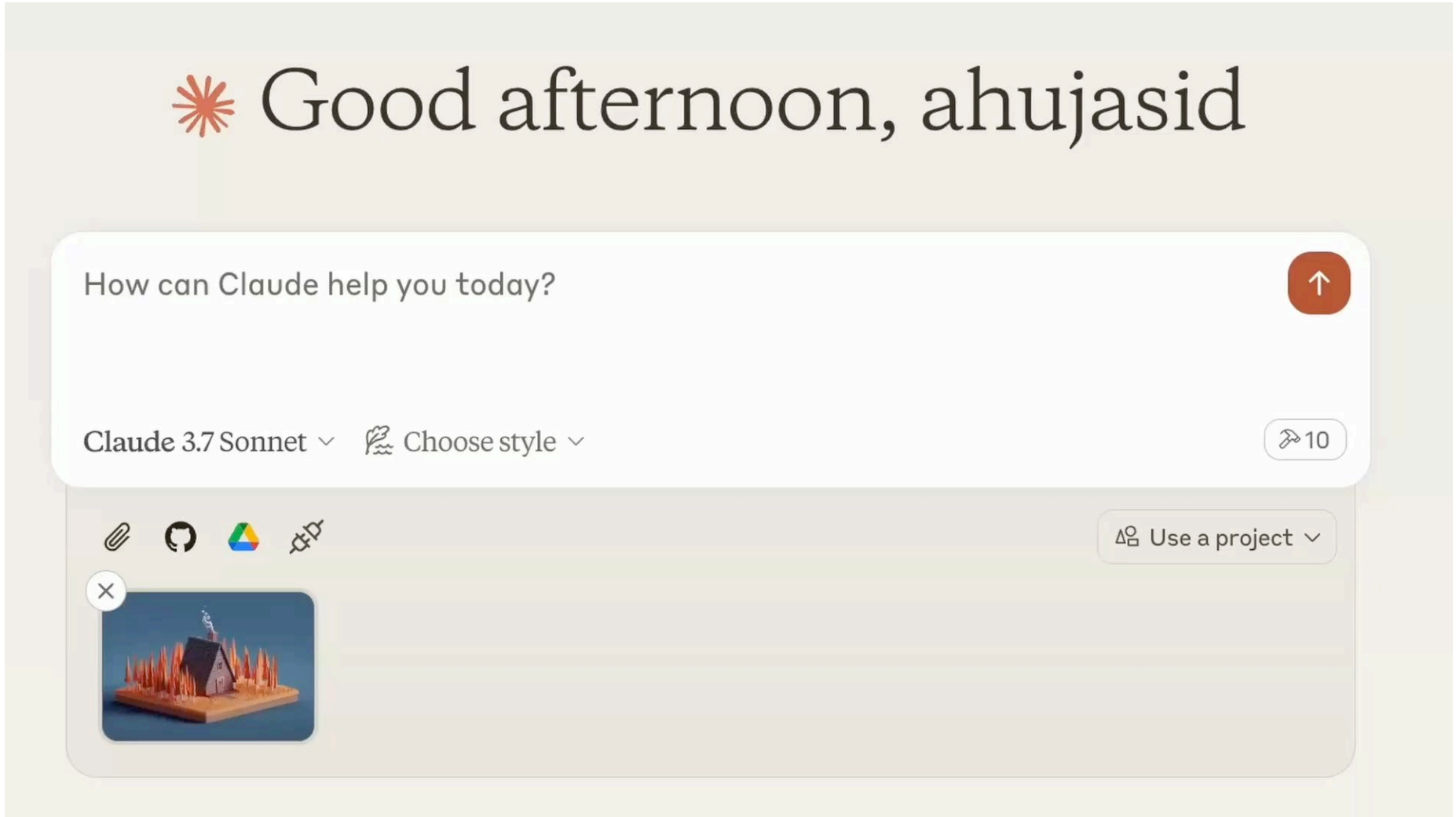
Credit: architechtures.com

Tool Use



Credit: Xun Liu

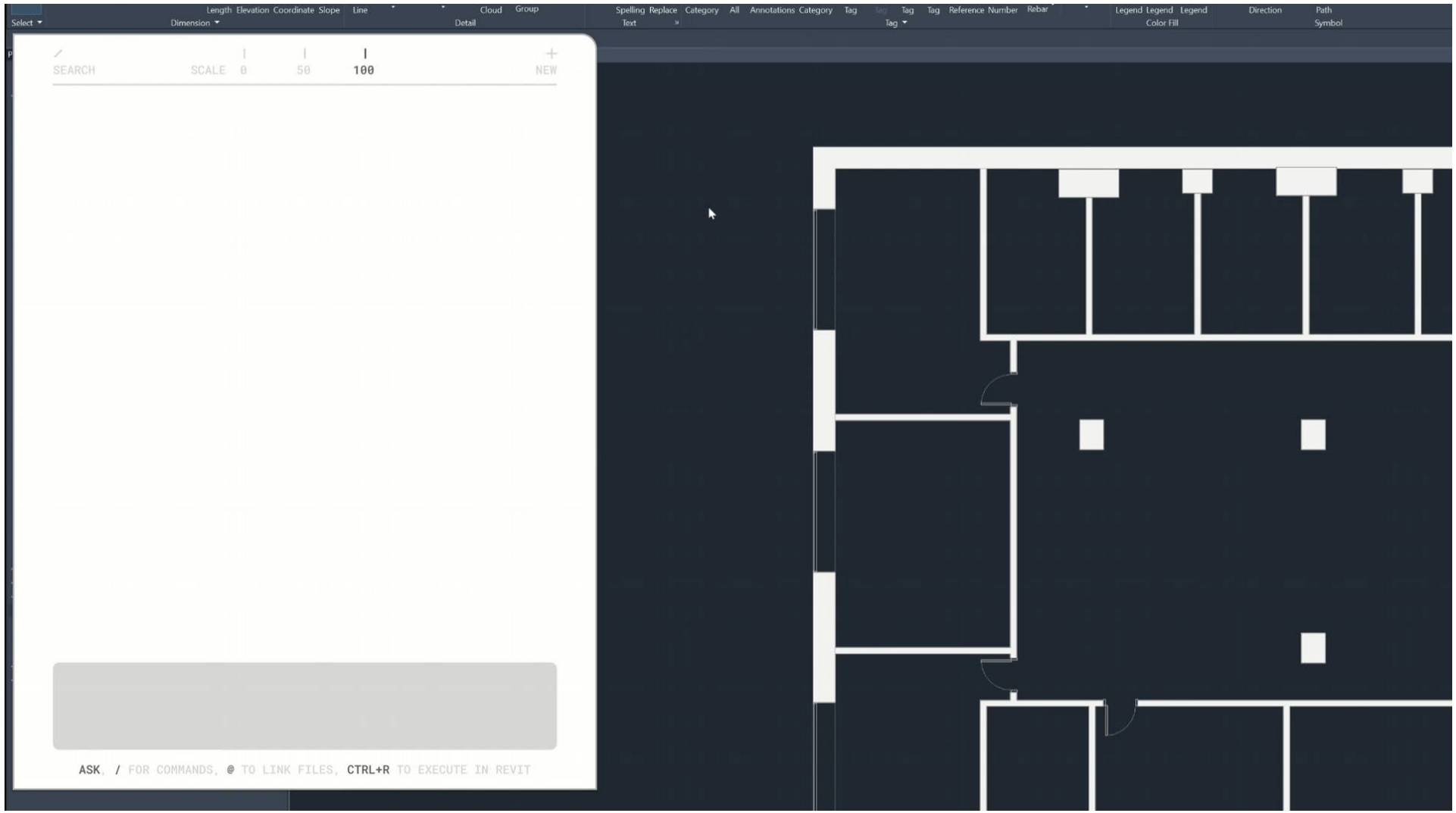
Tool Use



MCP + Blender

Credit: Blender MCP

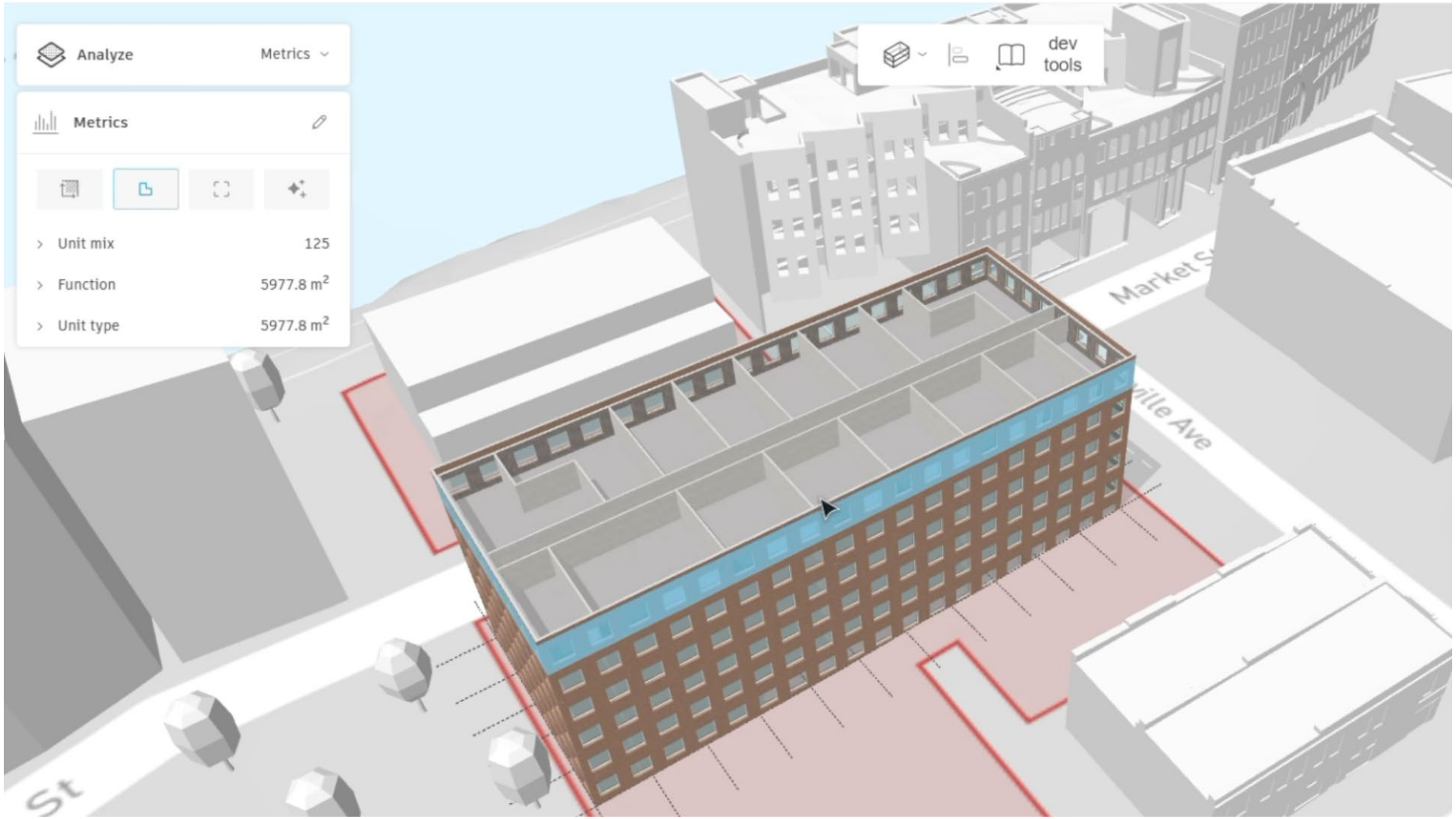
Tool Use



MCP + Revit

Credit: bimengine.ai

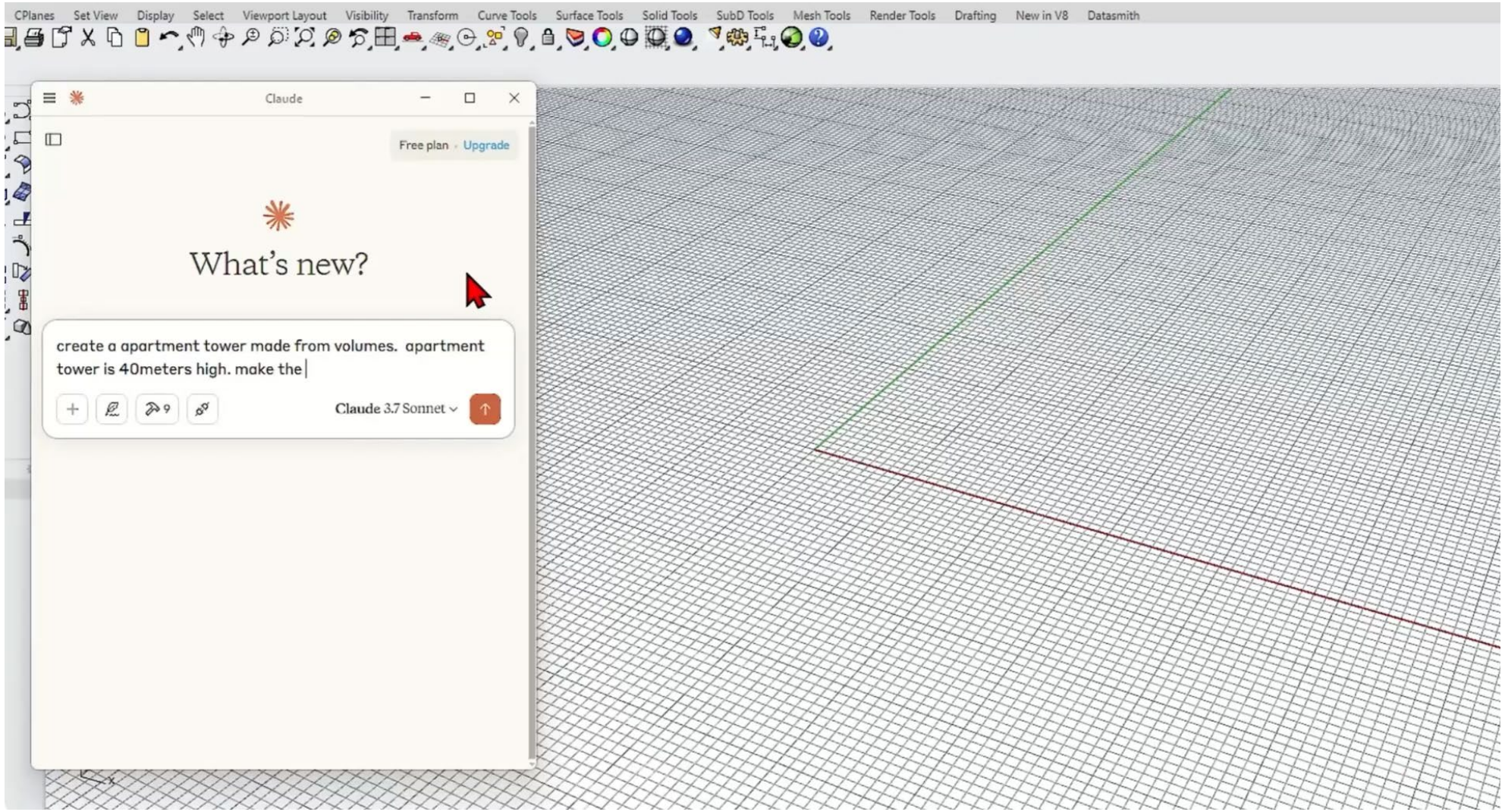
Tool Use



***MCP* + AutoCAD (Upcoming NeuralCAD)**

Credit: Autodesk

Tool Use

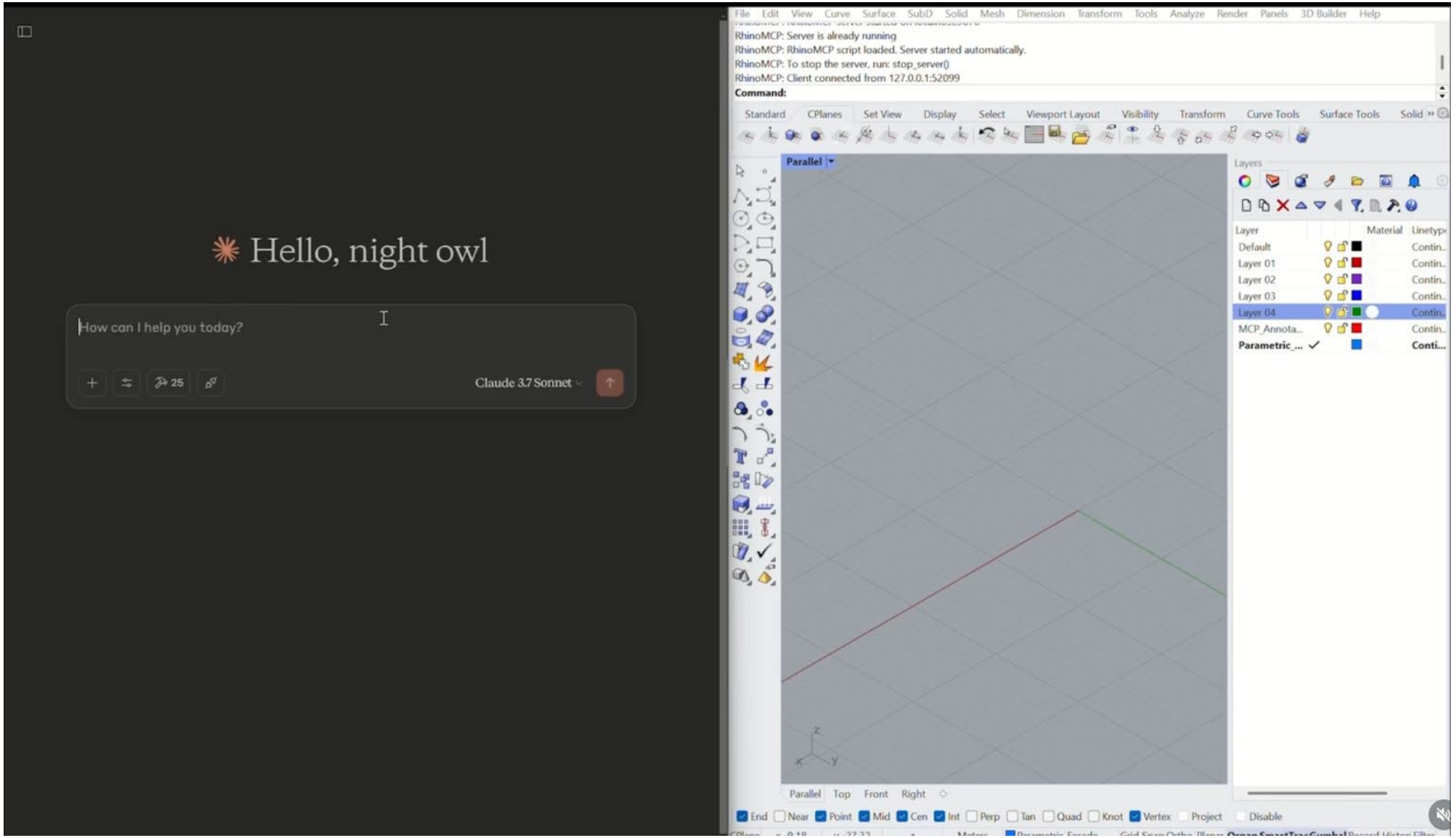


MCP + Rhino

Rhinoceros

Credit: Urban Decoders

Tool Use

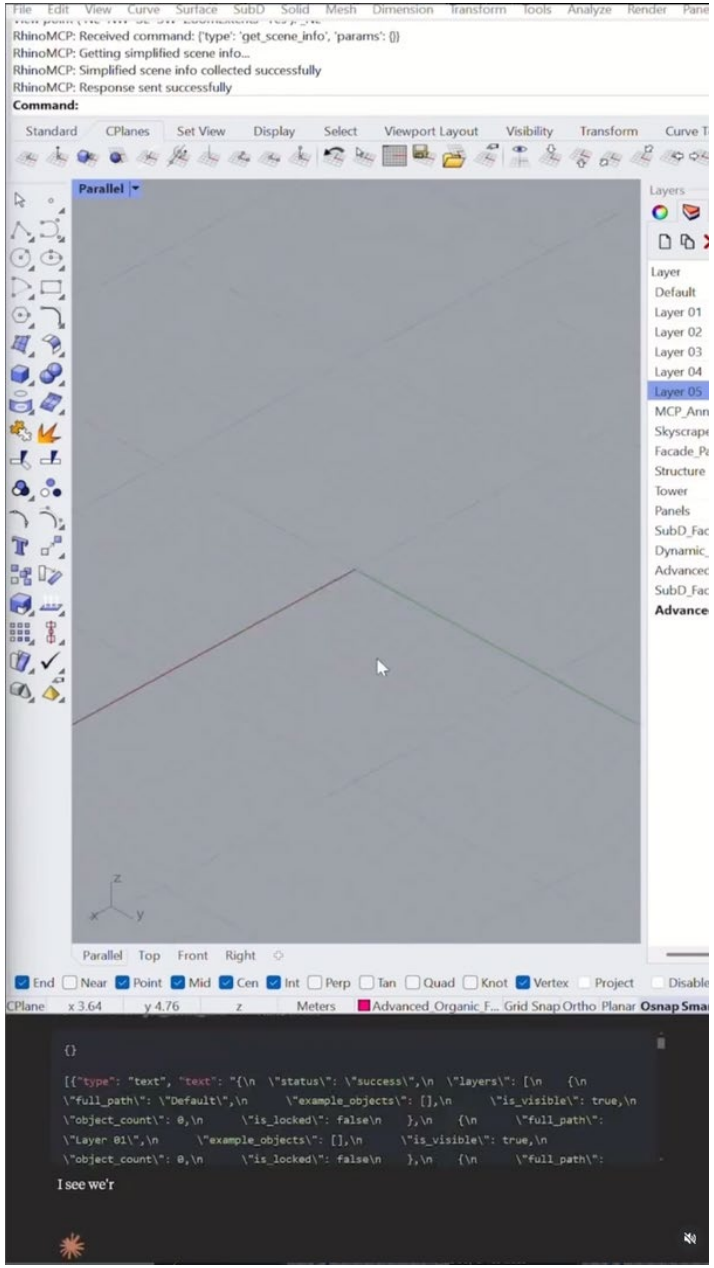


MCP + Rhino

Rhinoceros

Credit:Nikhil Bang

Tool Use

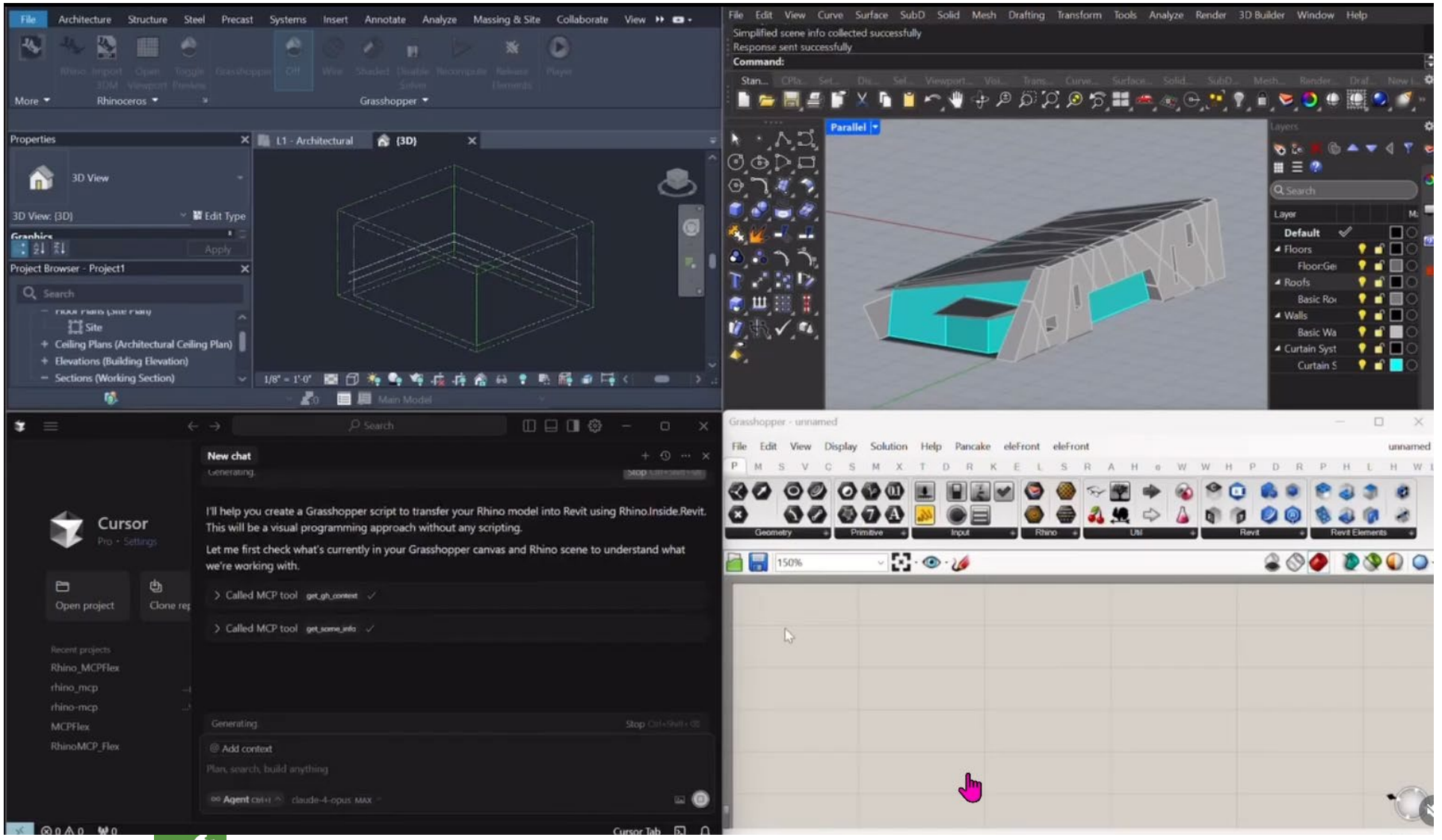


MCP + Rhino

Rhinoceros

Credit: Nikhil Bang

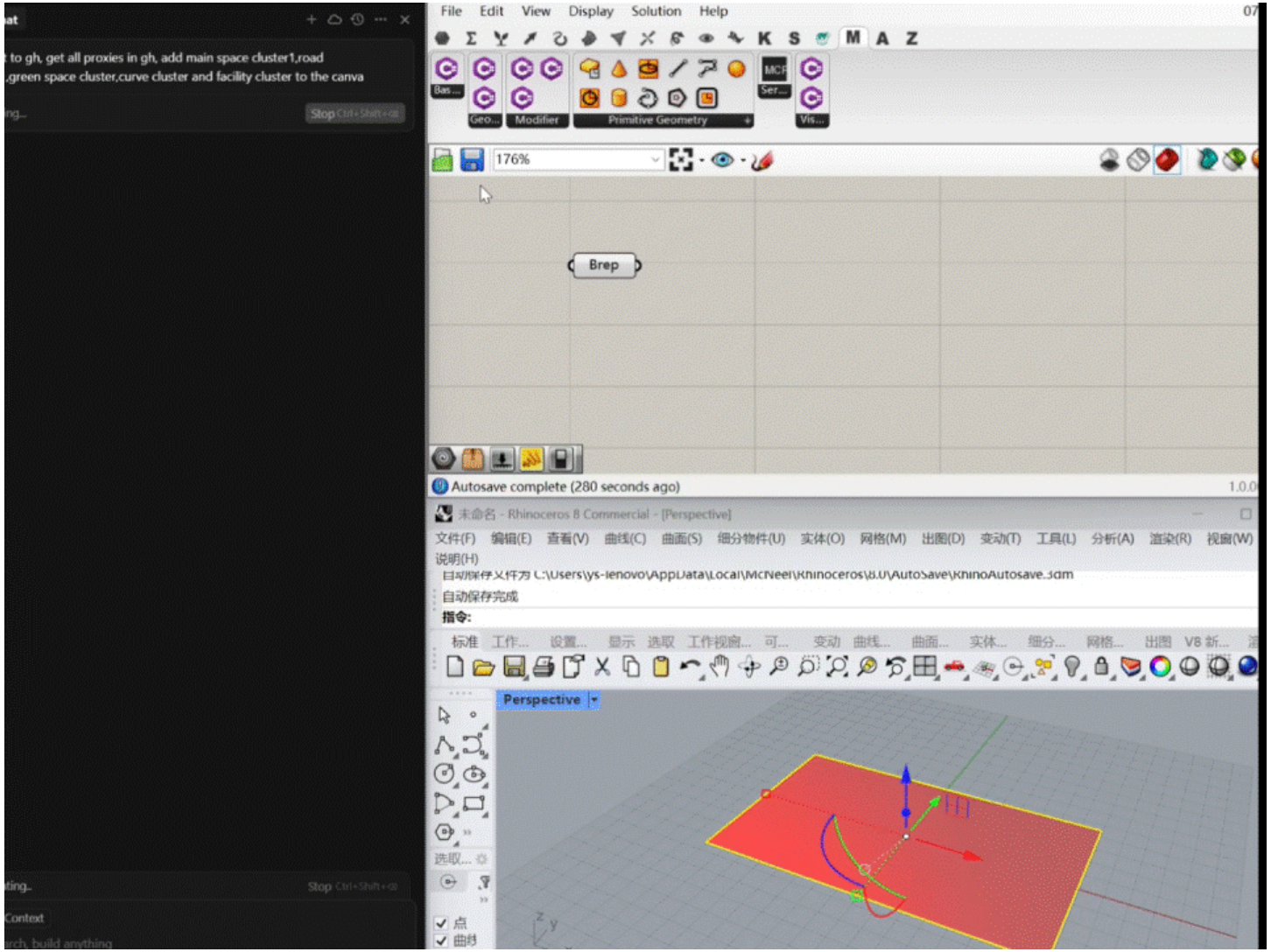
Tool Use



MCP + Grasshopper

Credit: Nikhil Bang

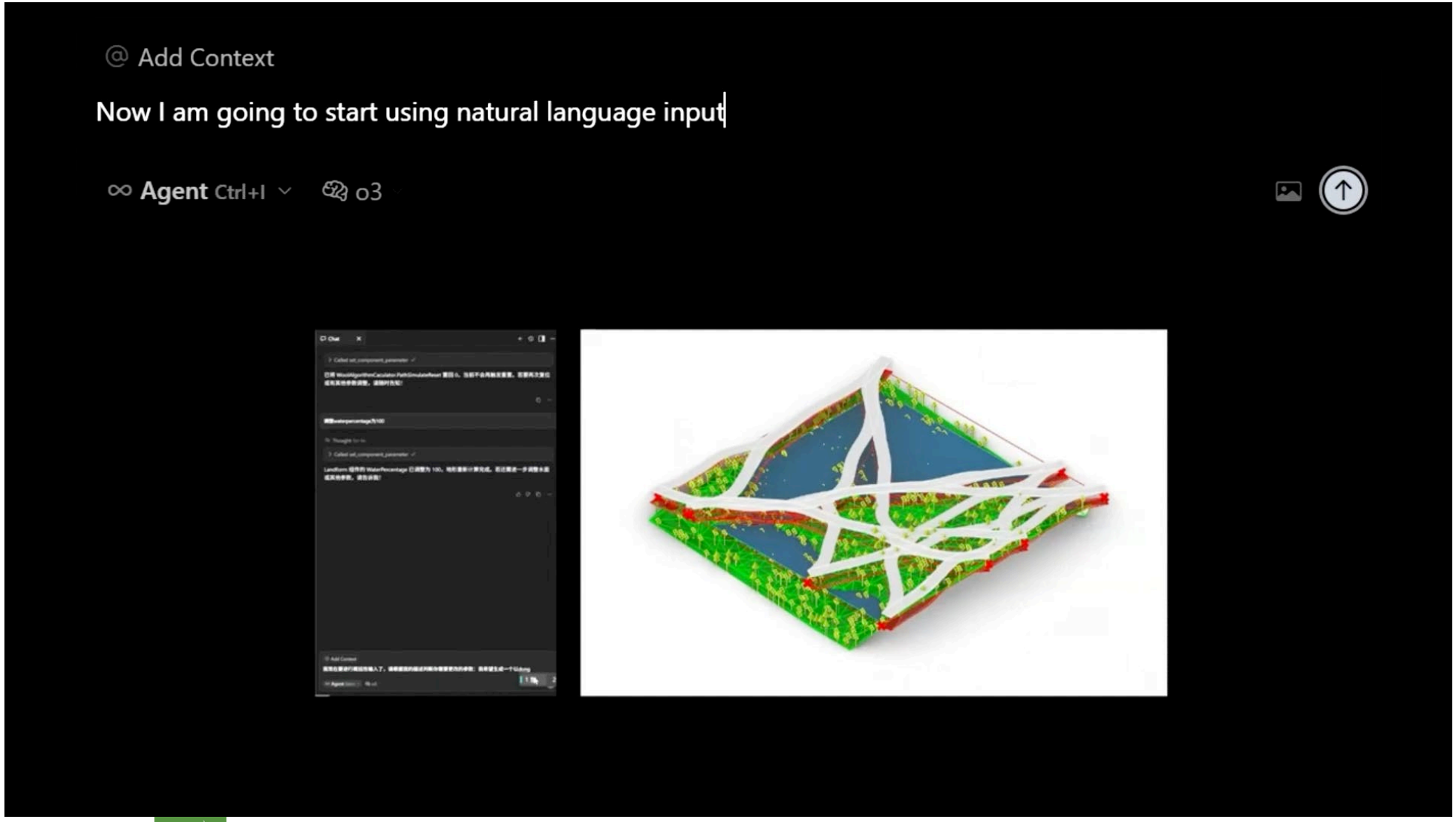
Tool Use



MCP + Grasshopper

Credit: DigitalFuture2025 Students Work
Instructor: Xun Liu, Runjia Tian

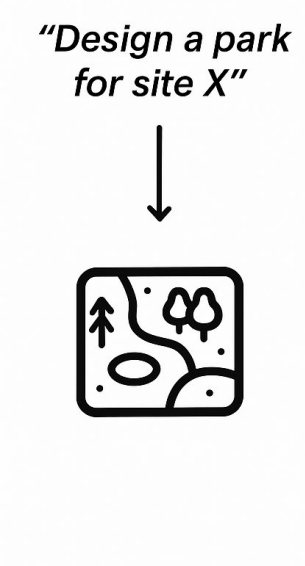
Tool Use



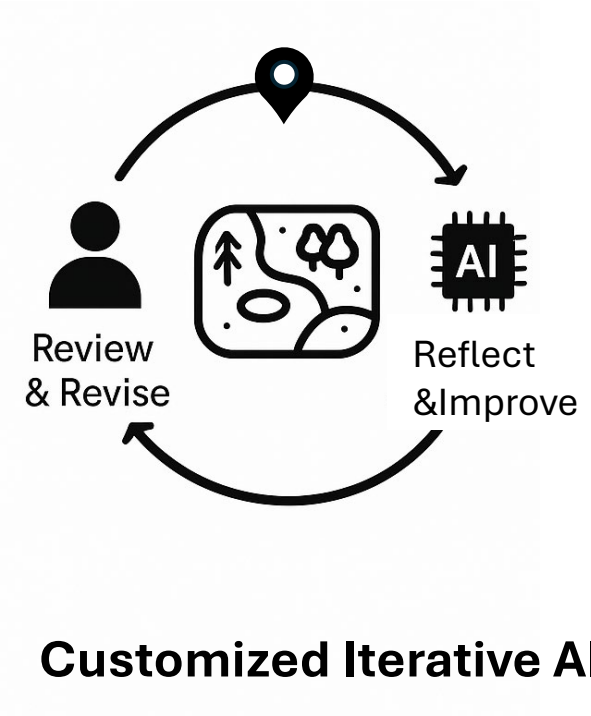
MCP + Grasshopper

Credit: DigitalFuture2025 Students Work
Instructor: Xun Liu, Runjia Tian

[Design the Data Flow]

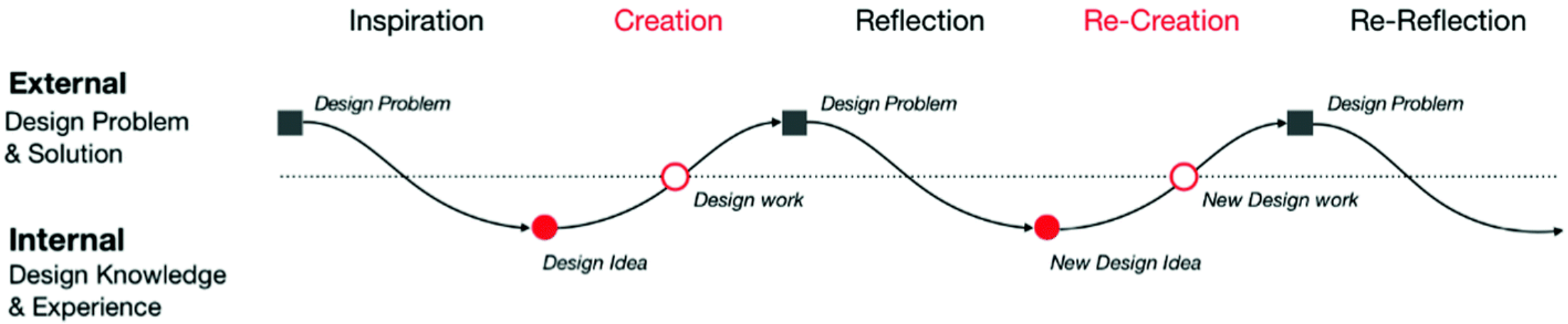


Single-Step AI



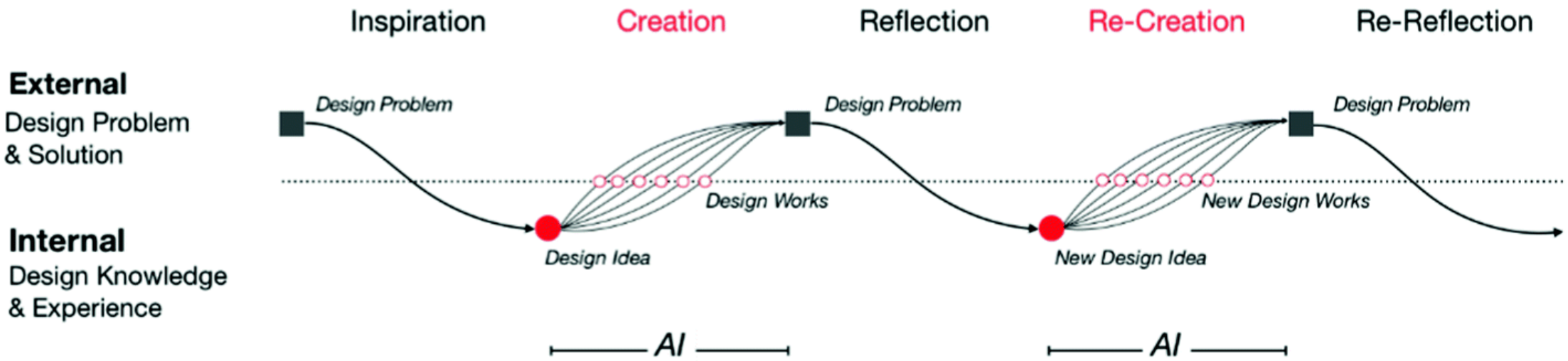
Customized Iterative AI

[Design the Data Flow]



The AI-augmented creative design cycle as described by Zeng et al. (2019).

[Design the Data Flow]



The AI-augmented creative design cycle as described by Zeng et al. (2019).

Design the Data Flow

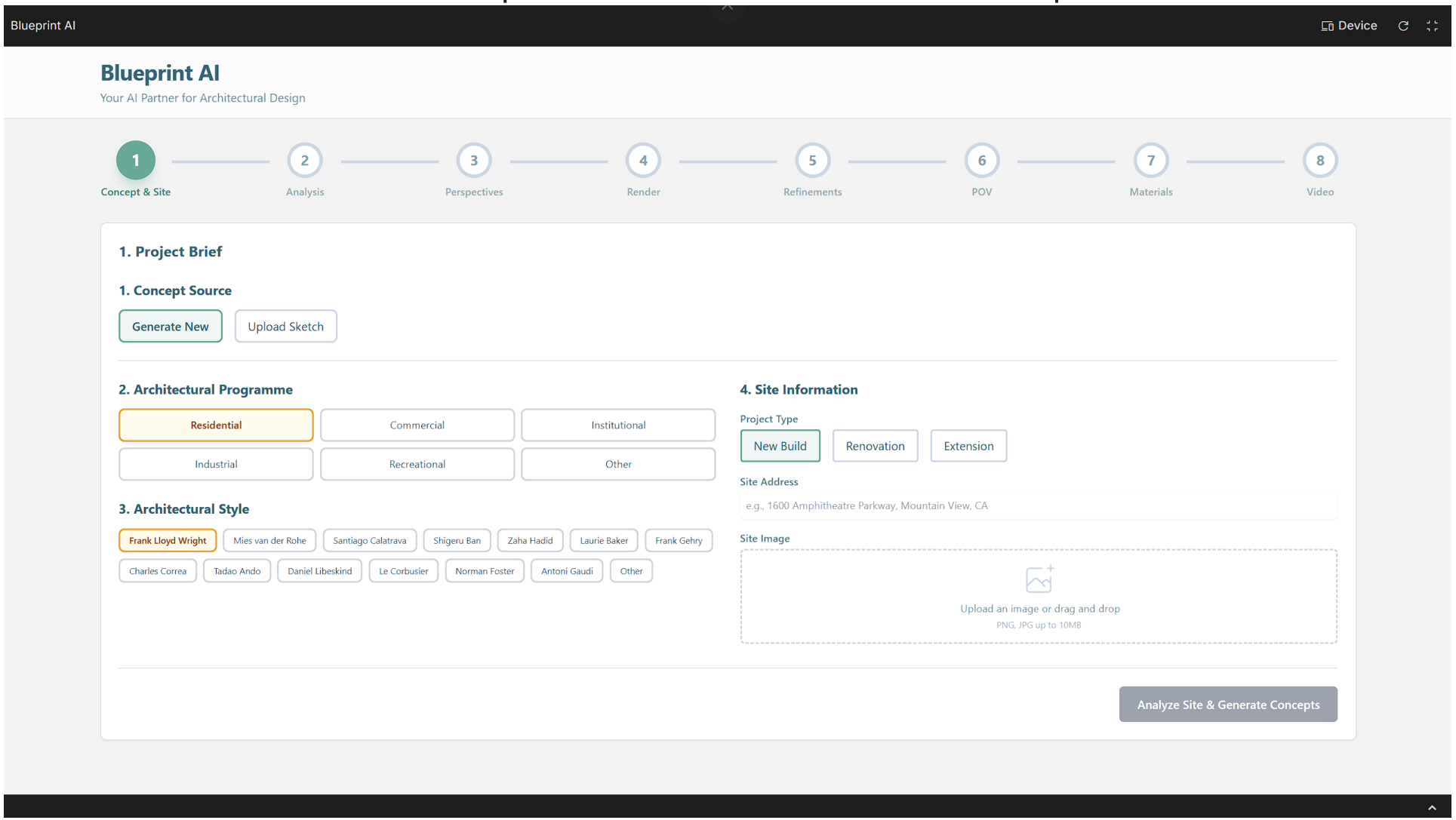
“Blueprint AI” Workflow



Student: Karl Lam
2025. UBC Arch540. Instructor: Xun Liu

Design the Data Flow

Data Input for AI-Generated Concept

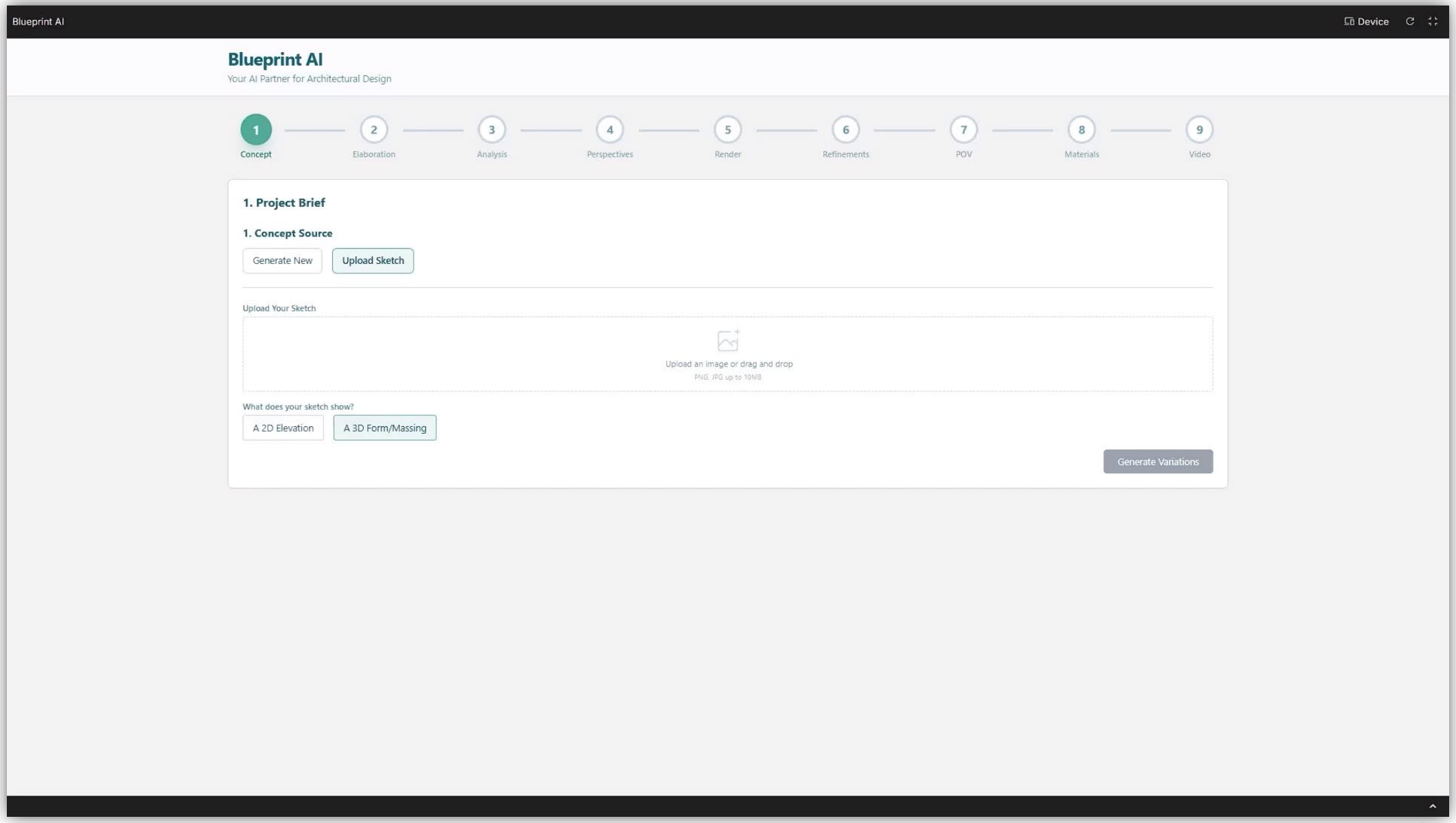


Student: Karl Lam
2025. UBC Arch540. Instructor: Xun Liu

Generated Video Clips



Design the Data Flow



Design the Data Flow

Video Demo (Marble)



Modern Building Rainy Urban Setting

Completed

ID: e6c8646c...f0fd

World Guide

The scene is a contemporary urban environment captured in a realistic style, conveying a somewhat somber and tranquil mood due to the overcast weather. The architecture showcases bold, angular designs and a combination of natural wood and glass, providing a

Model: Marble 0.1-plus

Seed: 0

Reuse prompt

View world



Modern Building Interior Overlooking City

Completed

ID: f4c03aab...7561

World Guide

The scene is a contemporary interior space, rendered with precise realism, showcasing architectural boldness and an industrial-chic aesthetic. The overall tone is one of modern minimalism and sophisticated design, characterized by clean lines and a muted color palette

Model: Marble 0.1-plus

Seed: 0

Reuse prompt

View world

Older



Tuesday, Sep 23 at 2:05 PM

Completed

Beta

Explore

Create

Worlds

Plan

Refill credits

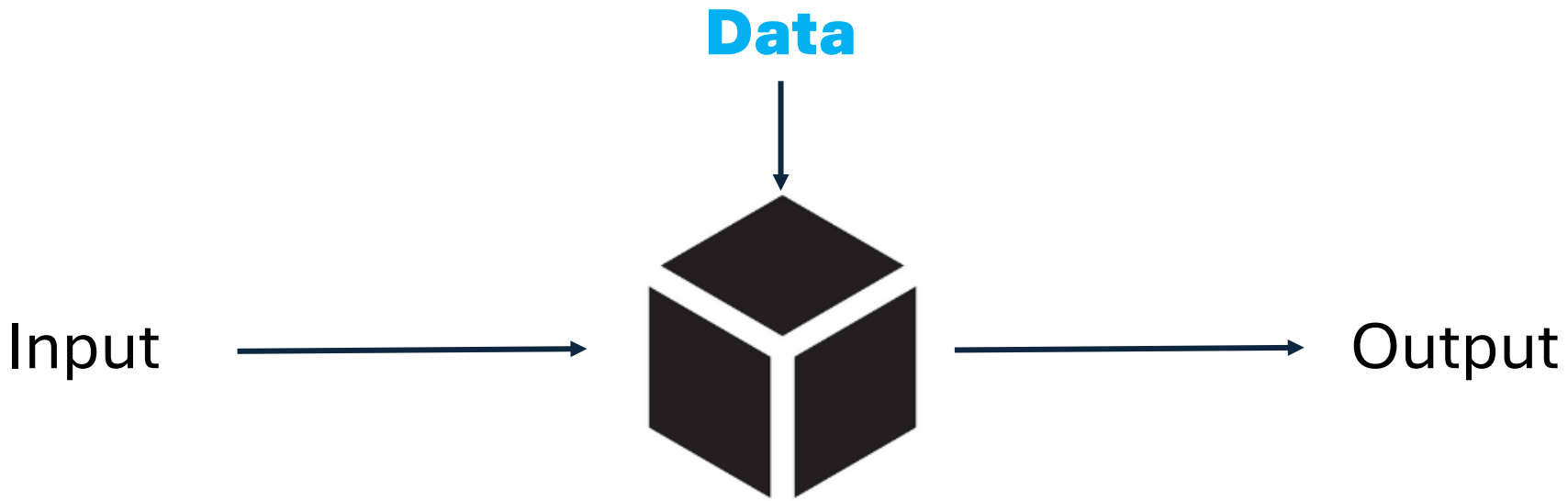
Discord

Help

@ubcsalaaivisual

Student: Karl Lam
2025. UBC Arch540. Instructor: Xun Liu

Fine-tune with Selected Data

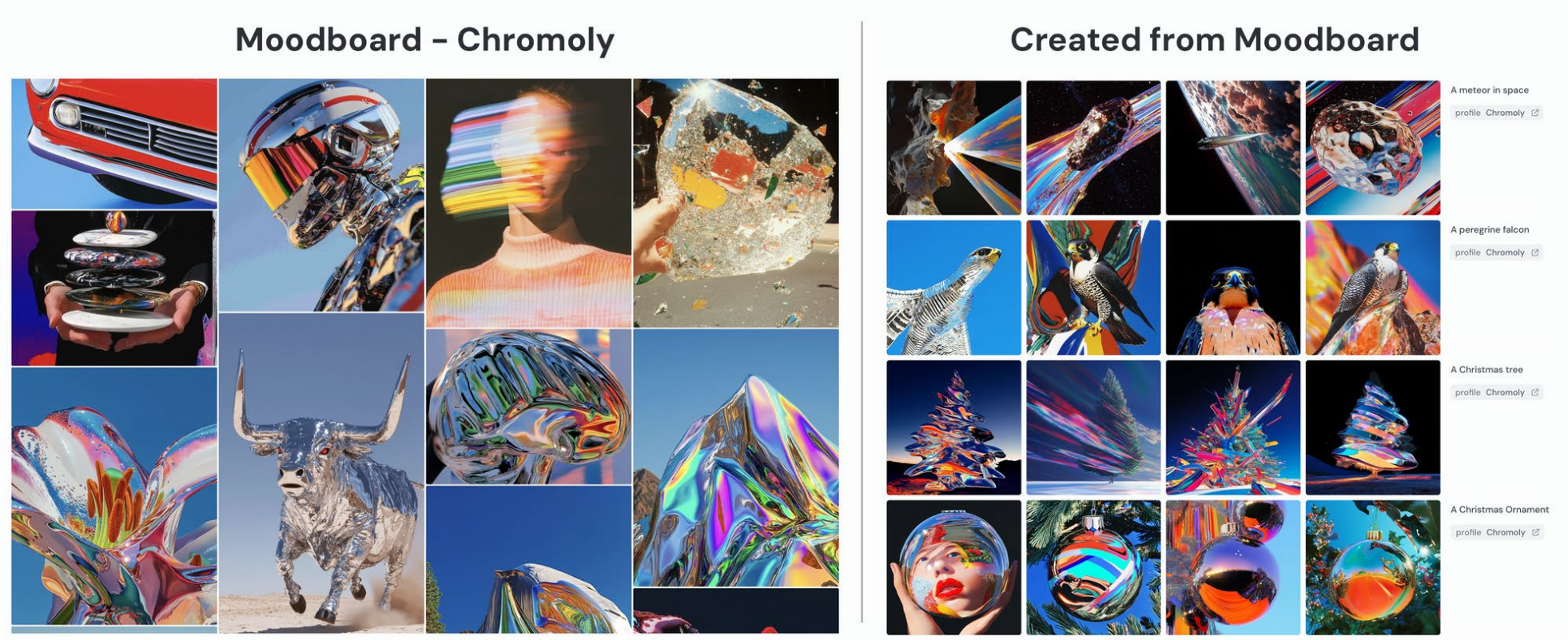


Fine-tune with Selected Data



ChatGPT
With GPTs

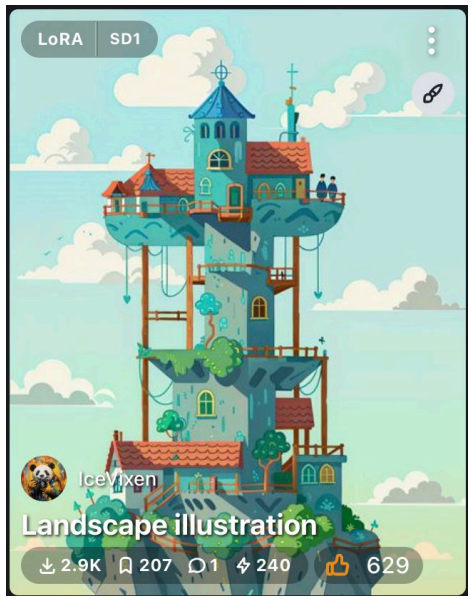
Fine-tune with Selected Data

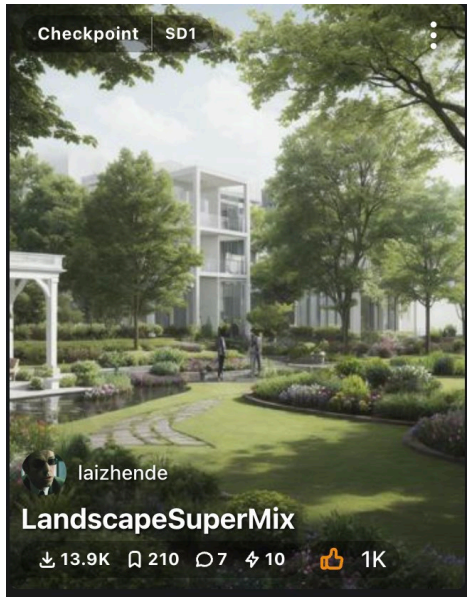


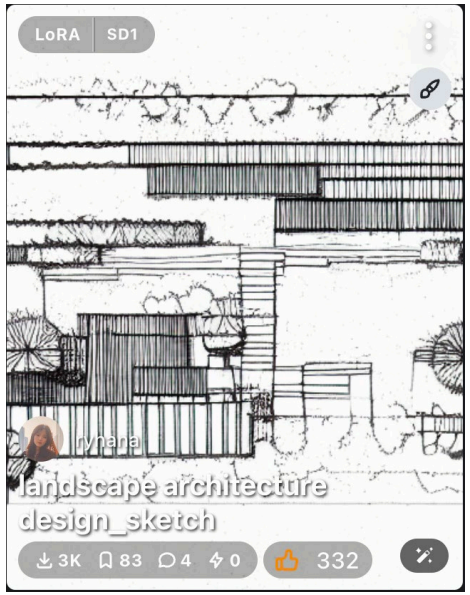
Midjourney

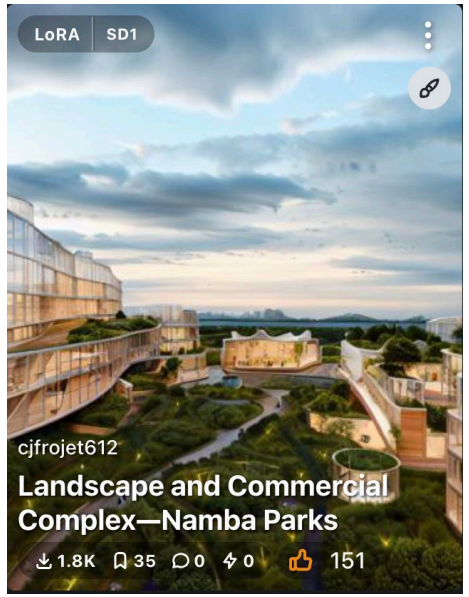
Credit: Midjourney Moodboards

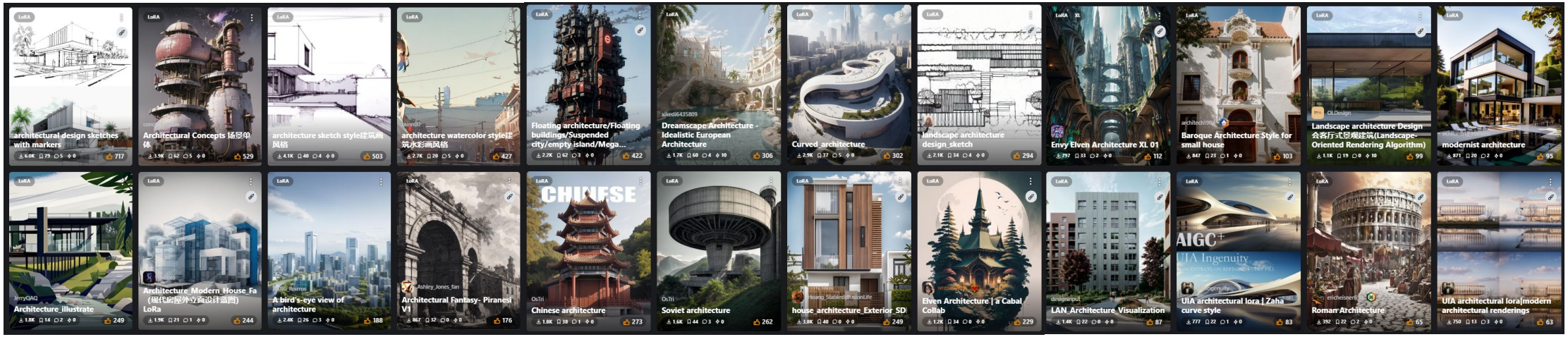
Fine-tune with Selected Data





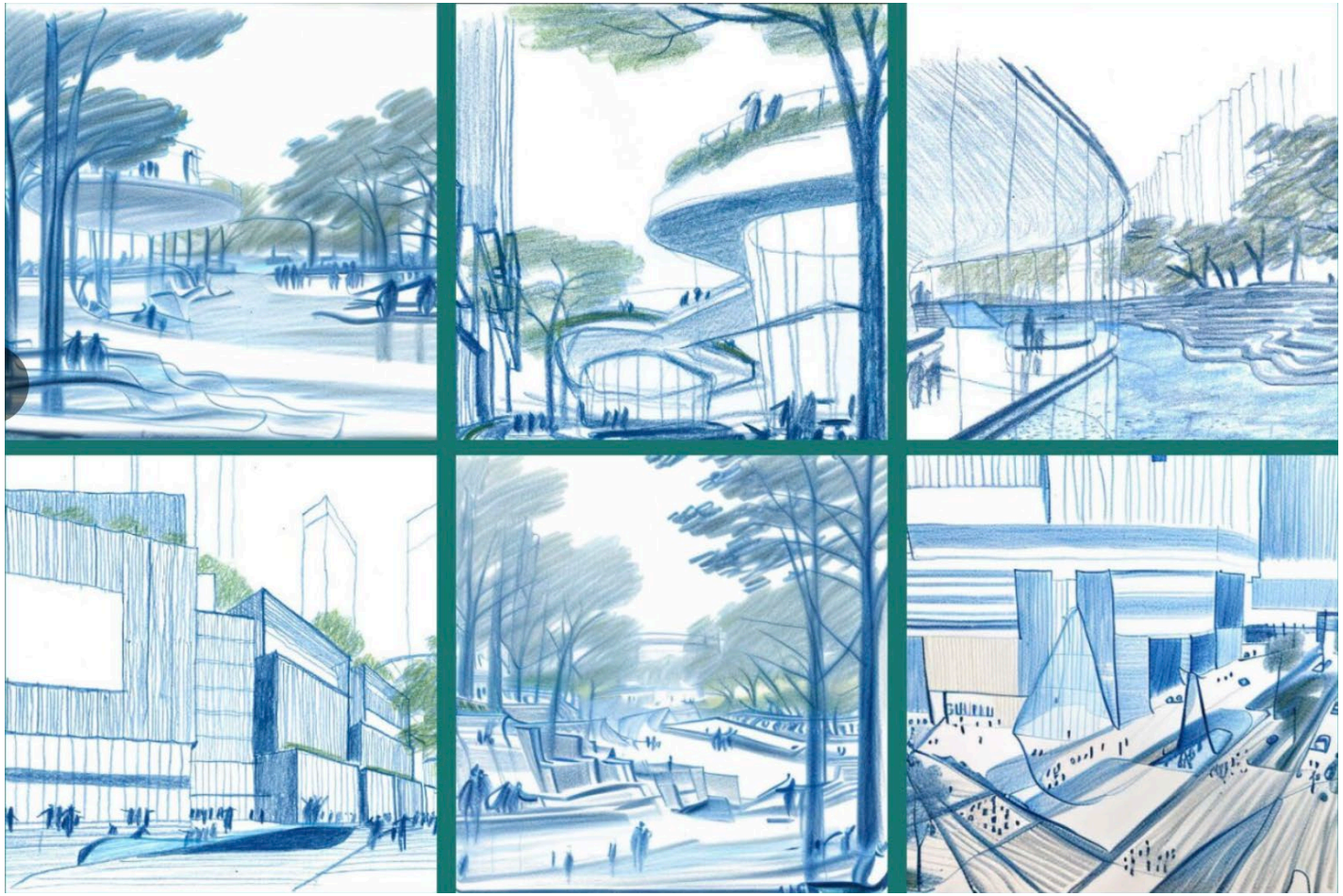






Credit: Civitai.com

Fine-tune with Selected Data



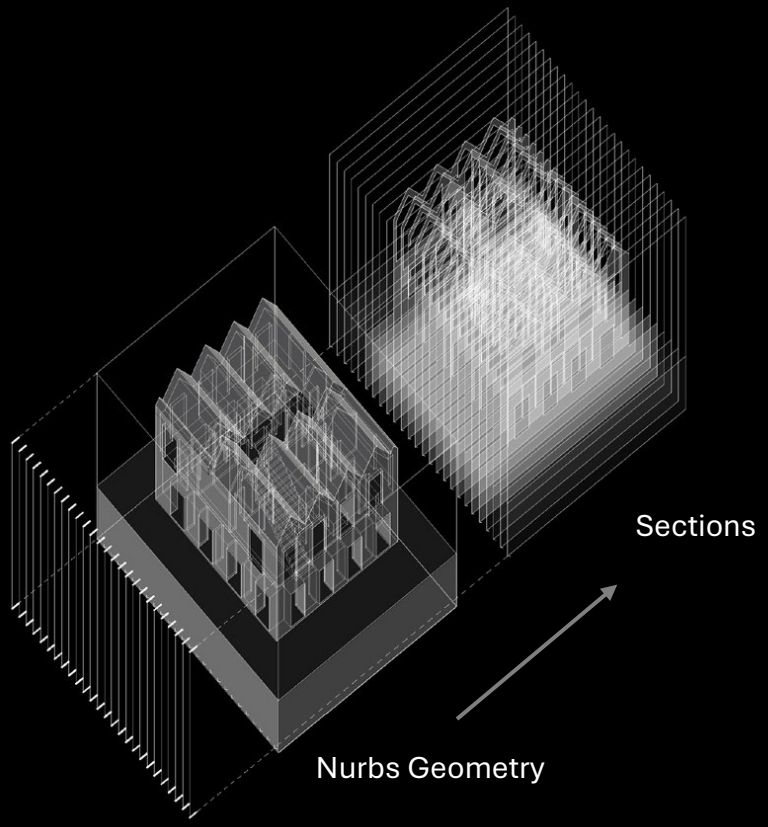
Text Prompt

monochrome, Poli House, Motherhouse, Single family home, architectural section, architectural poche, white background, no human

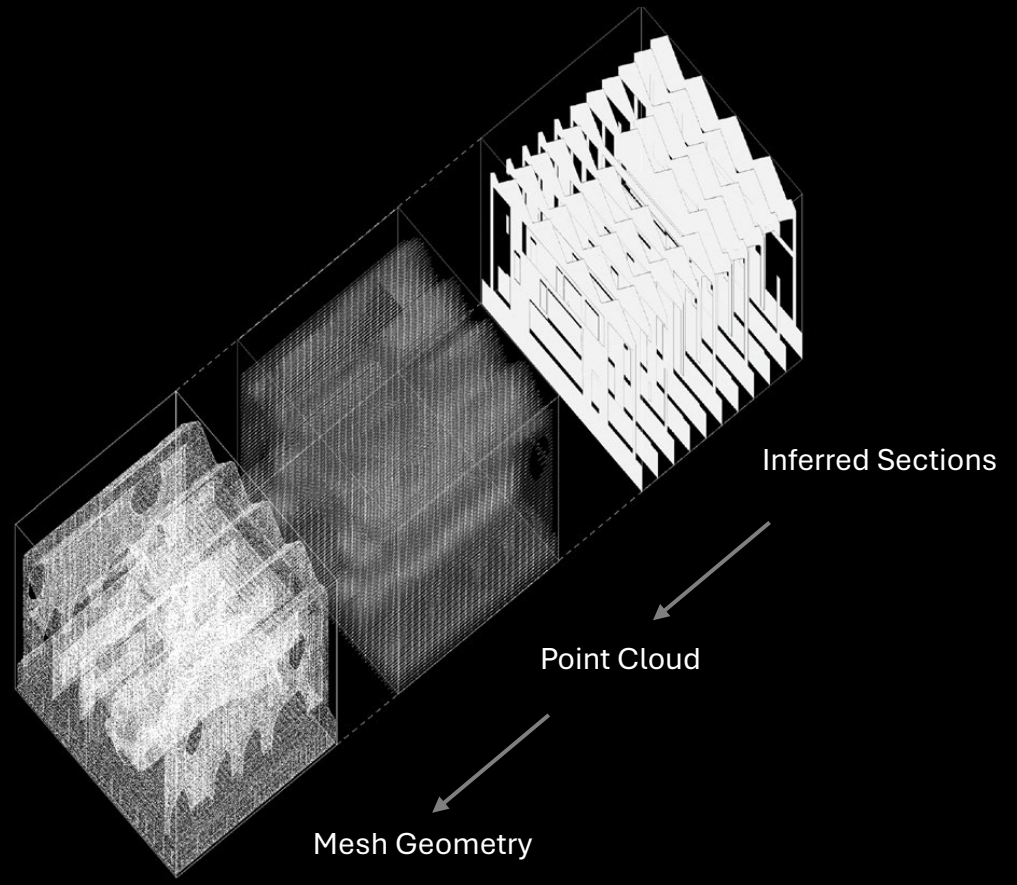
Text to Poché



Students: *Zheng Fang, Xuechun Li*
Instructors: Xun Liu, Runjia Tian



Serial Sectioning

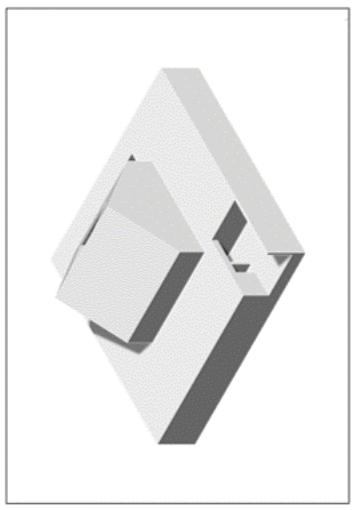


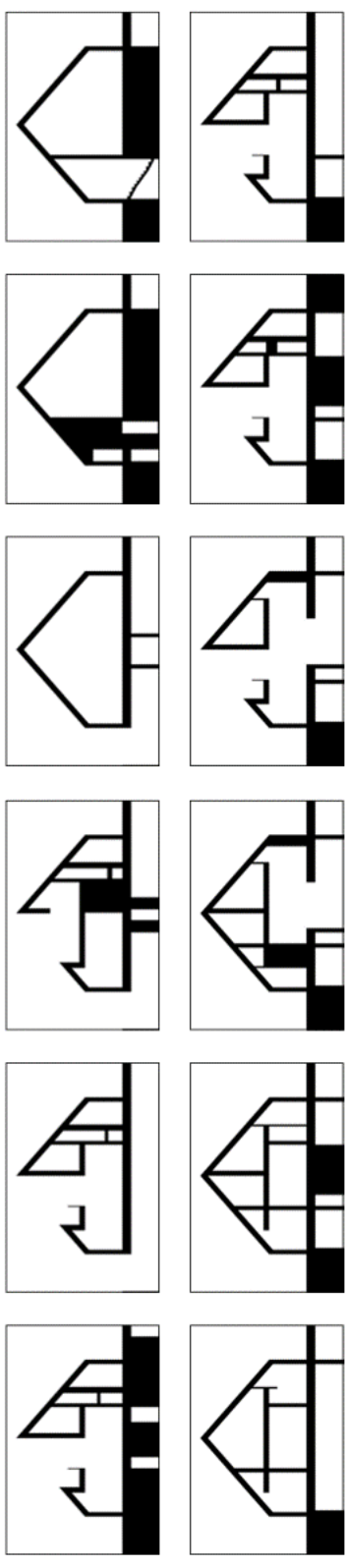
3D Synthesis

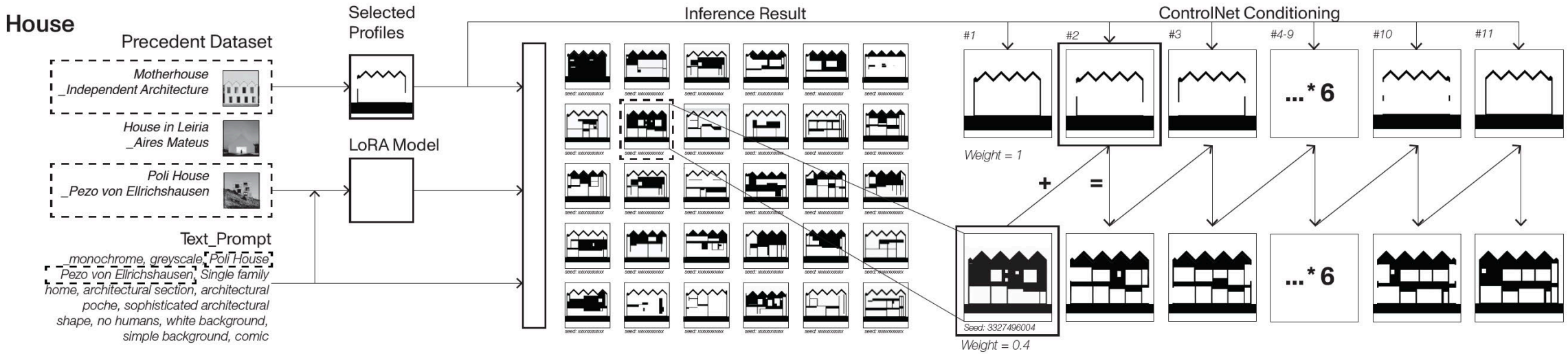
***Students**: Zheng Fang, Xuechun Li*
Instructors: Xun Liu, Runjia Tian

Students: *Zheng Fang, Xuechun Li*
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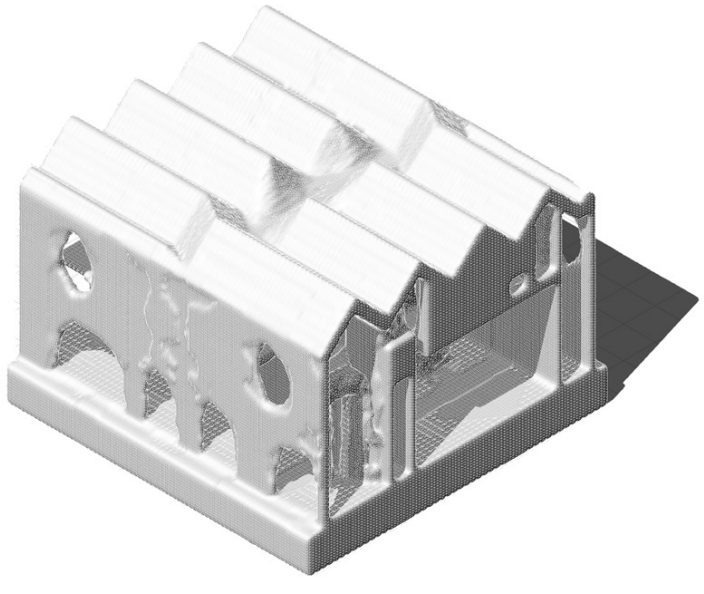
House In Leiria



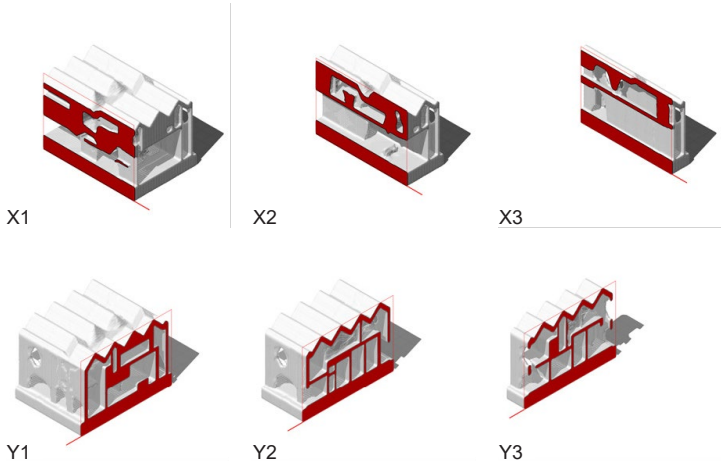


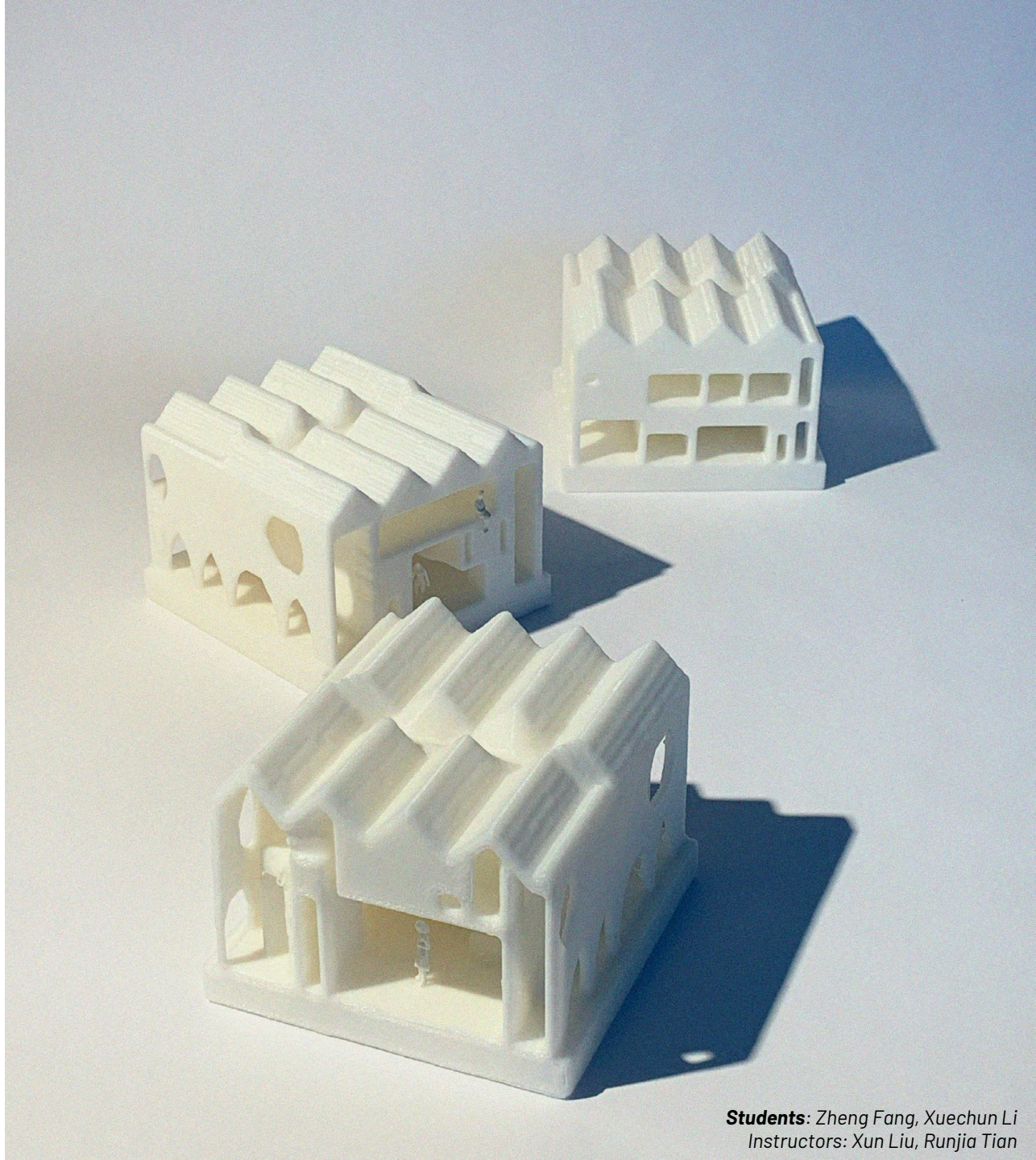


Students: *Zheng Fang, Xuechun Li*
Instructors: Xun Liu, Runjia Tian



Motherhouse
& House in Leiria

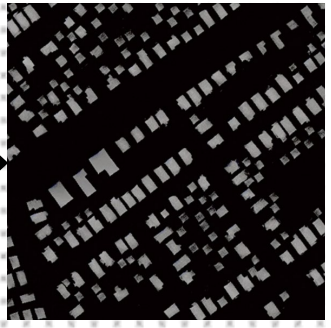




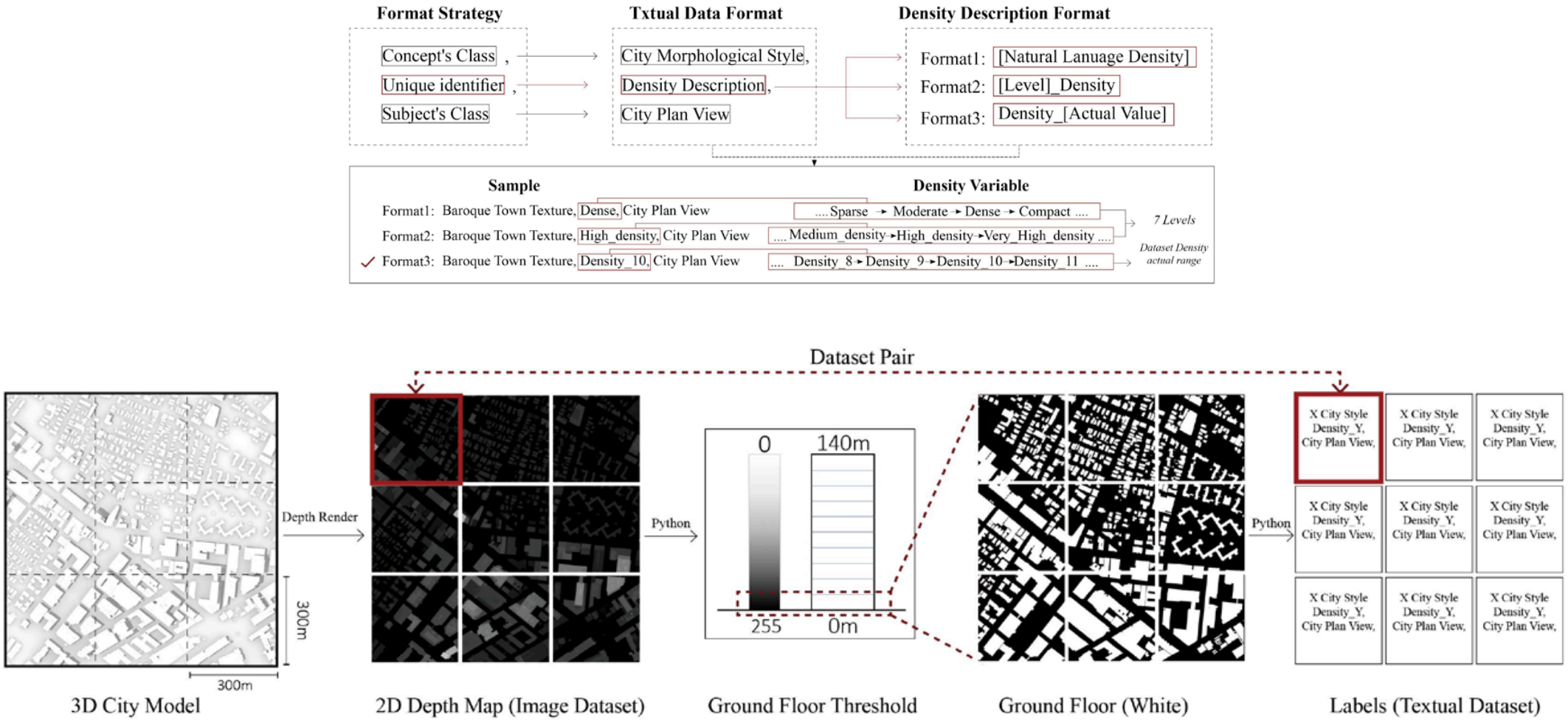
***Students**: Zheng Fang, Xuechun Li*
Instructors: Xun Liu, Runjia Tian

Text Promp:
Grid AmericanTownTexture,
Density_24,
City Plan View

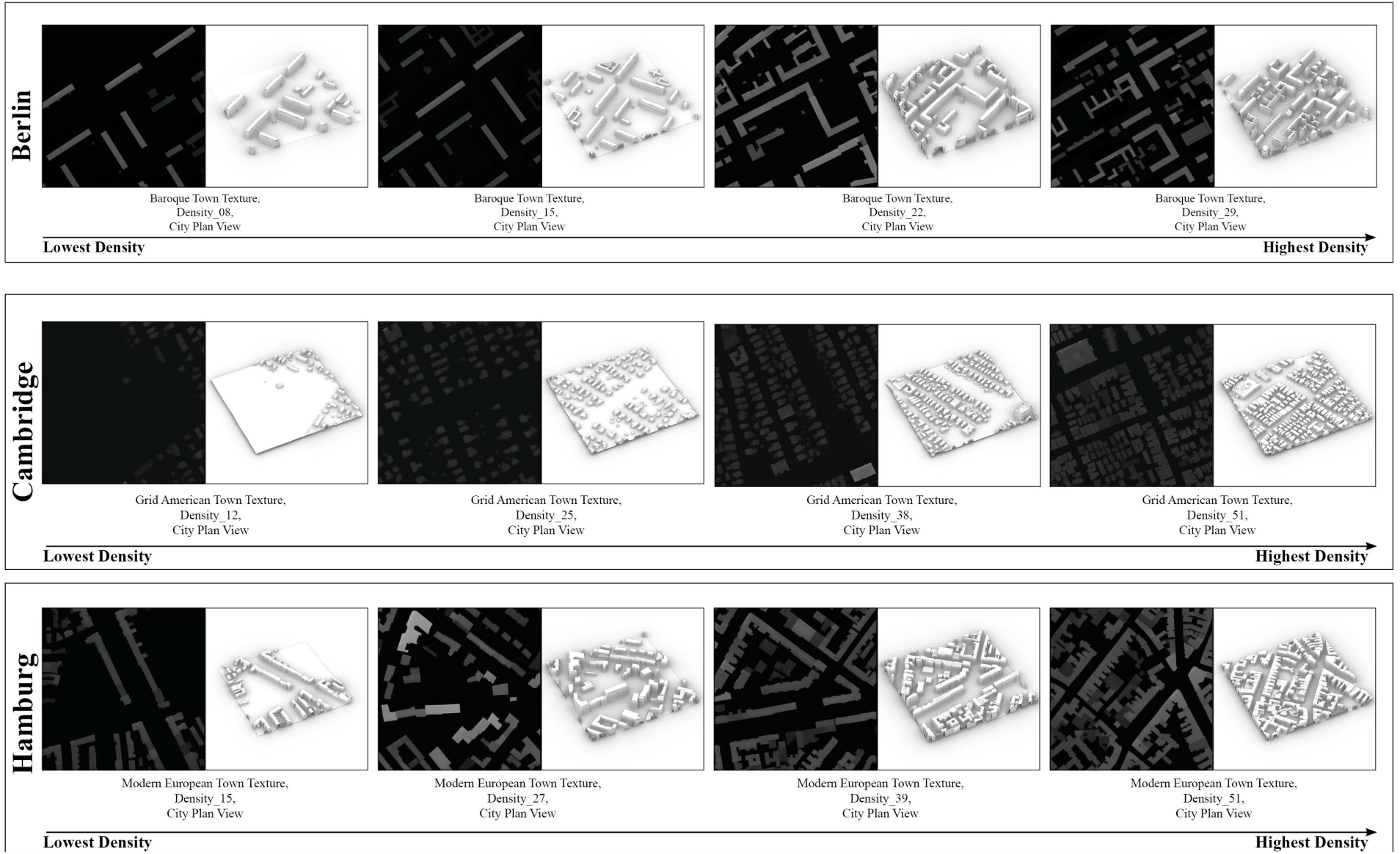
Text to Urban Fabric



***Students**: Junling Zhuang, Guanhong Li, Hang Xu, Jintu Xu*
Instructors: Runjia Tian, Xun Liu



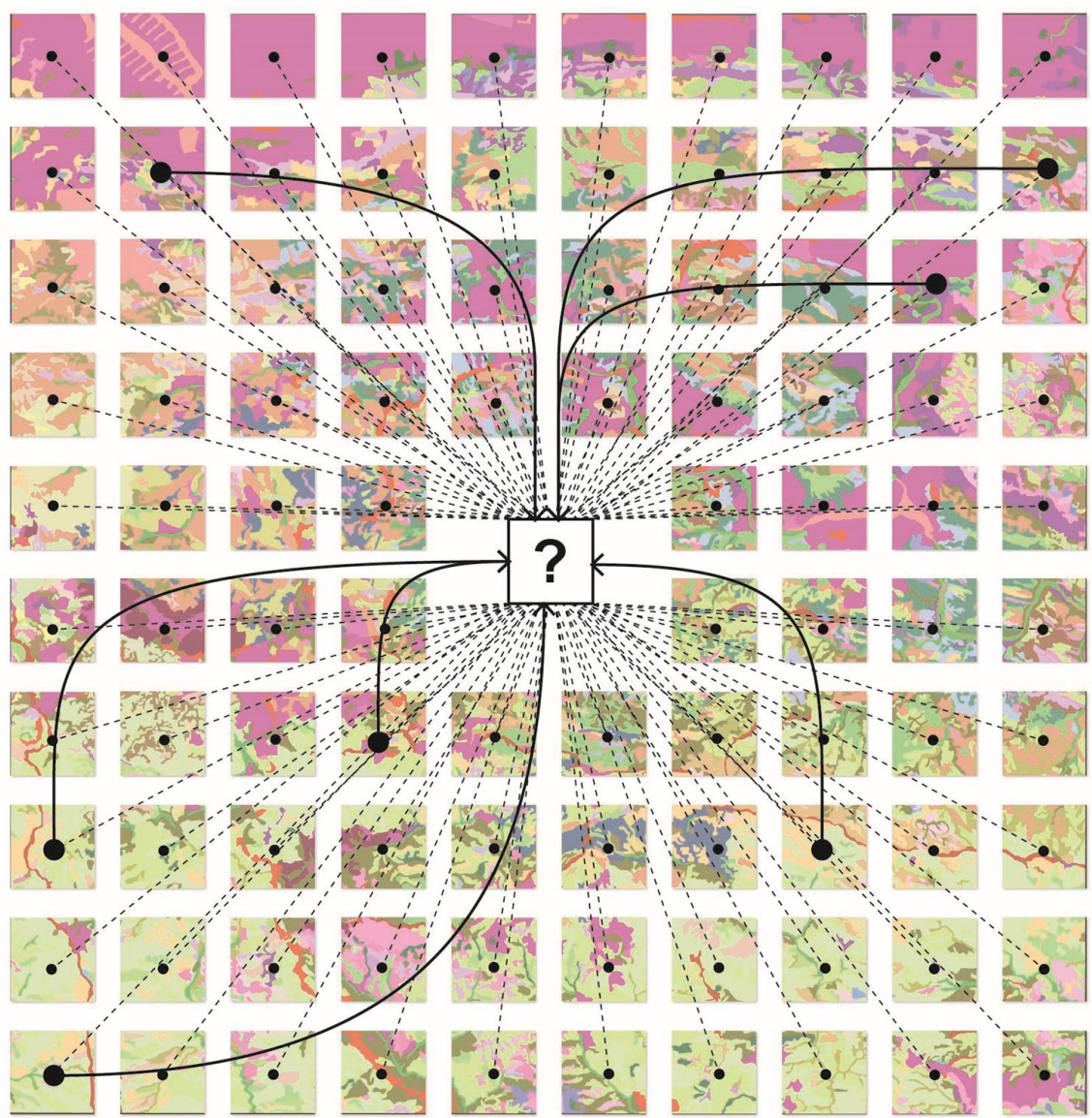
Students: *Junling Zhuang, Guanhong Li, Hang Xu, Jintu Xu*
Instructors: Runjia Tian, Xun Liu



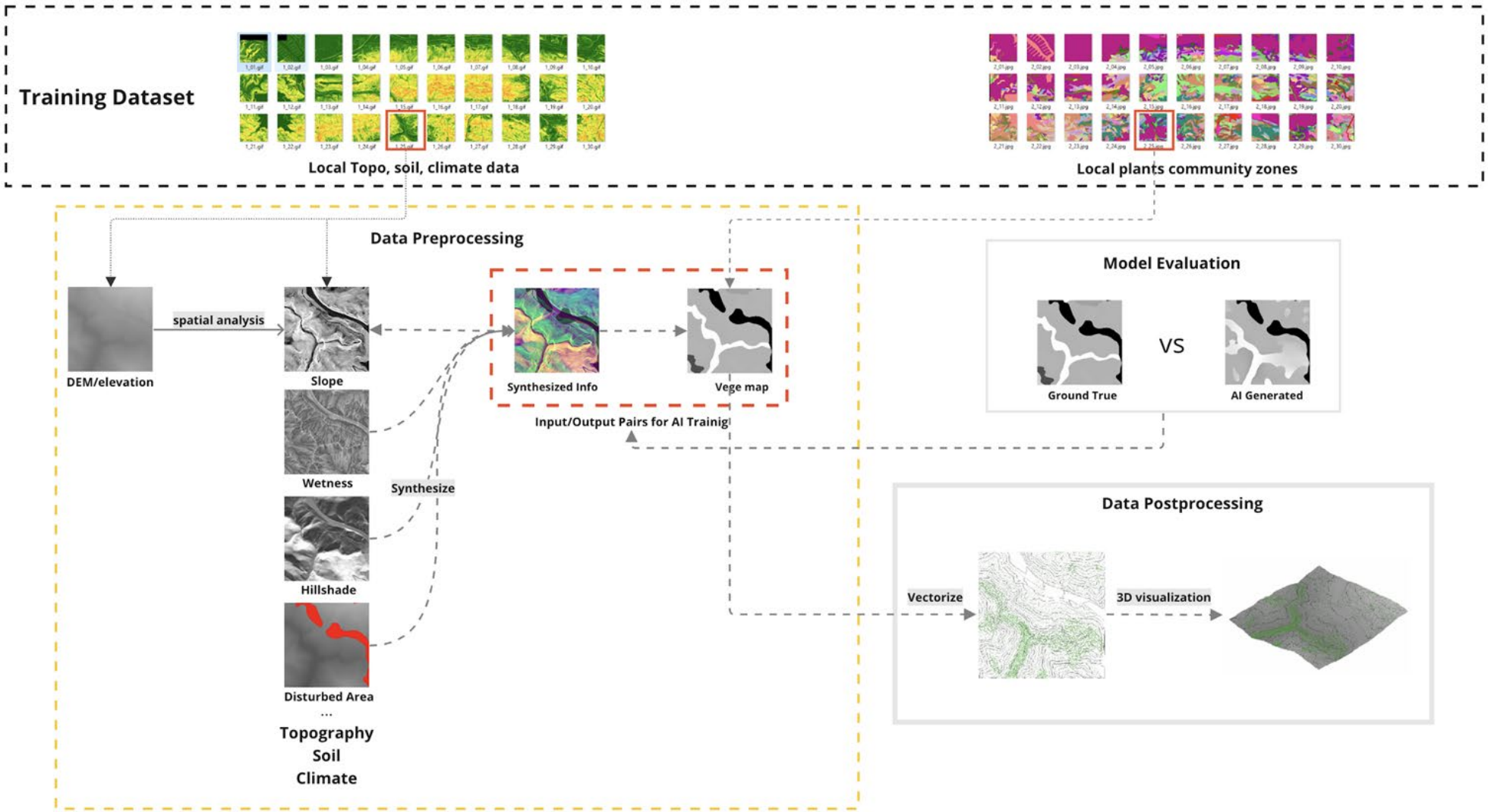
***Students**: Junling Zhuang, Guanhong Li, Hang Xu, Jintu Xu*
Instructors: Runjia Tian, Xun Liu



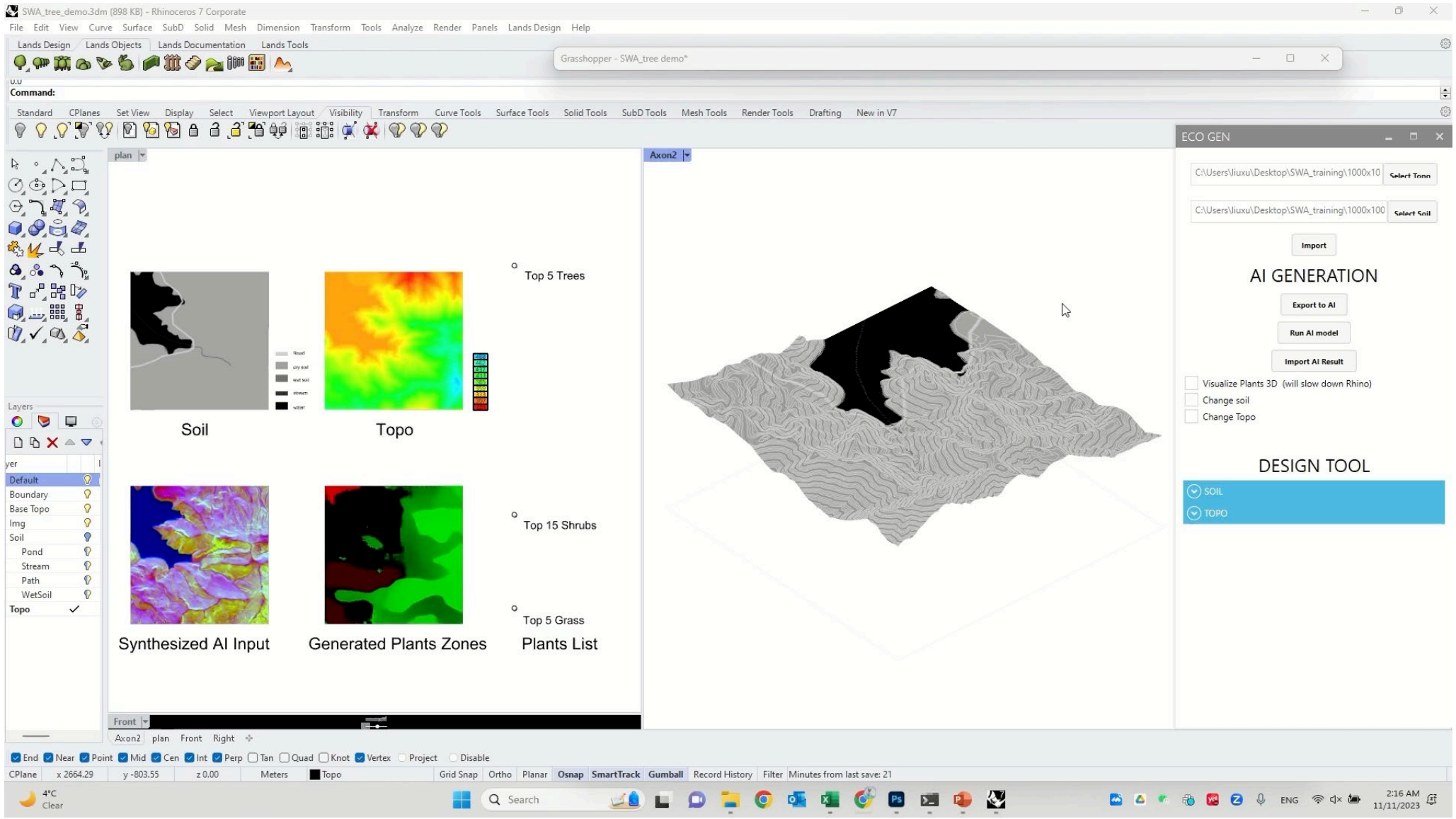
Credit: Xun Liu, Nandi Yang (SWA), developed for SWA Group



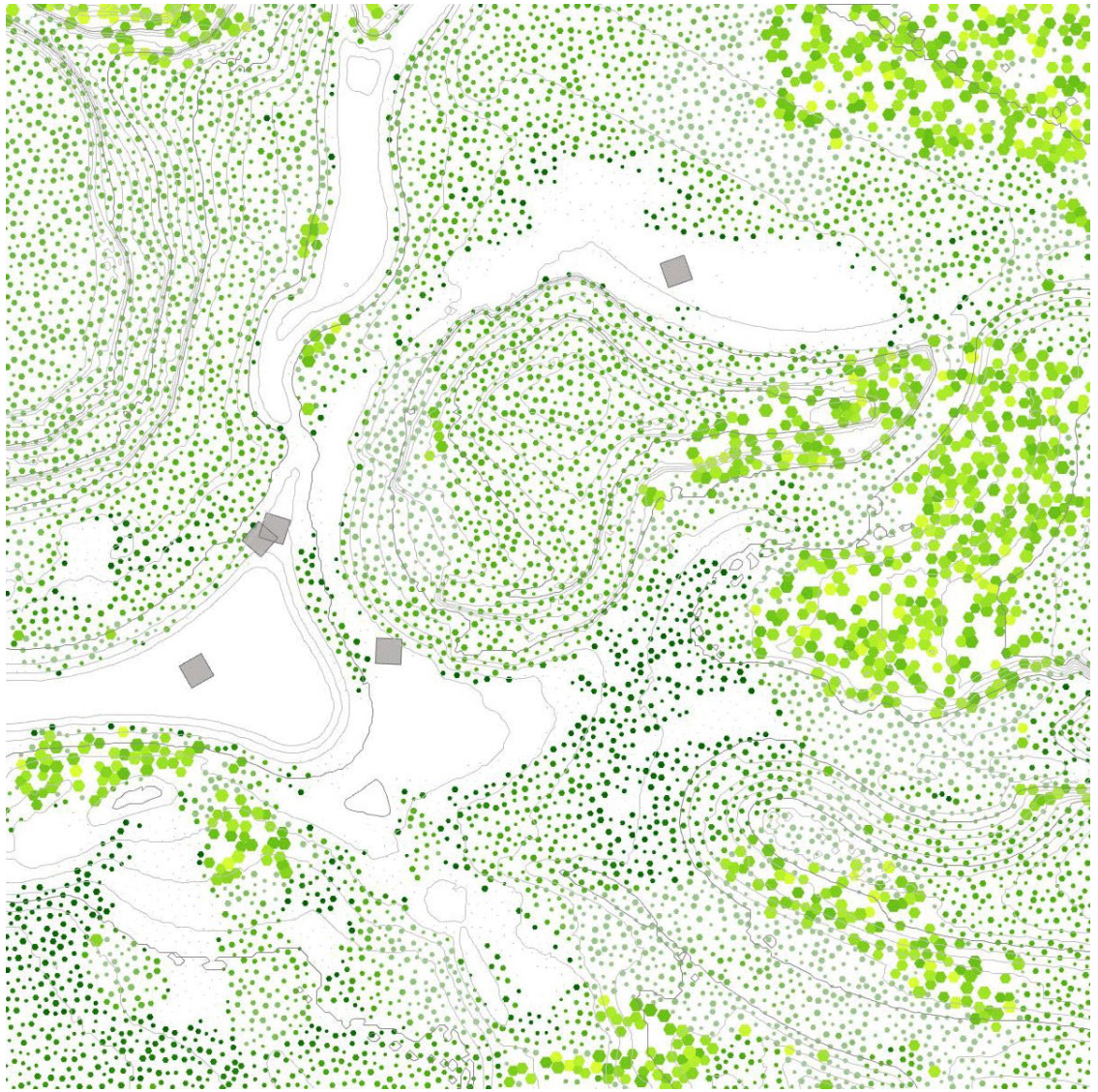
Credit: Xun Liu, Nandi Yang (SWA), developed for SWA Group



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Credit: Xun Liu, Nandi Yang (SWA), developed for SWA Group



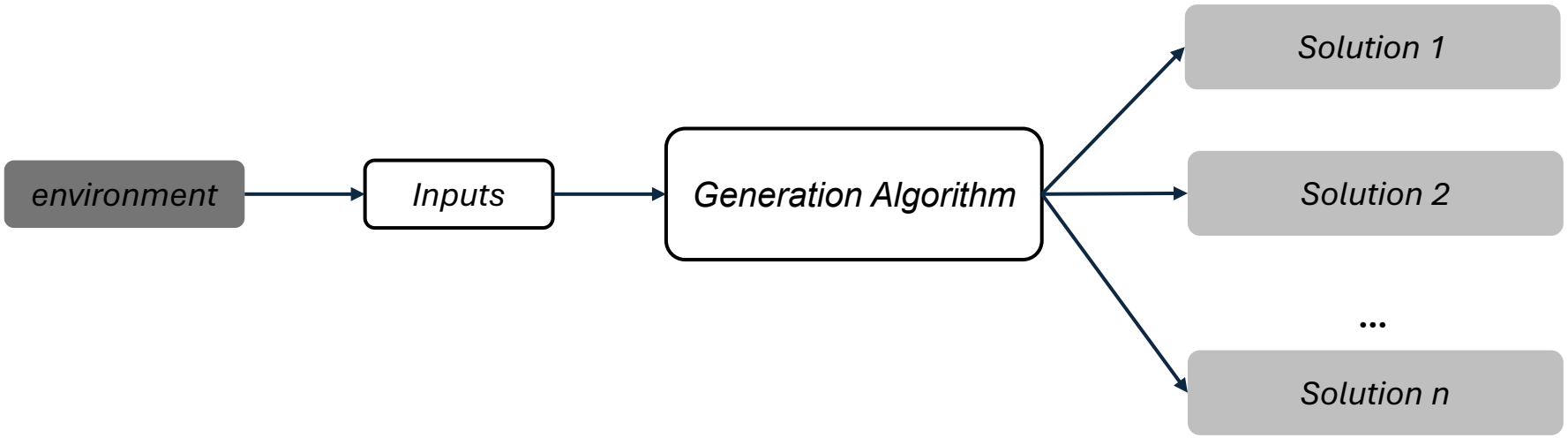
TREE:10
- Umb cal
- Que agr
- Jug cal
- Que lob
- Salix MU
- Sal lae
- Sal las
- Aln rho
- Pla rac
- Cea meg/spi - Cer bet MU

GRASS: 13
- Ley con
- Pen set
- Aru don
- Jun acu
- Wetland MU
- Scir cal
- Typha spp.
- Dist spi
- Sal vir
- Ven car
- Foe vul
- Sel blg
- California Annual Grassland

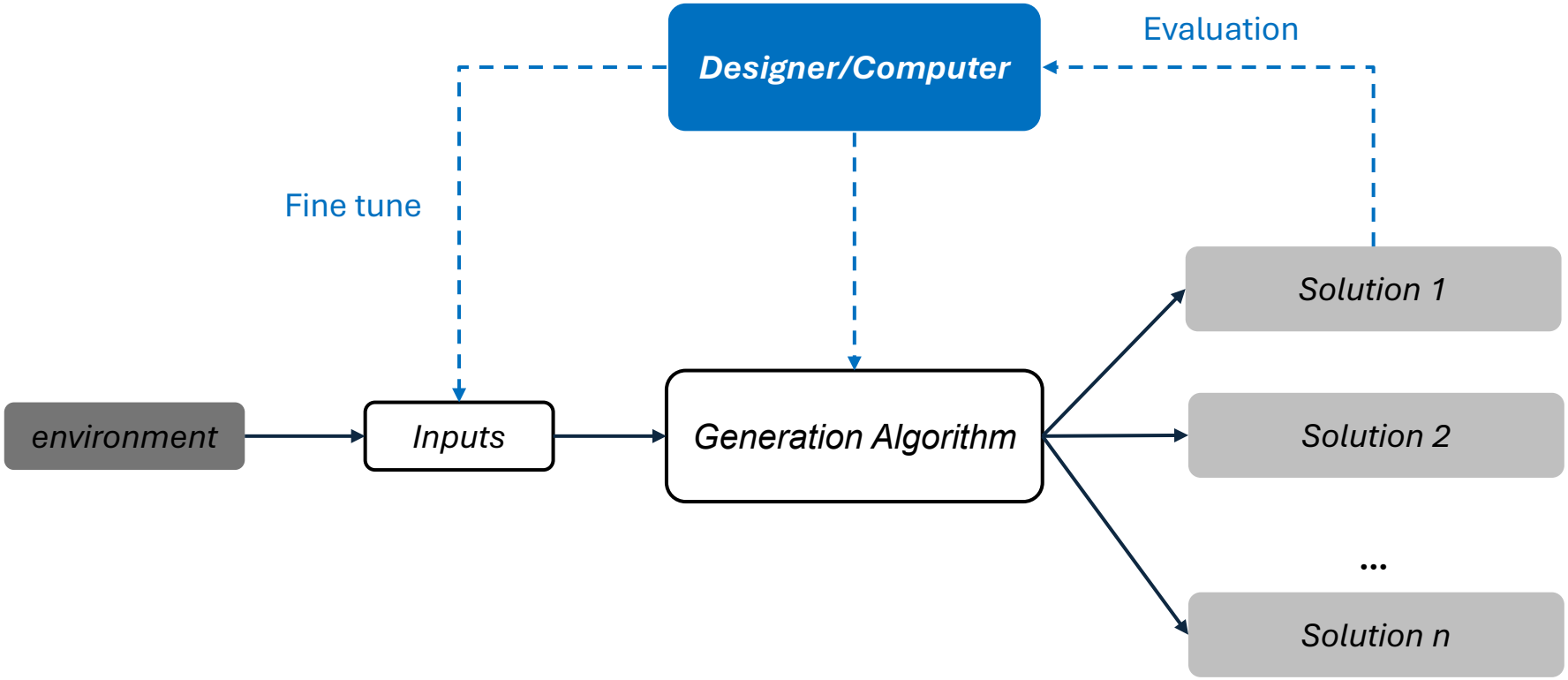
SHRUB: 55
- Jug cal - Tall Shrubs MU
- Mim aur - Tox div MU
- Ceanothus spp. - Cer bet MU
- Cea cun - Ade fas MU
- Ceanothus spp. - Ade fas MU
- Ade fas
- Ade fas - Arc glan
- Ade fas - Sal mel
- Ade fas - Ade spa
- Ade spa
- Cea cra
- Cea oli
- Cea meg
- Cea spi
- Cer bet
- Pru ill
- Het arb
- Mal lau
- Rhu int
- Que ber
- Mim aur
- Rhu ova
- Bac sal
- Lep squ
- Bac pil
- Atr len
- Opuntia spp.
- Ade fas - Cea cun
- Cea cun
- Ade fas - Arc glau
- Arc glau
- Arc glan
- Que wis
- Ade fas - Cea cra
- Que ber - Ade fas
- Que ber - Cer bet
- Sam mex
- Sal exi
- Art cal
- Enc cal
- Eri fas
- Eri cin
- Haz squ
- Lot sco
- Mal fas
- Sal leu
- Sal mel
- Tox div
- Cor qig
- Den rig
- Eri cro
- Art cal - Eri fas
- Eri fas - Sal api
- Sal mel - Art cal
- Eric palm MU

Credit: Xun Liu, Nandi Yang (SWA), developed for SWA Group

Rule-based Generative Design	Generative AI
Quantitative	**Qualitative**
Deterministic Controls	**Indeterminate** Outcomes
Predictable Result	**Unpredictable** Response
Define & **execute procedure**	Train, **learn and create**
Adaptable **Parametric Rules**	Statistical **Model Weights**

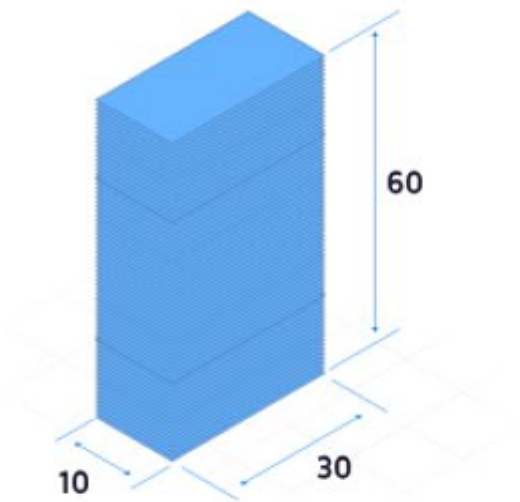


Adapted from "Generative Design" by H Bohnacker, J Laub, B Groß, and C Lazzeroni, 2009

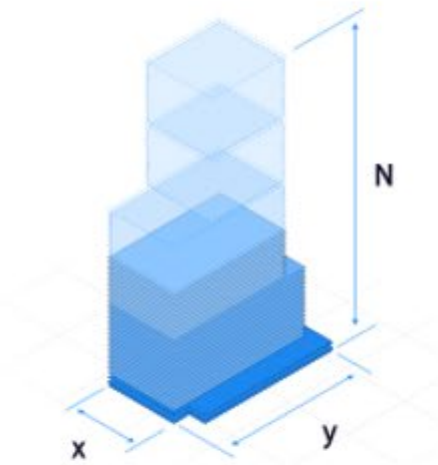


Adapted from "Generative Design" by H Bohnacker, J Laub, B Groß, and C Lazzeroni, 2009

Traditional design



Parametric design



Number of levels (N)

Generative design

