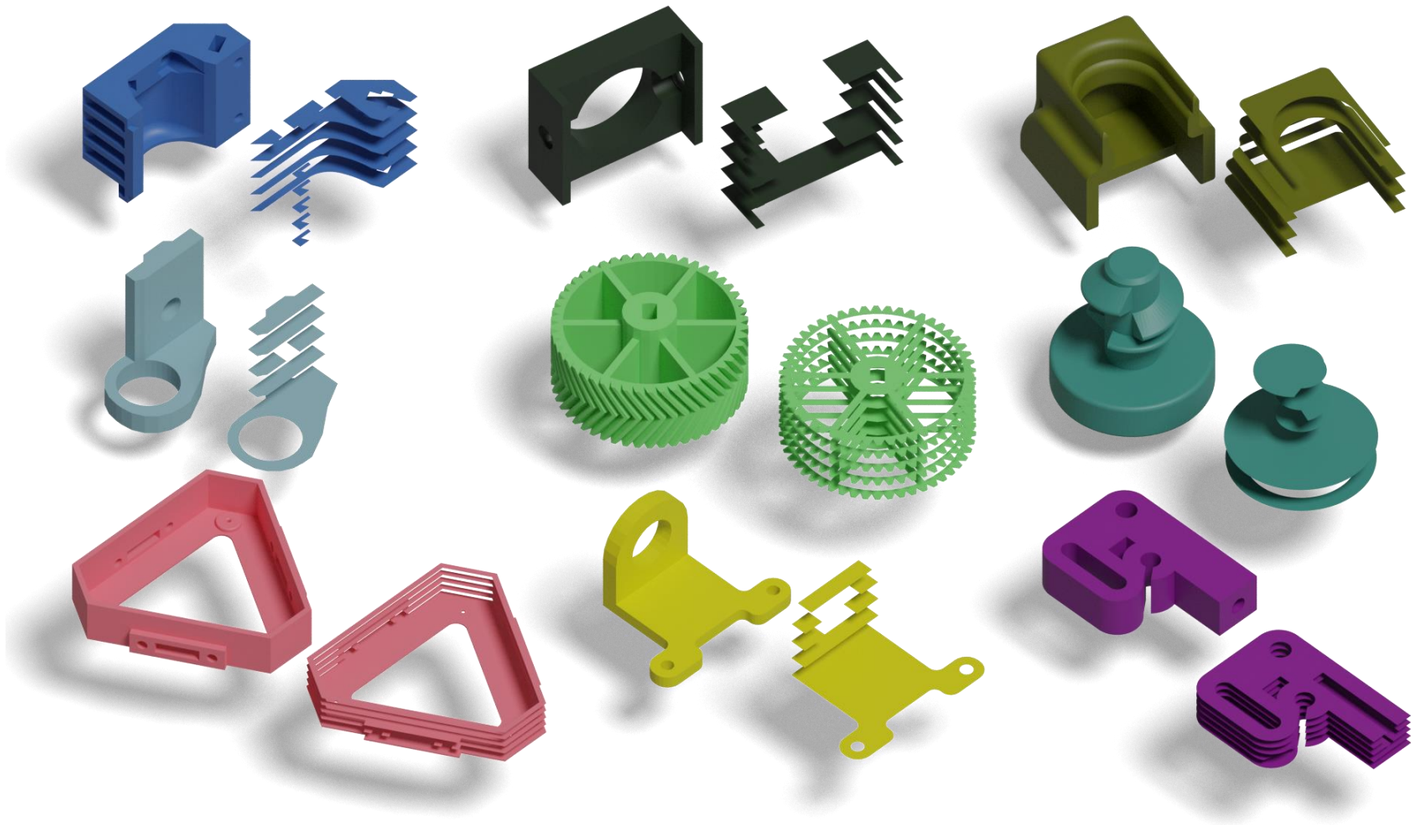
Slice-100K: A Multimodal Dataset for Extrusion-based 3D Printing



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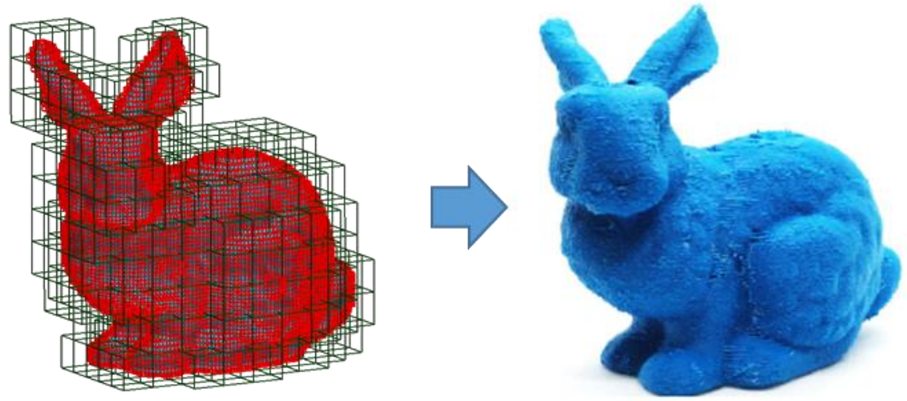
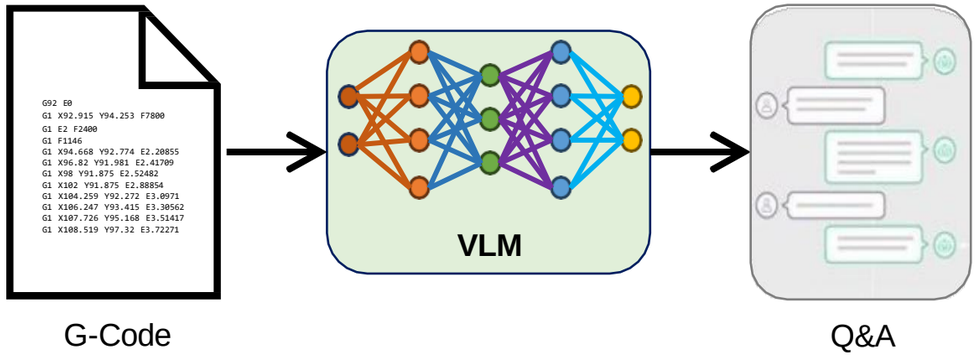
* Equal contribution

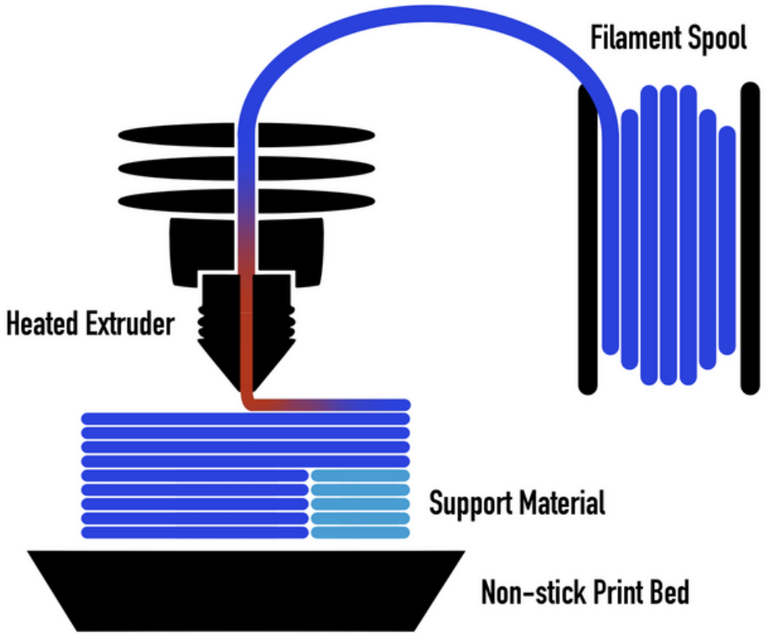
Overview

- Digital design + Computer-aided manufacturing
  - 3D printing
- Foundation models
  - LLMs for 3D shape modeling
  - Untapped for CAD and Cybermanufacturing
- Lack of curated avenues
  - Domain-specific foundation model



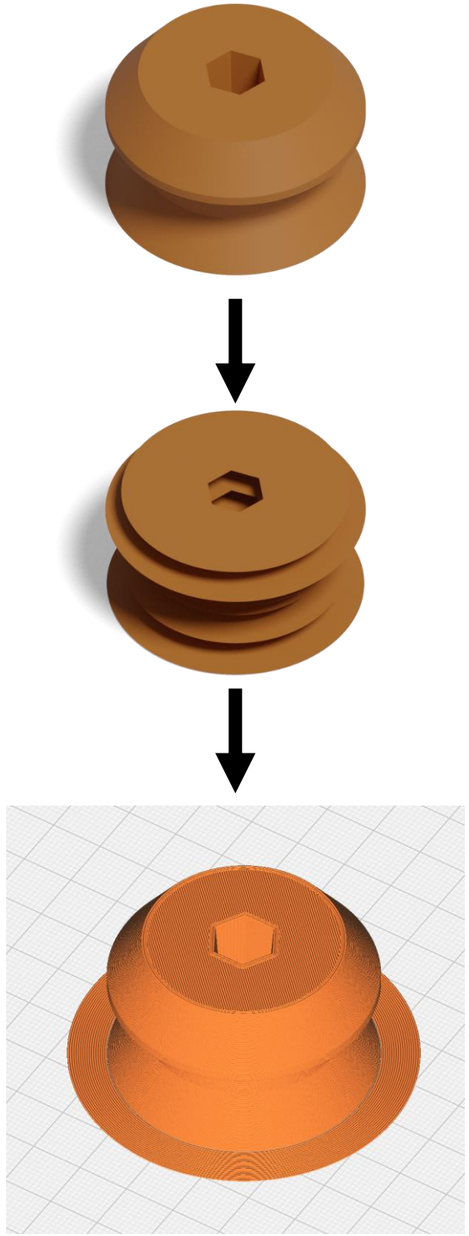


Additive Manufacturing

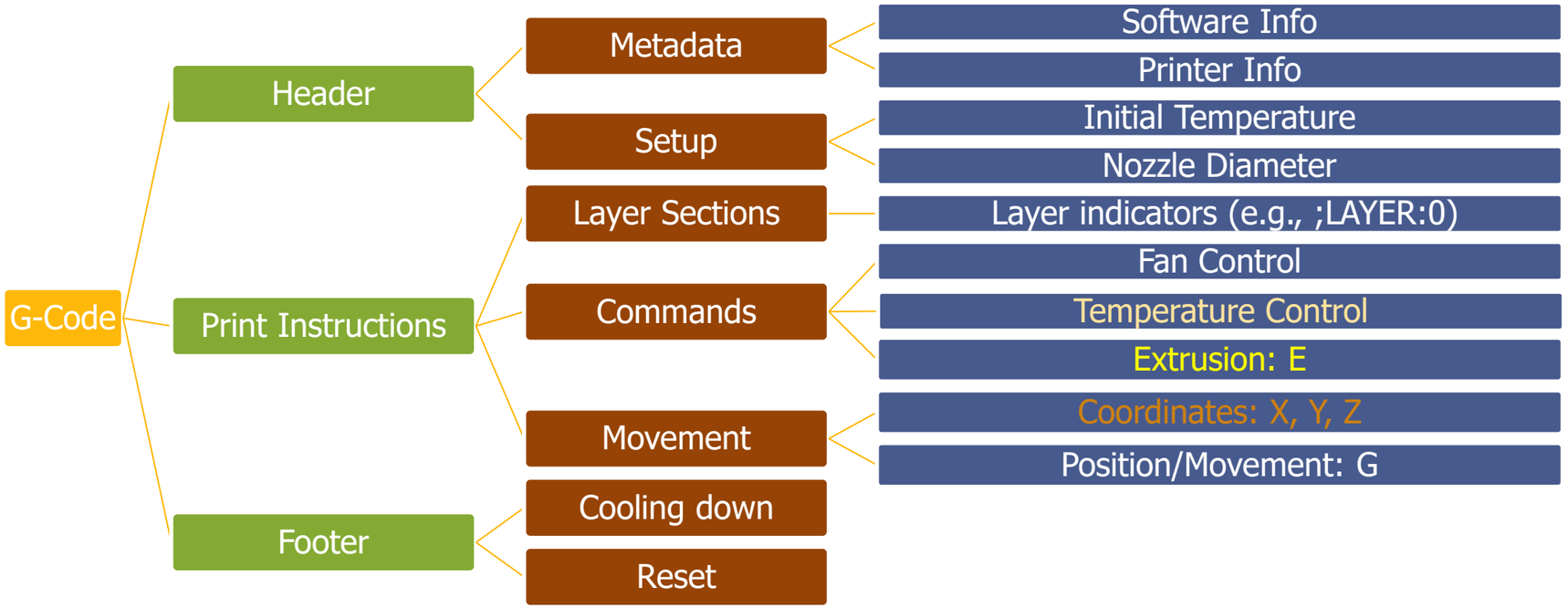


Slicing

- Boundary of geometry -> 3D coordinates
- Use triangles
  - Perform triangle-plane intersection along print direction
  - Store line segment
  - Contour = collection of line segments



G-Code

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M107
M190 S60
M104 S215
G28
G1 Y10
G1 Z5 F5000
M109 S215
G21
G90
M82
G92 E0
G1 Z-1.25 F4800.0
G1 X23.525 Y56.552 F6000.0
G1 X90.576 Y56.552 E2.694
G1 X90.576 Y189.655 E8.042
G1 X23.525 Y189.655 E10.735
G1 X23.525 Y56.552 E16.083
G1 X52.834 Y61.552 F6000.0
G1 X52.338 Y62.034 E16.111 F1800
G1 X51.842 Y62.034 E16.131
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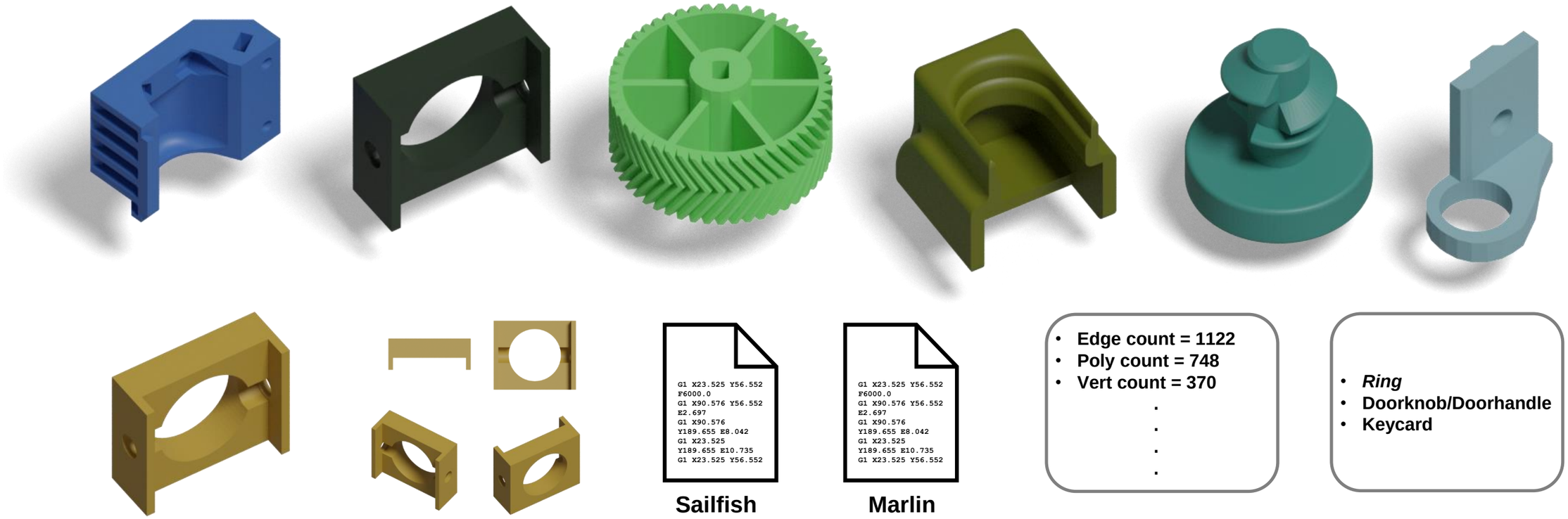
Example G-Code

Slice-100K

- Largest multimodal dataset for additive manufacturing
  - >100,000 models
  - CAD Model, Renderings, G-code, Geometric Properties, and Captions



- Edge count = 924
- Poly count = 616

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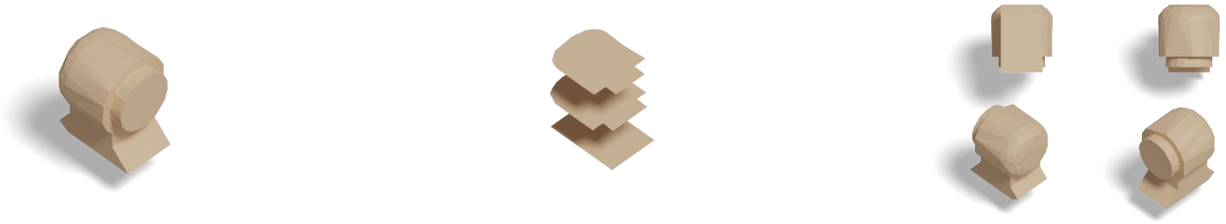
- Pitchfork
- Thumbtack/Pushpin
- Dustpan



- Edge count = 342
- Poly count = 228

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- Earplug
- Football helmet
- Urn

- Edge count = 1644
- Poly count = 1096

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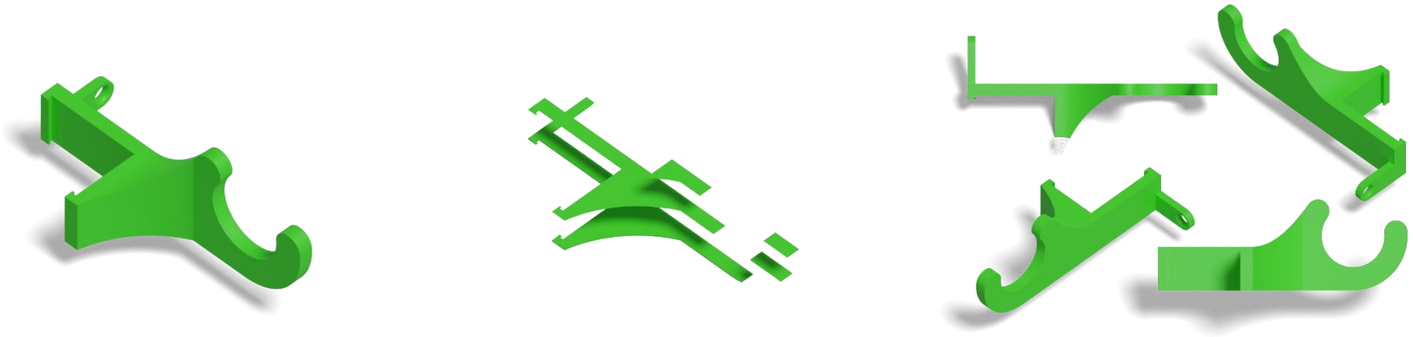
- File/File Tool
- Flashlight/Torch
- Razorblade



- Edge count = 35313
- Poly count = 23542

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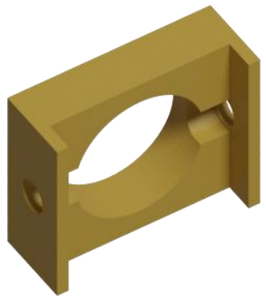
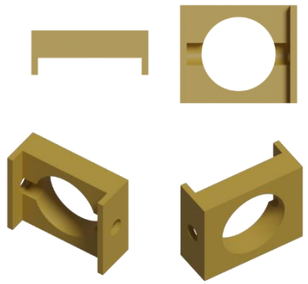
- Pin
- Broach
- Thumbtack/Pushpin

Related Datasets

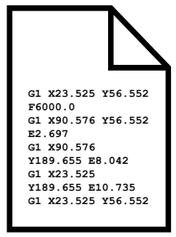
Dataset	Mesh	Renderings	Categories	G-code
ABC	✓	✓	✗	✗
ShapeNet	✓	✓	✓	✗
Thingi10K	✓	✓	✗	✗
Objaverse 1.0	✓	✓	✓	✗
Objaverse-XL	✓	✓	✓	✗
Slice-100K	✓	✓	✓	✓



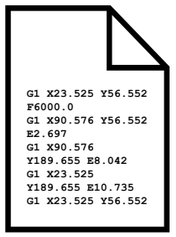
CAD Model



Renderings



Sailfish



Marlin

G-code

- Edge count = 1122
- Poly count = 748
- Vert count = 370

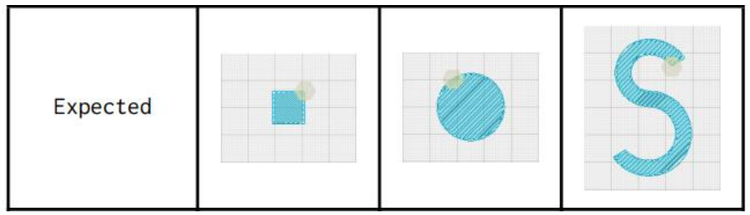
Geometric Properties

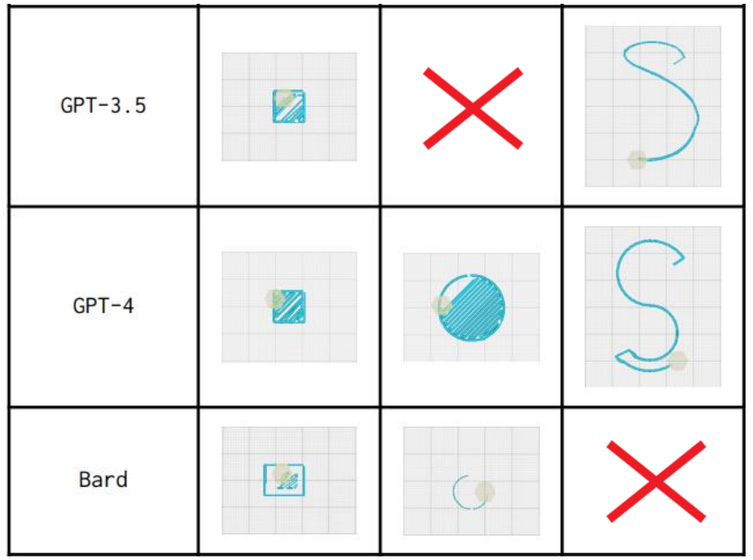
- *Ring*
- Doorknob/Doorhandle
- Keycard

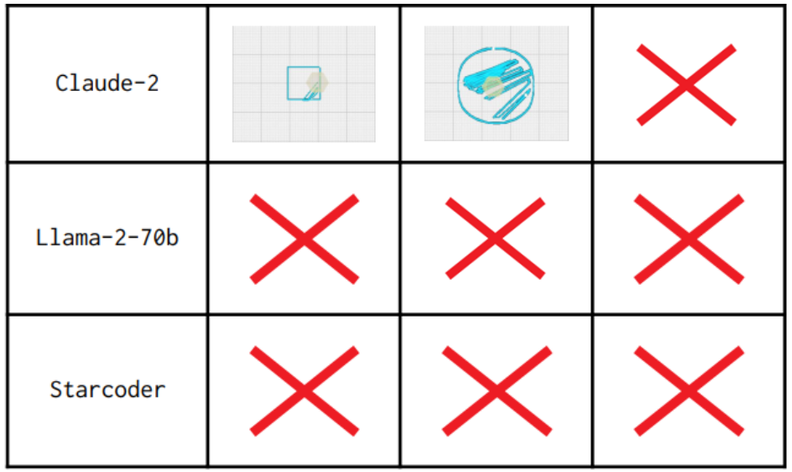
LVIS Categories

G-code Transformation - Scaling

- LLM-based G-code manipulation
  - “Can you scale the coordinates by a factor of 2 and give me the updated G-code?”
  - “Can you scale the entire layer by a factor of 2 and return the updated G-code?”



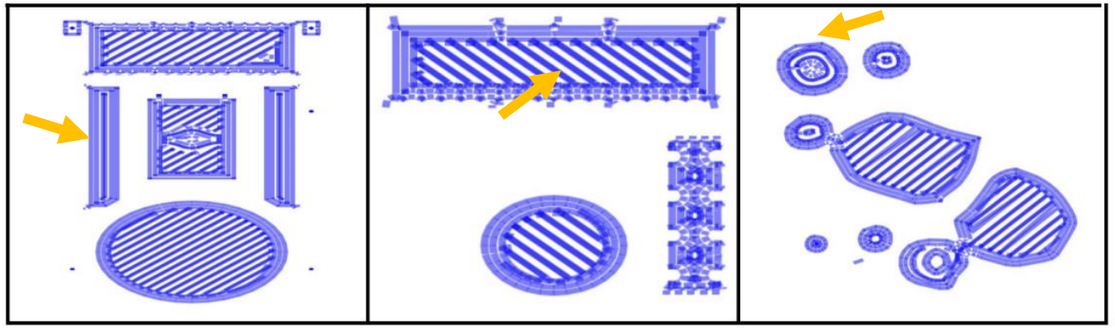




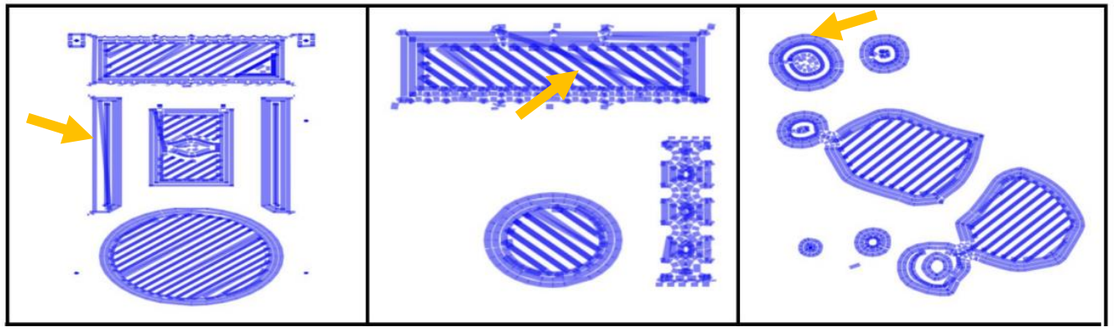
- Finetuning on G-code is needed

G-code Translation

- Convert G-code from one flavor to another
  - Sailfish (legacy) to Marlin (modern)
- Finetune GPT-2 using next-token prediction loss



Actual



Predicted

Model	*Training Data*			*IOU Metrics*			
	Files	*Layers*	*Chunks*	**IOU@0.9**	**IOU@0.95**	**IOU@0.98**	**IOU@0.99**
GPT-2 Base	0	0	0	67	61	17	4
GPT-2$^{(1)}$	1	49	3933	95	88	71	27
GPT-2$^{(5)}$	5	545	13371	96	91	74	30
GPT-2$^{(25)}$	25	2298	51295	98	94	71	30

Project Page

- https://slice-100k.github.io/