3D Printing Hardware

- Fused Deposition Modeling (FDM) : my ender3
  - pros : easy
  - cons : layers are visible, limited material types
- Stereolithography (SLA) : it's a resin printer. A laser solidifies the photo polymer resin
  - pro : - can archieve high resolution
    - no support
  - cons : only photopolymers can be used
- Digital light projector (DLP) : replace laser (SLA) with projector.
  - pro : - faster than SLA
    - high resolution (depending on the projector)
    - no support
  - cons : same as SLA
- Selective laser sintering (SLS) : Actually similar to SLA!

Direct metal laser sintering (DMLS)

You put material (plastic, metal, ceramic) and melt it with an high power laser ⇒ trace one layer. Then add other material

- pro : - no support
  - can print metal!
- cons : each layer is made of the same material

• Plaster-based Printing (PP) : similar to SLA but uses glue instead of laser

pros : - no support
- color print!

cons : use only plaster

• Photopolymer phase change inkjets : you have a printhead which ejects liquid photopolymer
↳ it's cured by UV

pros : support multi material!

cons : photopolymer only

If excess material, a roller removes it

• Thermal phase change inkjets : you have a print head which ejects liquid plastic and support material which solidifies by cooling down

pros : - high resolution
- support easy to remove

cons : - slow print speed
- limited materials

- Laminated object manufacturing (LOM): You have a long sheet of material and at each printing layer a laser cuts through it

pros: - cheap (low material cost)
- color can be added using additional printhead

cons: low resolution

3D Printing <u>Software</u>

input model
(Stl file
"triangle soup")

$\Rightarrow$ Orientation

Slicing

Support structure design

G-code
(Path planning)

can affect both printing time and quality!
also mechanical properties

- Orientation

manual (User)

semi-manual (live feedback)

automatic

Support structure computation

- Simple conservative algorithm: cast a ray and by counting intersections detect inside and outside. Put support outside (any outside interval before the last inside)

Slicing

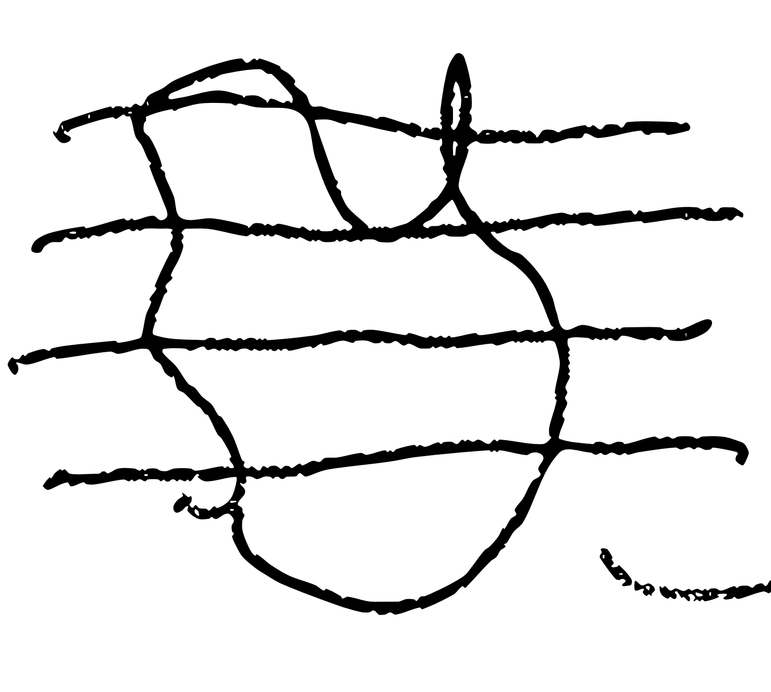
- is used to generate printing layers. For a discrete z value compute intersection with model

underfitting overfitting average

you get the same discretization problem of integrals

How to slice? (Naive)

- Consider n z-planes



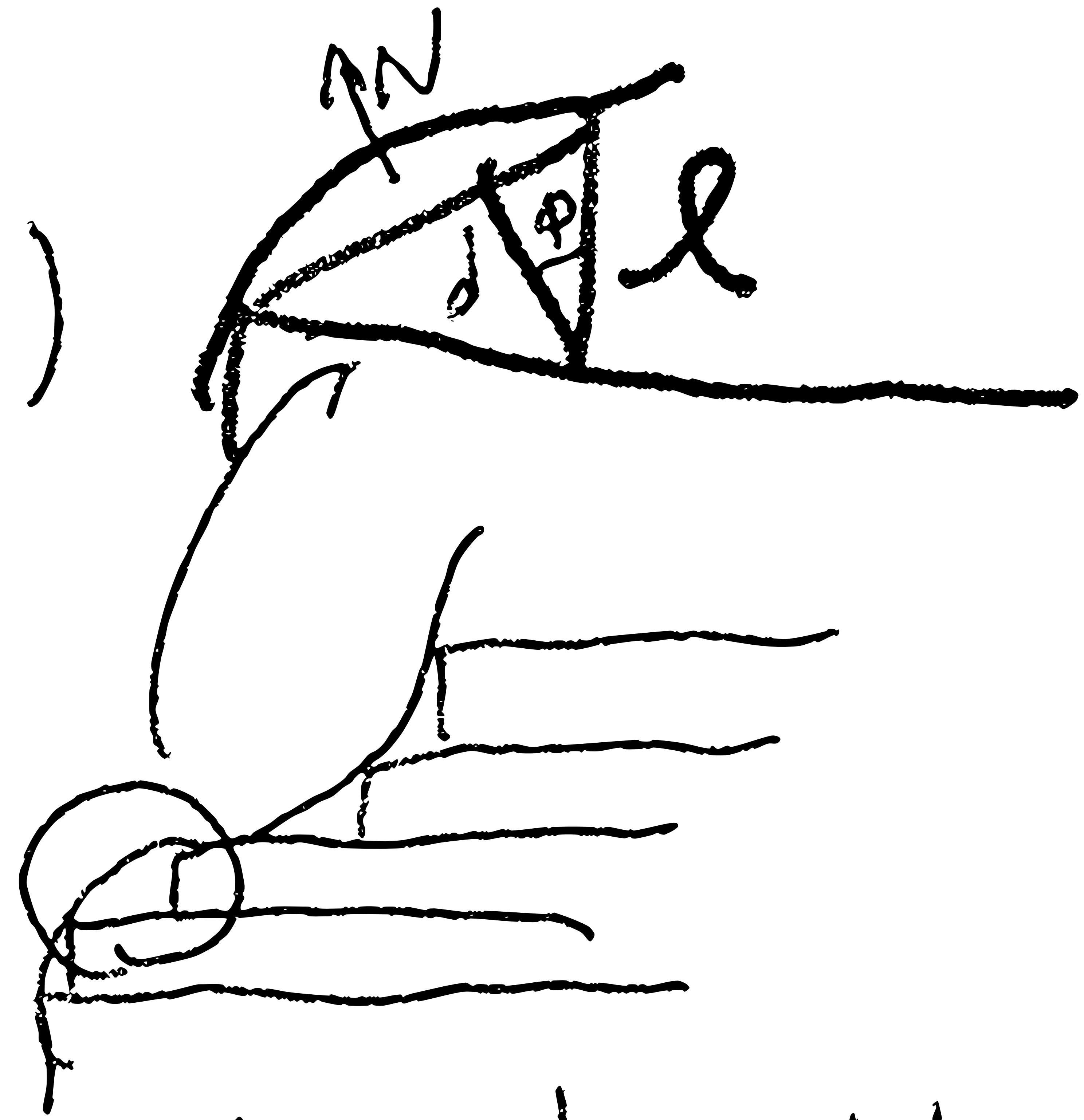
- Intersect each triangle with plane
- Store intersection segment

→ triangle mesh

↪ connect all of them for each z plane, we get contours

More advanced slicing

- Parallel computing (Octree ...)
- GPU
- Adaptive slicing
- multi directional slicing



$$l = \frac{d}{\sin\theta} = \frac{d}{N_z}$$

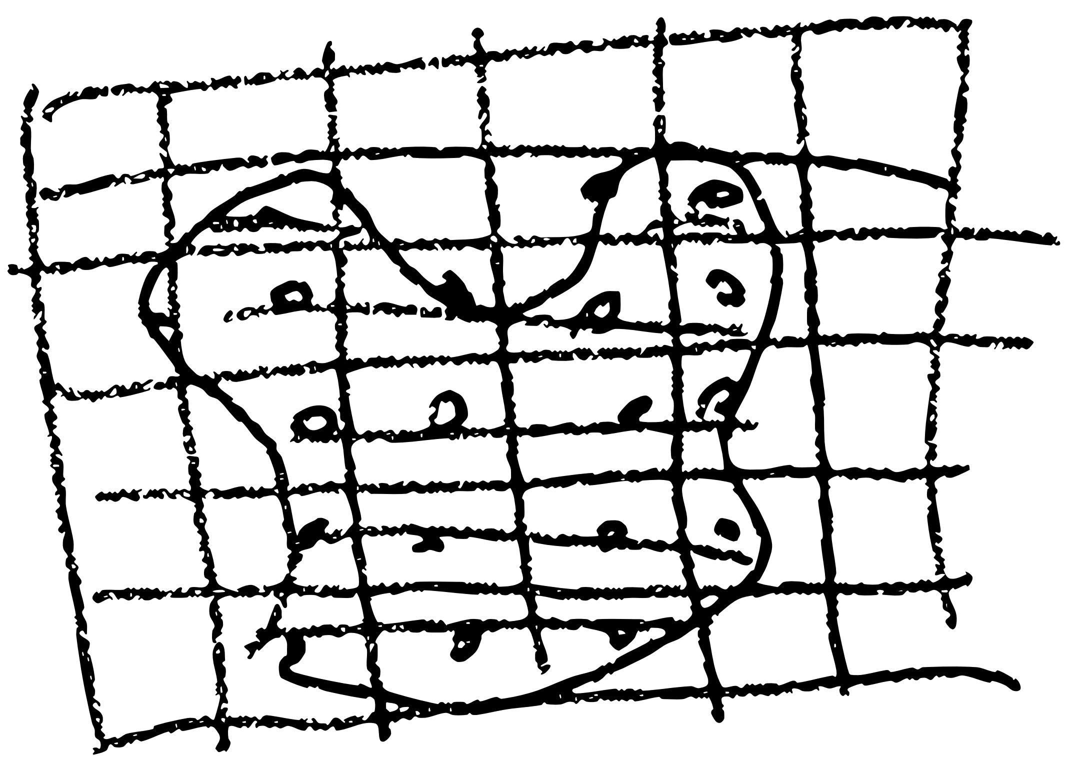
build layer thickness

take z comp. of normal

decompose model into components and optimize slicing for each of them

Path planning

- Trivial if layer is printed in one step (DLP)
- Employ a grid on the contour of the object

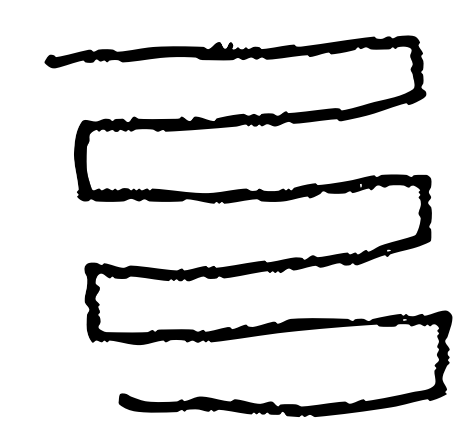


compute intersection intervals with model

then you can use a fill pattern:

- tri hatch

- stairwave



All this is then converted into code readable by the machine

For DLP type
PNG (raster file format)
describing each layer

For FDP G-code
(was born for milling machines)

Questions:

1) Everything: from the amount of support required to the mechanical properties of the object and print time

2) Optimize for support material

3) Where the support is connected to the object the quality is lower

4) Ray tracing

5) By optimizing it or using low volume support patterns

6) TODO

7) Naive Slicing: - n z plane
   - intersect with all triangles
   - join segments into contours for each z plane

8) Probably not touch the object with printhead?