Centro de Investigación
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CrossShade:
Shading Concept Sketches Using Cross-Section Curves

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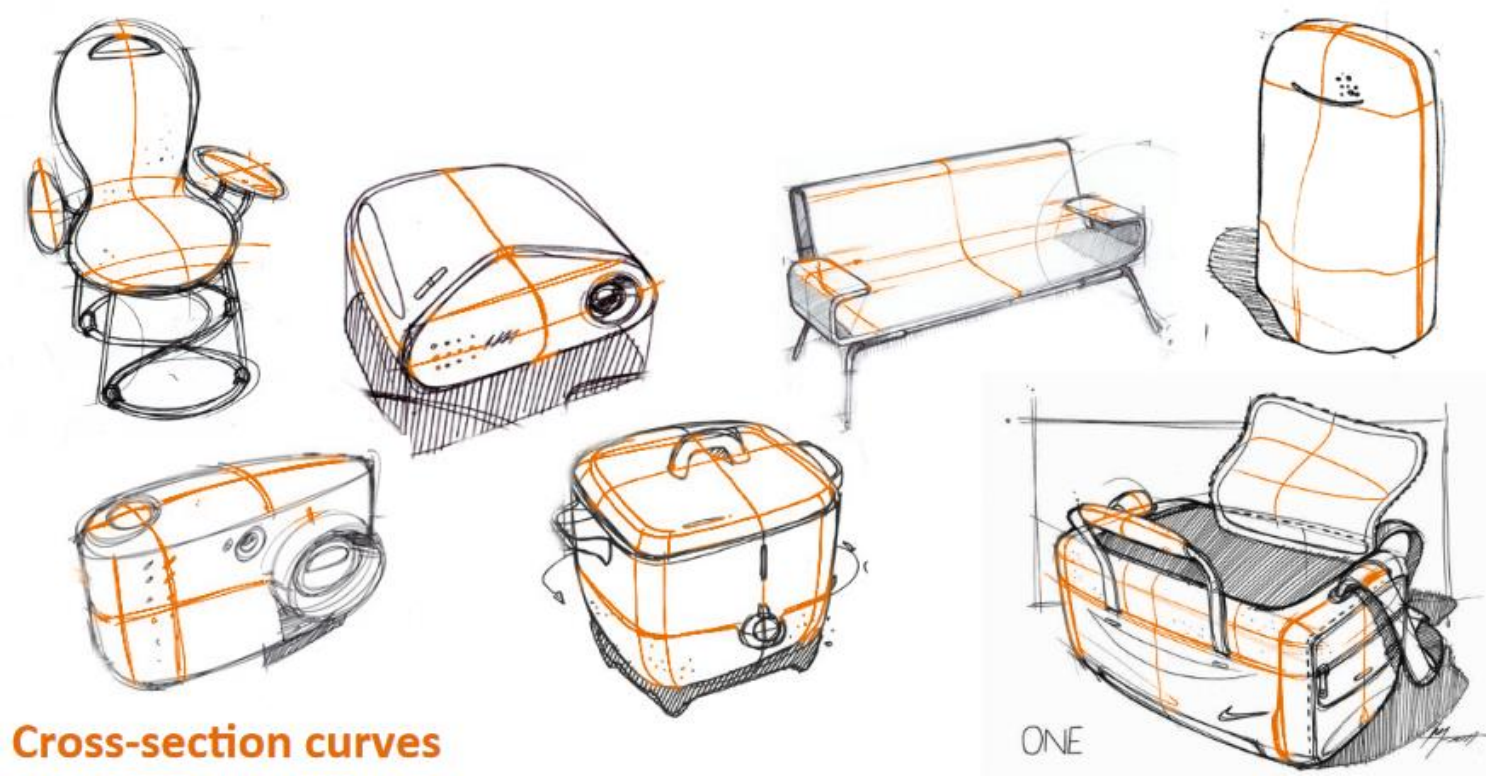
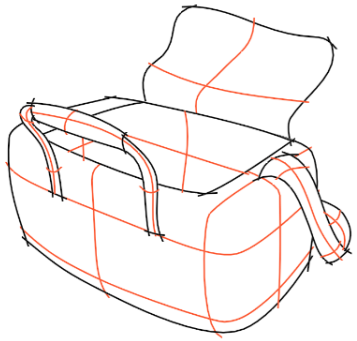
Overview

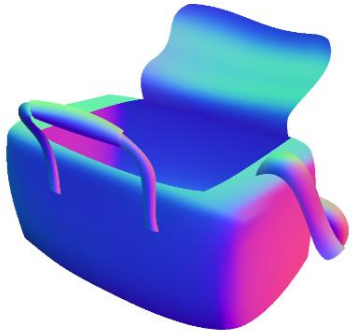


Pipeline

Start from a single sketch …



Estimate normals …



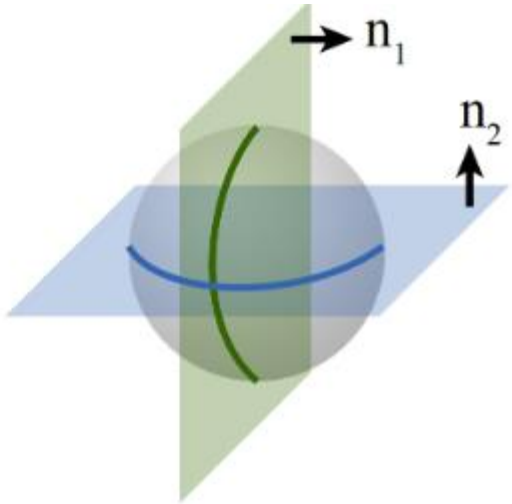
Compute shading!

CrossSection Properties

1. Orthogonal planes
2. Orthogonal tangents
3. Local geodesics
4. Minimal foreshorteing

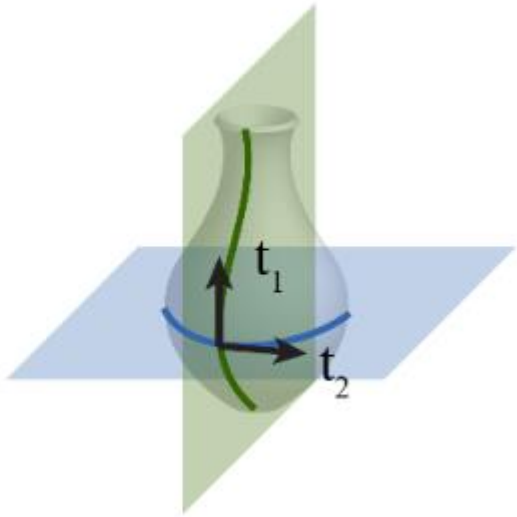
Orthogonal planes

$$\mathbf{n}_1 \cdot \mathbf{n}_2 = 0$$



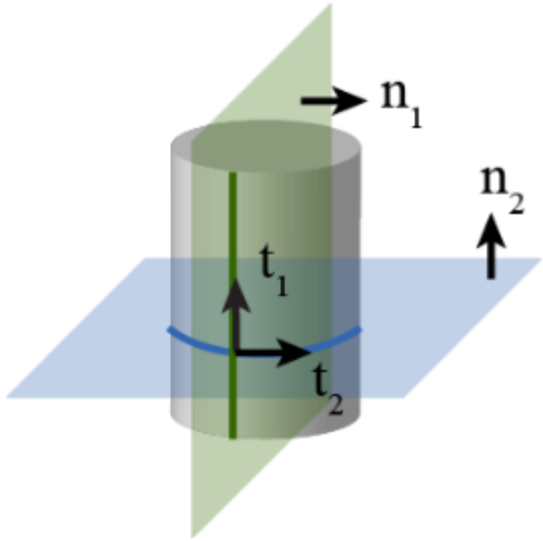
Orthogonal tangents

$$t_1 \cdot t_2 = 0$$



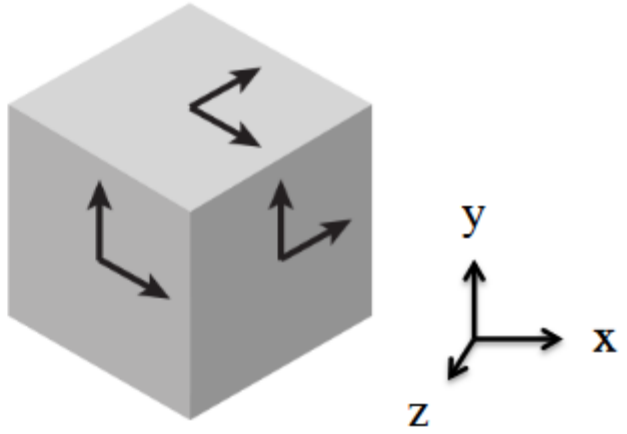
Local geodesics

$$t_1 \times n_2 = 0$$
$$t_2 \times n_1 = 0$$



Minimal foreshorteing

$$\sum (\mathbf{t}_1^z)^2 + (\mathbf{t}_2^z)^2$$



Algorithm - Constrained minimization

Minimization Function (weak properties)

$$\min_{\mathbf{n}_i} \sum_{ij} (\|\mathbf{t}_{ji} \times \mathbf{n}_i\|^2 + \|\mathbf{t}_{ij} \times \mathbf{n}_j\|^2) + (\mathbf{t}_{ij}^z)^2 + (\mathbf{t}_{ji}^z)^2$$

Inequality Constraints

$$-\epsilon \leq \mathbf{n}_i \cdot \mathbf{n}_j \leq \epsilon$$

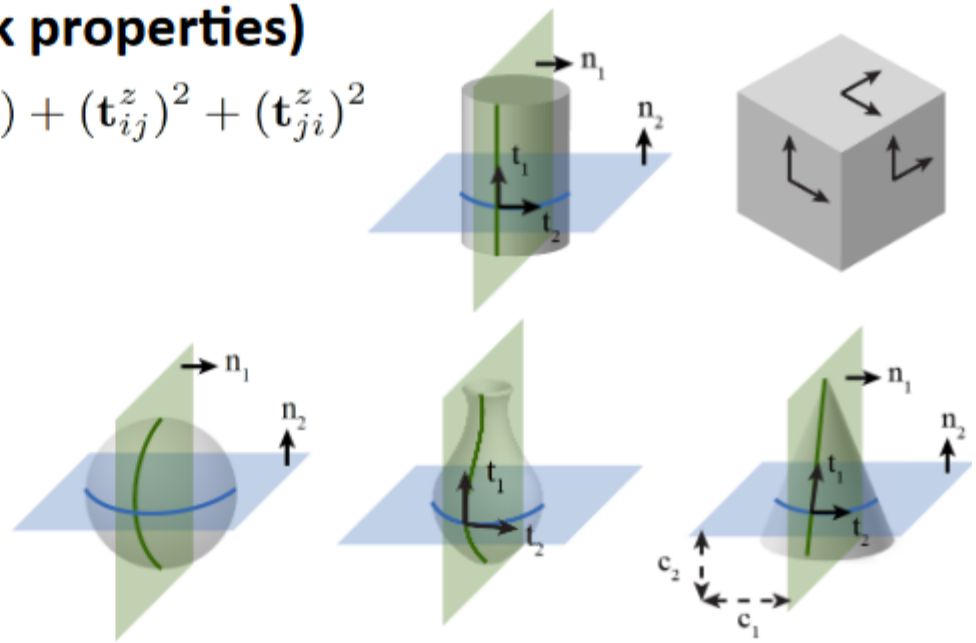
$$-\epsilon \leq \mathbf{t}_{ij} \cdot \mathbf{t}_{ji} \leq \epsilon$$

Hard Constraints

$$\mathbf{t}_{ij} \cdot \mathbf{n}_i = 0$$

$$\mathbf{x} \cdot \mathbf{n}_i + \mathbf{c}_i = 0$$

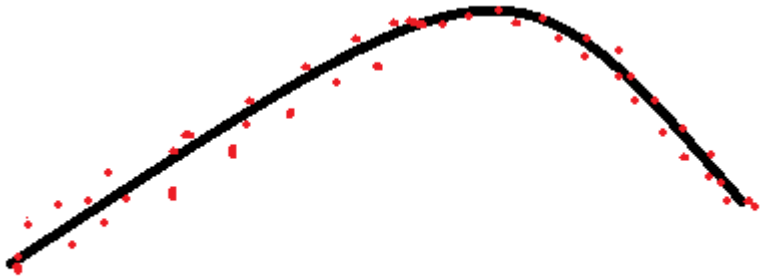
$$\mathbf{x} \cdot \mathbf{n}_j + \mathbf{c}_j = 0$$

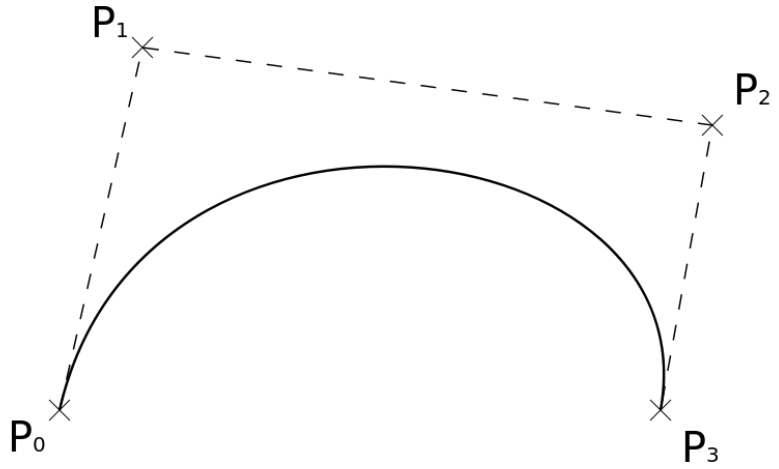


Estimate Normal

- Read Cross Sections Curves
- Solve Minimization Problem

Read Cross Sections Curves





$$\mathbf{B}(t) = \mathbf{P}_0(1-t)^3 + 3\mathbf{P}_1 t(1-t)^2 + 3\mathbf{P}_2 t^2(1-t) + \mathbf{P}_3 t^3 \ , t \in [0,1].$$

Solve Minimization Problem

Minimization Function (weak properties)

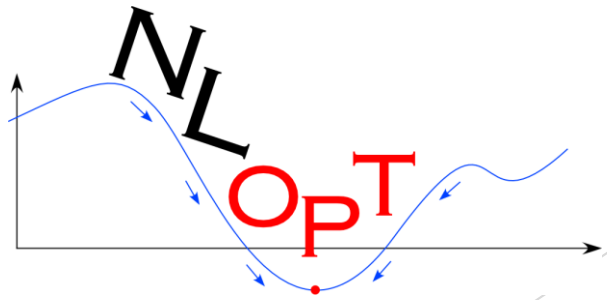
$$\min_{\mathbf{n}_i} \sum_{ij} (\|\mathbf{t}_{ji} \times \mathbf{n}_i\|^2 + \|\mathbf{t}_{ij} \times \mathbf{n}_j\|^2) + (\mathbf{t}_{ij}^z)^2 + (\mathbf{t}_{ji}^z)^2$$

Inequality Constraints

$$-\epsilon \leq \mathbf{n}_i \cdot \mathbf{n}_j \leq \epsilon$$
$$-\epsilon \leq \mathbf{t}_{ij} \cdot \mathbf{t}_{ji} \leq \epsilon$$

Hard Constraints

$$\mathbf{t}_{ij} \cdot \mathbf{n}_i = 0$$
$$\mathbf{x} \cdot \mathbf{n}_i + \mathbf{c}_i = 0$$
$$\mathbf{x} \cdot \mathbf{n}_j + \mathbf{c}_j = 0$$



Results

```
MinOptimize
run optimization
69.6429729323573
0 ( -0.776321291923523, 0.383692383766174, 0.500105261802673 )
1 ( -0.782151818275452, 0.423584252595901, 0.456962823867798 )
2 ( -0.0462705753743649, -0.798190116882324, 0.600626051425934 )
3 ( 0.584855139255524, 0.723092138767242, 0.367535501718521 )
tan 0 2( 0.0656202808022499, -0.739887714385986, 0.669522404670715 )
tan 2 0( 0.321990460157394, -0.581094801425934, -0.747429609298706 )
tan 0 3( -0.579387187957764, -0.746844112873077, -0.326396048069 )
tan 3 0( 0.0757069662213326, -0.499795198440552, 0.862828612327576 )
tan 1 2( -0.109132163226604, -0.815176963806152, 0.568838059902191 )
tan 2 1( -0.284269332885742, -0.565888404846191, -0.773925840854645 )
tan 1 3( -0.592472791671753, -0.732651472091675, -0.334959536790848 )
tan 3 1( -0.203397810459137, -0.30789703130722, 0.929423868656158 )
normCH 0 2( 0.943219006061554, 0.264949113130569, 0.200349226593971 )
normCH 0 3( -0.808453023433685, 0.475744783878326, 0.346511989831924 )
normCH 1 2( -0.954080283641815, 0.246497973799706, 0.170204192399979 )
normCH 1 3( -0.78455114364624, 0.619162738323212, 0.0334211140871048 )
```

Trabajo Futuro

Propagate all Cross Hair Normals over the entire sketch.