POINT NORMAL TRIANGLES

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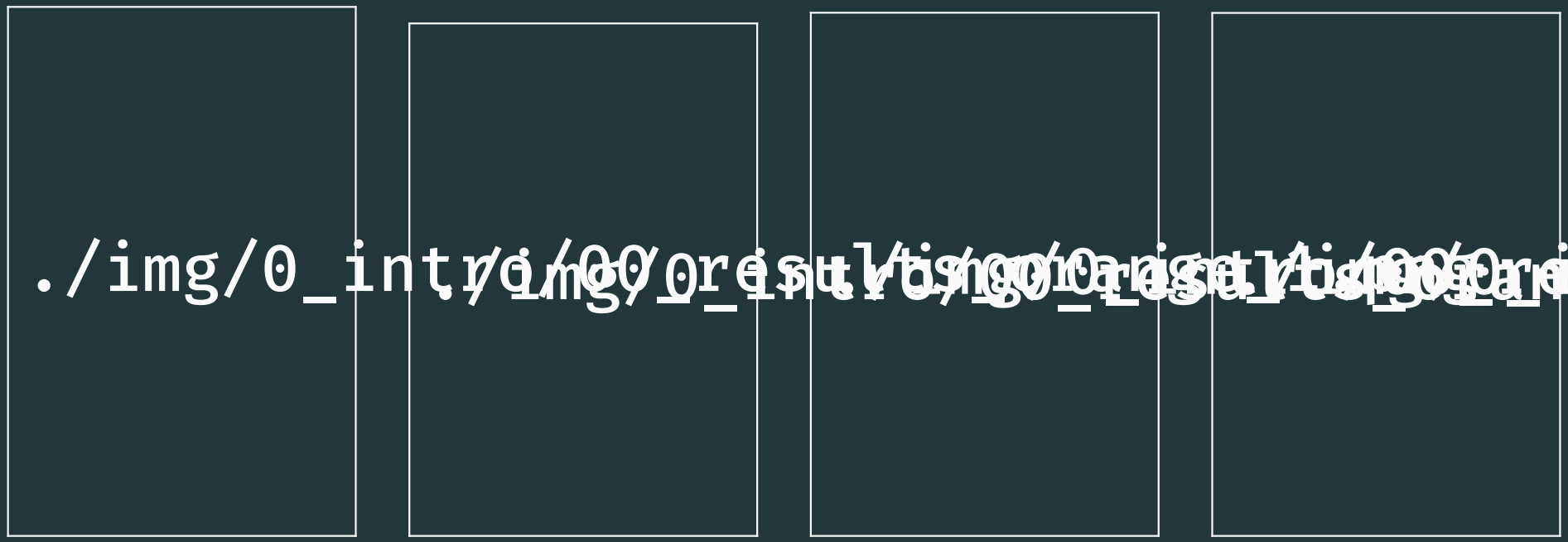
Advanced Computer Graphics



INPUT MESH GOURAUD PN GEOMETRY PN TRIANGLES

SINGLE PN TRIANGLE

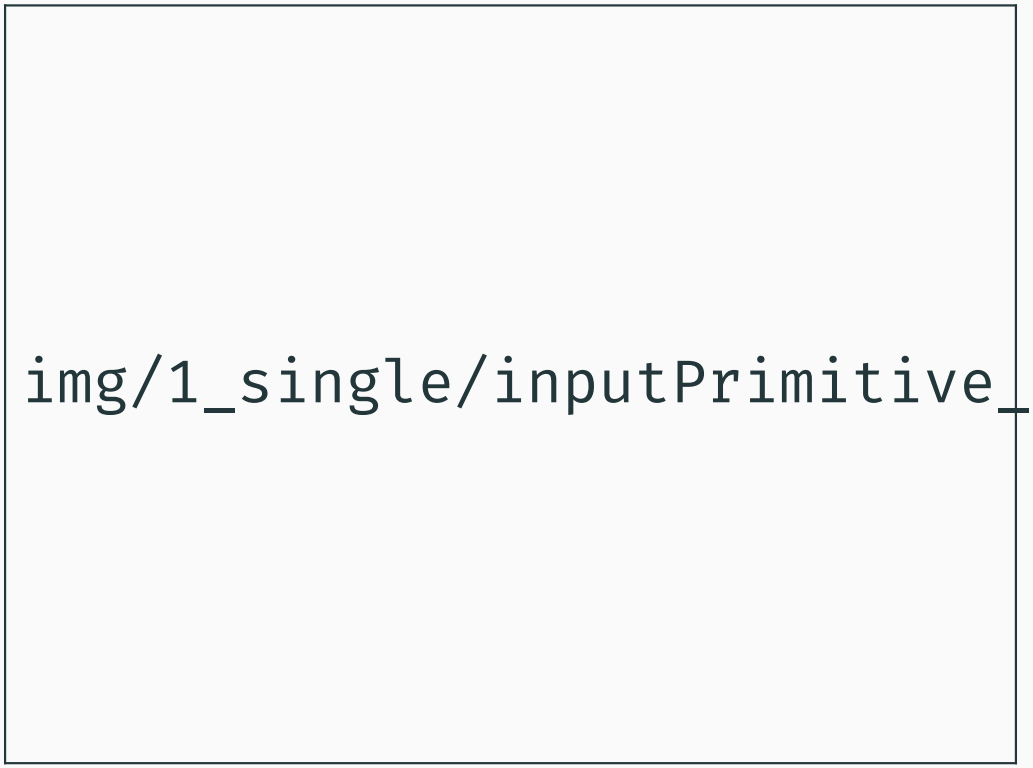
OVERVIEW

OVERVIEW

./img/1_single/recap_inputToGeom.png

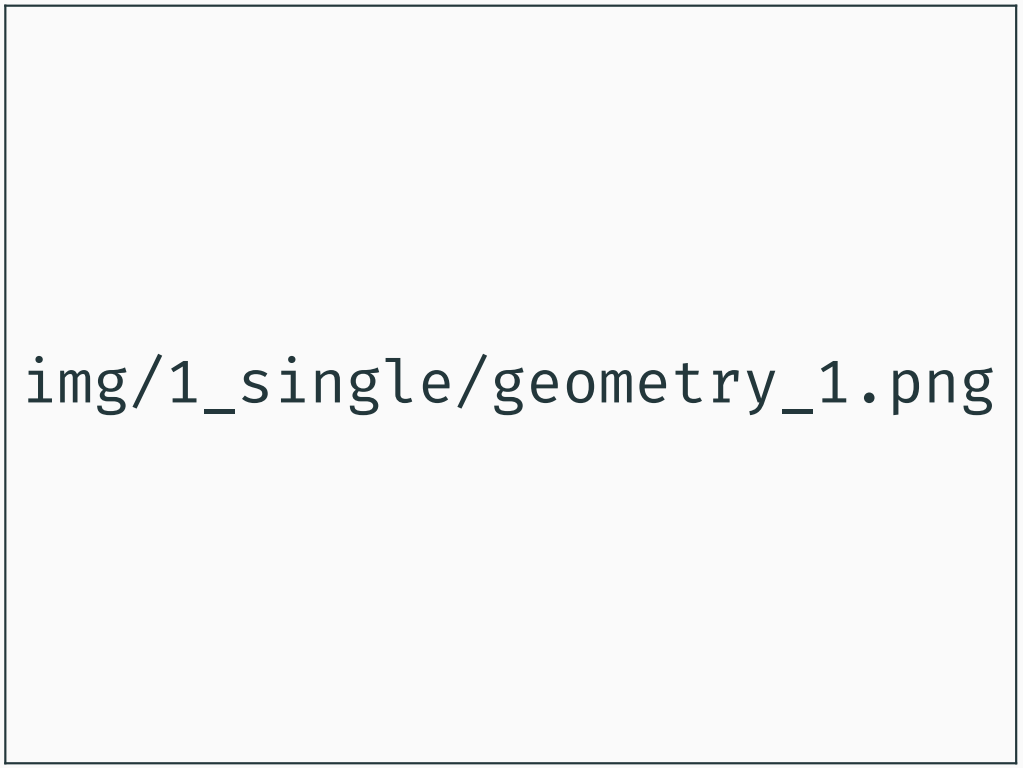
GEOMETRY

enhancement: emphasize vertices better



input primitive

GEOMETRY - VERTEX COEFFICIENTS



control net

$$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$$

$$b_{300} = P_1,$$

$$b_{030} = P_2,$$

$$b_{003} = P_3$$

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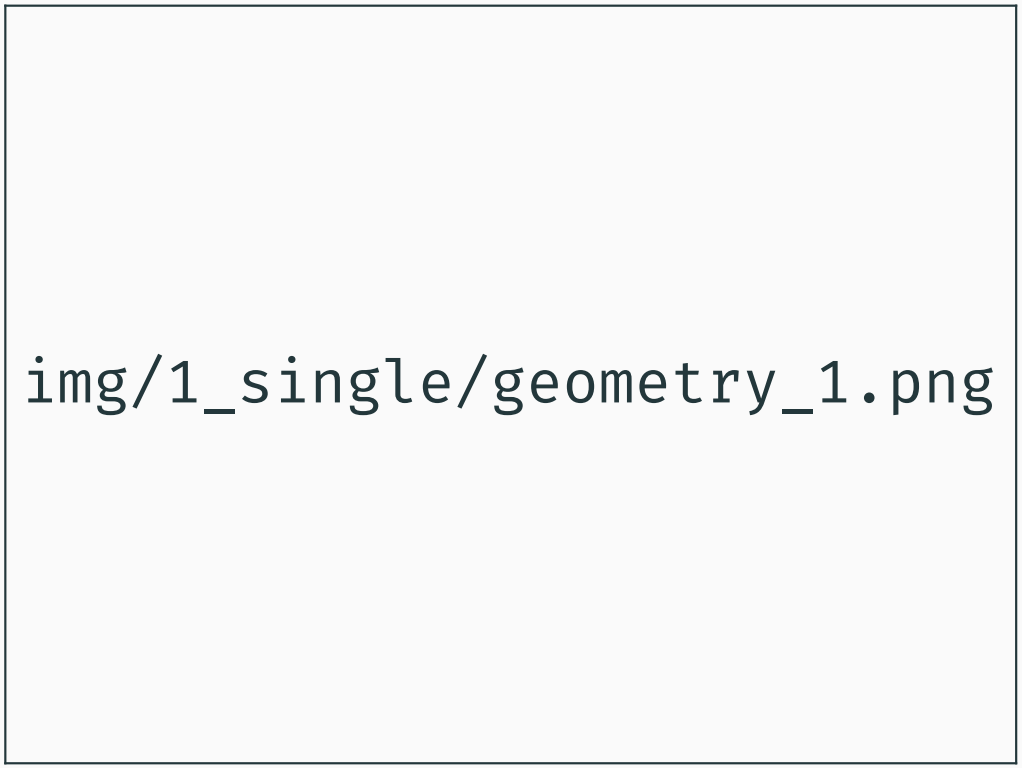

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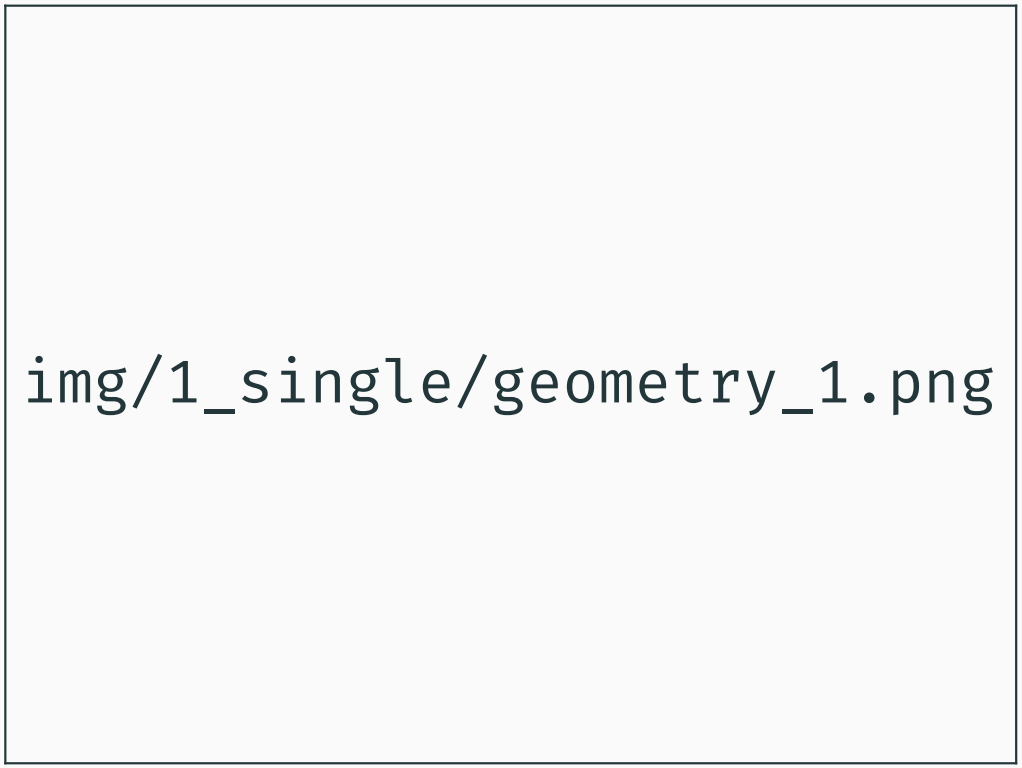

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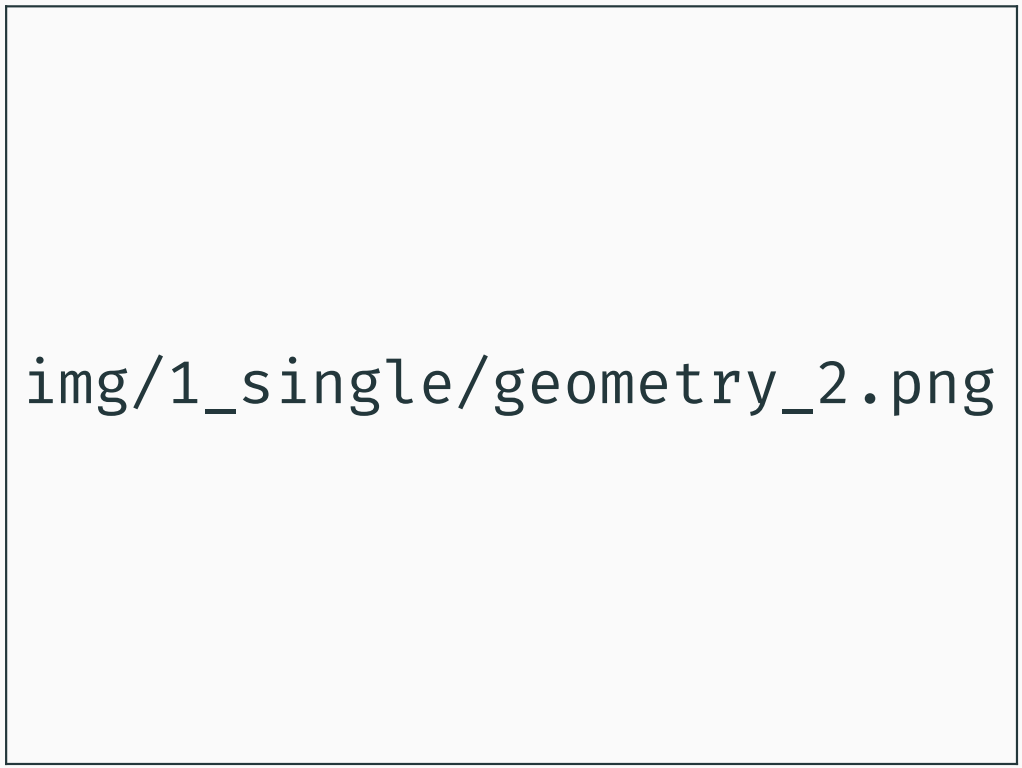
GEOMETRY - TANGENT COEFFICIENTS



normal projection

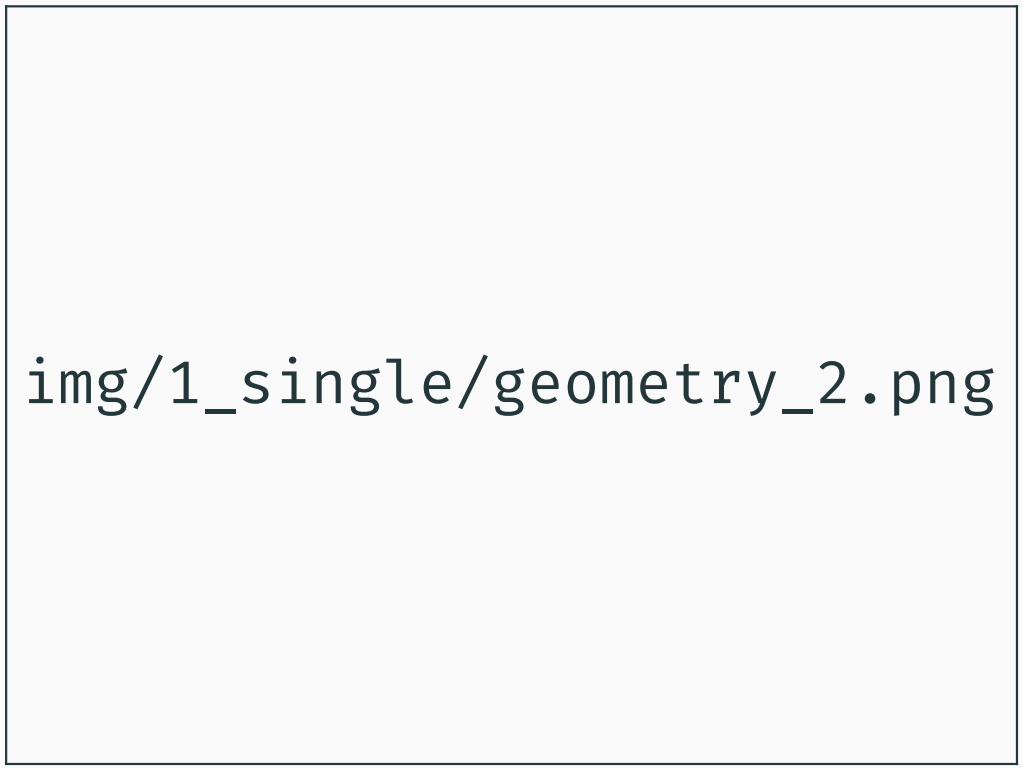
$$w_{ij} = (P_j - P_i) \cdot N_i \in \mathbb{R}$$

$$b_{210} = \frac{2P_1 + P_2 - w_{12}N_1}{3},$$

$$\vdots$$

$$b_{201} = \frac{2P_1 + P_3 - w_{13}N_1}{3}$$

GEOMETRY - TANGENT COEFFICIENTS



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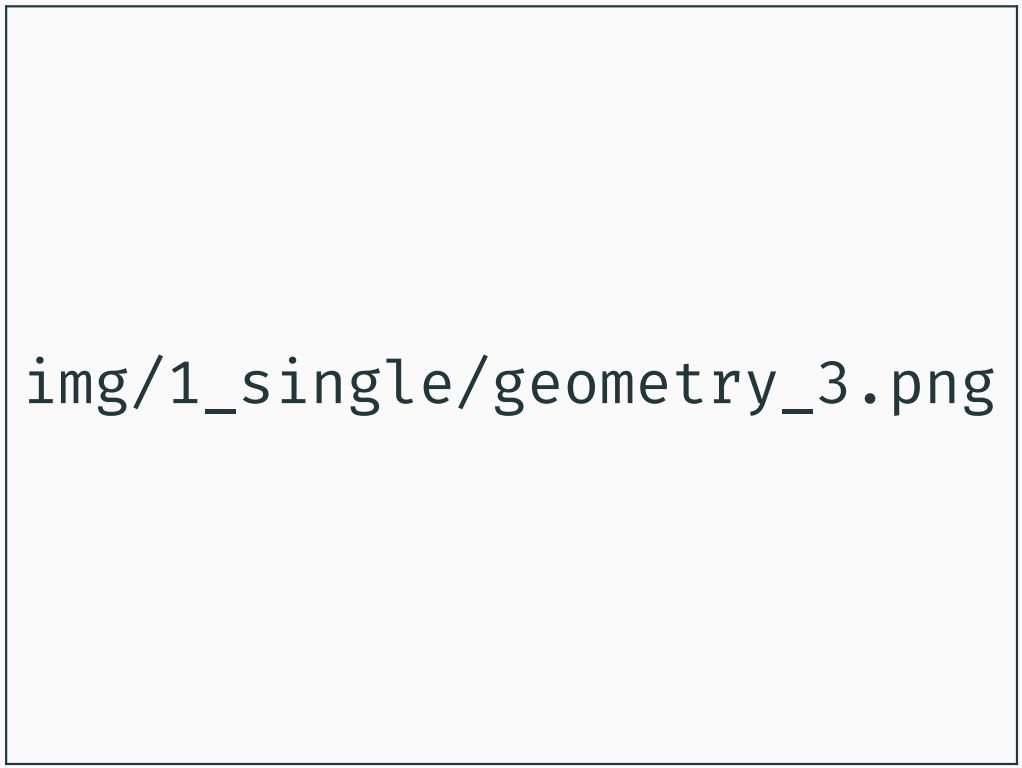
GEOMETRY - CENTER COEFFICIENT



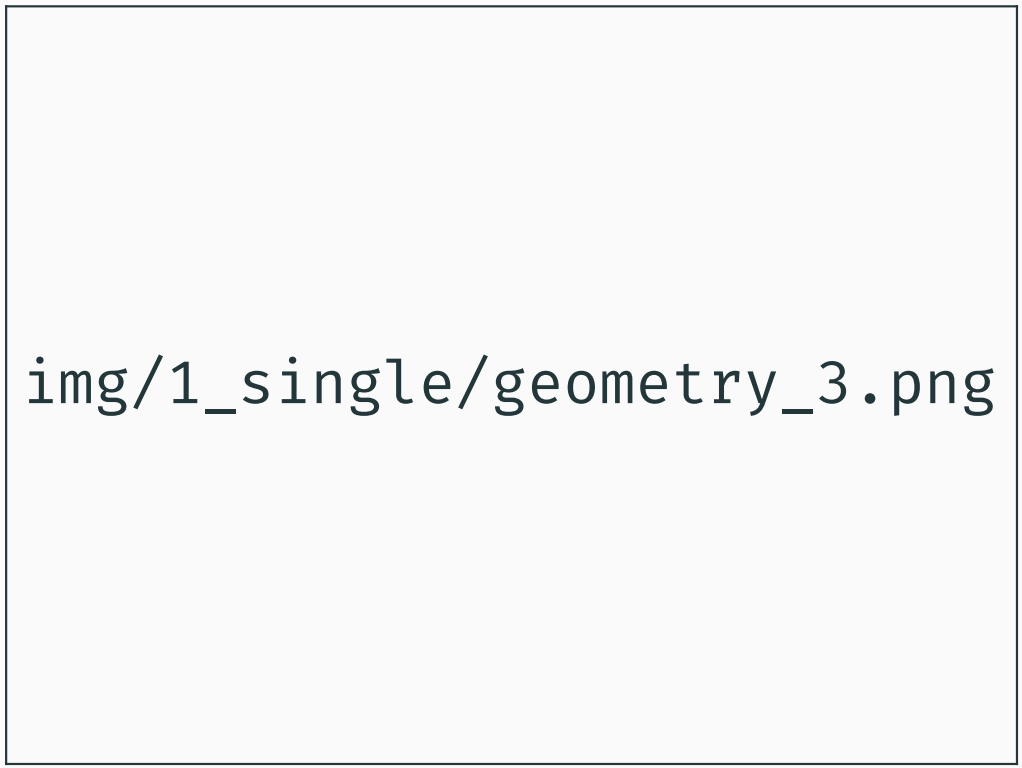
center control point

$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

$$V = (P_1 + P_2 + P_3)/3,$$

$$b_{111} = E + (E - V)/2$$

GEOMETRY - CENTER COEFFICIENT



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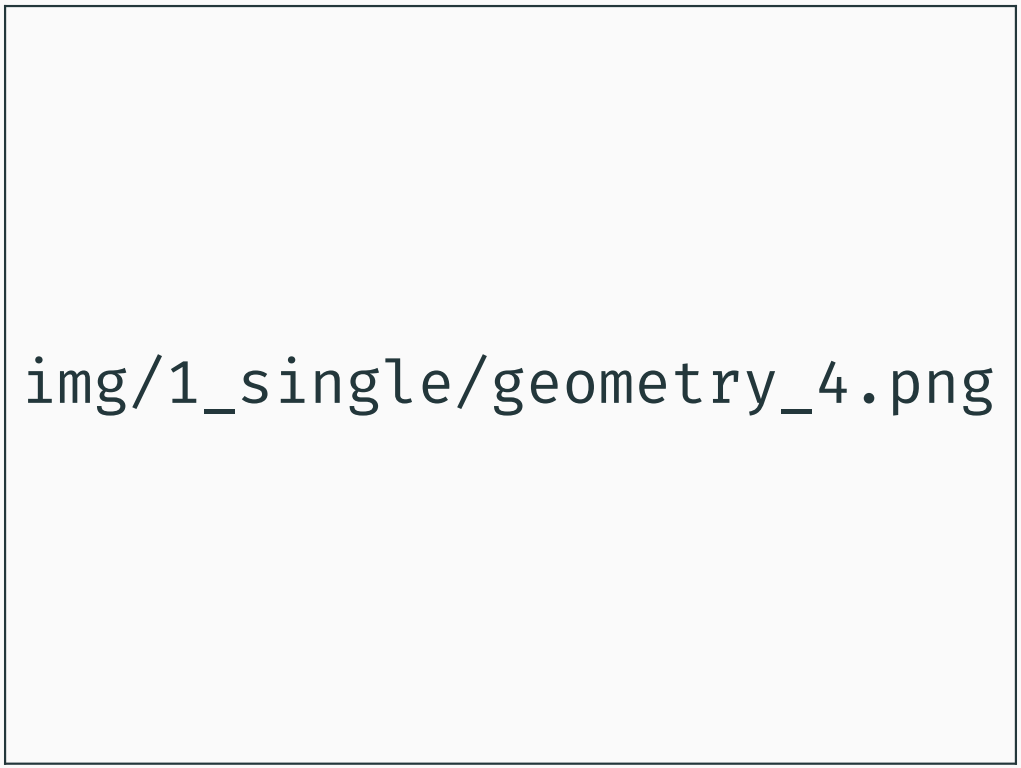
GEOMETRY - RESULT

enhancement: Set result slide to plain



OVERVIEW

CUBIC BÉZIER PATCH

$$w = 1 - u - v$$

$$u, v, w \geq 0$$

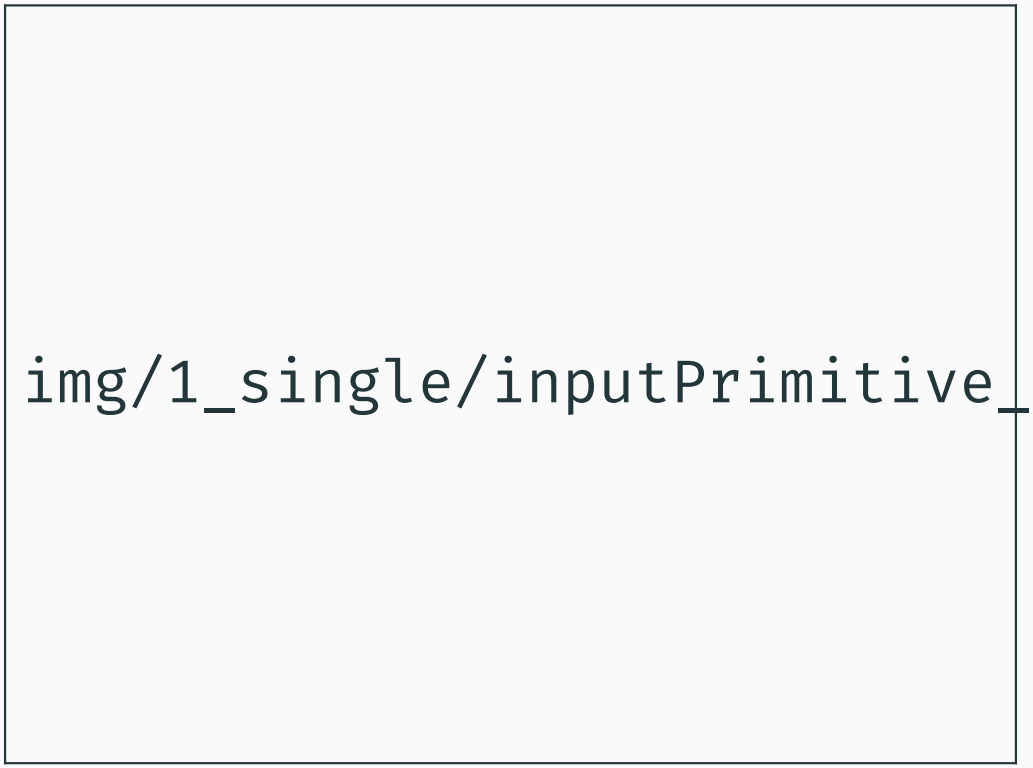
$$b(u, v) = \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k$$

OVERVIEW

./img/1_single/recap_inputToNormals.png

NORMALS

enhancement: emphasize normals more



input primitive

NORMALS - THEORY

linear

quadratic

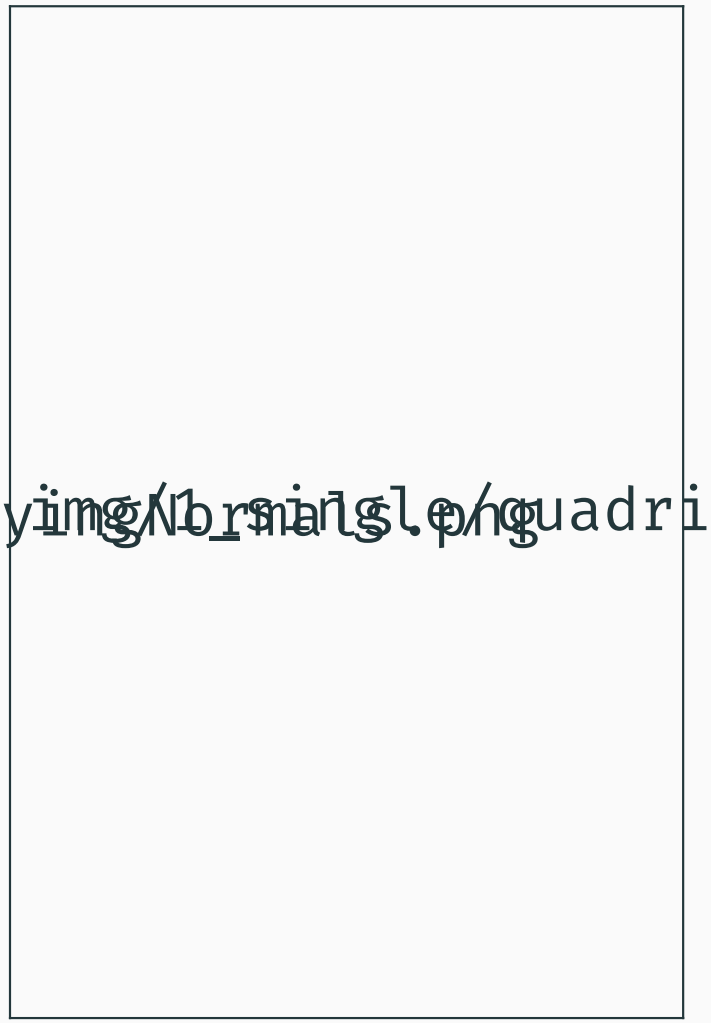
NORMALS - THEORY

linear

quadratic

NORMALS - EXAMPLE

linear



quadratic

NORMALS - THEORY

$$v_{ij} = 2\frac{(P_j - P_i)\cdot(N_i + N_j)}{(P_j - P_i)\cdot(P_j - P_i)} \in \mathbb{R}$$

$$h_{110} = N_1 + N2 - v_{12}(P_2 - P_1)$$

NORMALS - THEORY

$$v_{ij} = 2\frac{(P_j - P_i) \cdot (N_i + N_j)}{(P_j - P_i) \cdot (P_j - P_i)} \in \mathbb{R}$$

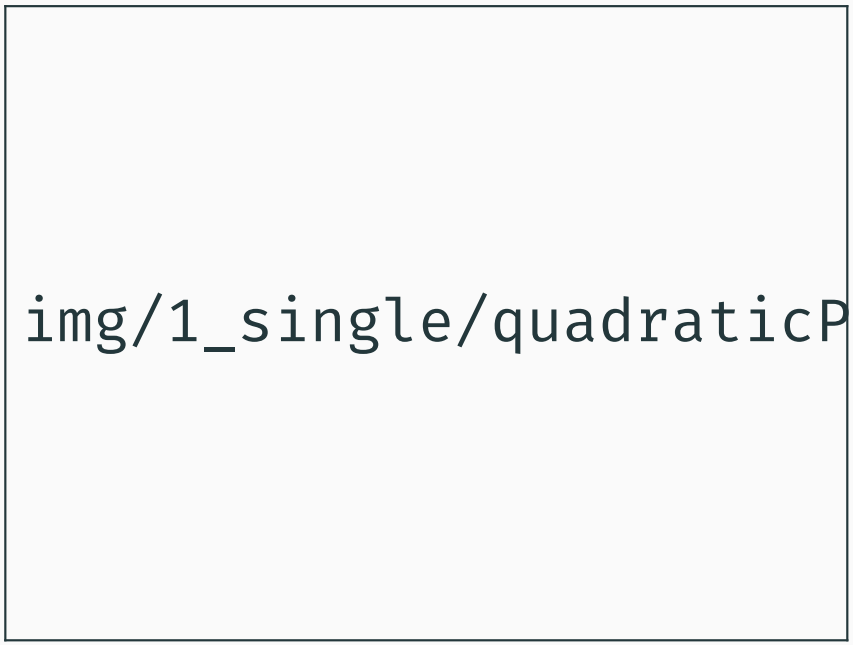
$$h_{110} = N_1 + N2 - v_{12}(P_2 - P_1)$$

NORMALS - RESULT

enhancement: Set result slide to plain

OVERVIEW

QUADRATIC PATCH



$$w = 1 - u - v$$

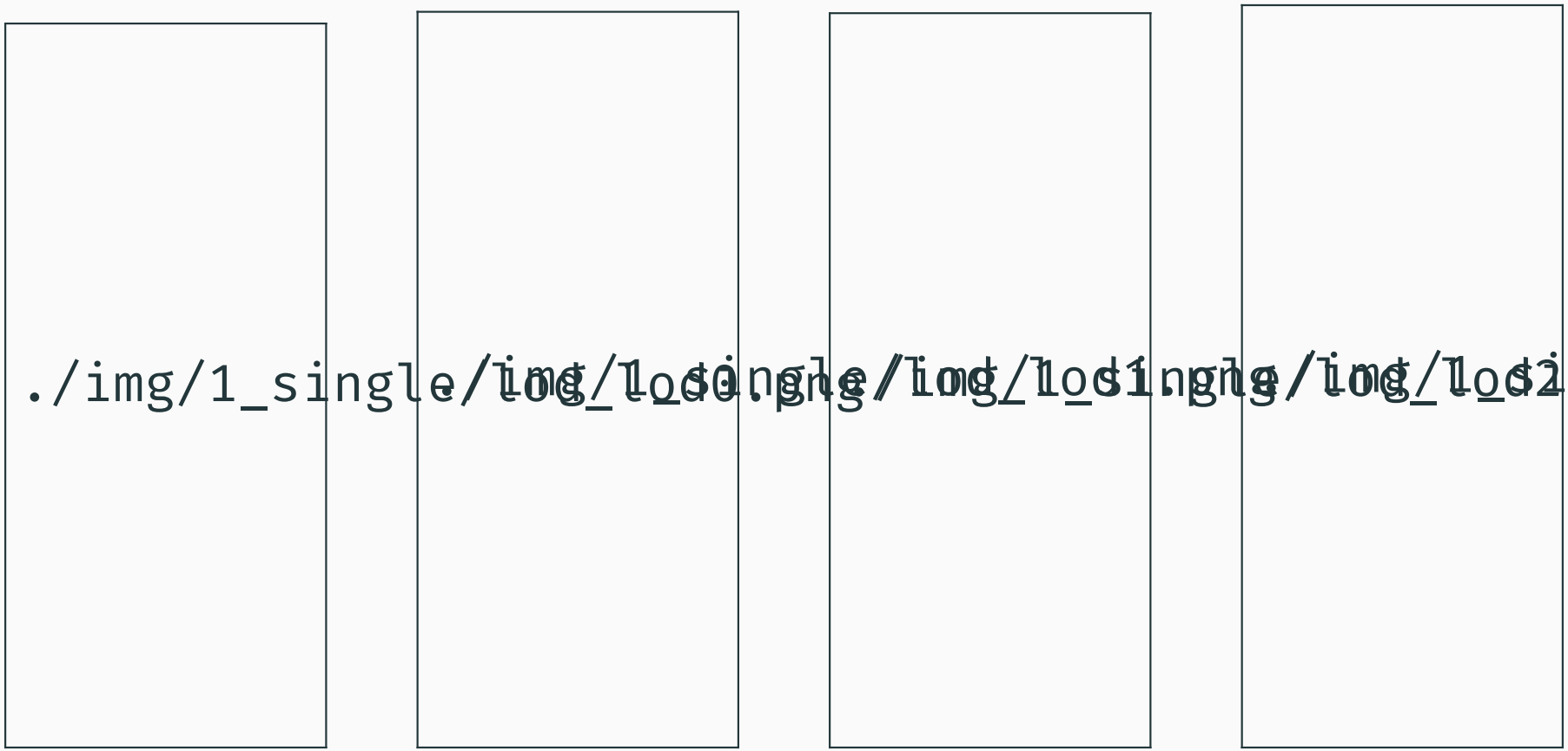
$$u, v, w \geq 0$$

$$n(u,v) = \sum_{i+j+k=2} n_{ijk} u^i v^j w^k$$

LEVEL OF DETAIL

(u, v, w)

LEVEL OF DETAIL



OVERVIEW

A TRIANGLE MESH

PROPERTIES

"PN triangles should not deviate too much from the original triangle to preserve the shape and avoid interference with other curved triangles." [1]

[1] Vlachos et al.

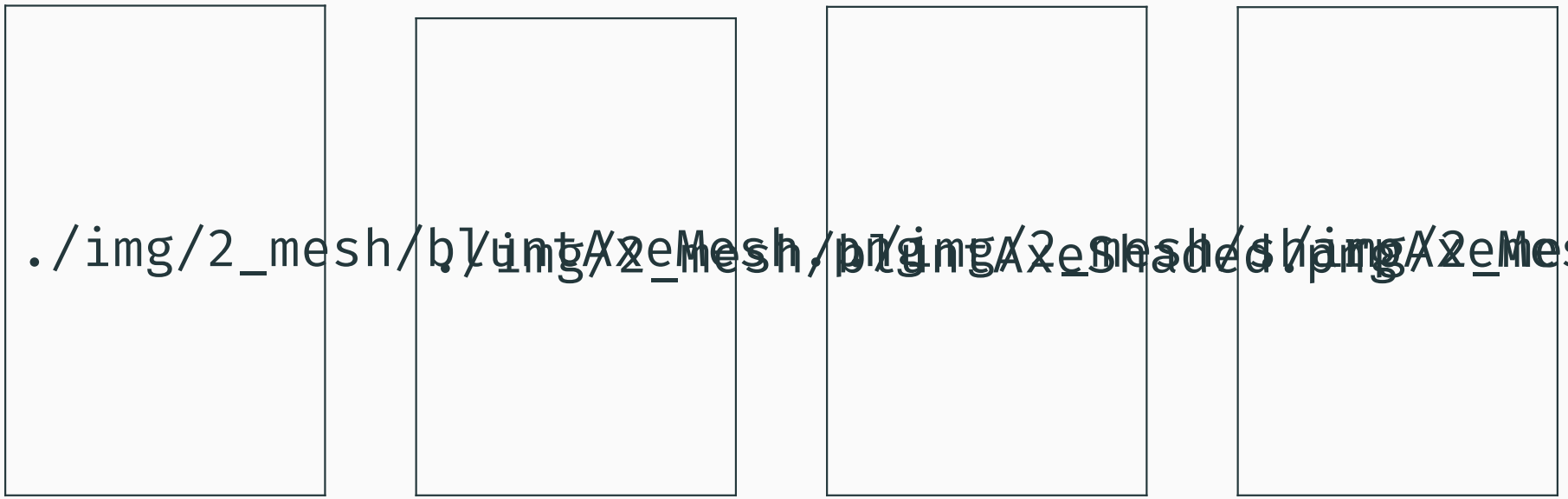
CONTINUITY

PN triangles have:[2]

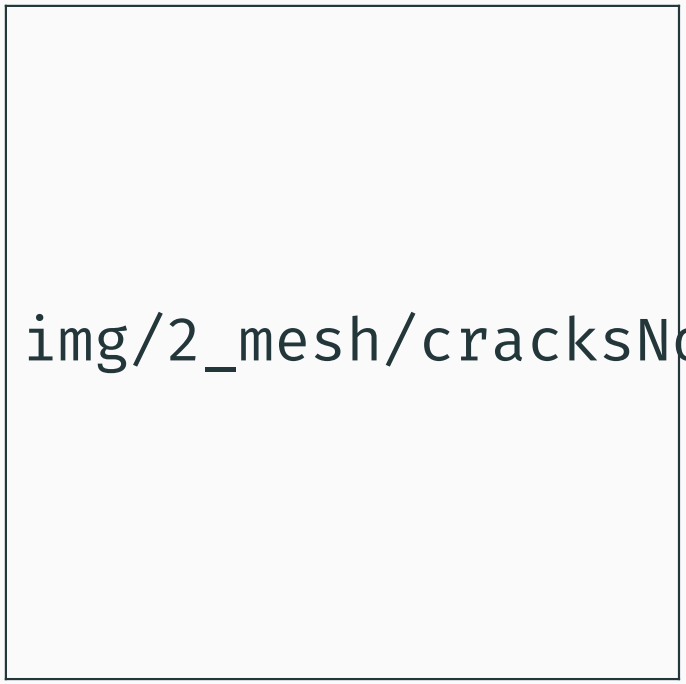
- C^1 continuity in the vertex points
- C^0 continuity along the edges
- C^∞ everywhere else

[2] Jiao and Alexander

SHARP EDGES


./img/2_mesh/bluntAxeMesh.png
./img/2_mesh/sharpAxeMesh.png
mesh
blunt
mesh
sharp

SEPARATE NORMALS



normals

cracks

GRAPHICS PIPELINE

HARDWARE - PIPELINES

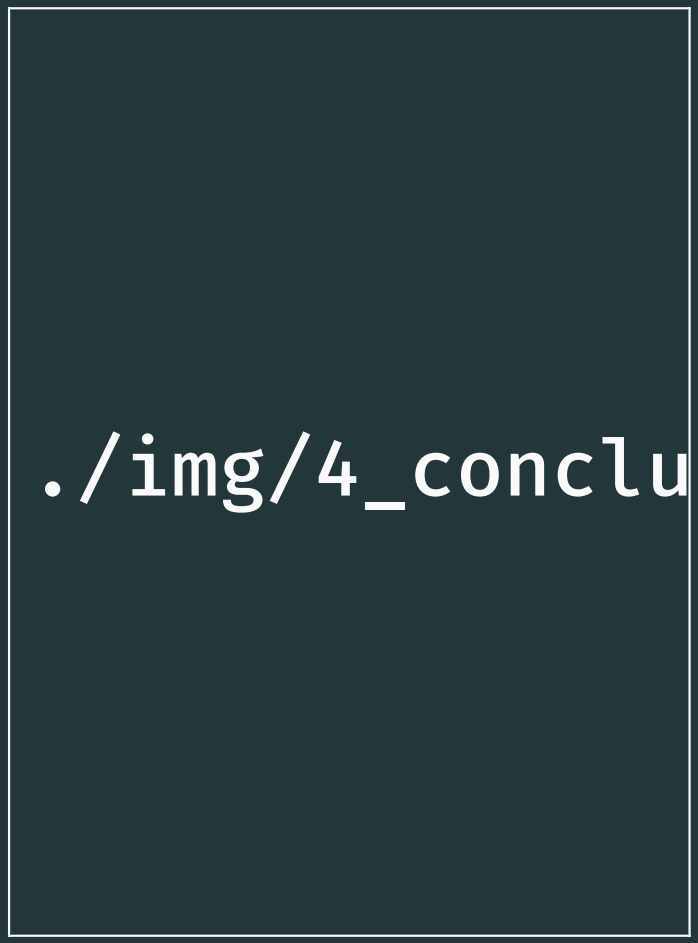
2001

2015

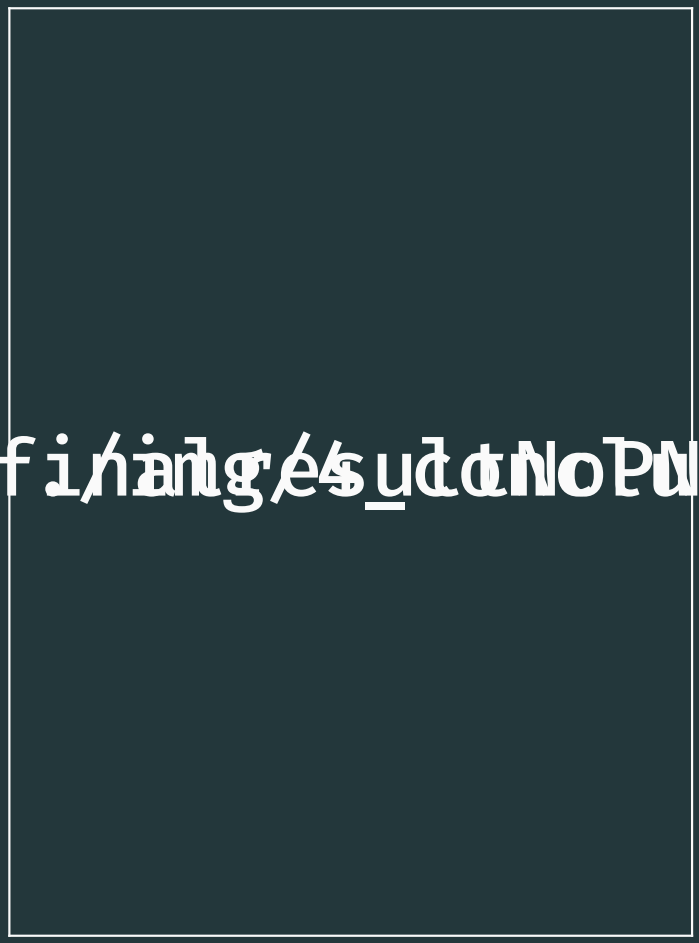
HARDWARE - PIPELINES

2001

2015

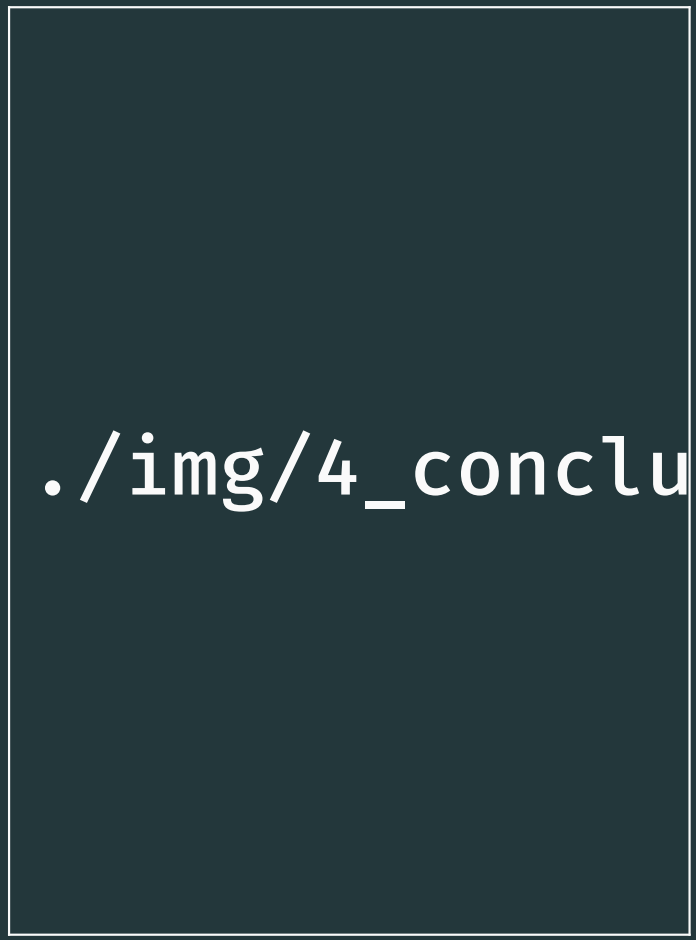


TRIANGLES

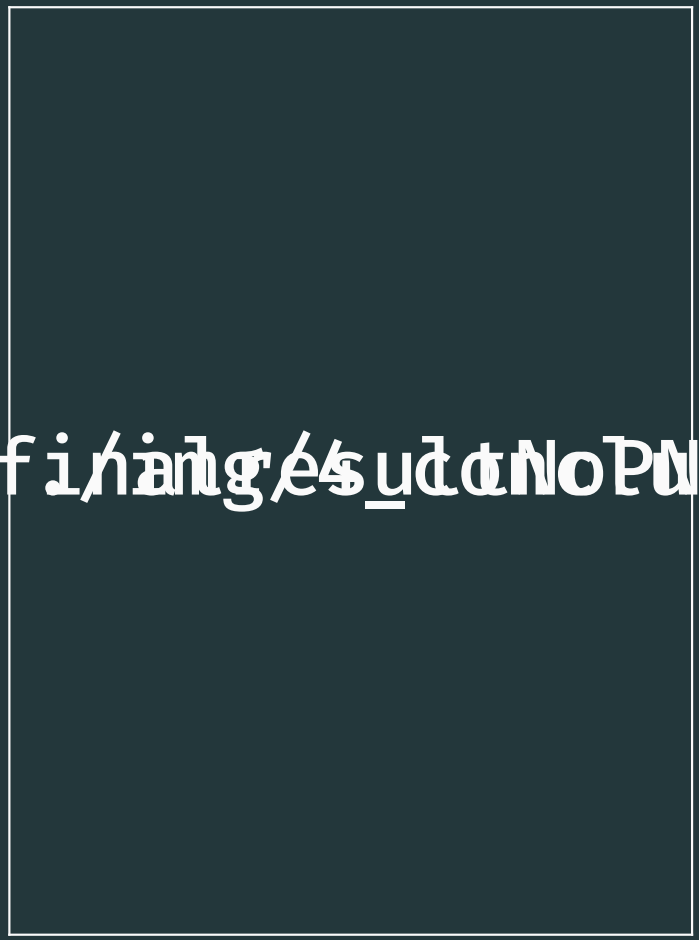


PN TRIANGLES

QUESTIONS?



TRIANGLES



PN TRIANGLES

REFERENCES

beamer_manual.pdf

Xiangmin Jiao and Philip J Alexander. “Parallel feature-preserving mesh smoothing”. In: *Computational Science and Its Applications–ICCSA 2005*. Springer, 2005, pp. 1180–1189.

beamer_manual.pdf

Jeremiah J. Kipgard. *Crack-free point-normal triangles using adjacent edge normals*. 2010.

beamer_manual.pdf

Alex Vlachos et al. “Curved PN triangles”. In: *Proceedings of the 2001 symposium on Interactive 3D graphics*. ACM. 2001, pp. 159–166.