

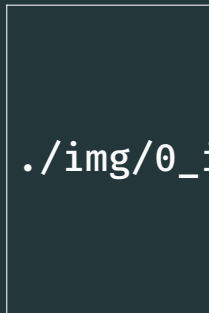
# POINT NORMAL TRIANGLES

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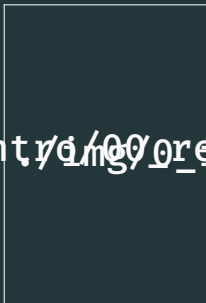
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Advanced Computer Graphics



INPUT MESH



GOURAUD



PN GEOMETRY



PN TRIANGLES

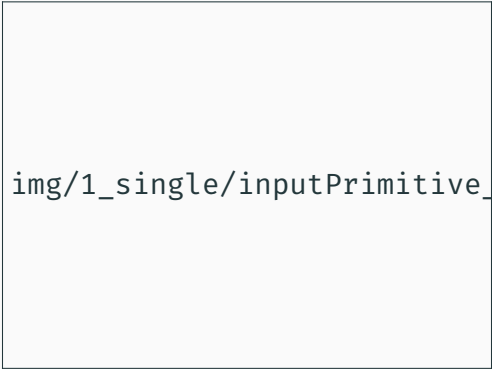
## SINGLE PN TRIANGLE

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# OVERVIEW

`./img/1_single/recap_geometry.png`

From input to geometry control net



```
img/1_single/inputPrimitive_emphGeometry.p
```

Input primitive

# GEOMETRY - VERTEX COEFFICIENTS



img/1\_single/geometry\_1.png

Control net

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

$$b_{300} = P_1,$$

$$b_{030} = P_2,$$

$$b_{003} = P_3$$



img/1\_single/geometry\_1.png

Control net

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

$$b_{300} = P_1,$$

$$b_{030} = P_2,$$

$$b_{003} = P_3$$



img/1\_single/geometry\_1.png

Control net

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

$$b_{300} = P_1,$$

$$b_{030} = P_2,$$

$$b_{003} = P_3$$





img/1\_single/geometry\_2.png

Normal projection

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

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

$$\vdots$$

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



img/1\_single/geometry\_2.png

Normal projection

$$\begin{aligned}w_{ij} &= (P_j - P_i) \cdot N_i \in \mathbb{R} \\b_{210} &= \frac{2P_1 + P_2 - w_{12}N_1}{3}, \\&\vdots \\b_{201} &= \frac{2P_1 + P_3 - w_{13}N_1}{3}\end{aligned}$$

## GEOMETRY - CENTER COEFFICIENT



img/1\_single/geometry\_3.png

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



img/1\_single/geometry\_3.png

Center control point

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

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

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

with control net point to curve (shading)



`img/1_single/geometry_4.png`

# OVERVIEW

```
./img/1_single/recap_result.png
```

# CUBIC PATCH

$b : \mathbb{R}^2 \rightarrow \mathbb{R}^3$ , for  $w = 1 - u - v$ ,  $u, v, w \geq 0$

$$\begin{aligned} b(u, v) &= \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k \\ &= b_{300} w^3 + b_{030} u^3 + b_{003} v^3 \\ &\quad + b_{210} 3w^2 u + b_{120} 3wu^2 + b_{201} 3w^2 v \\ &\quad + b_{021} 3u^2 v + b_{102} 3wv^2 + b_{012} 3uv^2 \\ &\quad + b_{111} 6wuv. \end{aligned}$$

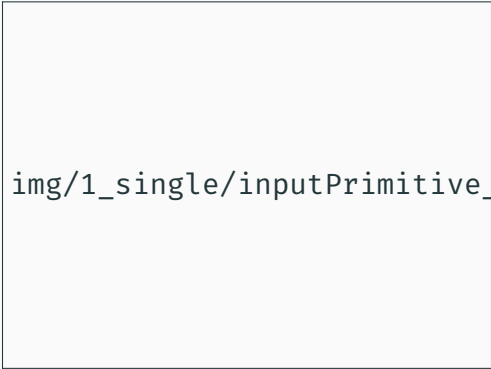
# OVERVIEW

`./img/1_single/recap_normals.png`



# NORMALS

from input to more normals



`img/1_single/inputPrimitive_emphNormal.png`

Input primitive

# NORMALS - THEORY

Why do we want to compute these normals?

img/1\_single/linearVsQuadraticNormals\_linear

Linear

Quadratic

# NORMALS - THEORY

Why do we want to compute these normals?

`img/1_single/linearVsQuadraticNormals_linear`

Linear

`img/1_single/linearVsQuadraticNormals_quadratic`

Quadratic

# NORMALS - EXAMPLE



Linear



Quadratic

# NORMALS - THEORY

How to compute them

img/1\_single/computingNormals.png

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

# NORMALS - THEORY

How to compute them

img/1\_single/computingNormals.png

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



`img/1_single/normals.png`

# OVERVIEW

`./img/1_single/recap_result.png`



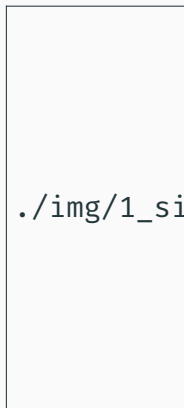
# QUADRATIC PATCH

$$n : \mathbb{R}^2 \rightarrow \mathbb{R}^3, \text{ for } w = 1 - u - v, u, v, w \geq 0$$

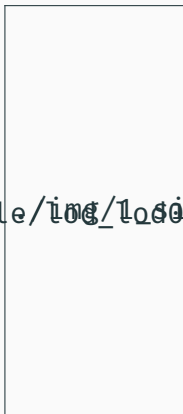
$$\begin{aligned} n(u, v) &= \sum_{i+j+k=2} n_{ijk} u^i v^j w^k \\ &= n_{200} w^2 + n_{020} u^2 + n_{002} v^2 \\ &\quad + n_{110} wu + n_{011} uv + n_{101} wv \end{aligned}$$

# LEVEL OF DETAIL

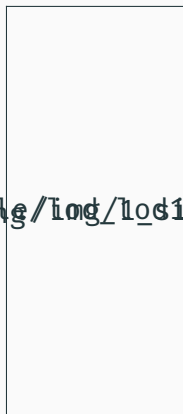
LOD verhaal



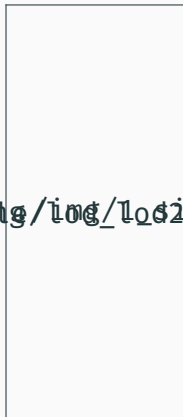
0



1



2



3

# OVERVIEW

`./img/1_single/recap_quadraticVsCubicPatch.png`

## A TRIANGLE MESH

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# PROPERTIES

Shared normals + [Thales of Milet, 500 BC]?



# SHARP EDGES

Sharp edges

# GRAPHICS PIPELINE

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Waarom waren PN triangles hip in 2001? Plus pipeline

Hoe zou je het nu kunnen implementeren? Plus pipeline

## CONCLUSION

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FIN.

Questions?

## REFERENCES

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beamer presentation  
Alex Martelli et al. "Quilfed PN triangles". In: *Proceedings of the 2001 symposium on Interactive 3D graphics*. ACM. 2001, pp. 159–166.