UNIVERSITÀ DEGLI STUDI DI MILANO
FACOLTÀ DI SCIENZE E TECNOLOGIE
Corso di Laurea Magistrale in Informatica
Anno Accademico 2022/2023

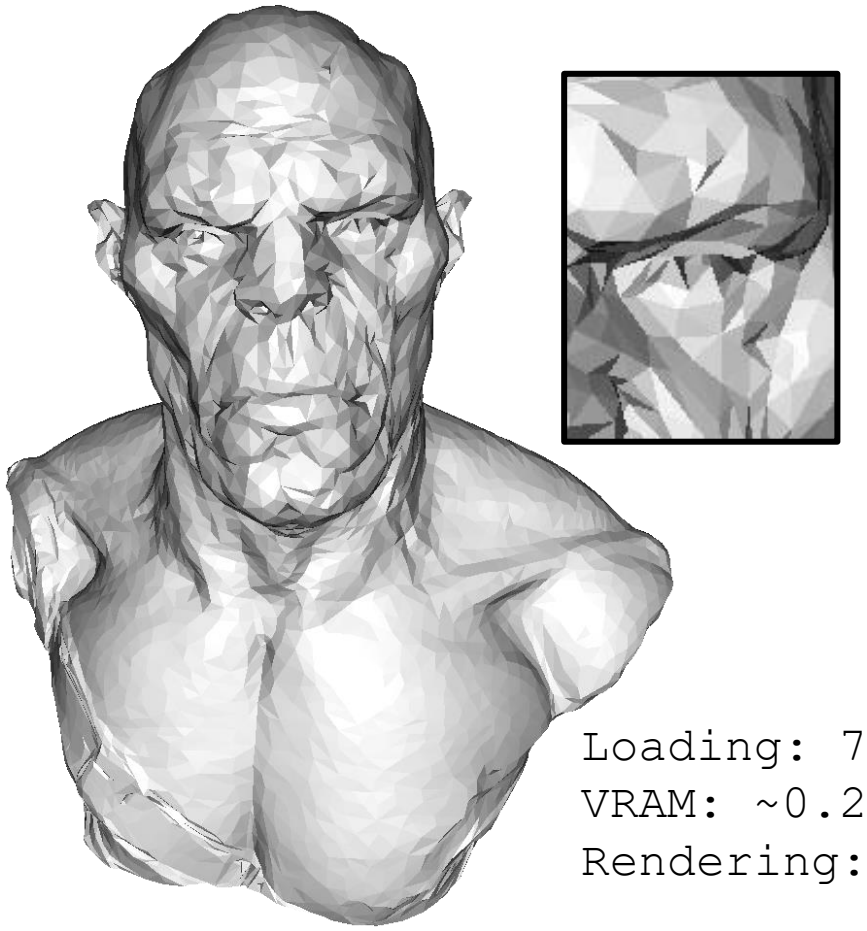
Efficient representations of high-resolution polygonal surfaces: adding anisotropy control to the Micro-meshes schema

Relatore
Marco Tarini

Candidato
Manuel Pagliuca

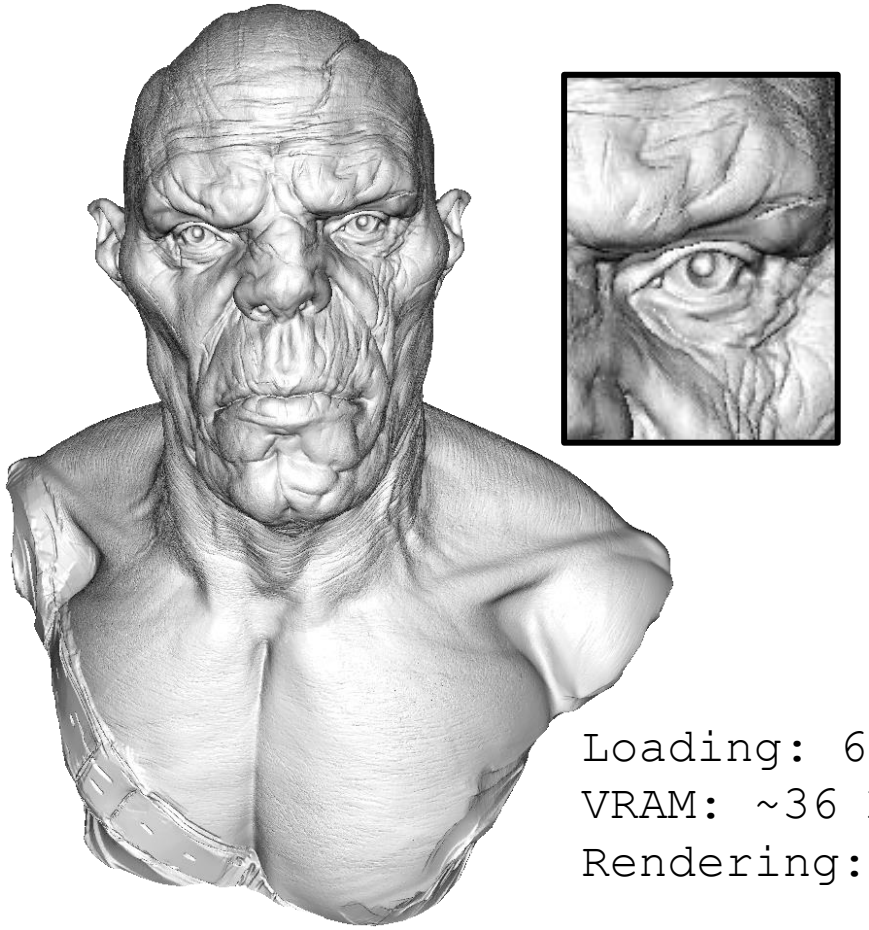
Premessa – Un trade-off della CG

Resolution: 15K △



Loading: 72 msec
VRAM: ~0.27 MB
Rendering: 0.15 µsec

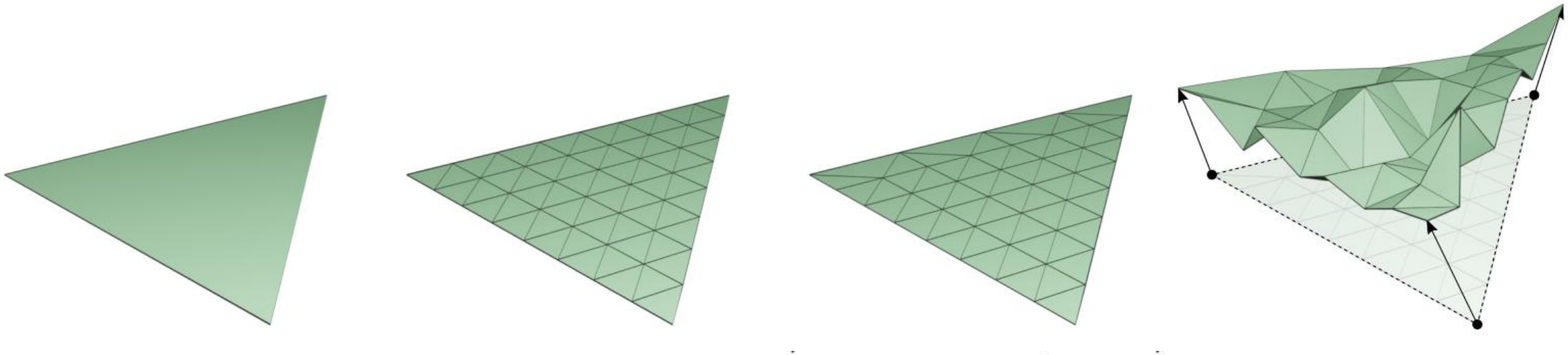
Resolution: 1500K △



Loading: 6777 msec
VRAM: ~36 MB
Rendering: 15 µsec

Background – Micro-Mesh

- **Nuova primitiva grafica** by NVIDIA
- HW supported
- Base-mesh + suddivisione + displacement field
- Vantaggi: compatta, include CLOD, animation ready, ray–tracing ready



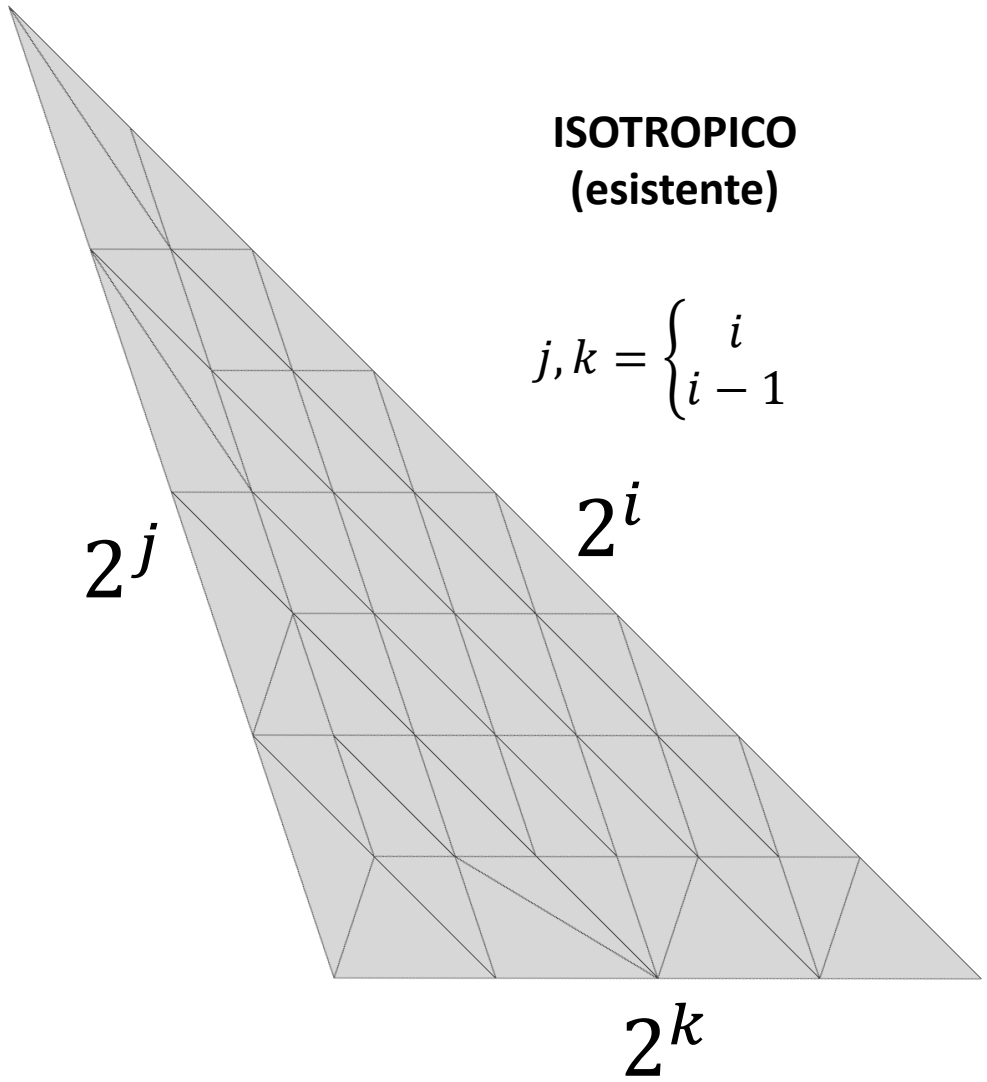
Obiettivo

- Esplorare una variante "anisotropica" dello schema Micro-Mesh
- Stima e confronto (costo / qualità)

Come:

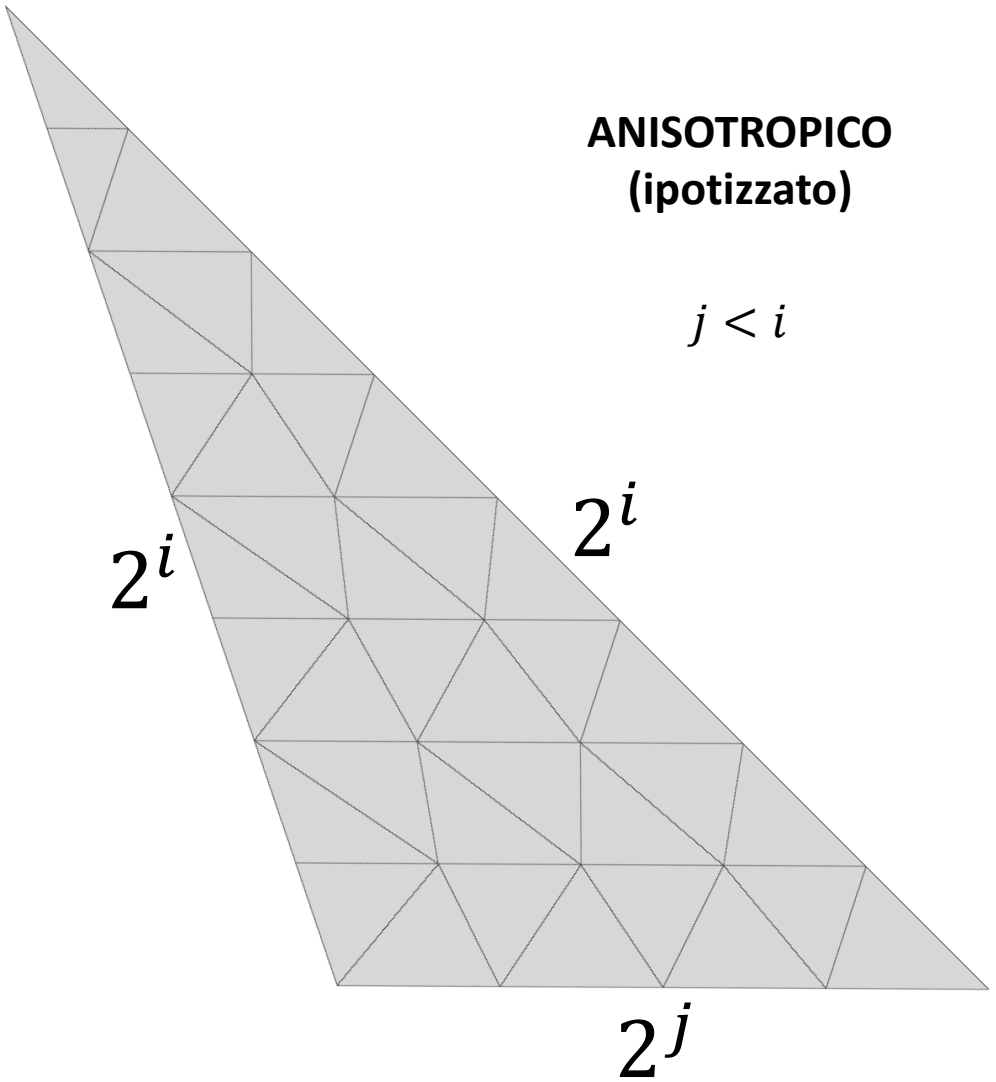
- Re-implementazione costruzione Micro-Mesh
- Implementazione variante
- Analisi comparativa geometrica dei risultati

Schemi di suddivisione



ISOTROPICO
(esistente)

$$j, k = \begin{cases} i \\ i-1 \end{cases}$$



ANISOTROPICO
(ipotizzato)

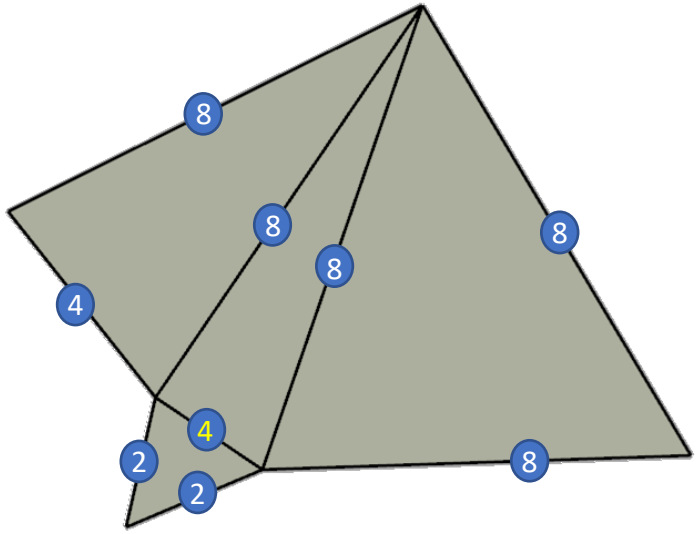
$$j < i$$

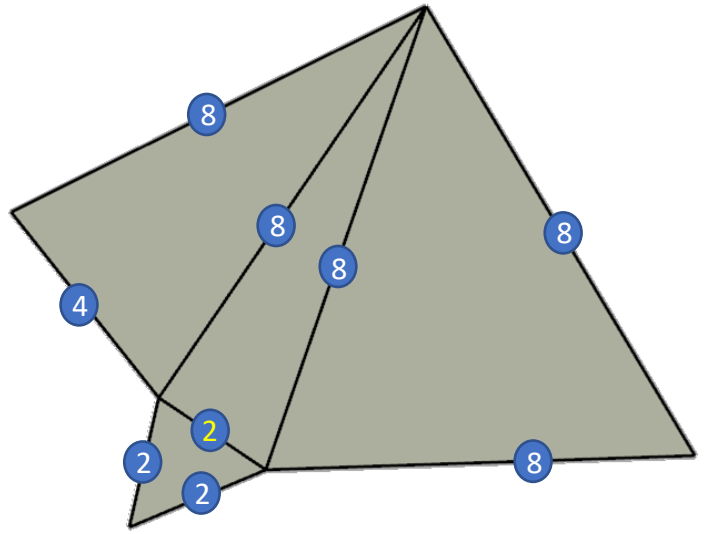
Rationale

ISOTROPICO (esistente)

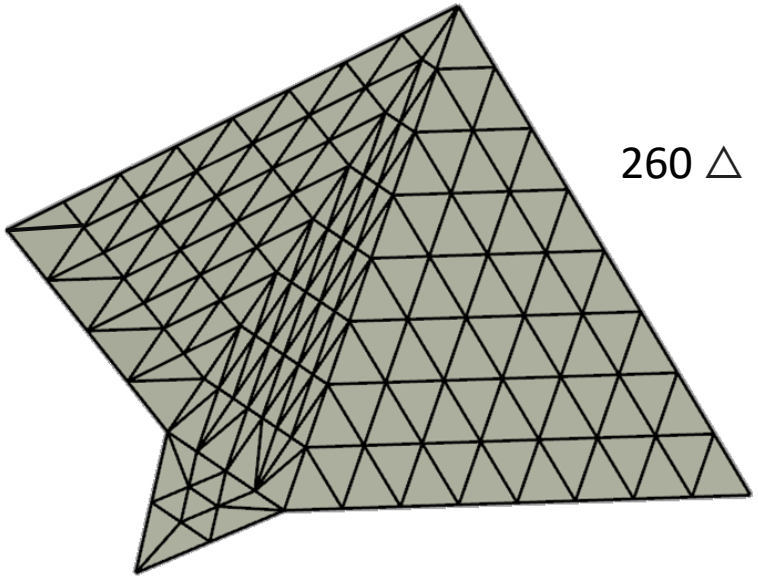
ANISOTROPICO (ipotizzato)

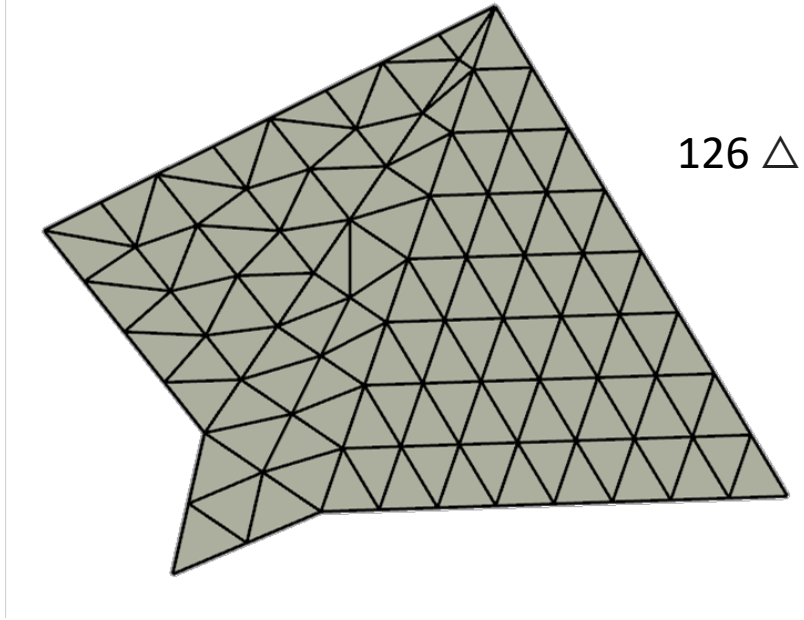
BASE MESH



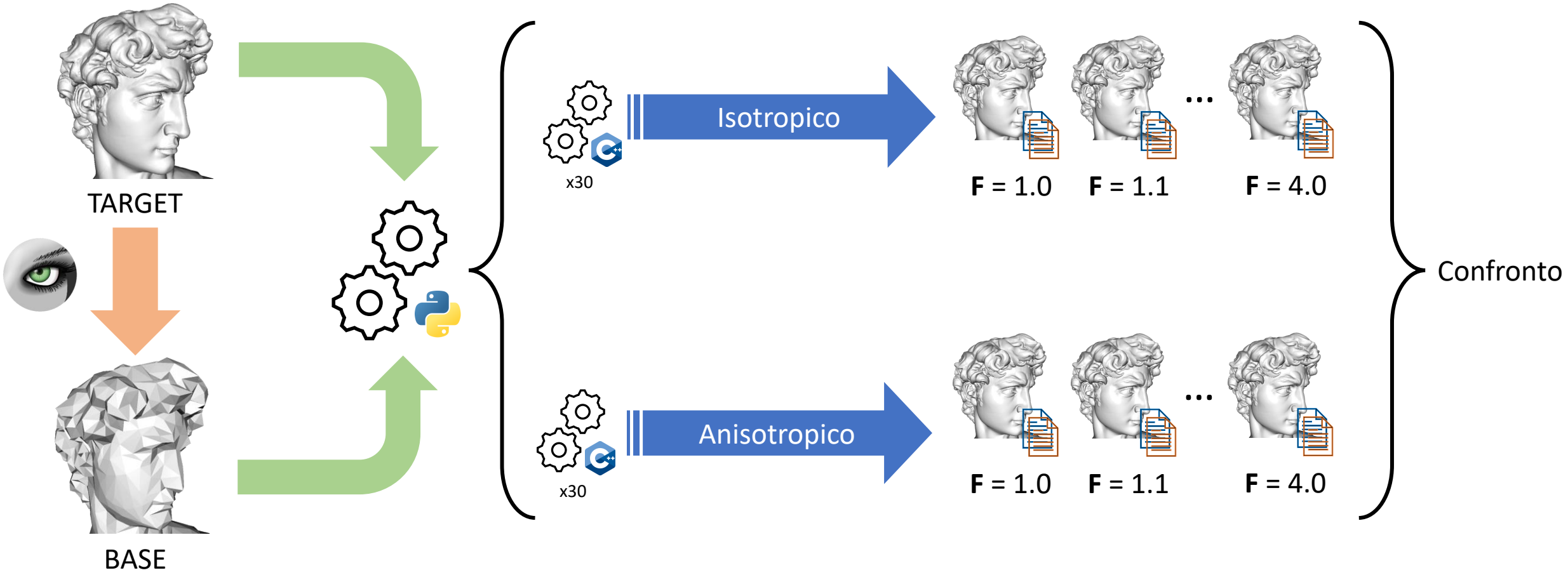


MICRO-MESH





Generazione samples per modello



Generazione μ-Mesh

TARGET

BASE

RAY-CAST

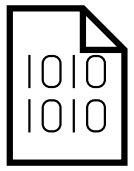
F

ISOTROPICO

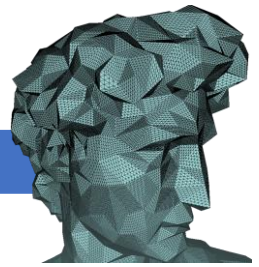
ANISOTROPICO

F

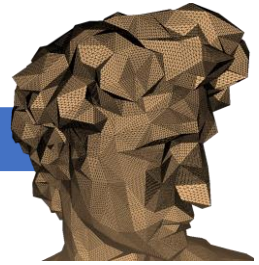
RAY-CAST



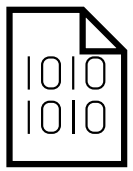
Spostamenti



SUBDIVIDED



SUBDIVIDED



Spostamenti

EXPORT

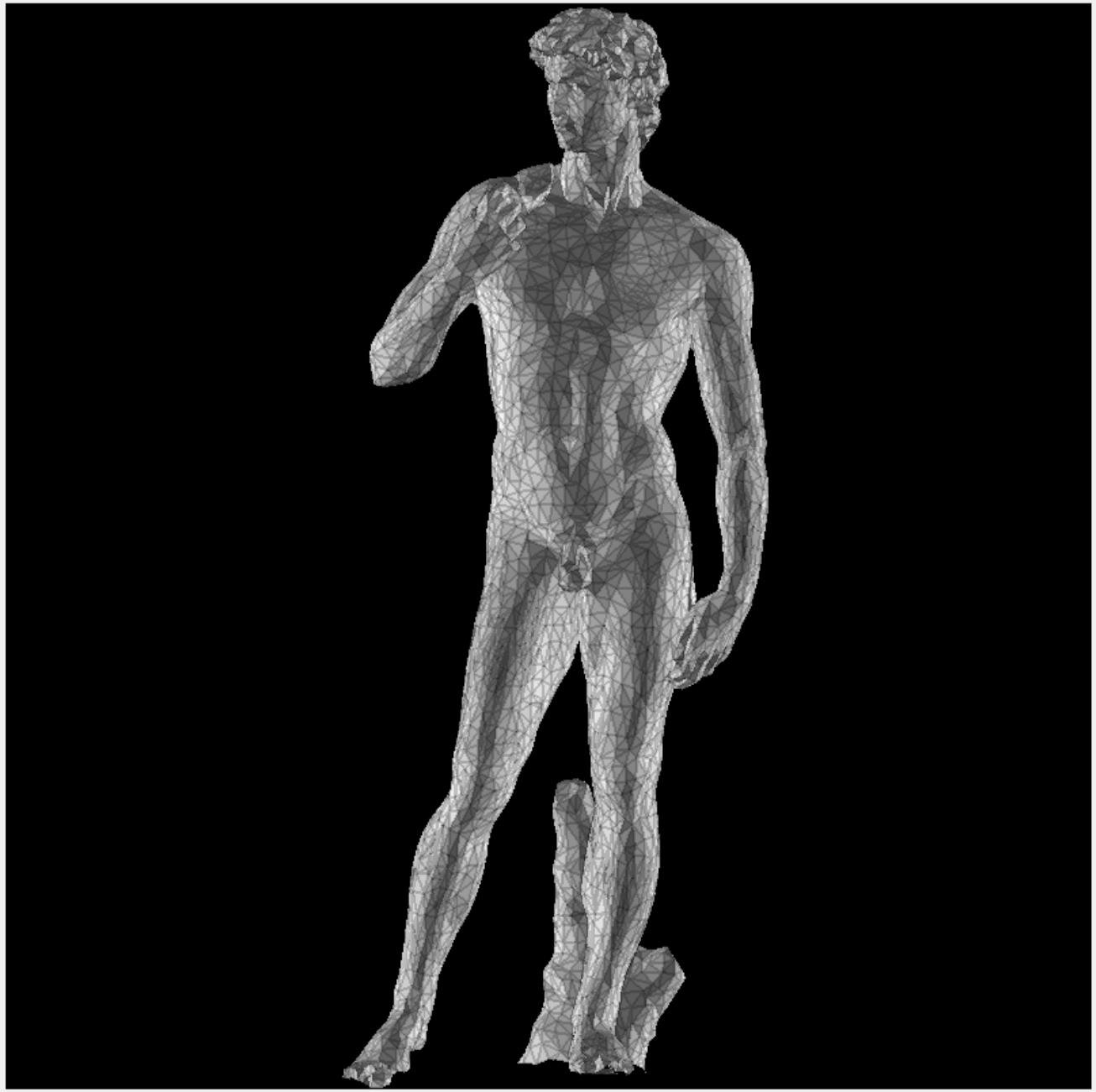
μ-Mesh
isotropica

EXPORT

μ-Mesh
anisotropica

Master's Degree Final Project, Manuel Pagliuca (975169), A.Y. 2022/2023

File Other operations



Current mesh

Subdivided mesh ☑ Wireframe

Base mesh samples

(1) 124 Faces | (2) 250 Faces | (3) 500 Faces | (4) 1000 Faces | (5) ...

Subdivision schemes

Micro-mesh | Anisotropic Micro-mesh

Micro-faces 13577

Target mesh samples

250 Faces | 500 Faces | 1000 Faces | 2500 Faces | 5000 Faces | ...

Displacement 0

Export OBJ | Export OFF

Info

Base mesh vertices	4962
Base mesh faces	9847
Subdivision scheme	Micromesh
Micro-vertices	33264
Micro-faces	13576
Target mesh vertices	0
Target mesh faces	0

KeyBoard commands

ESC will quit the application.
W will show/hide the mesh wireframe.
U will unload the base mesh.
1, **2**, **3** and **4** will load the sample base mesh
5 will unload the base mesh.
B will display the base mesh.
S will display the subdivided mesh.
T will display the target mesh.
P will display the projected/displaced mesh.
E will extract the displacements given a target (midpoint)

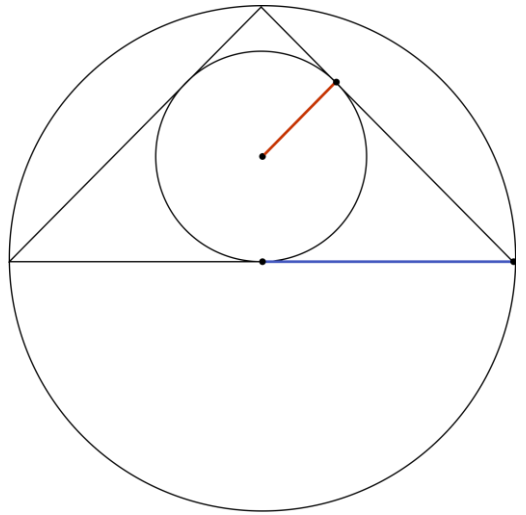
Analisi risultati:
Coefficente di variazione delle aree

$$CV = \frac{\sigma}{|\mu|} \cdot 100\%$$ (best = 0)

Model	ISOTROPIC CV (%)	ANISOTROPIC CV (%)	Rendimento (%)
Dragon	59.49	36.25	-39.06
Borghese Ares	56.56	34.12	-39.67
Dancing Faun	54.88	33.04	-39.79
Michelangelo's David	65.19	36.64	-43.79
Homo Heidelbergensis	63.85	36.94	-42.14
Koma Inu	57.63	34.80	-39.61

Decremento medio = 40.68%

Analisi risultati:
Qualità delle facce



(2 x inraggio) / circumraggio (best = 1)

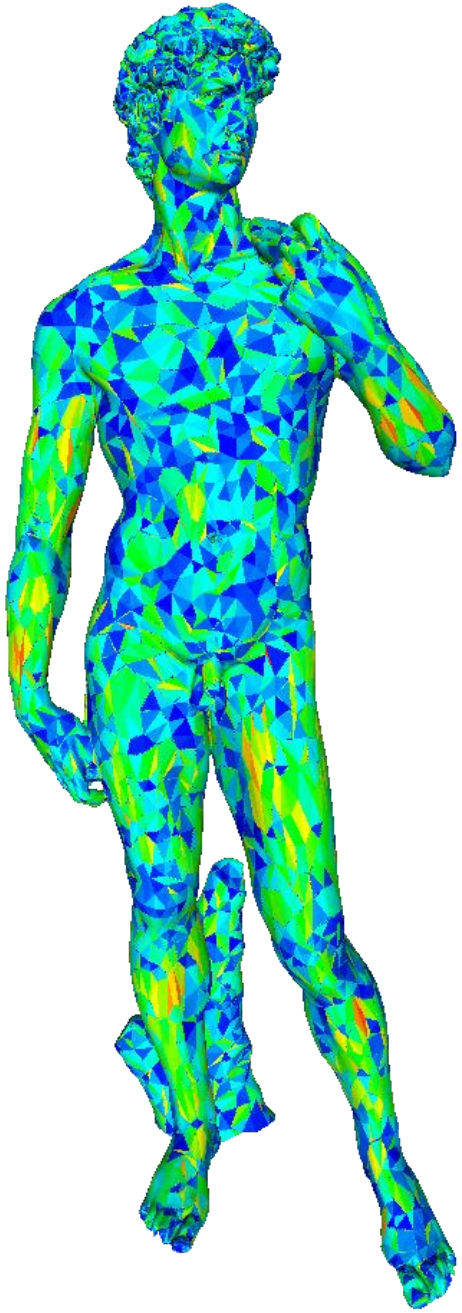
Model	ISOTROPIC	ANISOTROPIC	Rendimento (%)
Dragon	0.41	0.51	+24.39
Borghese Ares	0.44	0.53	+20.45
Dancing Faun	0.47	0.51	+8.51
Michelangelo’s David	0.38	0.50	+31.57
Homo Heidelbergensis	0.39	0.45	+25.64
Koma Inu	0.43	0.51	+18.60

Incremento medio = +21.53%

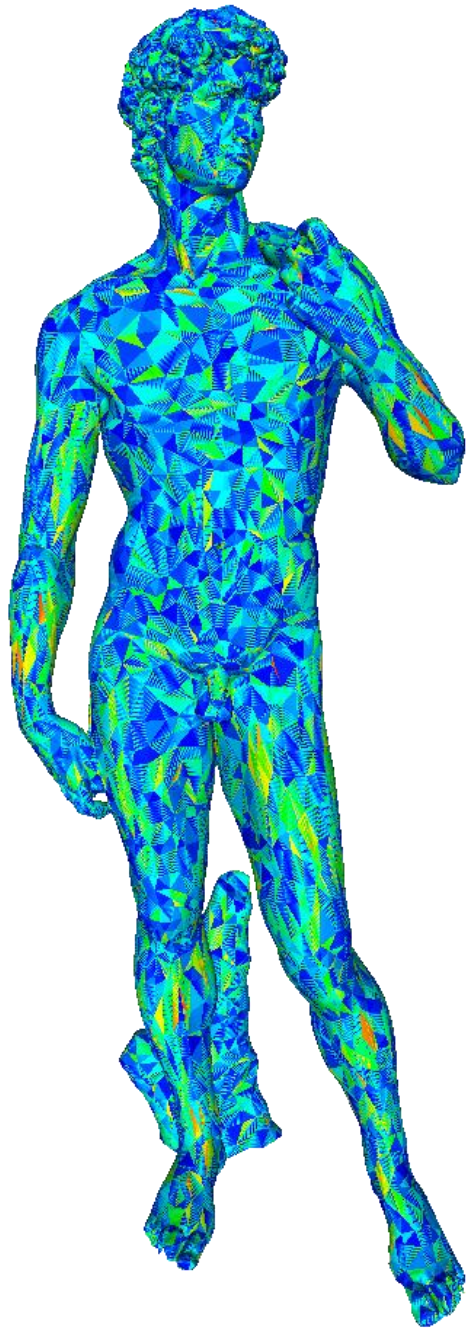
(2 x inraggio)/ circumraggio

1.0

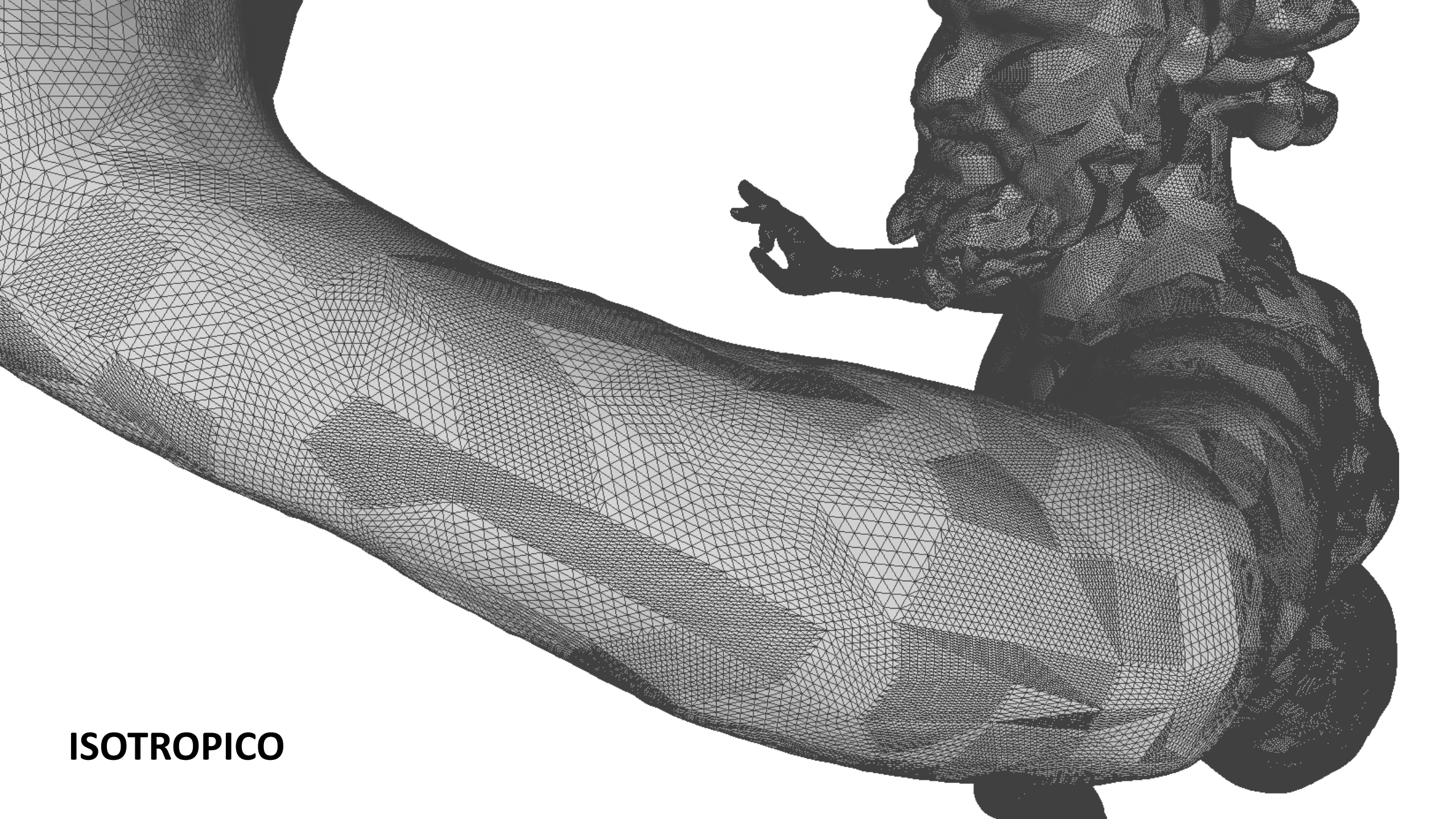
0.0



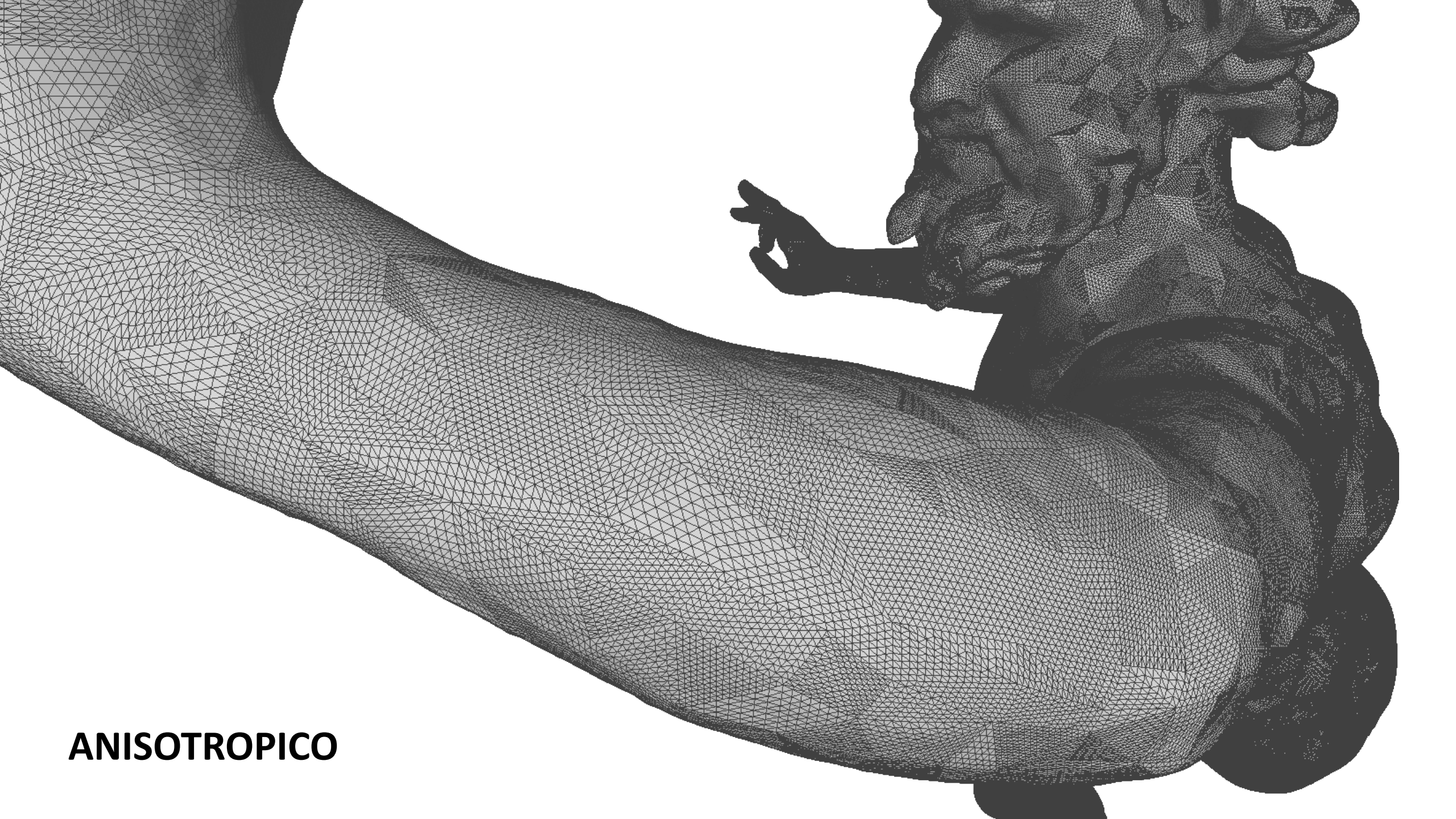
ISOTROPICO



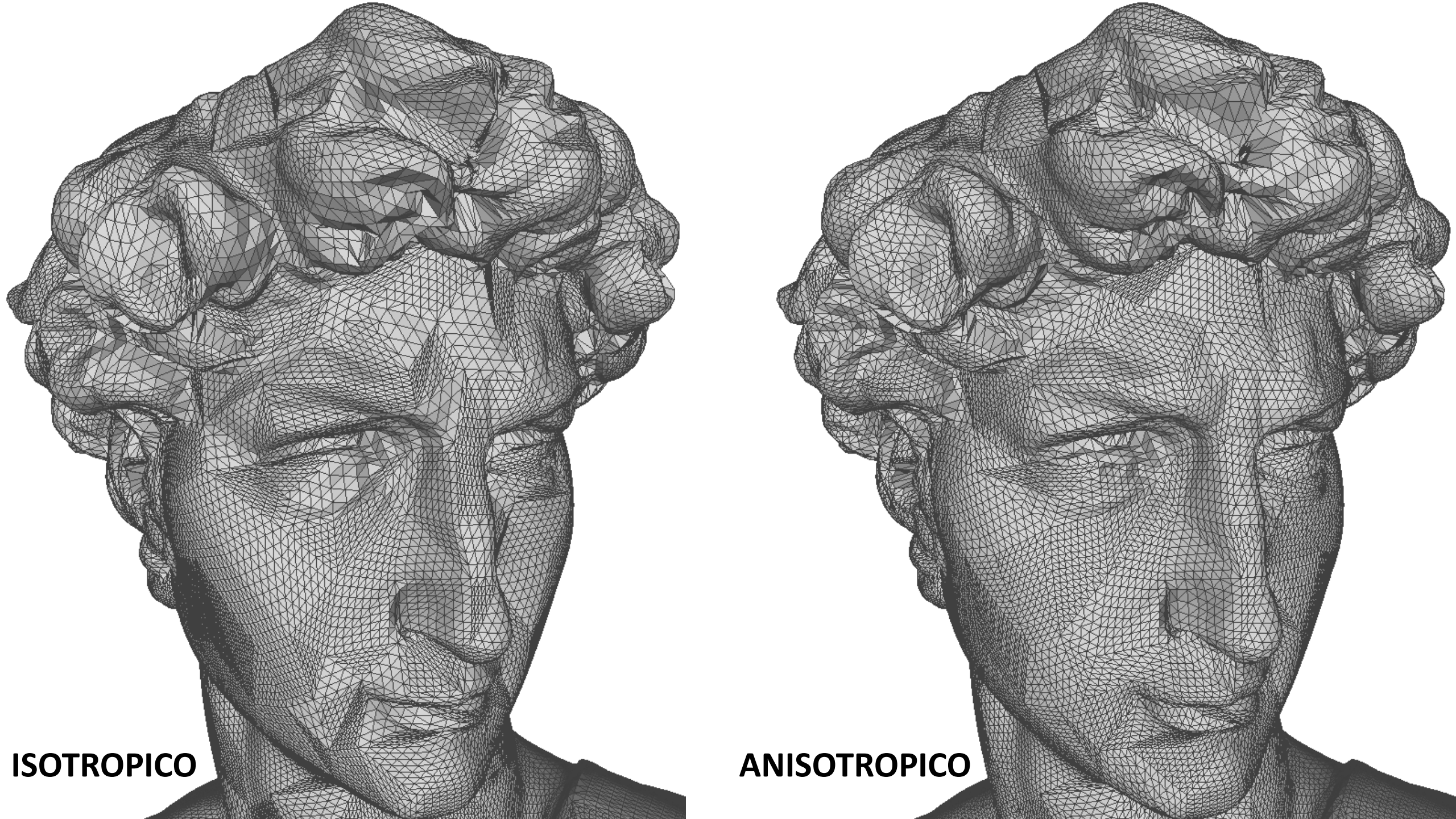
ANISOTROPICO



ISOTROPICO



ANISOTROPICO


ISOTROPICO
ANISOTROPICO

Strumenti utilizzati

Origine dataset

Preprocessing dataset

MeshLab

Implementaz. strumento costruzione Micro-Mesh

+

Implementaz. strumento analisi risultati

(scripting)

+

Librerie

(per math)

(per real-time rendering)

(per GUI)

PyMeshLab

Visualizzazione

Render

Diagrammi

Conclusioni – Risultati del assessment

- Maggiore fedeltà geometrica
- Implementazione HW giustificabile?

Ulteriori conclusioni:

- Difetto di modellazione schema anisotropico (T-junction)
- Richiede limiti più stringenti
- Perdita dei vantaggi ottenuti
- Rivisitare lo schema

Grazie per la
vostra attenzione,
Manuel Pagliuca