SAN ANTONIO
SIGGRAPH
2002

SIGGRAPH 2002

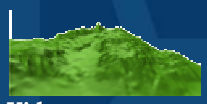
Parameterization and Meshes

Progressive and lossless compression of arbitrary simplicial complexes

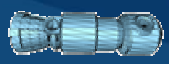
Pierre-Marie Gandoin
Olivier Devillers

INRIA

Context: Compression of 3D models



- **Applications:**
  - GIS, CAD, Medical, Video-games…



- **Properties:**
  - Progressive
  - Lossless

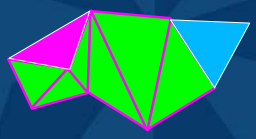
This paper:

- Efficient compression rate
- Progressive
- Lossless
- Works for triangle soup
- Works for 3D meshes

Related work

- **Connectivity driven approach**
- **3D model**

Describe the connectivity graph in canonical way



- **When a new point is needed,**

predict its position, code the error

Related work

Connectivity driven approach

PROGRESSIVE / LOSSLESS

96 Hoppe	Progressive Meshes
97 Denny - Sohler	Edge Permutation Encoding
98 Taubin et al.	Progressive Forest Split
99 Pajarola - Rossignac	Compressed Progressive Meshes
99 Cohen-Or et al.	2/4 Coloring
01 Alliez - Desbrun	Progressive valence approach

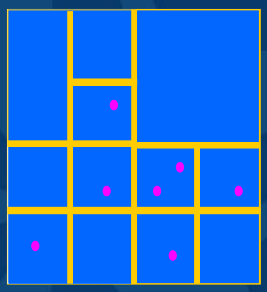
Previous work

Geometry driven approach

93 Rossignac Borel
97 Schmalstieg Schaufler — Geometric Clusters
00 Devillers Gandoin — Kd tree

Kd tree

Geometry driven approach



Code

7	3	1	0	0	1	3	0	0	1	2	1	...

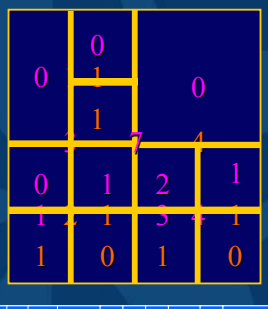
32 bits — 3 — 2 — 2.3 — 1 — 1.6 — 2.3 — 1 — 1 — 1 — 2 — 1

Log 8 — Log 4 — Log 5

Arithmetic coding

Kd tree

Geometry driven approach



Code

7	3	1	0	0	1	3	0	0	1	2	1	...

Theoretical gain : > log n -2.402 bits/v

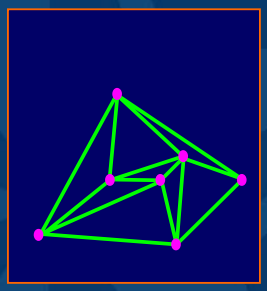
This paper:

- **Cheap encoding of connectivity**
- **Compatible with kd tree**

- **Prediction scheme**

Encoding connectivity

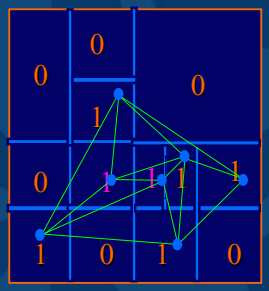
Assign connectivity to intermediate models



original connectivity

Encoding connectivity

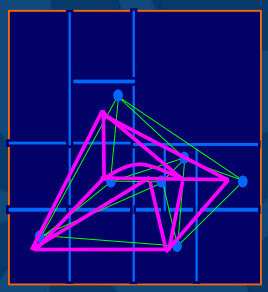
Assign connectivity to intermediate models



When points are separated apply original connectivity to center of cells

Encoding connectivity

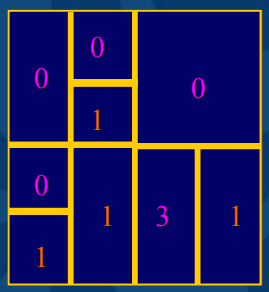
Assign connectivity to intermediate models



When points are separated apply original connectivity to center of cells

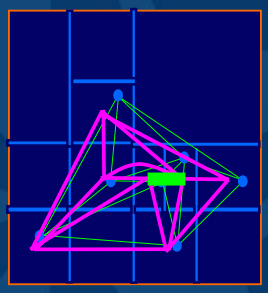
Encoding connectivity

Connectivity for non separated model ?



Encoding connectivity

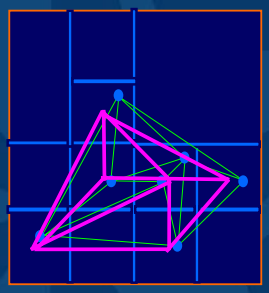
Connectivity for non separated model ?



Merge cells using edge collapse

Encoding connectivity

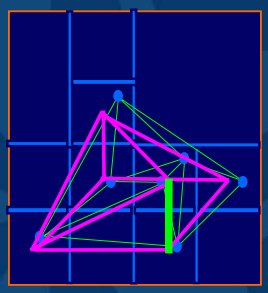
Connectivity for non separated model ?



Merge cells using edge collapse

Encoding connectivity

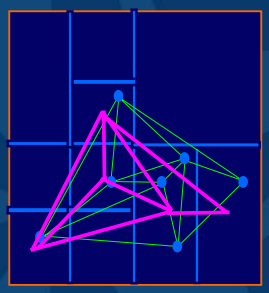
Connectivity for non separated model ?



Merge cells using edge collapse

Encoding connectivity

Connectivity for non separated model ?

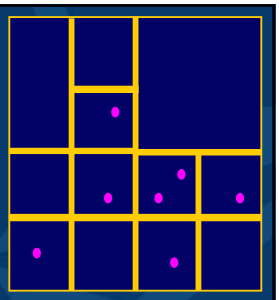


Merge cells using edge collapse

If locally non manifold use vertex merge

General scheme

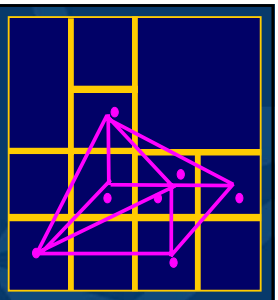
- Run geometric coder



7	3	1	0	0	1	3	0	0	1	2	1	...

General scheme

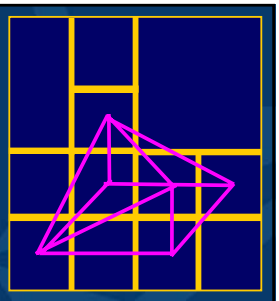
- Run geometric coder
- Map connectivity



7	3	1	0	0	1	3	0	0	1	2	1	...

General scheme

- Run geometric coder
- Map connectivity

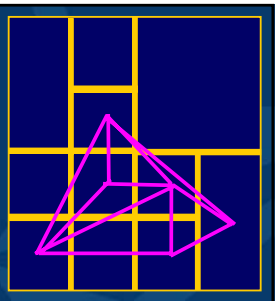


7	3	1	0	0	1	3	0	0	1	2	1	...

- Run the splitting backwards

General scheme

- Run geometric coder
- Map connectivity

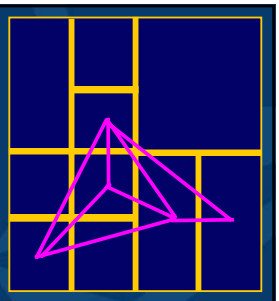


7	3	1	0	0	1	3	0	0	1	2	1	...

- Run the splitting backwards

General scheme

- Run geometric coder
- Map connectivity



7	3	1	0	0	1	3	0	0	1	2	Expansion	1	...

- Run the splitting backwards
- Insert code for edge expansion or vertex split

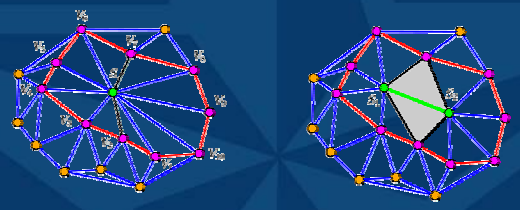
Edge expansions

The ordering of edge expansions is driven by the geometric coder

No control of quality of edge expansion

No expense to tell which vertex is expanded

Edge expansion encoding



Two index of vertices incident to S

Naive : 2 log(degree S) bits

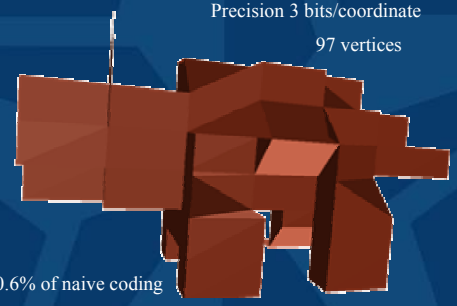
Geometric prediction

0.2 bits

Results

Precision 3 bits/coordinate

97 vertices



0.6% of naive coding

Results

Precision 4 bits/coordinate

358 vertices

1.5% of naive coding

Results

Precision 5 bits/coordinate

999 vertices

4% of naive coding

Results

Precision 6 bits/coordinate

1845 vertices

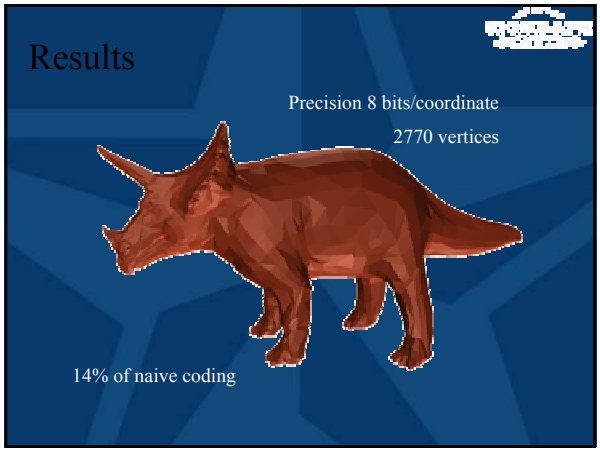
7% of naive coding

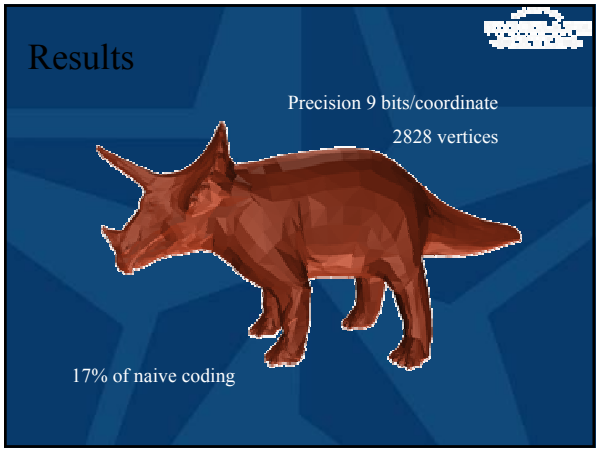
Results

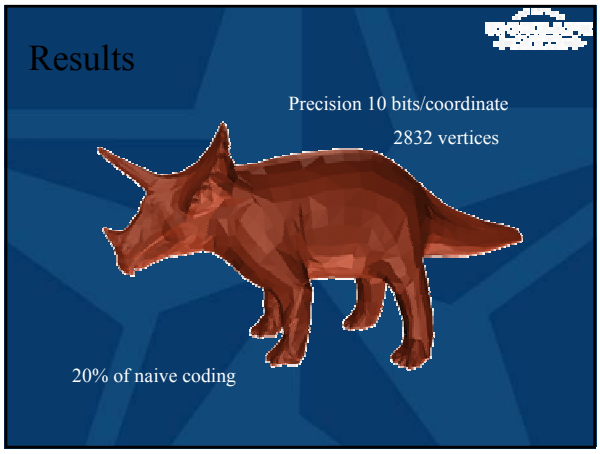
Precision 7 bits/coordinate

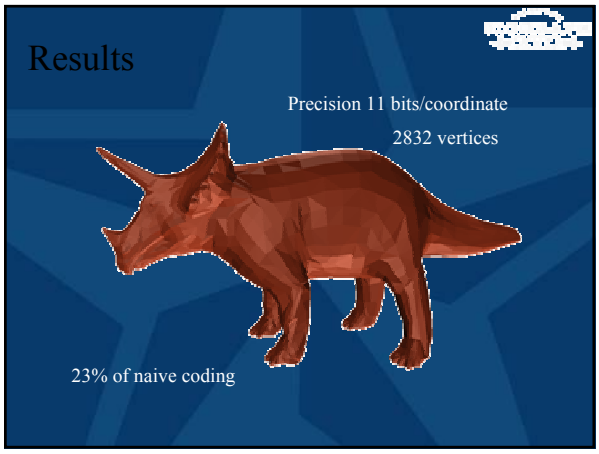
2520 vertices

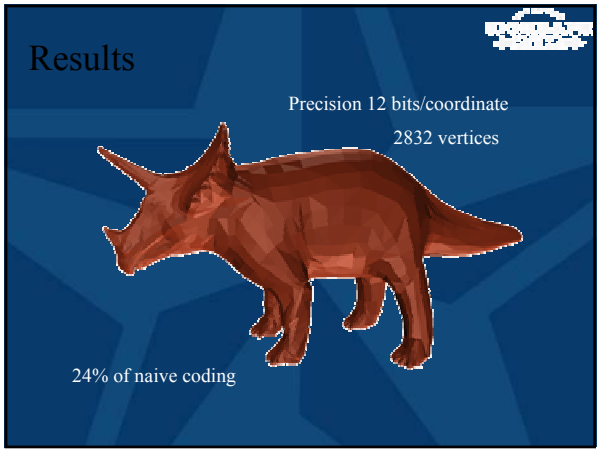
11% of naive coding

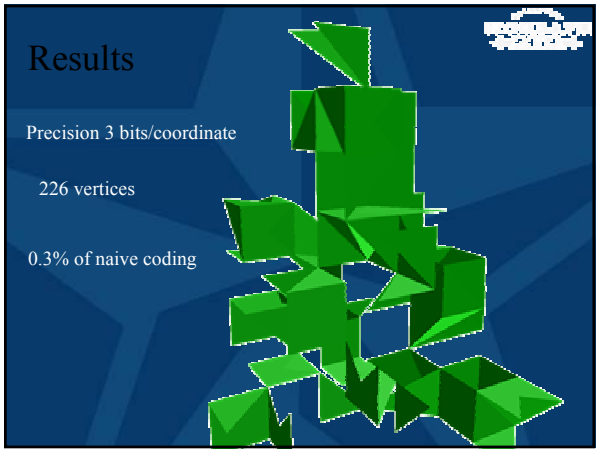

Results
Precision 8 bits/coordinate
2770 vertices
14% of naive coding


Results
Precision 9 bits/coordinate
2828 vertices
17% of naive coding


Results
Precision 10 bits/coordinate
2832 vertices
20% of naive coding


Results
Precision 11 bits/coordinate
2832 vertices
23% of naive coding


Results
Precision 12 bits/coordinate
2832 vertices
24% of naive coding

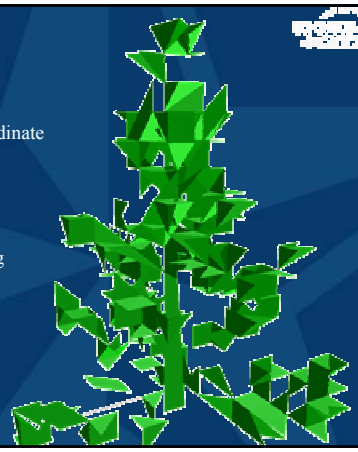

Results
Precision 3 bits/coordinate
226 vertices
0.3% of naive coding

Results

Precision 4 bits/coordinate

925 vertices

0.8% of naive coding



Results

Precision 5 bits/coordinate

3020 vertices

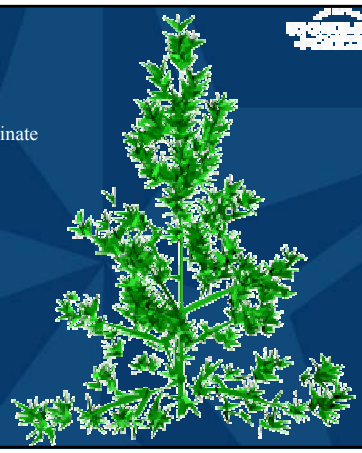
2% of naive coding

Results

Precision 6 bits/coordinate

5649 vertices

4% of naive coding

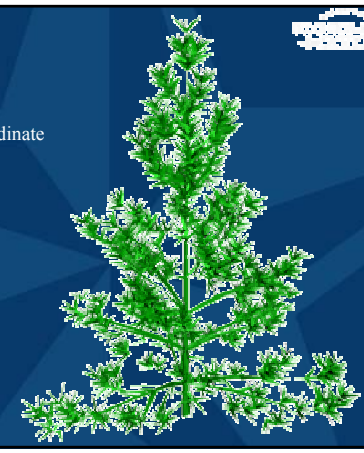


Results

Precision 7 bits/coordinate

7555 vertices

7% of naive coding



Results

Precision 8 bits/coordinate

9927 vertices

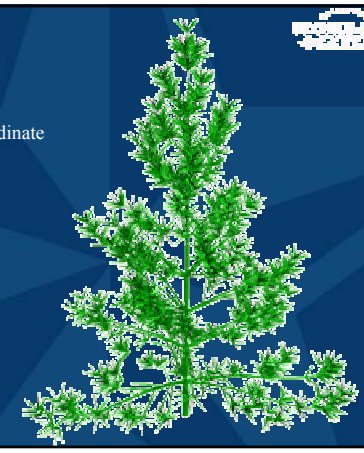
9% of naive coding

Results

Precision 9 bits/coordinate

13778 vertices

12% of naive coding



Results

Precision 10 bits/coordinate

17064 vertices

15% of naive coding

Results

Precision 11 bits/coordinate

17681 vertices

18% of naive coding

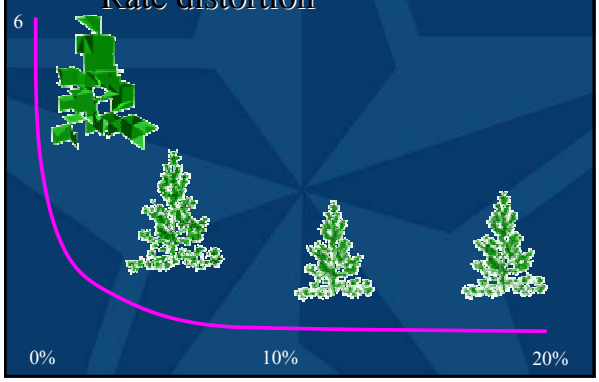
Results

Precision 12 bits/coordinate

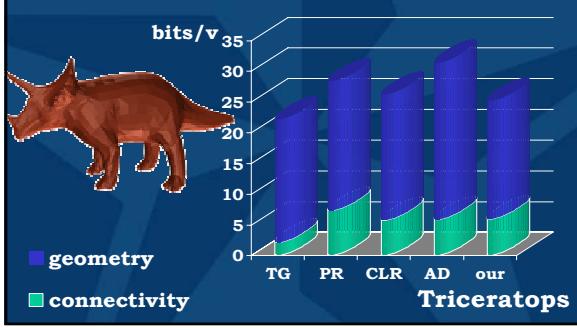
17773 vertices

20% of naive coding

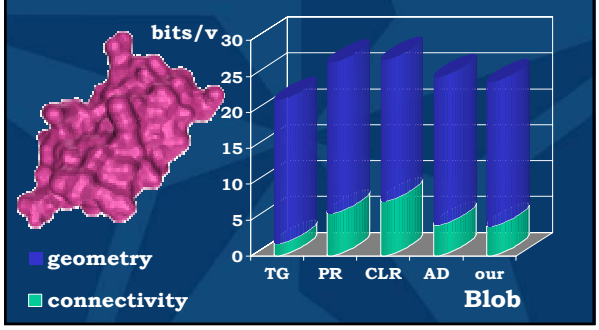
Rate distortion



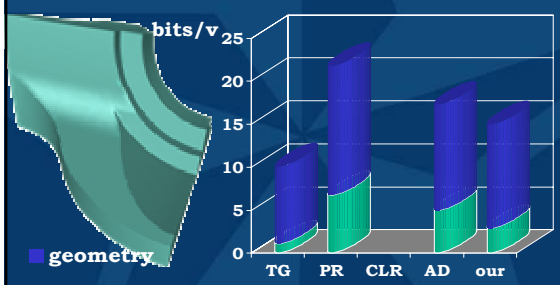
Manifold models



Manifold models

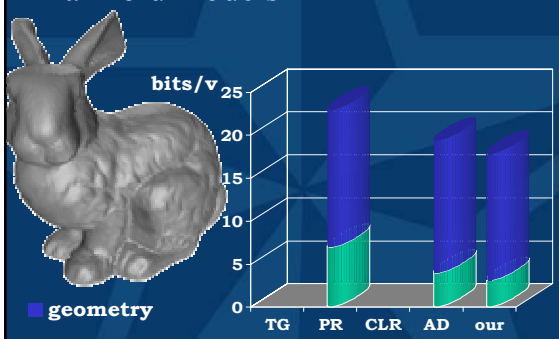


Manifold models



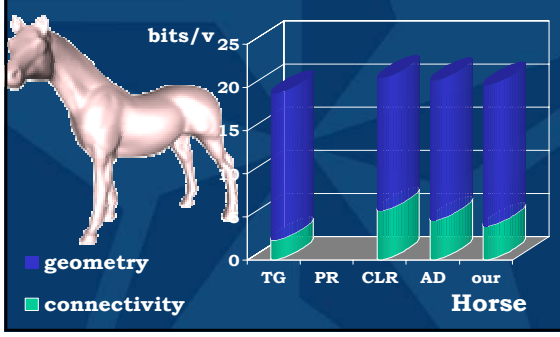
Fandisk

Manifold models



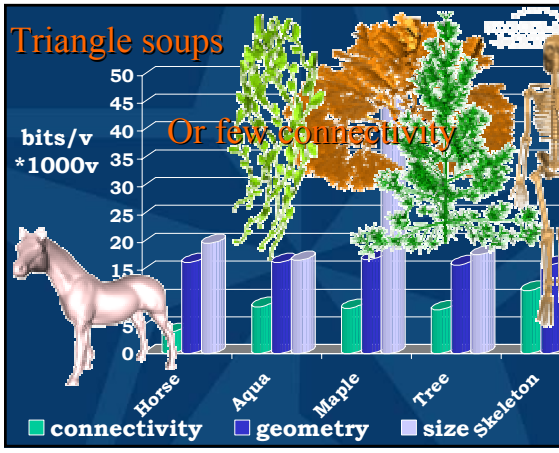
Bunny

Manifold models



Horse

Triangle soups



3D tetrahedral mesh (progressive)

Falcon jet
10188 vertices
16 bits/coordinate

23 bits/v geometry
25 bits/v connectivity

[Pajarola Rossignac Szymczak]

Conclusion

Progressive, lossless compression

Single approach

- **Competitive for manifold surfaces**
- **Efficient for triangle soups**
- **3D tetrahedral meshes**

Originality

- **Priority to geometry**

SIGGRAPH 2002

Parameterization and Meshes

Progressive and lossless compression of arbitrary simplicial complexes

Pierre-Marie Gandoin
Olivier Devillers

compression of arbitrary simplicial complexes

Pierre-Marie Gandoin
Olivier Devillers
INRIA SOPHIA ANTIPOLIS

Competitive for manifold surfaces
Efficient for triangle soups
Works for 3D meshes

Previous work

Connectivity driven approach

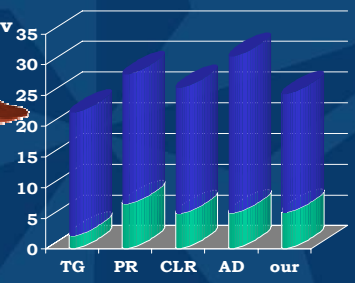
Our work

Geometry driven approach

16+4 bits/v

17+8 bits/v

Manifold models



Triceratops