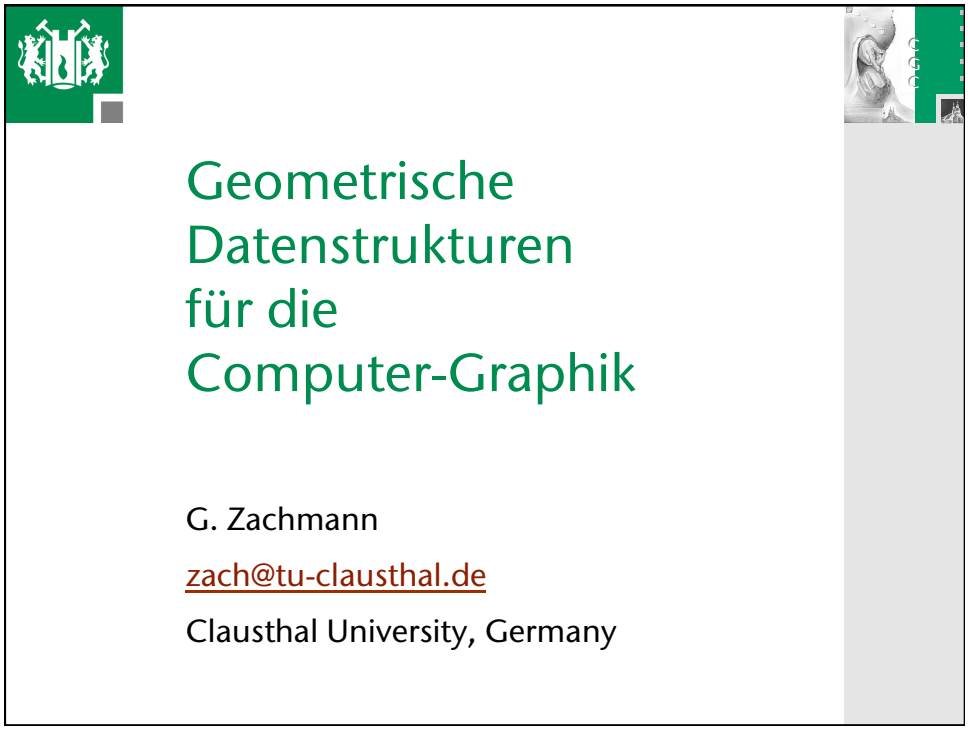
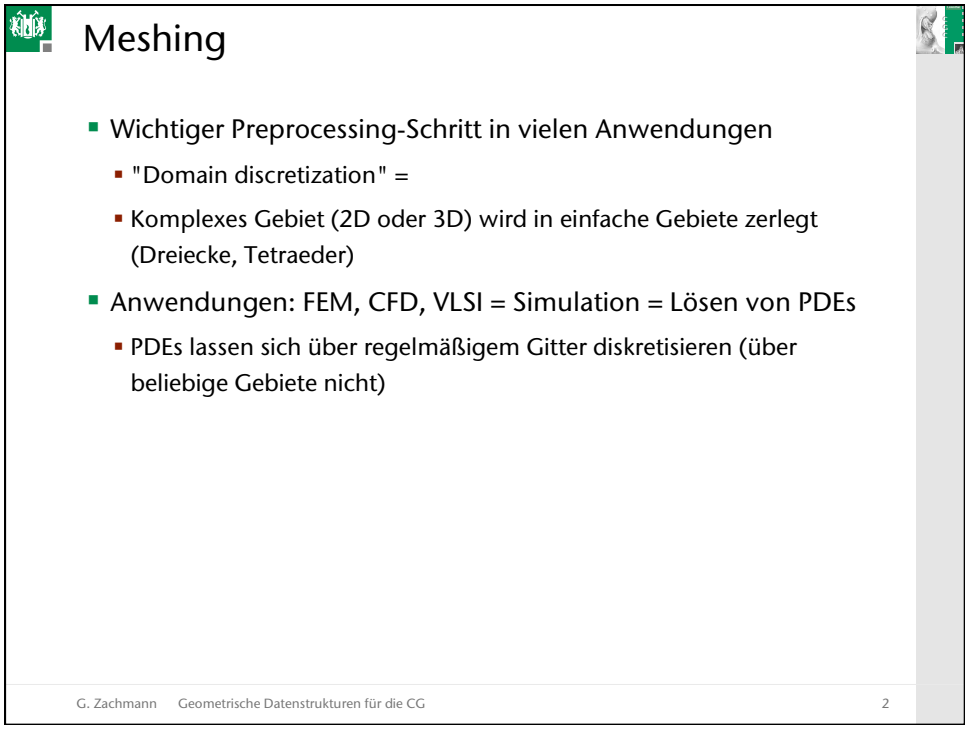


Geometrische Datenstrukturen für die Computer-Graphik

G. Zachmann

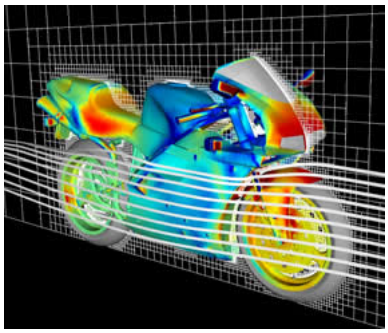
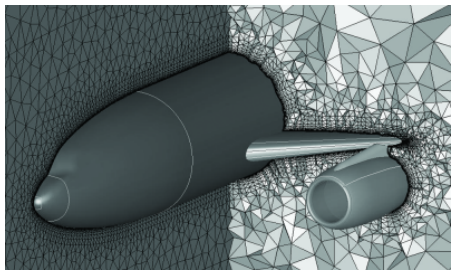
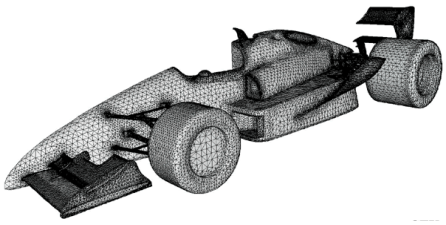
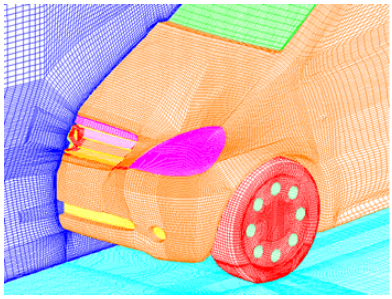
zach@tu-clausthal.de

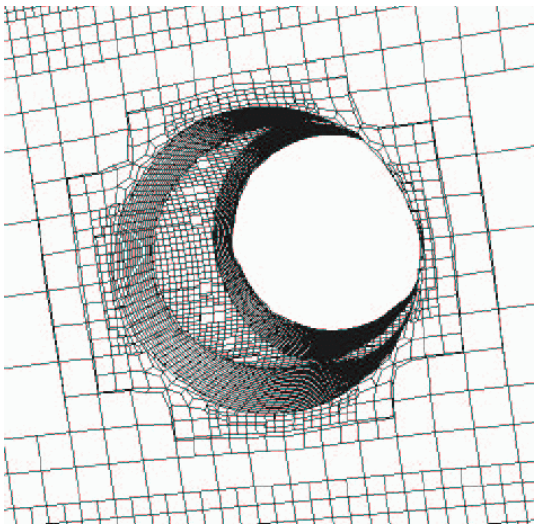
Clausthal University, Germany



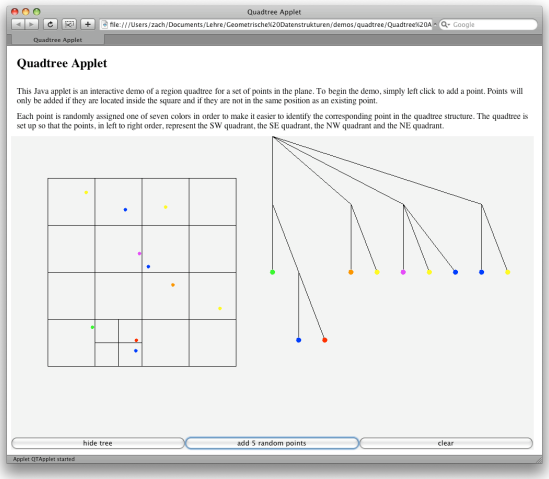
Meshing

- Wichtiger Preprocessing-Schritt in vielen Anwendungen
  - "Domain discretization" =
  - Komplexes Gebiet (2D oder 3D) wird in einfache Gebiete zerlegt (Dreiecke, Tetraeder)
- Anwendungen: FEM, CFD, VLSI = Simulation = Lösen von PDEs
  - PDEs lassen sich über regelmäßigem Gitter diskretisieren (über beliebige Gebiete nicht)

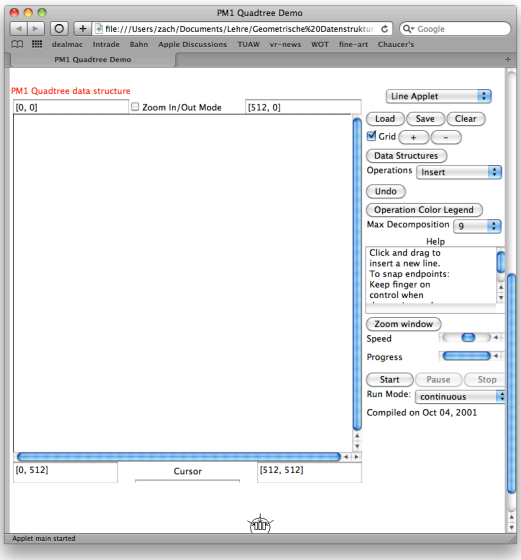







Quadtree demo



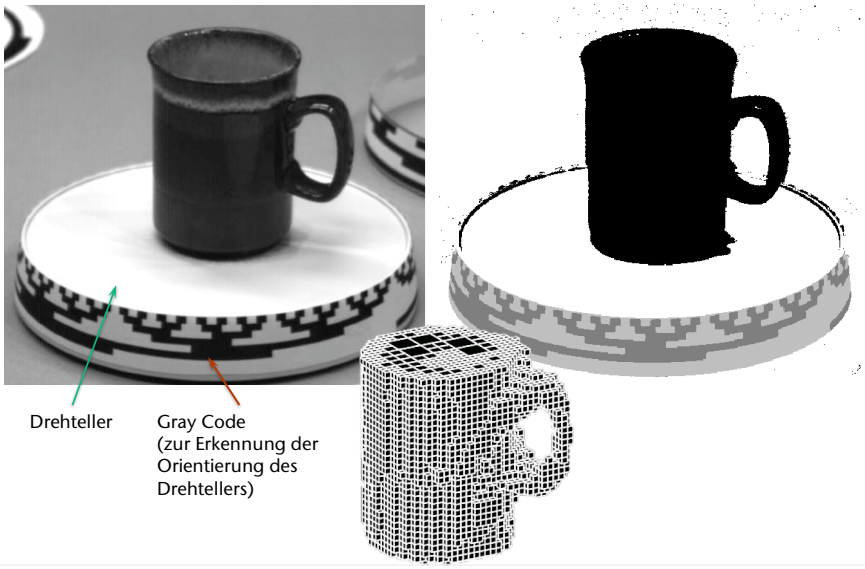
http://www.cs.utah.edu/~croberts/courses/cs7962/project/index.html



Ist IMHO buggy! (unnötige Unterteilungen)

http://donar.umiacs.umd.edu/quadtree/points/prquad.html

Octree Models from Images



Drehteller

Gray Code (zur Erkennung der Orientierung des Drehtellers)

Example Models

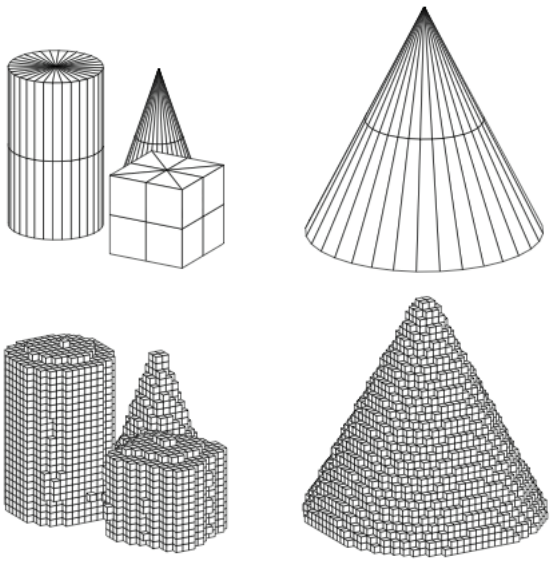
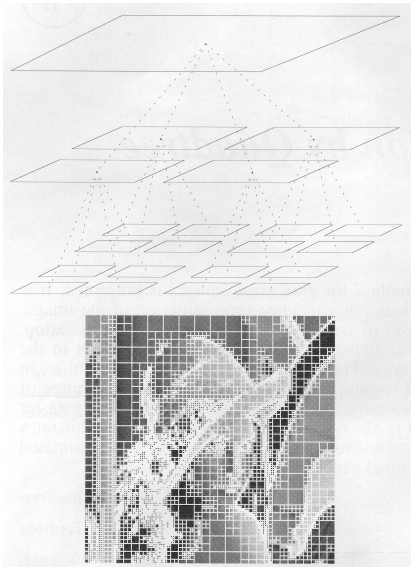
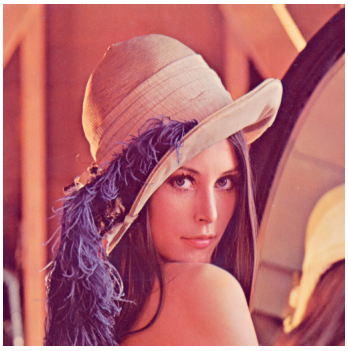


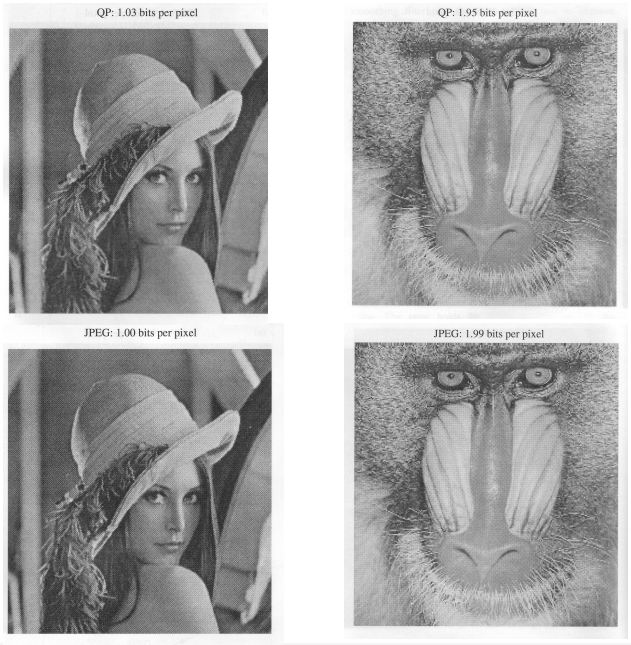
Image Compression using Quadtrees



Die beiden Test-Bilder schlechthin



Resultate

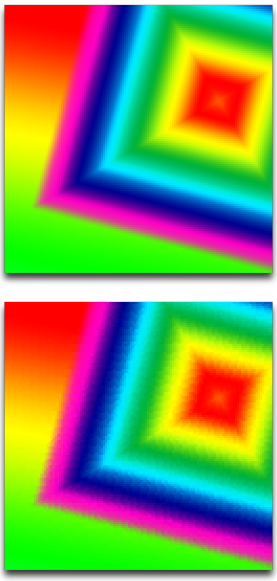


S3TC texture compression

- Vergleich:

DXT1 Uncompressed

[Philipp Klaus Krause]



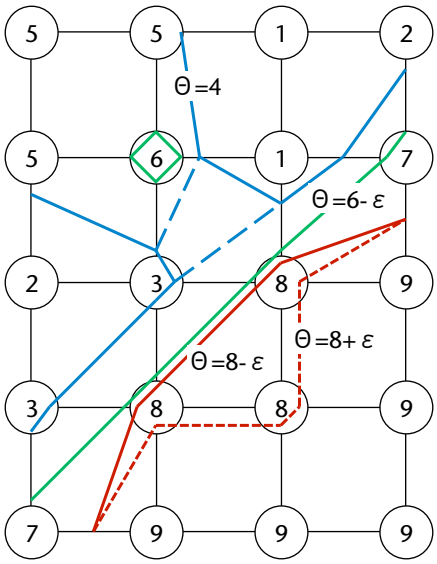
[Simon Brown]

- Vorteil: größere Texturen möglich → höhere Qualität
- Beispiel aus der Unreal Engine:

uncompressed — Unreal Retexturing Project — mit S3TC

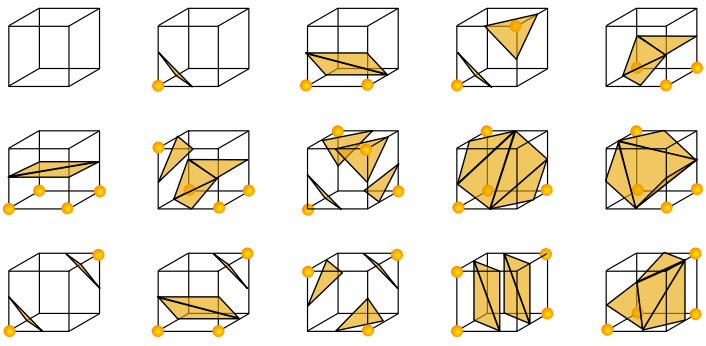
Isosurfaces

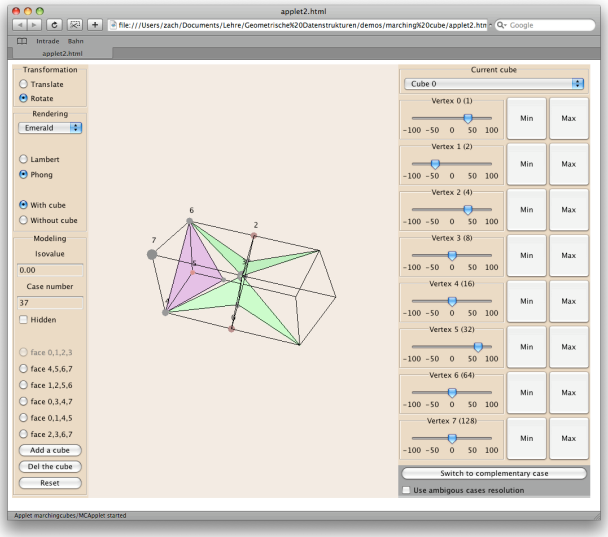
- Beispiel zur Motivation:
  - Gegeben ist ein 2D-Höhenfeld
  - Gesucht ist eine Visualisierung (in 2D!), so daß man die Form / den Verlauf des Höhenfeldes gut "erkennt"
- Eine Möglichkeit: Höhenlinien (= Konturen)
- Mögliche Probleme:
  - Plateaus
  - Singuläre "Isopunkte"
  - Uneindeutigkeiten



Beispiele für Höhenfelder und Volumendatensätze

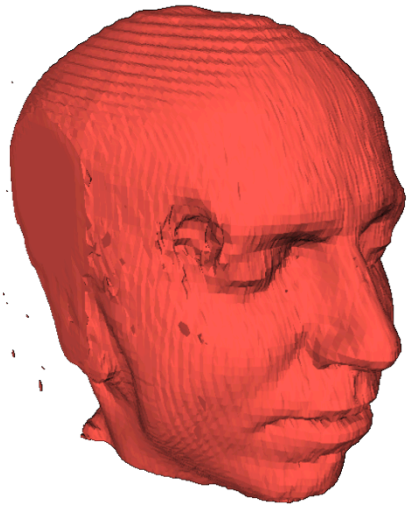
- Die 15 echt verschiedenen Fälle in 3D:



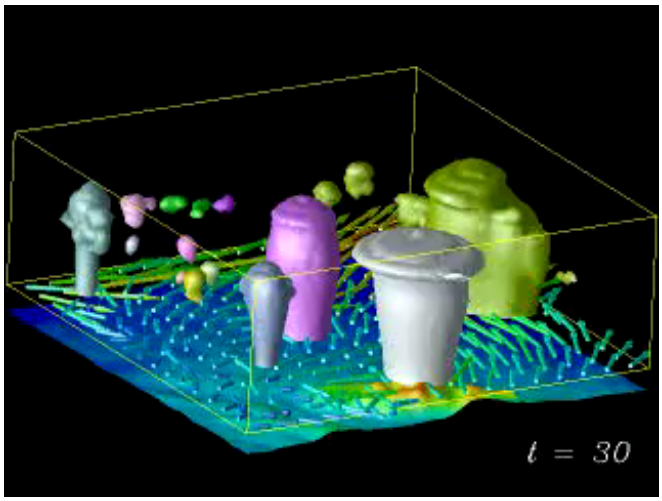


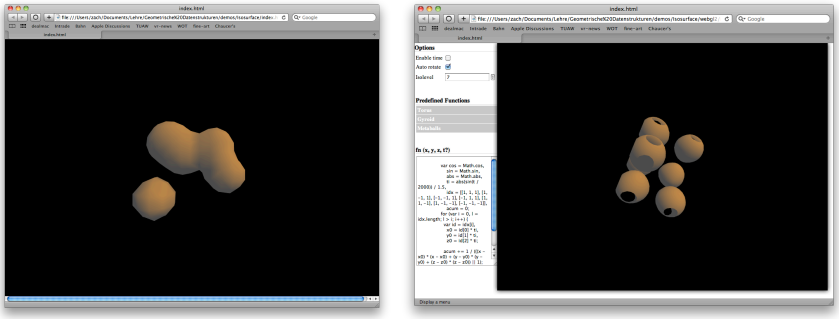
http://users.polytech.unice.fr/~lingrand/MarchingCubes/accueil.html

- Output eines einfachen Marching-Cube-Algorithmus':



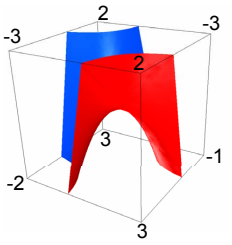
Beispiel aus einer Wetter-Simulation



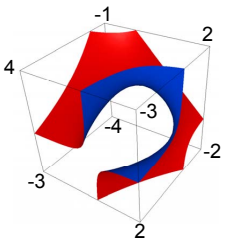


http://blog.thejit.org/2010/12/10/animating-isosurfaces-with-webgl-and-workers/

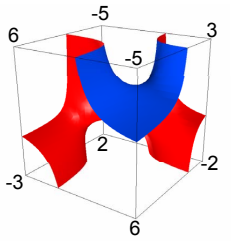
Knifflige Fälle für jeden Isosurface-Algorithmus



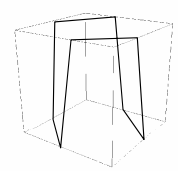
8-sided polygon



9-sided polygon



12-sided polygon

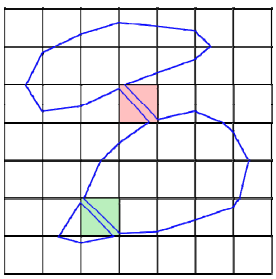


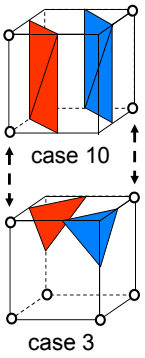
The 8-sided polygon has no valid triangulation!

- either some triangles lie on faces of the cell
- or an extra vertex has to be used

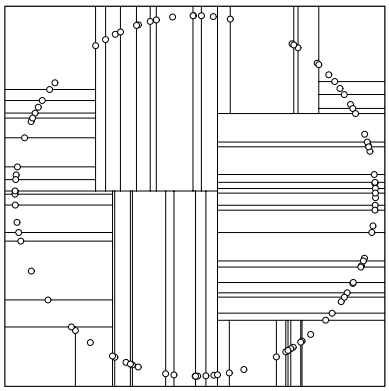
~/avs/networks/SciVis/AD*net

- Manchmal passen die Dreiecke der benachbarten Zellen nicht zusammen:
- Uneindeutiger Fall im 2D:

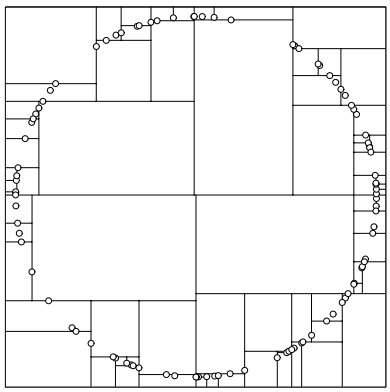




Pivot-Strategien beim Aufbau von kd-Trees

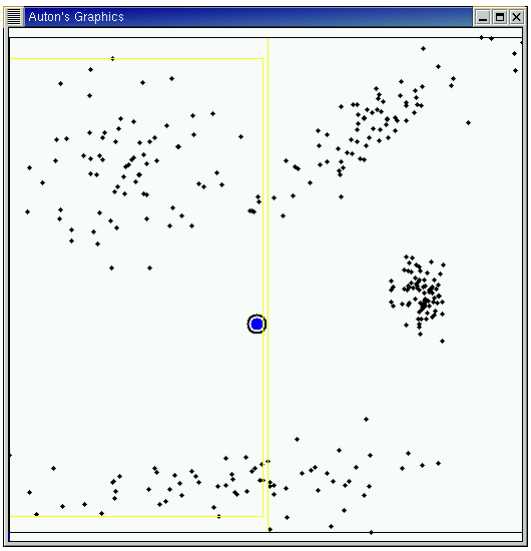


median along the dimension
with the widest spread of the points

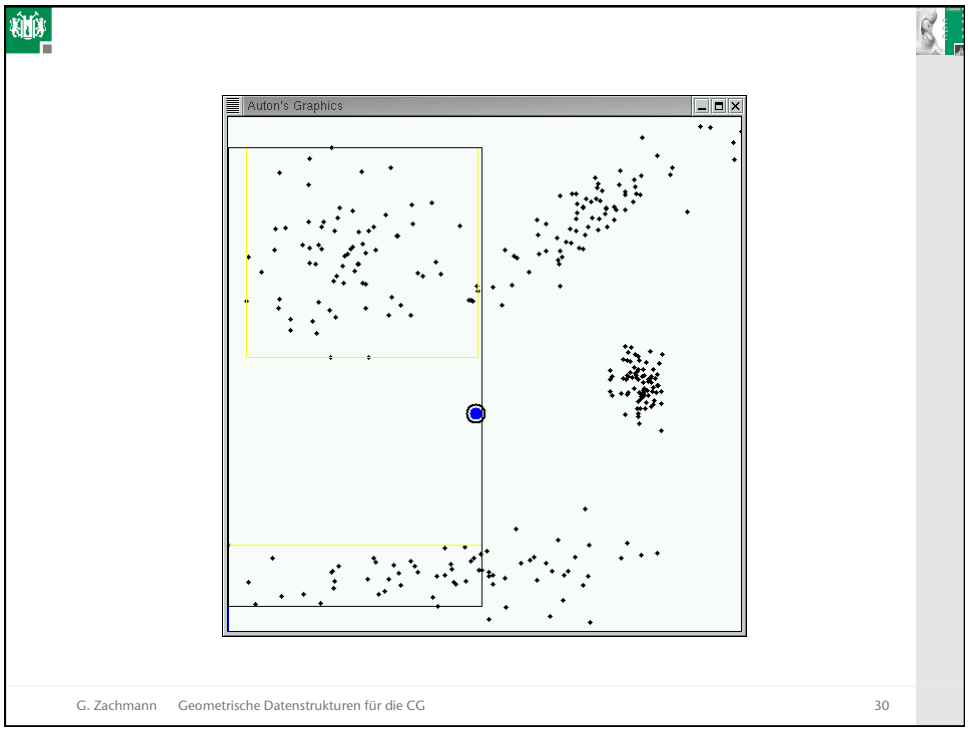


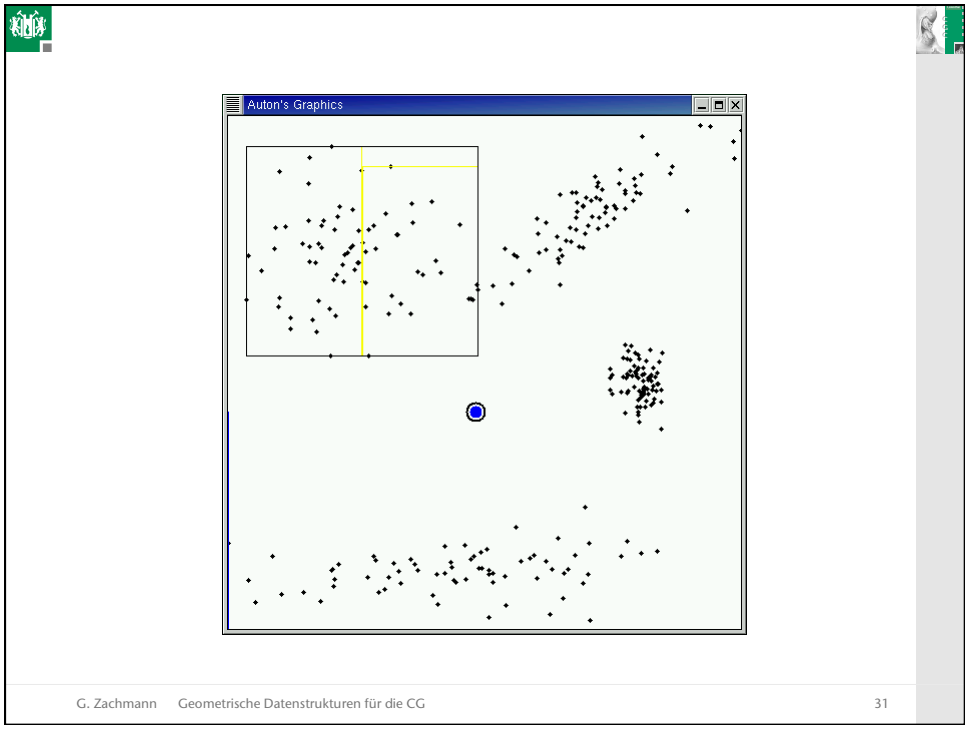
the point closest to the center along the
dimension with longest side of the region

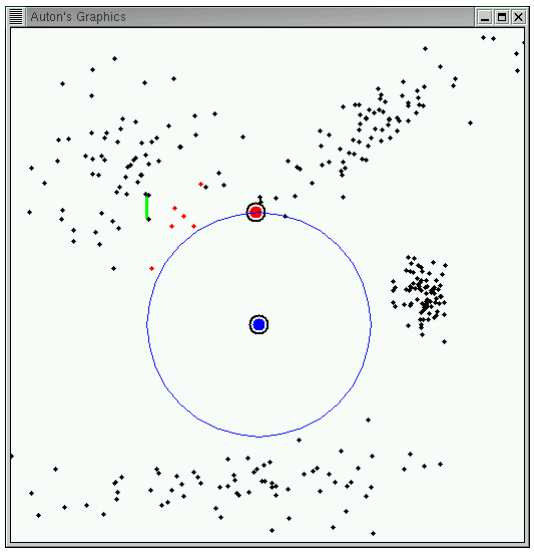
Animation of Nearest-Neighbor using kd-Trees



Andrew Moore, CMU


Auton's Graphics


Auton's Graphics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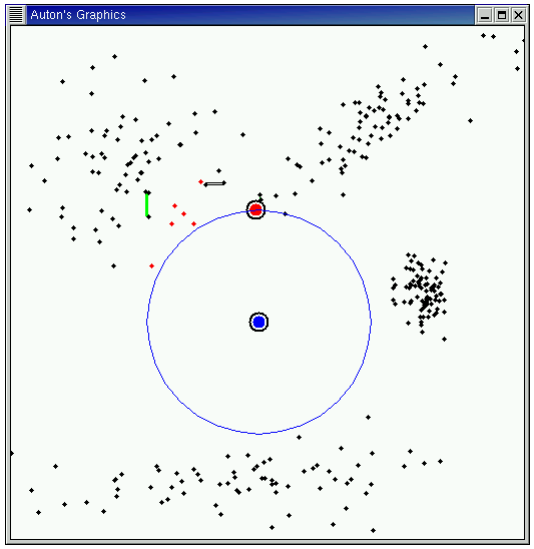
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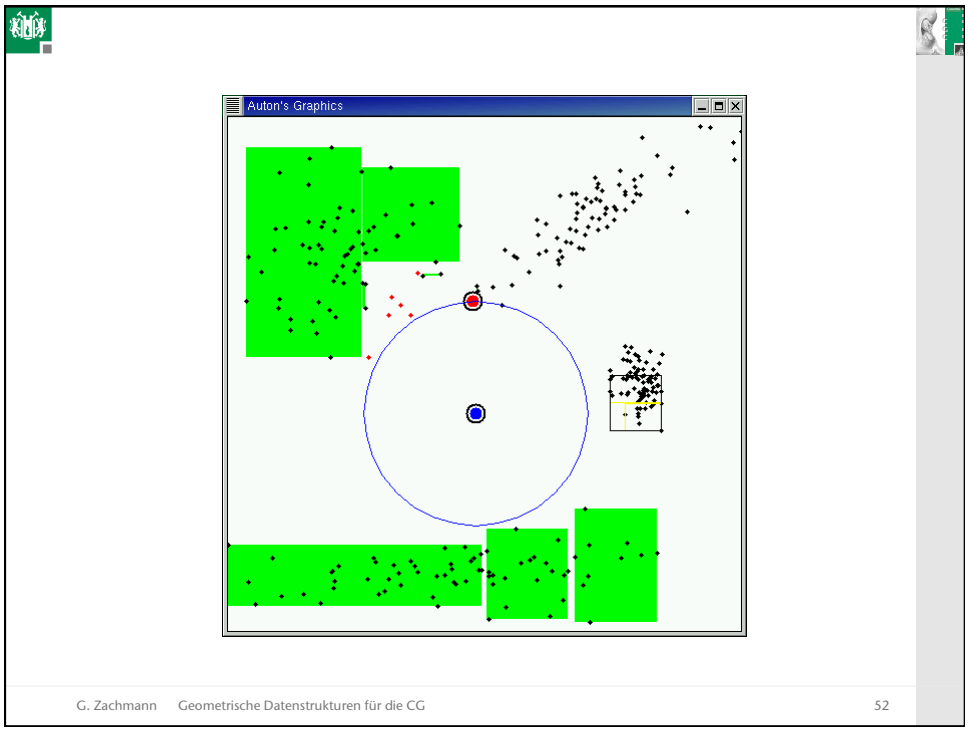
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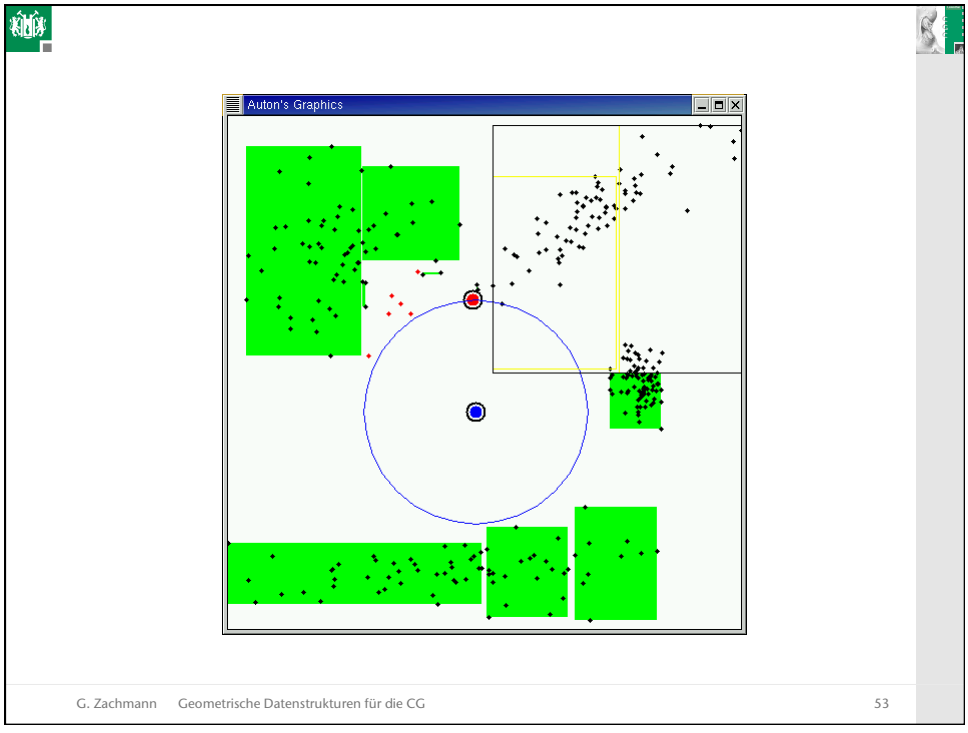
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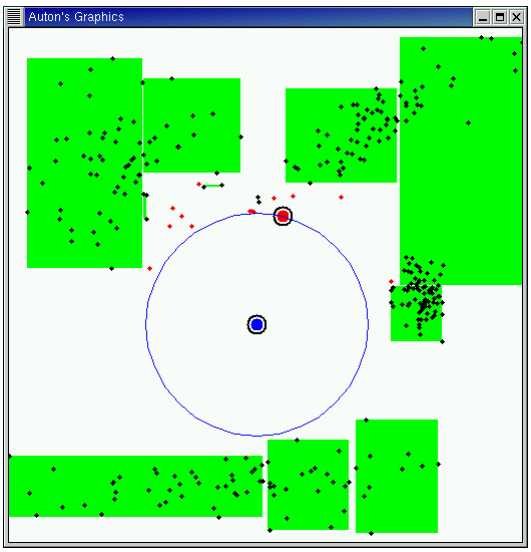
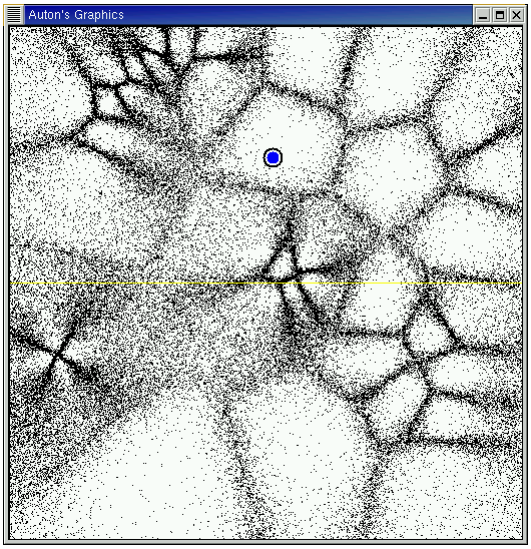
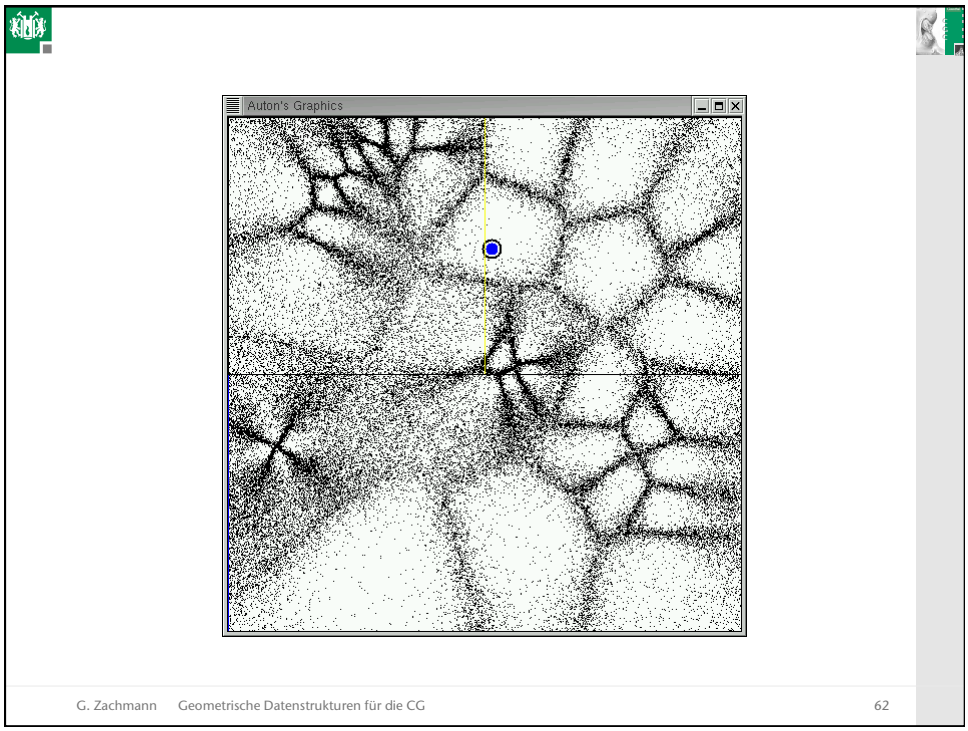


Animation of NN search with large data set

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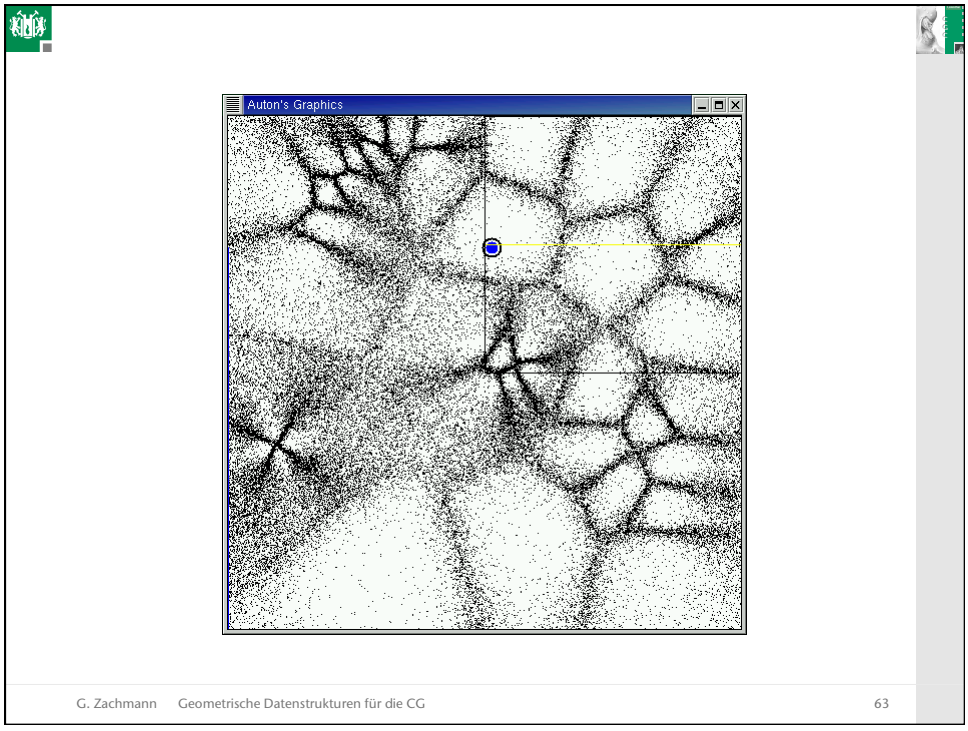
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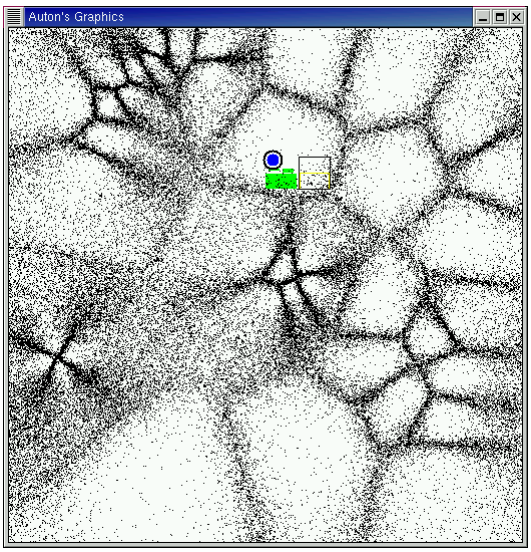
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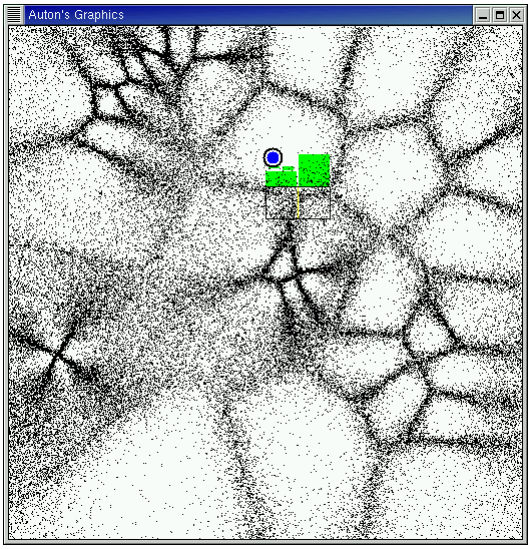
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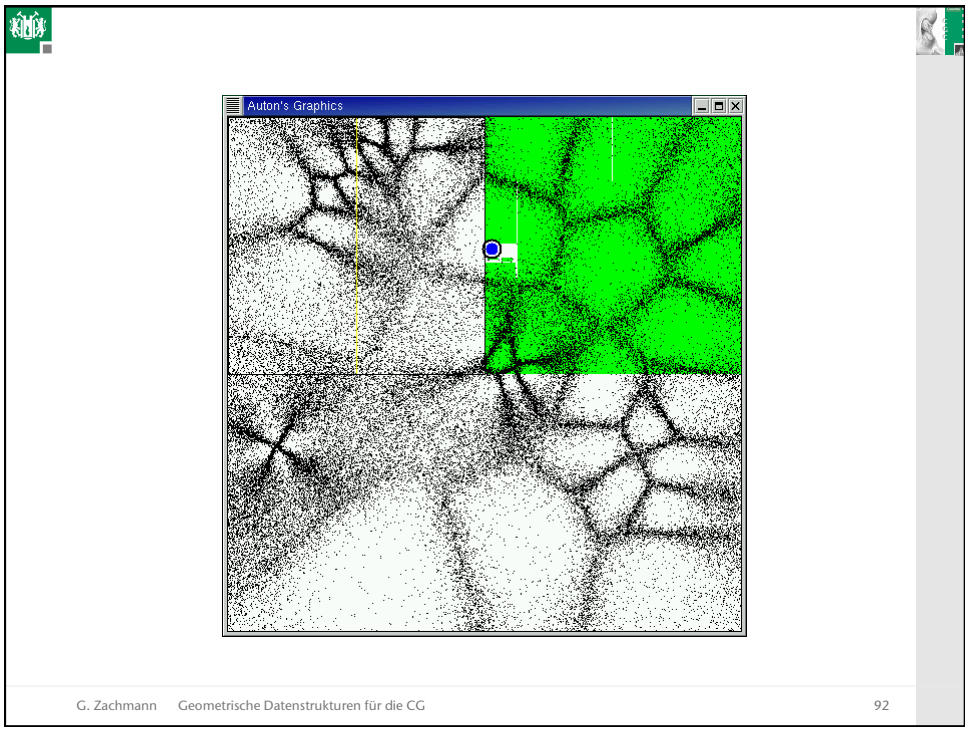
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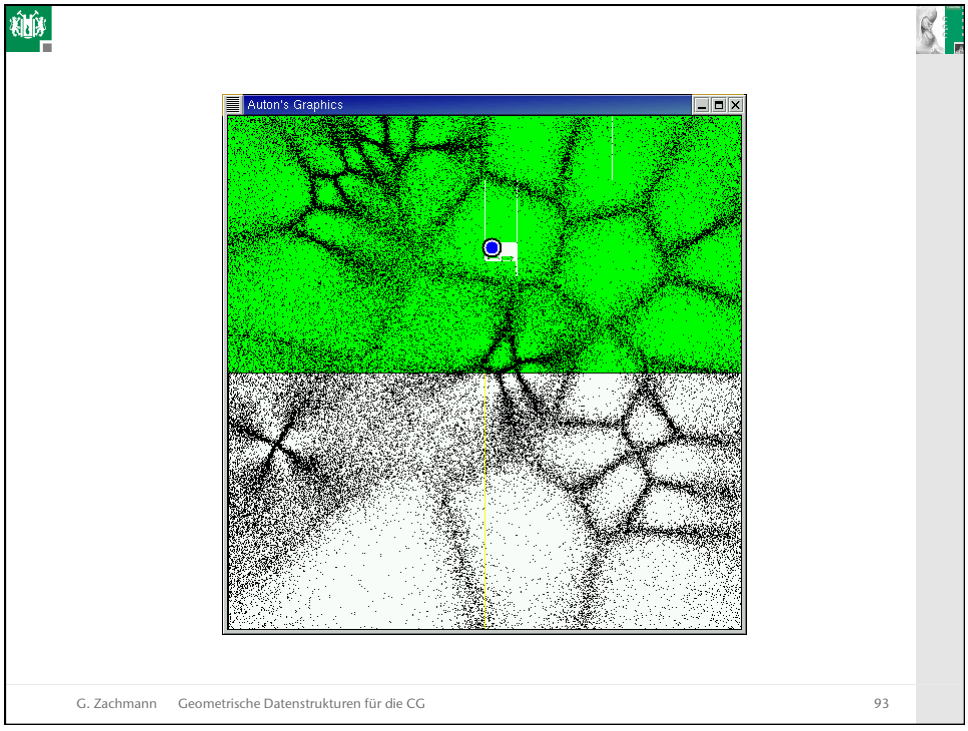
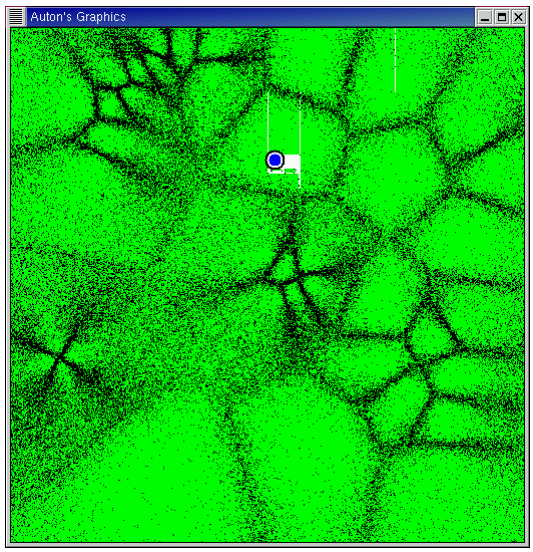
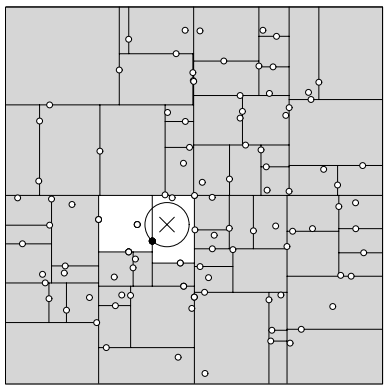
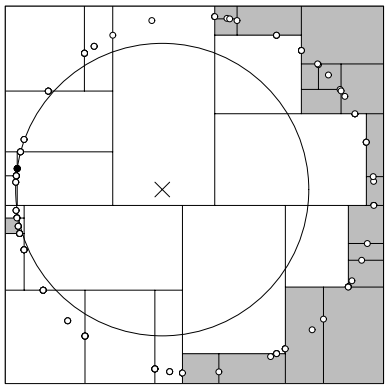

Auton's Graphics



A worst-case for NN-Search using kd-Trees



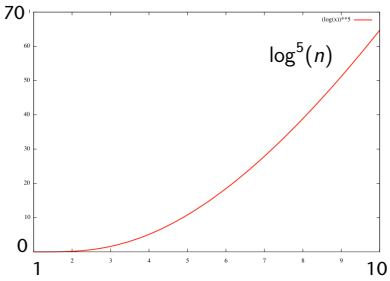


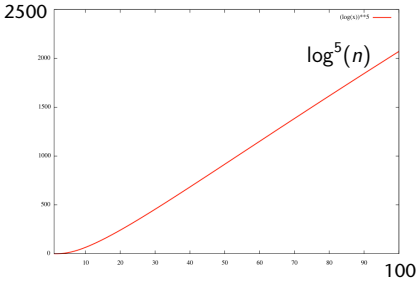
Gutartiger Fall

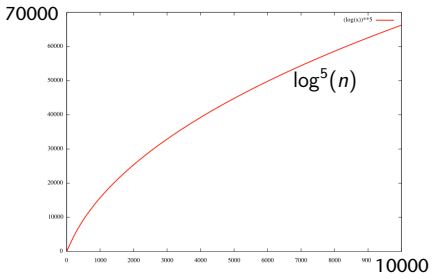
Bösartiger Fall

Alle weißen Blätter muß der NN-Algorithmus besuchen!

Zum Verhalten von $\log^d(n)$

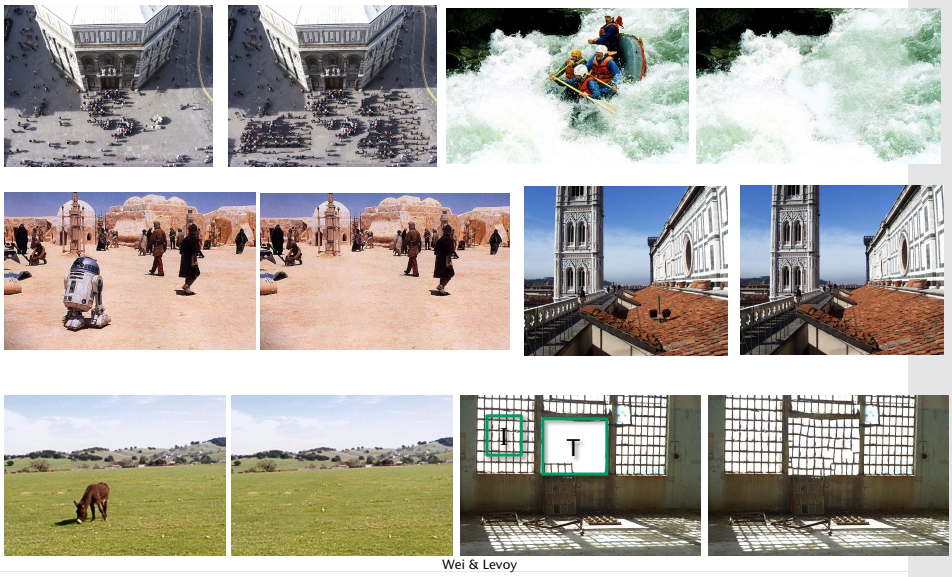




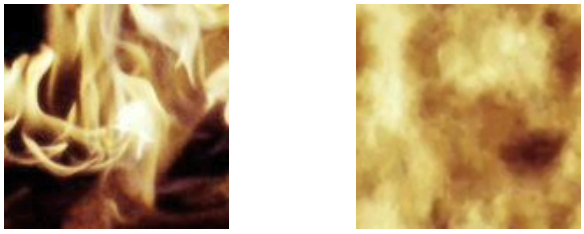


Der Algorithmus für die ANN-Suche ist also besser (asymptotisch) als brute-force-mäßig alle n Punkte zu besuchen und deren Abstand zum Query-Punkt q zu berechnen.

Texture Synthesis

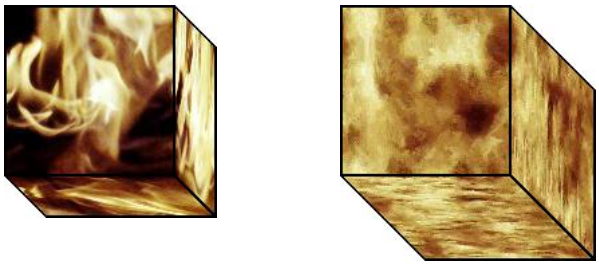


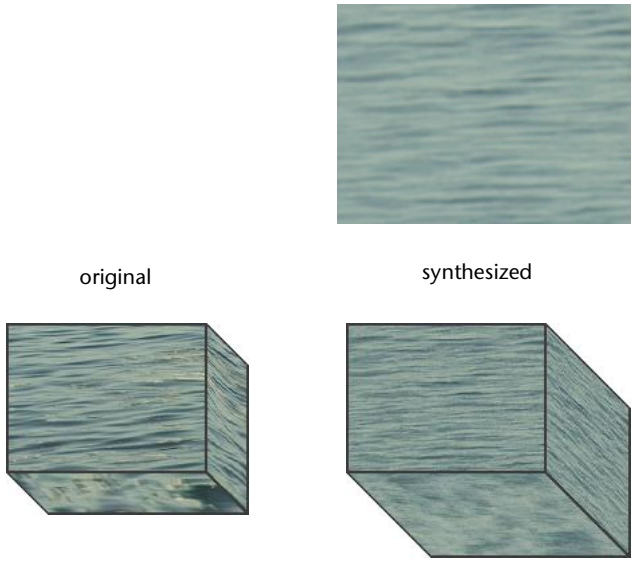
Wei & Levoy



original

synthesized





Stackless kd-tree traversal for ray-tracing

Stefan Popov, Johannes Günther, Hans-Peter Seidel, and Philipp Slusallek.
Nvidia GeForce 8800GTX, CUDA, 2007.

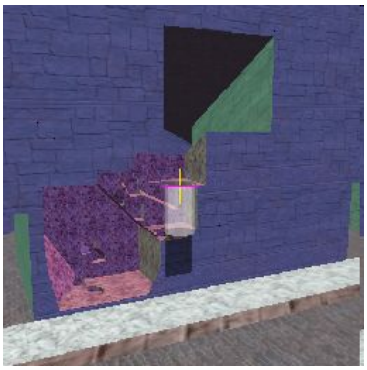
Daniel Horn, Jeremy Sugerman, Mike Houston, Pat Hanrahan
ATI X1900XTX, PixelShader 3.0, 2007

Real-Time KD-Tree Construction on Graphics Hardware

Kun Zhou, Qiming Hou, Rui Wang, Baining Guo; SIGGRAPH Asia 2008

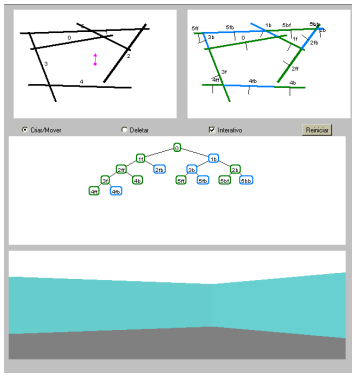
Applications of the BSP

Boolen Operations



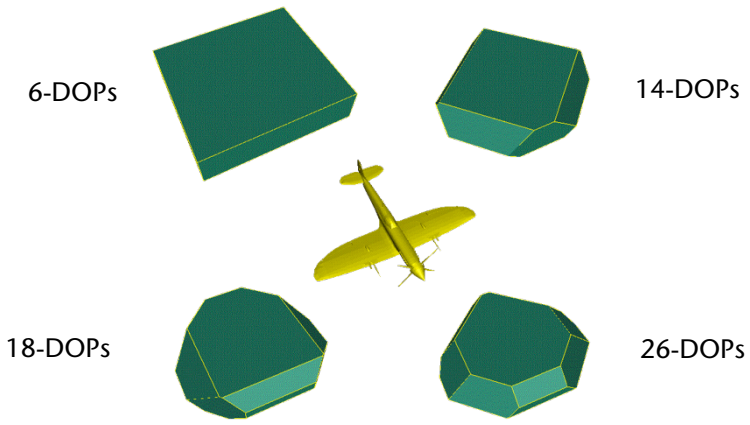
Stan Melax

Painter's Algorithm

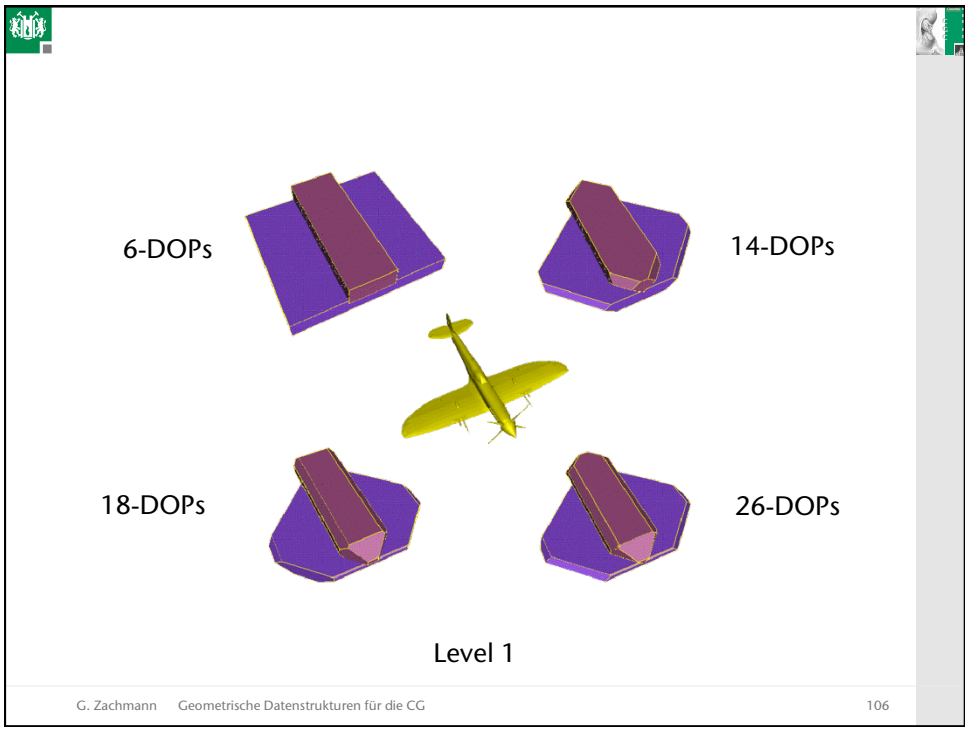


Paton J. Lewis

BVH mit *k*-DOPs



Level 0



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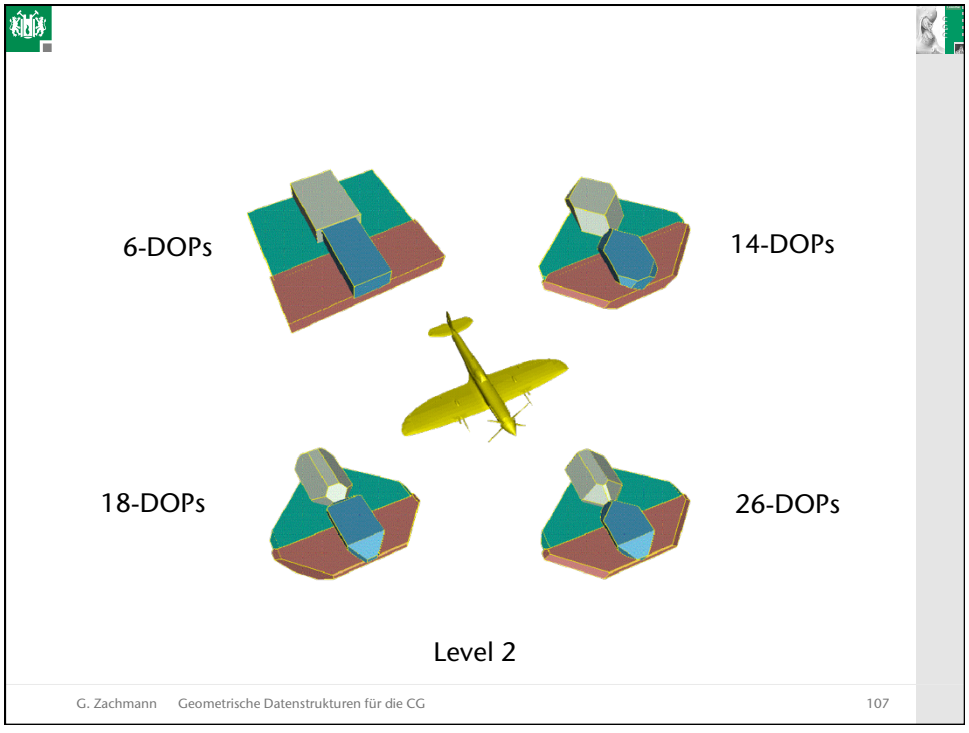

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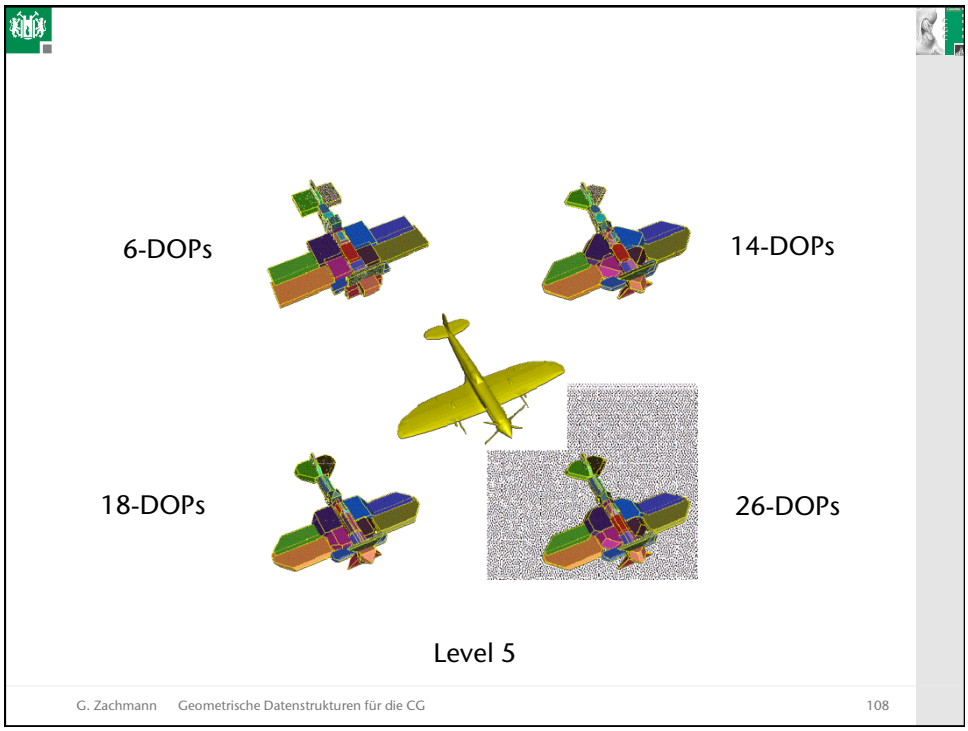

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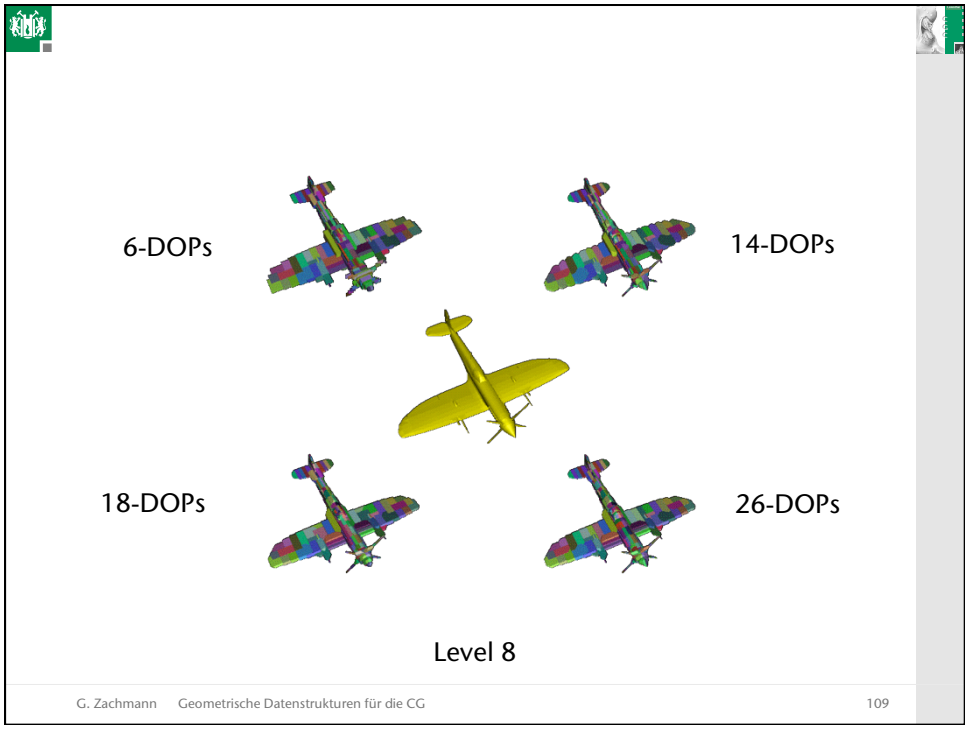
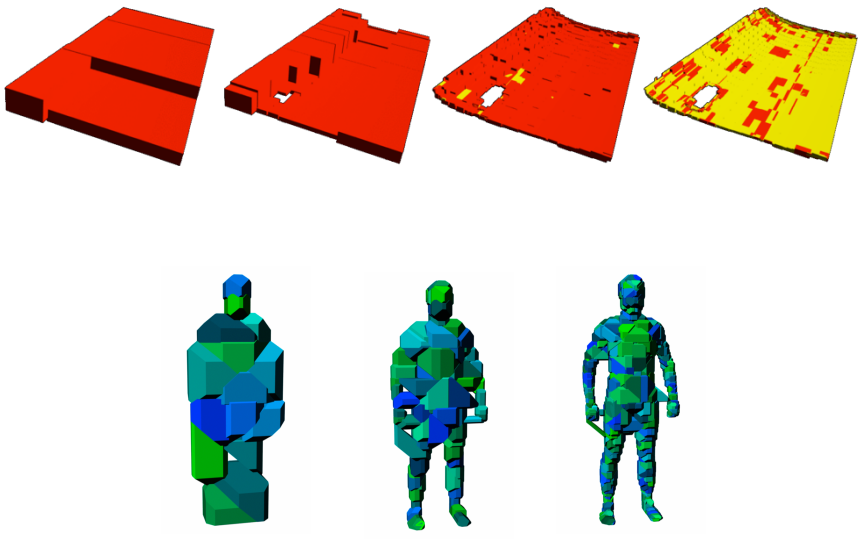
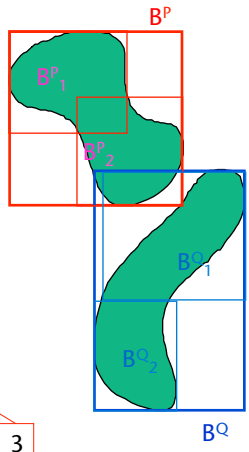


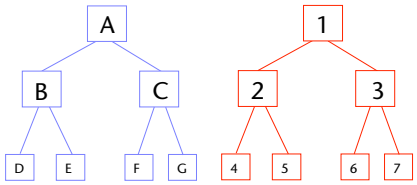
Level 8



Hierarchische Kollisionserkennung mittels BVHs

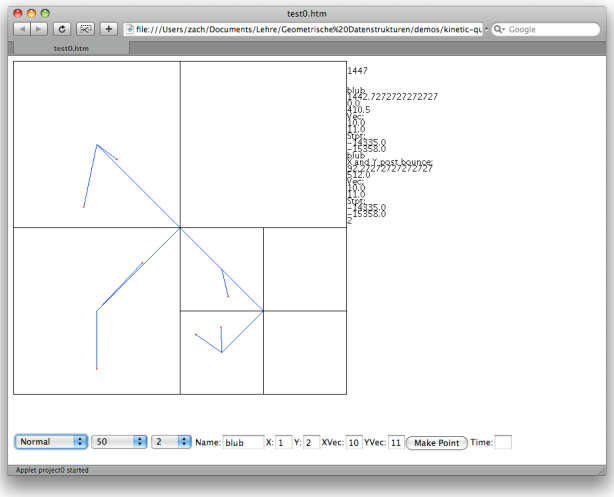
traverse(X, Y)
if X,Y do not overlap **then**
  return
if X,Y are leaves **then**
  check polygons
else
  for all children pairs **do**
  traverse(X_i, Y_j)



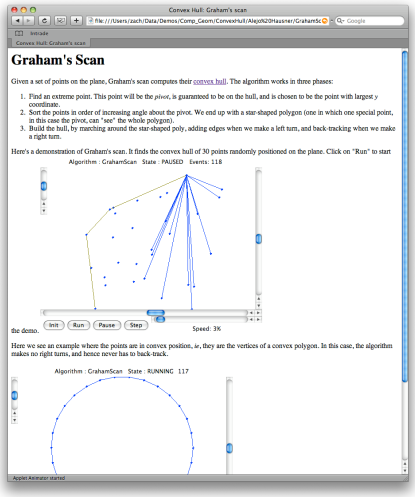


Applications using Distance Fields

Kinetic Quadtree Demo



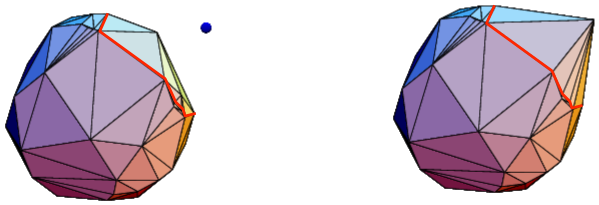
Convex Hull Demos in 2D

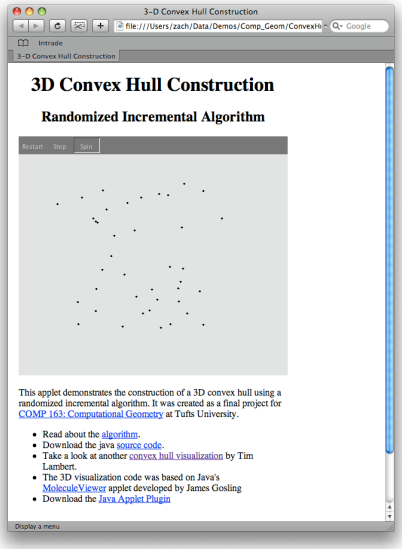


Alejo Hausner - http://www.cs.princeton.edu/~ah/alg_anim/version1/GrahamScan.html

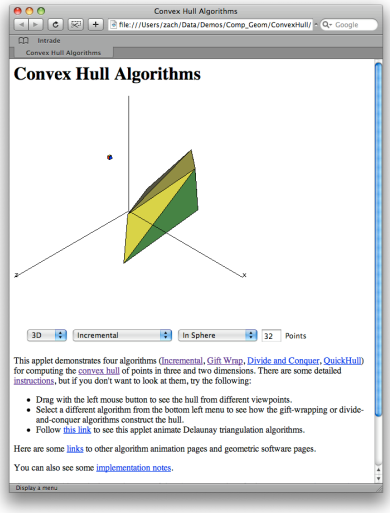
Convex Hull in 3D

- Ein Schritt des inkrementellen Algorithmus':



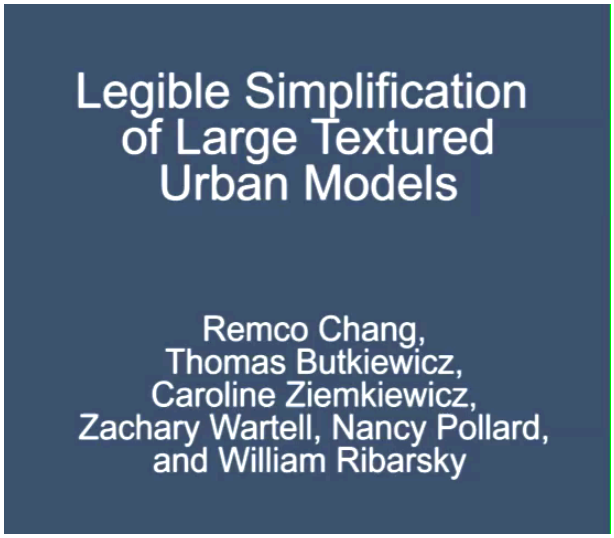


Michael Horn - http://www.eecs.tufts.edu/~mhorn01/comp163/



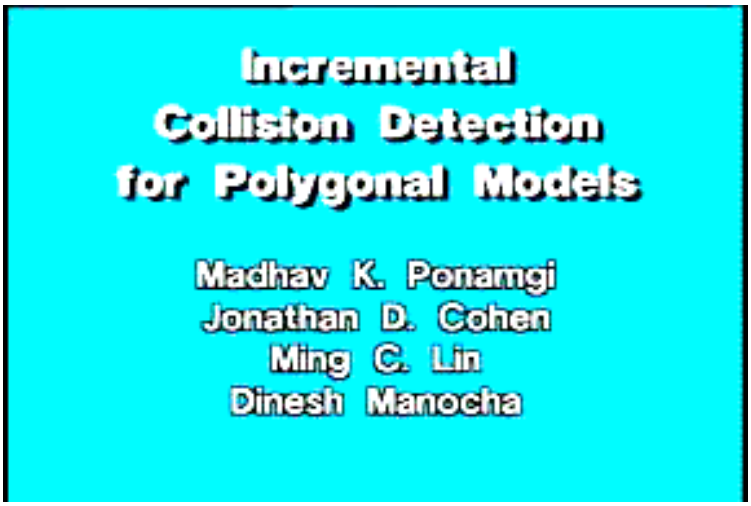
Tim Lambert - http://www.cse.unsw.edu.au/~lambert/java/3d/hull.html

Simplification of Urban Models



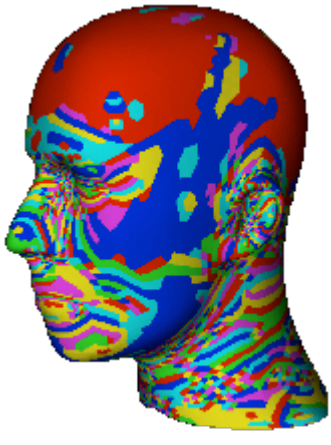
Remco Chang, Thomas Butkiewicz, Caroline Ziemkiewicz, Zachary Wartell, Nancy Pollard, William Ribarsky

Convex Collision Detection



Achtung: der hier demonstrierte Algo ist in Wahrheit
etwas komplexer als der in der Vorlesung dargestellte!
(aber möglicherweise nicht schneller ...)

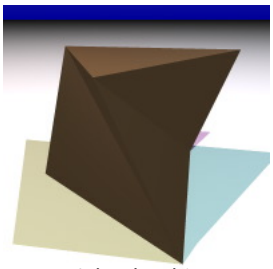
Convex Surface Decomposition



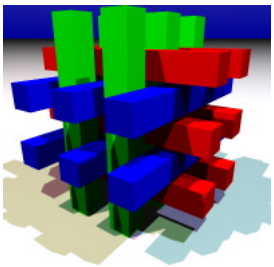
Zerlegung in
konvexe Surface-Patches

Konvexe Stücke auf einem
mittleren Level der Hierarchie
(grün = orig. Fläche, rot = freie Fläche,
gelb = "contained")

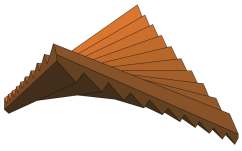
Untetrahedralizable Objects



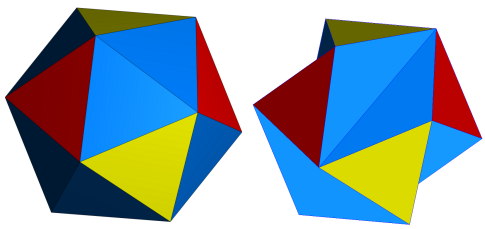
Schönhardt's
Polyeder
(1928)

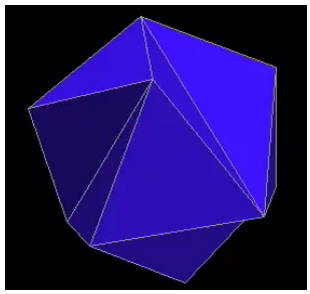


Thurston-
Polyeder
(1971)



Chazelle's
Polyeder
(1984)





Jessen's Ikosaeder