

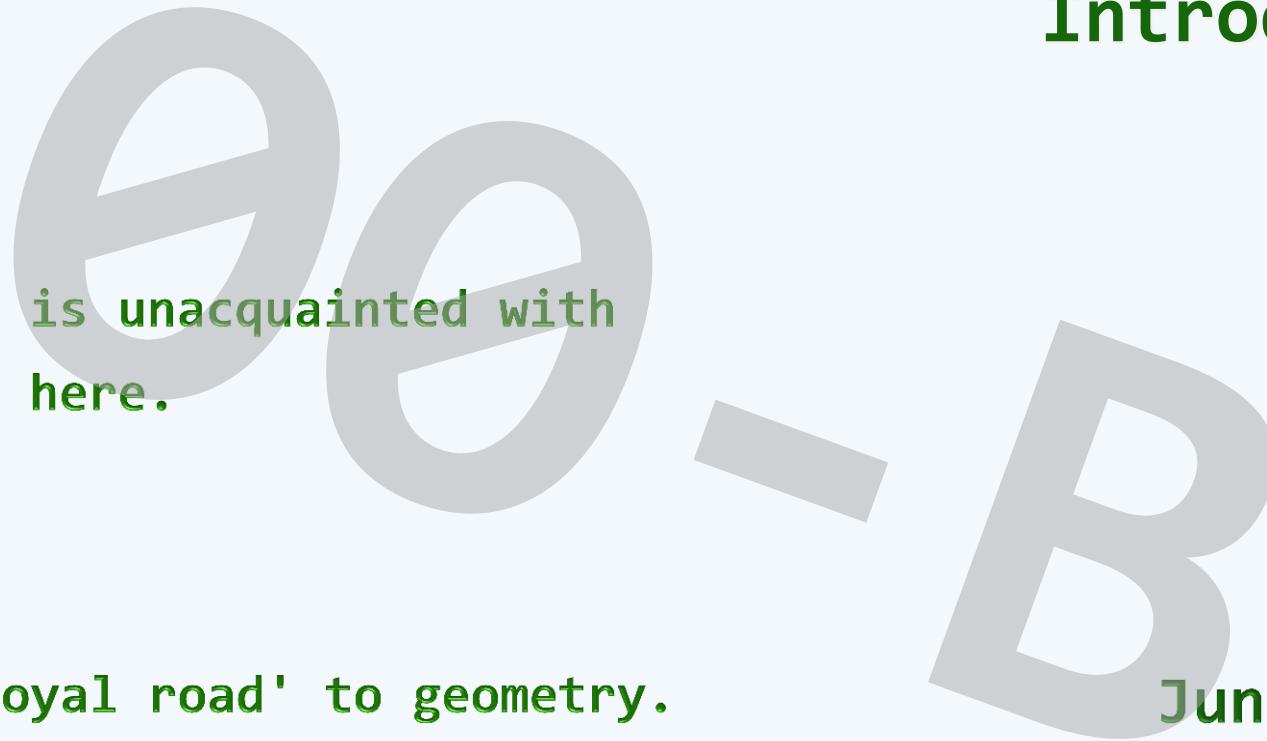
Introduction

Let no one who is unacquainted with geometry enter here.

- Plato

There is no 'royal road' to geometry.

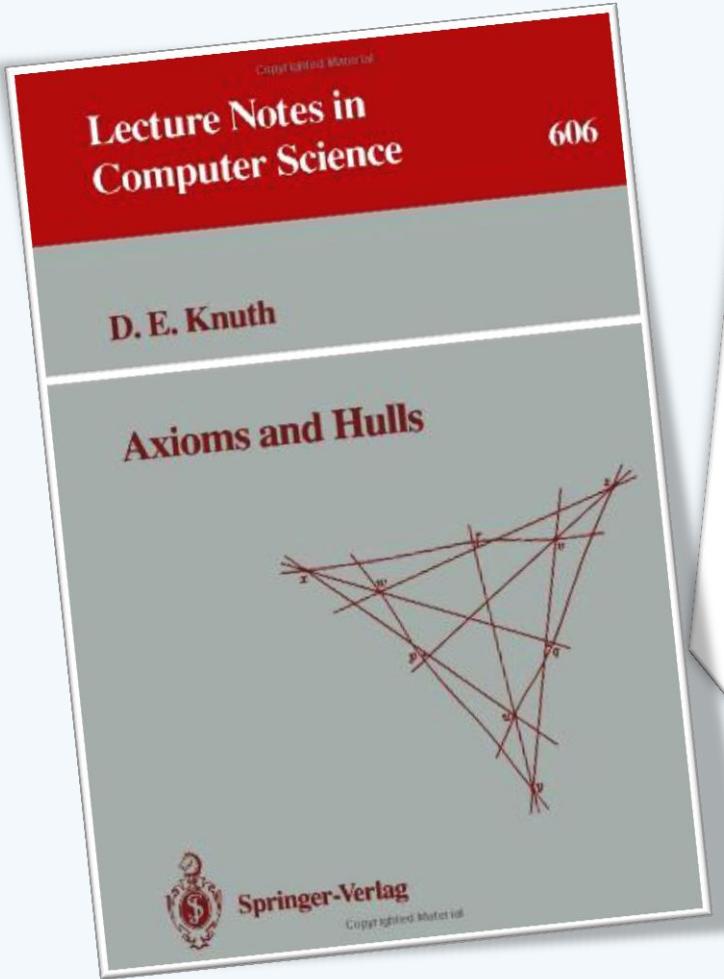
- Euclid



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D. Knuth & L. Guibas



We began to look for an algorithm that would find all neighboring pairs of points $\{p, q\}$, according to our criterion. But time ran out; our meeting had to break up, and we went our separate ways. I wonder what would have happened if we had had more time to explore the problem on our own, before learning that it was a famous problem in computational geometry.

Leo Guibas's office was next to mine, and we soon learned from him that points p and q are neighbors in S by our definition if and only if the line segment pq belongs to the so-called Delaunay triangulation of S . I had never encountered that branch of geometry before, and I hadn't had time to read much of the fast-growing literature of computational geometry. After all, I had never promised to write a book about such things, and the other topics that had kept me going for 30 years were already proving to be more than adequate to occupy an entire lifetime! Furthermore I knew that my geometric intuition was rather poor; algebra and logic have always been much easier for me than visualization. I have absolutely no ability to understand 3-dimensional objects until I have built physical models to represent them.

Computational Geometry: That vs. This

计算几何 (O241.5 3 @lib.THU)

苏步青、刘鼎元

上海科技出版社，1980年12月第一版



Computational Geometry

M. I. Shamos

Ph.D. Dissertation, **1978**, Yale



Classical: Discrete & Combinatorial

- ❖ Studying combinatorial properties and constructive methods of discrete geometric objects:
line, circle, polytope, ...

- ❖ The second sample problem in

Concrete Mathematics:

How many slices of pizza
can one obtain by
making n straight cuts?

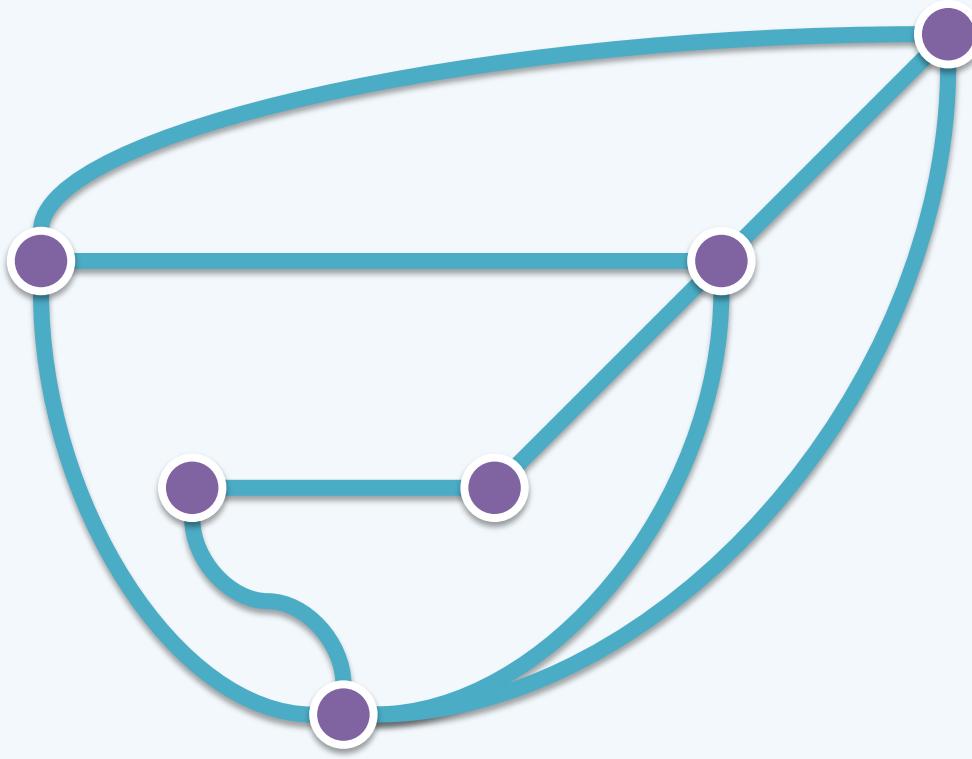
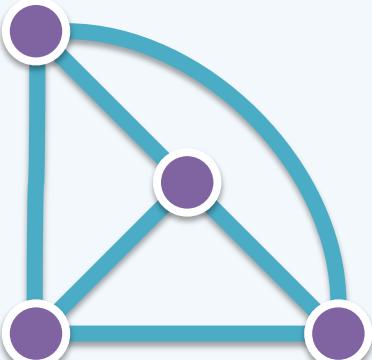


Classical: Discrete & Combinatorial

❖ [Euler's Formula]

$$V - E + F - C = 1$$

for any planar graph



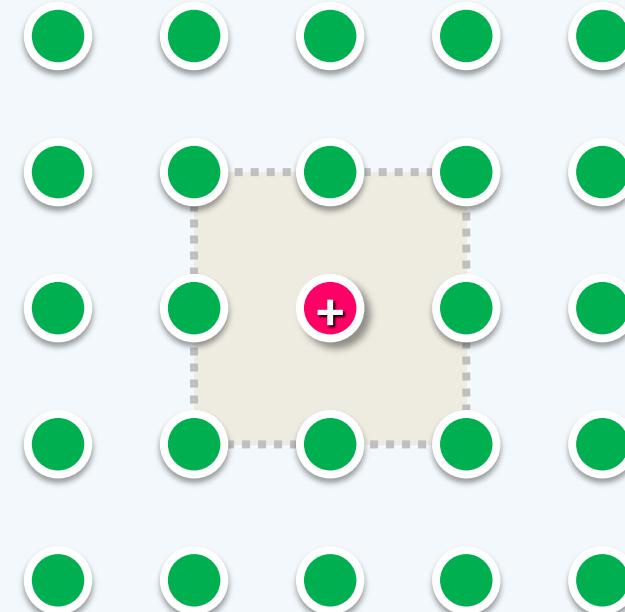
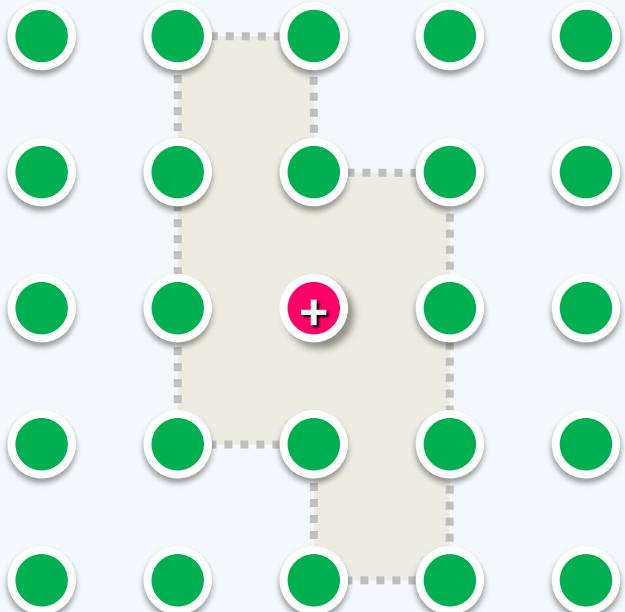
Classical: Discrete & Combinatorial

❖ [Minkowski's theorem]

Any **convex** set in \mathbb{R}^d which is

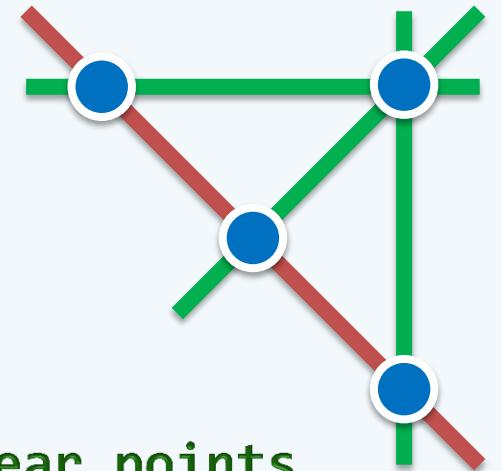
symmetric w.r.t to the origin and with a volume **Greater than 2^d**

contains a non-zero lattice point



Classical: Finite

- ❖ [Ordinary Line] //Sylvester's Problem, 1893
 - Does each non-collinear planar configuration admit an ordinary line?
- ❖ [Gallai, 1944]
 - Every non-collinear planar configuration admits an ordinary line!
- ❖ [Kelly & Moser, 1958]
 - Each planar configuration of n non-collinear points defines at least $\lceil \frac{3n}{7} \rceil$ ordinary lines
- ❖ [Hansen, 1981]
 - Each planar configuration of n ($\neq 7$ or 13) non-collinear points defines at least $\lceil \frac{n}{2} \rceil$ ordinary lines
- ❖ Polytope theory



Early Years

❖ Planar sorting & searching

convex hull (sorting)

center point (selection & median)

point location (search)

closest point (search)

orthogonal range searching

Voronoi diagram

❖ More Mathematics

Algebraic //e.g. Davenport-Schinzel sequences

Probability //e.g. backward analysis

Topology //e.g. higher-dimensional convex hull

Graph Theory //e.g. extremal graph theory

Differential Geometry

Since 1980's

- ❖ Higher dimensional //convex hull / triangulation / ...
discrete geometric structures and algorithms
- ❖ Generic geometric structures:
properties, algorithms and complexity //arrangement / k-set / ...
- ❖ Analysis and optimization of geometric algorithms //upper/lower bound
- ❖ Data structures for geometric problem solving
//quadtree / octree / k-d tree / tile tree / BSP tree / ...
//range tree / segment tree / Interval tree / priority search tree / ...
- ❖ Approximation/randomization of geometric algorithms
- ❖ Geometric algorithms with applications

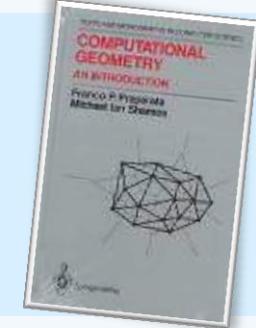
Books



Computational Geometry: An Introduction

by F. P. Preparata & M. I. Shamos

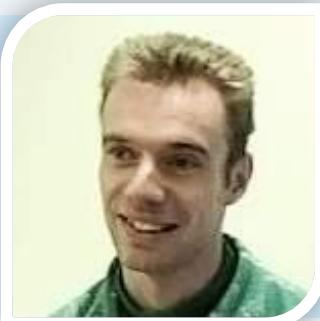
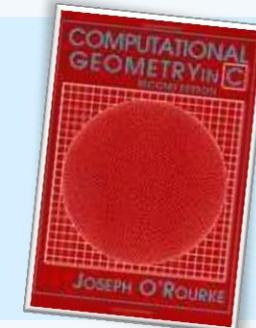
Springer-Verlag, Jan. 1985, ISBN: 0-387-96131-3



Computational Geometry in C, by J. O'Rourke

Cambridge University Press, Dec. 1998, 2nd edition

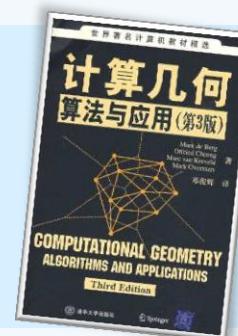
0-521-64010-5 (Hardback) & 0-521-64976-5 (Paperback)



Computational Geometry: Algorithms and Applications

by Mark de Berg, et al., Springer-Verlag, Mar. 2008, 3rd edition

ISBN: 978-3-540-77973-5 & 中译本: 978-7-302-19938-0

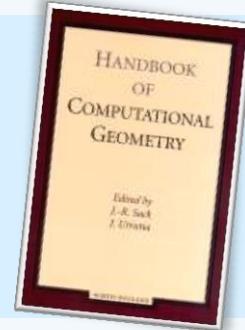


Books



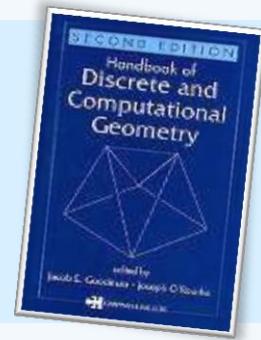
Handbook of Computational Geometry
by J. R. Sack & J. Urrutia (eds)

North-Holland, Jan. 2000, ISBN: 0-444-82537-1



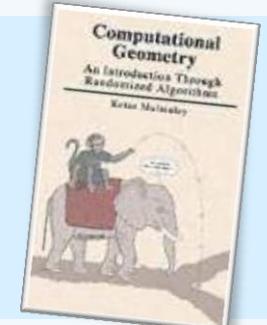
Handbook of Discrete and Computational Geometry
by J. E. Goodman and J. O'Rourke (eds)

CRC Press LLC, Boca Raton, FL, Jul. 1997, ISBN: 0-849-38524-5



Computational Geometry: An Introduction Through Randomized Algorithms
by K. Mulmuley

Pearson Education POD, Feb. 1998, ISBN: 0-133-36363-5



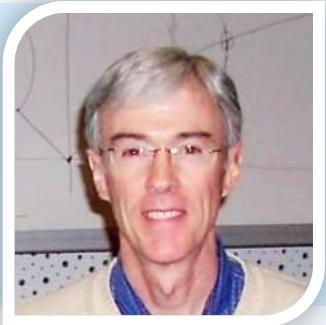
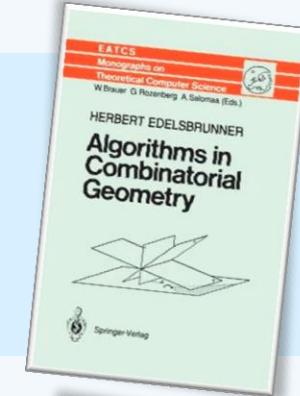
Books



Algorithms in Combinatorial Geometry

by H. Edelsbrunner

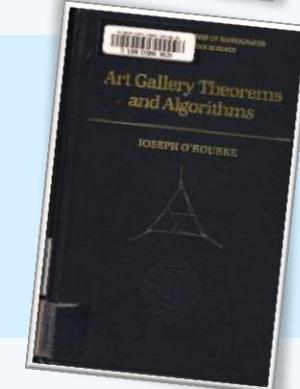
Springer-Verlag, Nov. 1987, ISBN: 0-387-13722-X



Art Gallery Theorems and Algorithms

by J. O'Rourke

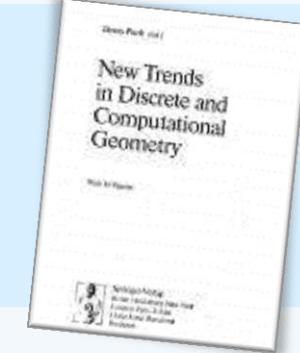
Oxford University Press, Nov. 1987, ISBN: 0-195-03965-3



New Trends in Discrete and Computational Geometry (Algorithms and Combinatorics, Vol. 10)

by J. Pach (eds)

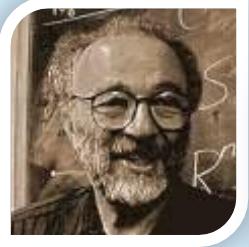
Springer Verlag, Mar. 1993, ASIN: 0-387-55713-X



Conferences

- ❖ SoCG: The ACM Symposium on Computational Geometry
SoCG'13, SoCG'12, SoCG'11, SoCG'10, SoCG'09, SoCG'08, SoCG'07,
SoCG'06, SoCG'05, SoCG'04, SoCG'03, SoCG'02, SoCG'01, SoCG'00, SoCG'99
- ❖ SoDA: The ACM-SIAM symposium on Discrete algorithm
SoDa'13, SoDa'12, SoDA'11, SoDA'10, SoDA'09, SoDA'08, SoDA'07,
SoDA'06, SoDA'05, SoDA'04, SoDA'03, SoDA'02, SoDA'01, SoDA'00, SoDA'99, SoDA'98
- ❖ CCCG: The Canadian Conference on Computational Geometry
CCCG'13, CCCG'12, CCCG'11, CCCG'10, CCCG'09, CCCG'08, CCCG'07,
CCCG'06, CCCG'05, CCCG'04, CCCA'03, CCCA'02, CCCA'01, CCCA'00, CCCA'99
- ❖ EuroCG: The European Workshop on Computational Geometry
EuroCG'13, EuroCG'12, EuroCG'11, EuroCG'10, EuroCG'09, EuroCG'08,
EuroCG'07, EuroCG'06, EuroCG'05, EuroCG'04, EuroCG'03, EuroCG'02, EuroCG'01
- ❖ JCDCG: Japan Conference on Discrete and Computational Geometry
JCDCG'04, JCDCG'02, JCDCG'00, JCDCG'98

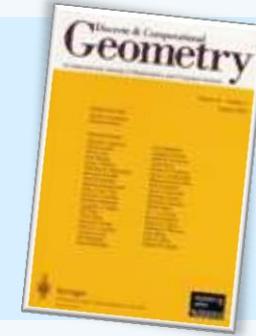
Journals



Discrete & Computational Geometry

R. Pollack, J. E. Goodman, J. Pach

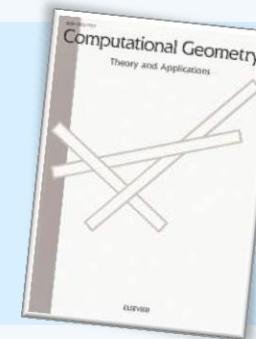
<http://springer.lib.tsinghua.edu.cn/content/100356/>



Computational Geometry: Theory & Applications

J.-R. Sack, K. Mehlhorn

<http://www.sciencedirect.com/science/journal/09257721>



Computational Geometry & its Applications

D. T. Lee, J. S. B. Mitchell

<http://worldscinet.lib.tsinghua.edu.cn/jour-list.nsp + IJCGA>



Resources

CG Authors	http://www.ics.uci.edu/~eppstein/gina/authors.html
CG Tribune	http://mathforum.org/library/view/6754.html
Geometry in Action	http://www.ics.uci.edu/~eppstein/geom.html
Geometry Junkyard	http://www.ics.uci.edu/~eppstein/junkyard/
Geom. Algorithms	http://geometryalgorithms.com
Dict. Combinatorics	http://www.southernct.edu/~fields/comb_dic/
CG Software Lib	http://compgeom.cs.uiuc.edu/~jeffe/compgeom/software.html
CG Algorithm Lib	http://www.CGAL.org/
LEDA	http://www.algorithmic-solutions.com/
K. Clarkson's HULL	http://www.cs.sunysb.edu/~algorith/implement/clarkson/implement.shtml
GeomView	http://www.GEOMVIEW.org/
J. Shewchuk's TRIANGLE	http://www.cs.cmu.edu/~QUAKE/triangle.html
M. Bern's Mesh Generation	http://www2.parc.com/csl/members/bern/mesh.html

Courses

- ❖ <http://www-2.cs.CMU.edu/~me/courses/geometry.html>
- ❖ <http://www.cs.UMD.edu/~samir/754/754.html>
- ❖ <http://graphics.STANFORD.edu/courses/courses.html>
- ❖ <http://compgeom.cs.UIUC.edu/~jeffe/compgeom/courses.html>
- ❖ <http://www.cs.PRINCETON.edu/courses/archive/spring02/cs451/>
- ❖ <http://www.cs.DUKE.edu/~pankaj/spring97/cps234.html>
- ❖ <http://cs.SMITH.edu/~orourke/274/>
- ❖ <http://www.cs.UCSB.edu/~suri/cs235/235.html>

Courses

- ❖ <http://www.cs.BROWN.edu/courses/cs252/>
- ❖ <http://cgm.cs.MCGILL.ca/~godfried/teaching/cg-web.html>
- ❖ http://www.ams.SUNYSB.edu/~jsbm/comp_geom/comp_geom.html
- ❖ <http://www.cs.UNC.edu/~snoeyink/comp290f01.html>
- ❖ <http://www.cs.NYU.edu/courses/fall00/G22.3033-009/nyucourse.html>
- ❖ <http://www.cc.GATECH.edu/people/home/schulman/cg.html>
- ❖ <http://www.cis.OHIO-STATE.edu/~wenger/cis788/cgeom/>
- ❖ <http://sal-cnc.me.WISC.edu/558.html>

Courses

- ❖ <http://dimacs.RUTGERS.edu/drei/96/course/>
- ❖ <http://www.cs.JHU.edu/~goodrich/teach/geom/>
- ❖ <http://web.comlab.OX.ac.uk/oucl/courses/topics01-02/cg/>
- ❖ <http://www.ics.uci.edu/~eppstein/266/>
- ❖ <http://www.cise.UFL.edu/~sitharam/COMPGEOM/compgeom.html>
- ❖ <http://marathon.csee.USF.edu/~sarkar/geometry.html>
- ❖ <http://www.cs.TECHNION.ac.il/~barequet/teaching/cg/current/>
- ❖ <http://www.cs1.MTU.edu/cs3621/www/Home.html>

Courses

- ❖ <http://www.owlnet.RICE.edu/~comp584/>
- ❖ <http://www.DIKU.dk/~pawel/comp-geom/compgeom99.html>
- ❖ <http://www.ecse.RPI.edu/Courses/S96/35679/>
- ❖ <http://www.cs.UTEXAS.edu/users/amenta/compgeom.html>
- ❖ <http://www.cs.TUFTS.edu/g/193GEO/>
- ❖ <http://cs.engr.UKY.edu/courses/cs677.html>
- ❖ <http://www.cs.UTAH.edu/~whitaker/classes/geom/>
- ❖ <http://www.erc.MSSTATE.edu/~bsoni/courses.html>