PROJECTS

* html & applet: explain a topic/result/theorem... etc
  interactive: a real learning tool
  many images, color, examples, animation
  (what is not possible in research papers)

You don’t have to implement the algorithm you’re describing
(just make the output appear that way)
Bonus: implement and test/compare.
HATE CODING?

- As mentioned, the requirements are already low.
- Options:
  - More theory -> much more
  - I will consider group projects: => 1 person codes
    \[x2\] total work
    (possibly 2 topics)
TOPICS

MODEL OF COMPUTATION

Straightedge & compass

RAM

BASIC GEOMETRIC OBJECTS & OPERATIONS

Again: François Labelle’s applet is great.
I don’t expect this much: A++

For this topic it’s up to you to propose something new.
I don’t see much left
TOPICS

CONVEX HULL
computing & updating

- Ultimate C.H. : demo or implement
- Chan’s C.H. \( \Rightarrow \) problem w/ input size for demo
- Tangent finding (also for intersecting polygons)
TBD

Probably not much left

(MINIMUM) WIDTH

TOPICS

DIAMETER

OF POINT SETS, POLYGONS, ETC
Topics

Art Gallery

How to Guard

Types of Guards

Lots of material & models.
- Book by O'Rourke.
- Papers.
TOPICS

SEGMENT INTERSECTION & PLANE SWEEP METHOD

OTHER INTERSECTION PROBLEMS

TBD
TOPICS

TRIANGULATIONS

ALGORITHMS & PROPERTIES

- EAR-finding (includes diagonal insert & GSP).
  \(\Rightarrow\) improve Ian Garto's page
- Improve 3-coloring & Thierry Dagnino.
- Show triangulation of specific polygon classes
TOPICS

POINT LOCATION

for the remaining topics you will have to ask me, and I will find if there is something suitable.
TOPICS

LINE ARRANGEMENTS

DUALITY
TOPICS

HAM SANDWICH CUTS

BORSUK-ULAM thm.

HAIRY BALL thm.
TOPICS

UNIT DISTANCE GRAPH

probably some possibilities here

PAINTING THE PLANE

FUN PAUL ERDÖS PROBLEMS

e.g. Sylvester-Gallai thm or distinct slope problem or Erdős-Szekeres thm. or empty k-gon
overdone

Voronoi Diagrams

&

Delaunay Triangulations
TOPICS

LARGEST EMPTY CIRCLE
SMALLEST ENCLOSED CIRCLE

PROXIMITY GRAPHS
TOPICS

LINEAR PROGRAMMING
  (2D solution)

PARAMETRIC SEARCH
TOPICS

OTHER METRICS/DISTANCES

CURVE SIMILARITY (distance)

POLYGONAL APPROXIMATION
TOPICS

DATA DEPTH

- definite possibilities

SPANNERS & DETOURS

- possible
  - several algorithms
TOPICS

LINKAGES
should be a range of varying difficulty
most interesting stuff is 3D

SEPARABILITY
probably limited

More opportunities will appear after each lecture
OTHER SOURCES FOR TOPICS

- I will try to put together a list
- Possibly re-do old projects: will require a bit more: 2 x 12 = 1 na?
  
  cg.m.c5.mc.gill.ca/nathens/cs507/Projects

- Read abstracts:
  
  CCCG
  EuroCG
  SoCG
  LATIN, ISAAC, SODA, ESA
  
  conf | journal
  CGTA
  IJCGA
  DCG

Find something that is described well, has clear definitions, figures...
If topic too hard, just do partial: (a THM)
• Reconfiguring triangulations with edge flips and point moves
  \[\leftrightarrow\] lots of related literature on "flipping"

• Vertex pops ... (flips & flipturns & other permutations on polygons)
- Convexifying polygons without losing visibilities

- Where to build a temple and where to dig to find one

- Finding regular polygons in a point set
- Even if not complete
• Bichromatic compatible matchings ➔ possible new research

• Non-crossing matchings of points with geometric objects

ex: how to find this or this or this ➔
• Establishing strong connectivity using optimal-radius half-disk antennas

Place antennas on points.
- Determine angle & radius to maintain full connectivity
  you choose orientations

• Covering points with disjoint unit disks

input: disk size

point set coverable by disjoint disks

Q: what point sets are not coverable?
how many points do you need?
• Coloring geometric range spaces
• Decomposition of multiple coverings into more parts
• Colorful strips

- probably more challenging
  ...so that any halfplane (or other shape of choice) containing "enough" points will have all colors

\[ \text{area covered twice} \]

\[ \begin{aligned} \text{input} & \quad \rightarrow \quad \text{you color...} \\
& \quad \quad (\& \text{pick # colors}) \end{aligned} \]

\[ \begin{aligned} \text{how many times} \\
\text{must area be covered, so that} \\
\text{we can split set} \\
\text{and each group still cover once?} \end{aligned} \]
Algorithms for bivariate medians and a Fermat-Torricelli problem for lines

- Find point inside most triangles
- \( n = n \) w/ min. weighted \( \Sigma \text{dist to} \)

more of a "data depth" implementation / update project

research other depths
Triangulating and guarding realistic polygons

"Realistic input" problems in general: e.g.,

Polygon triangulation: $O(n)$ but complicated in general

: $O(n)$ but easy for ... convex, star shaped....

4) Easily guardable.

Given a k-guardable polygon (without knowing k or guards)

4) Find an easy triangulation in $O(ku)$. 

Extra: project on computing visibility region of segment
Meshes preserving minimum feature size

min dist between non-adjacent objects

How to triangulate (allowing new pts) and preserve feature size

input

bad

good

potentially much better
Blocking coloured point sets

Constructing coloured point sets so that any \( \bullet \neq \bullet \) see each other and any \( \bullet = \bullet \) don't (and similar problems).
Draining a polygon -or- rolling a ball out of a polygon

- Fill polygon with water
- Place hole(s)
- Pick a gravity direction = tilt a bit
- Drain
- If leftover water, tilt again, etc

How many holes do you need?

(related to casting)
- Circle separability queries in logarithmic time

- You own a space station.
- "Pre-process" it, e.g., compute whatever you like
- I own a spaceship
  I just decloaked & am ready to attack
- You have to set up your
  □ → force field to keep me out
  Force fields cost money. The smaller the better.
Highway hull (revisited)

In general: geometry problems where distance is affected by highways.

plane: speed=1

speed > 1

Several models & problems

"highway hull" is specifically about defining & computing C.H.
Locating a line at unit distance with multiple agents

What path(s) are best, to search for a beach one mile away but in unknown direction, in the fog?
• Order-type invariant labeling and comparison of point sets

Triangulation shape doesn't rely on co-ordinates, only combinatorial relation between points.

How can this be done? How can you tell if two point sets are combinatorially equivalent?