「初中数学都不会」
——Computational Geometrics

Chris Xiong

2017-08-18

「初中数学都不会」

- Basics
  - Vectors
  - Distances
  - Area
  - Intersections
  - Transformations
- Convex hull
- Extra fun
- Templates
- 殴打宇宙智障

Basics

- Computational Gemoetrics in ICPC=
    - 40% Junior high school maths+
    - 30% Senior high school maths+
    - 20% Brainstorming+
    - 10% College maths
- **u**, **v**, $\vec{u}$, $\vec{v}$
- $\vec{u} + \vec{v}, \vec{u} - \vec{v}, s\vec{u}, \vec{u} \cdot \vec{v}, \vec{u} \times \vec{v}$

Basics
Distances

- point 2 point
- point 2 line

Basics

Distances

- point 2 point
- point 2 line
- polygon 2 polygon???

Basics

Area

- ► Circle???
- ► Triangle?
  - ► $ah/2$
  - ► Heron's formula
  - ► Cross product
- ► Polygon???
  - ► Slicing

Basics

Intersections

- point & line
- point & segment
- line & line
- line & segment
- segment & segment
- circle & line
- circle & circle

Basics

Intersections

- point & line
- point & segment
- line & line
- line & segment
- segment & segment
- circle & line
- circle & circle
- ~~convex~~ polygon & point

Basics
Intersections

- point & line
- point & segment
- line & line
- line & segment
- segment & segment
- circle & line
- circle & circle
- ~~convex~~ polygon & point
  - ~~randomizing~~ (polyhedron)
  - ray casting
  - winding number

Basics

Transformations

- Scaling
- Rotation
- $\begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix}$
- $\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$

Convex hull
WTF???

- Smallest convex polygon (set) that contains a set of points.

Convex hull

Algorithms

- Brute force: gift wrapping
- Graham scan

Convex hull
Gift wrapping

- The left most point must be in the resulting set
- Starting from that point, select the next point such that all points are **to the right** of the newly formed line.
- Time complexity: $O(nh)$

Convex hull
Graham scan

- Find an extreme point and sort the remaining point according to polar angle.
- Start with a stack with two items, the extreme point and the first point in the sorted list.
- (P_0 denotes the top element of the stack, P_1 denotes the element under P_0) For each point left in the list (T), pop the stack until $\overrightarrow{P_1 P_0}$ and $\overrightarrow{P_0 T}$ forms **a left turn**. Then push T onto the stack.
- Time complexity: $O(n log n)$ (with sorting)

Convex hull

Example: NEERC 08 A

Extra fun
Example: PetrSU SC 04 C

Arc-arc intersection

PROBLEMS SUBMIT CODE **MY SUBMISSIONS** STATUS STANDINGS CUSTOM INVOCATION

My Submissions

#	When	Who	Problem	Lang	Verdict	Time	Memory
26373052	2017-04-15 10:11:48	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26075584	2017-04-02 13:36:49	chirs241097	C - Creativity	GNU C++14	Accepted	15 ms	2100 KB
26075411	2017-04-02 13:27:09	chirs241097	C - Creativity	GNU C++14	Accepted	15 ms	2100 KB
26073761	2017-04-02 12:01:10	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 8	15 ms	2100 KB
26073622	2017-04-02 11:53:54	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 8	15 ms	2000 KB
26072340	2017-04-02 10:49:31	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2100 KB
26072137	2017-04-02 10:38:47	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26069587	2017-04-02 08:16:43	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26059861	2017-04-01 19:51:49	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26058136	2017-04-01 18:40:41	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26056970	2017-04-01 17:53:11	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB
26056698	2017-04-01 17:42:13	chirs241097	C - Creativity	GNU C++14	Wrong answer on test 4	15 ms	2000 KB

Extra fun

Example: PetrSU SC 04 C

ID	Who	Contest	When	Problem	Compiler	Result	Time	Memory	
127331	chirs241097	20030827	1:59:19	C. Creativity	GPP 5.1.0	Accepted			Log Src
127330	chirs241097	20030827	1:52:36	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127329	chirs241097	20030827	1:49:55	C. Creativity	GPP 5.1.0	Wrong answer on test #7			Log Src
127328	chirs241097	20030827	1:46:59	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127327	chirs241097	20030827	1:46:40	C. Creativity	GPP 5.1.0	Idleness limit on test #1			Log Src
127326	chirs241097	20030827	1:44:53	C. Creativity	GPP 5.1.0	Wrong answer on test #7			Log Src
127325	chirs241097	20030827	1:41:31	C. Creativity	GPP 5.1.0	Wrong answer on test #7			Log Src
127324	chirs241097	20030827	1:40:56	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127323	chirs241097	20030827	1:40:02	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127322	chirs241097	20030827	1:37:58	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127321	chirs241097	20030827	1:35:12	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127320	chirs241097	20030827	1:32:08	C. Creativity	GPP 5.1.0	Presentation error on test #8			Log Src
127319	chirs241097	20030827	1:31:26	C. Creativity	GPP 5.1.0	Idleness limit on test #1			Log Src
127317	chirs241097	20030827	0:01:47	C. Creativity	GPP 5.1.0	Wrong answer on test #4			Log Src

Extra fun

Example: MultiUniversity Traning 20170815 H

Extra fun

Example: Asia GuangzhouRC 14 H

Extra fun
Example: "Angry birds"

One of the few problems of computational geometrics in ICPC that involves college maths.

Extra fun

CG. Combined with other algorithms

Extra fun
Rotating calipers

Solves:
- Max/min width of convex polygon
- Max/min distance between two convex polygons
- Antipodal points/Farthest pairs
- Union/intersection of convex polygons
- Min area/perimeter obb
- etc.

Templates
Critical for Computational Geometrics (maybe)

- Basic operations
- Basic intersections
- Circle-line intersection
- Circle-triangle intersection
- Circle-circle intersection
- 3D vector operations
- Half-plane intersection
- Cloest/Farthest Pair
- etc.

殴打宇宙智障

- 建完图后把图清空然后跑网络流

殴打宇宙智障

光辉事迹+1

- ▶ 建完图后把图清空然后跑网络流
- ▶ 熟悉你的模板

殴打宇宙智障

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- 熟悉你的模板
- 多校睡觉

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- 多校睡觉
- 队伍组成
- 代码手?

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- 违反中央八项规定

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光辉事迹+1

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- ▶ 代码手?
- ▶ 违反中央八项规定
- ▶ 口技

殴打宇宙智障

后事

- 21日最后一次讲课
- 8月31日计科退宿舍
- 如有不同以宇宙智障为准

殴打宇宙智障
没来得及讲的东西

- 概率（解方程/dp）、高斯消元
- 网络流
- 好像没什么了?
- Good luck to ya.