



Tecnológico de Monterrey

Tecnológico de Monterrey - Campus Monterrey
School of Engineering and Sciences
Engineering in Computational Technologies
Analysis and Design of Advanced Algorithms

Homework 12: Convex Hull: Graham Scan and Jarvis March

Group: 607
Team #3

Luis Salomón Flores Ugalde

Santiago Quintana Moreno A01571222
Miguel Ángel Álvarez Hermida a01722925

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Homework12_Gift_Jarvis.py ×

Homework12 > Homework12_Gift_Jarvis.py > read_points

```
1 # Analysis and Design of Advanced Algorithms
2 # Group #607
3 # Team 3
4 # Luis Salomón Flores Ugalde
5
6 # Santiago Quintana Moreno A01571222
7 # Miguel Ángel Álvarez Hermida A01722925
8
9 # ----- HW 12: Convex Hull: Graham Scan and Jarvis March -----
10
11 from math import atan2
12 import sys
13 import os
14 import glob
15 from typing import List, Tuple, Iterable
16 import matplotlib.pyplot as plt
17 from matplotlib.patches import Polygon
18
19 Point = Tuple[float, float]
20
21
22 def read_points(path: str) -> List[Point]:
23     pts: List[Point] = []
24     with open(path, "r", encoding="utf-8") as f:
25         for line in f:
26             line = line.strip()
27             if not line or line.startswith("#"):
28                 continue
29             parts = line.replace(",", " ").split()
30             if len(parts) < 2:
31                 continue
32             x, y = float(parts[0]), float(parts[1])
33             pts.append((x, y))
34     return pts
35
36
37 def unique_points(points: Iterable[Point]) -> List[Point]:
38     seen = set()
39     out = []
40     for p in points:
41         if p not in seen:
42             seen.add(p)
43             out.append(p)
```

powershell ×

Processing: puntos-n10.txt

Points (n=10): [(-2.423, -8.469), (5.721, 9.354), (6.766, -3.823), (4.129, 6.744), (5.371, -5.404), (-8.101, 0.904), (-7.121, 1.38), (8.156, 6.039), (2.615, 2.077), (-0.822, 9.342)]

Graham Scan ---

Hull (h=7): [(-2.423, -8.469), (5.371, -5.404), (6.766, -3.823), (8.156, 6.039), (5.721, 9.354), (-0.822, 9.342), (-8.101, 0.904)]

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Jarvis March ---

Hull (h=7): [(-2.423, -8.469), (-8.101, 0.904), (-0.822, 9.342), (5.721, 9.354), (8.156, 6.039), (6.766, -3.823), (5.371, -5.404)]

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Hull (h=7): [(-5.084, -17.237), (19.759, -14.866), (14.789, 10.899), (-7.535, 16.486), (-14.452, 17.516), (-18.808, 0.094), (-17.786, -15.884)]

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Homework12 > Homework12_Gift_Jarvis.py > read_points

```
43     return out
44
45 def cross(o: Point, a: Point, b: Point) -> float:
46     return (a[0] - o[0]) * (b[1] - o[1]) - (a[1] - o[1]) * (b[0] - o[0])
47
48 def dist2(a: Point, b: Point) -> float:
49     dx, dy = a[0] - b[0], a[1] - b[1]
50     return dx*dx + dy*dy
51
52 def leftmost_lowest(points: List[Point]) -> Point:
53     return min(points, key=lambda p: (p[1], p[0]))
54
55 # ----- Graham Scan -----
56
57 def graham_scan(points: Iterable[Point]) -> List[Point]:
58     pts = unique_points(points)
59     n = len(pts)
60     if n <= 1:
61         return pts[:]
62     anchor = leftmost_lowest(pts)
63
64     def angle_key(p: Point):
65         return (atan2(p[1] - anchor[1], p[0] - anchor[0]), -dist2(p, anchor))
66
67     sorted_pts = sorted((p for p in pts if p != anchor), key=angle_key)
68
69     filtered: List[Point] = []
70     last_angle = None
71     last_best = None
72     for p in sorted_pts:
73         ang = atan2(p[1] - anchor[1], p[0] - anchor[0])
74         if last_angle is None or abs(ang - last_angle) > 1e-15:
75             if last_best is not None:
76                 filtered.append(last_best)
77             last_angle = ang
78             last_best = p
79         else:
80             if dist2(anchor, p) > dist2(anchor, last_best):
81                 last_best = p
82     if last_best is not None:
83         filtered.append(last_best)
84
```

powershell ×

Processing: puntos-n10.txt

Points (n=10): [(-2.423, -8.469), (5.721, 9.354), (6.766, -3.823), (4.129, 6.744), (5.371, -5.404), (-8.101, 0.904), (-7.121, 1.38), (8.156, 6.039), (2.615, 2.077), (-0.822, 9.342)]

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Hull (h=7): [(-2.423, -8.469), (-8.101, 0.904), (-0.822, 9.342), (5.721, 9.354), (8.156, 6.039), (6.766, -3.823), (5.371, -5.404)]

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Homework12_Gift_Jarvis.py ×

Homework12 > Homework12_Gift_Jarvis.py > read_points

```
43     return out
44
45 def cross(o: Point, a: Point, b: Point) -> float:
46     return (a[0] - o[0]) * (b[1] - o[1]) - (a[1] - o[1]) * (b[0] - o[0])
47
48 def dist2(a: Point, b: Point) -> float:
49     dx, dy = a[0] - b[0], a[1] - b[1]
50     return dx*dx + dy*dy
51
52 def leftmost_lowest(points: List[Point]) -> Point:
53     return min(points, key=lambda p: (p[1], p[0]))
54
55 # ----- Graham Scan -----
56
57 def graham_scan(points: Iterable[Point]) -> List[Point]:
58     pts = unique_points(points)
59     n = len(pts)
60     if n <= 1:
61         return pts[:]
62     anchor = leftmost_lowest(pts)
63
64     def angle_key(p: Point):
65         return (atan2(p[1] - anchor[1], p[0] - anchor[0]), -dist2(p, anchor))
66
67     sorted_pts = sorted((p for p in pts if p != anchor), key=angle_key)
68
69     filtered: List[Point] = []
70     last_angle = None
71     last_best = None
72     for p in sorted_pts:
73         ang = atan2(p[1] - anchor[1], p[0] - anchor[0])
74         if last_angle is None or abs(ang - last_angle) > 1e-15:
75             if last_best is not None:
76                 filtered.append(last_best)
77             last_angle = ang
78             last_best = p
79         else:
80             if dist2(anchor, p) > dist2(anchor, last_best):
81                 last_best = p
82     if last_best is not None:
83         filtered.append(last_best)
84
```

powershell ×

Processing: puntos-n10.txt

Points (n=10): [(-2.423, -8.469), (5.721, 9.354), (6.766, -3.823), (4.129, 6.744), (5.371, -5.404), (-8.101, 0.904), (-7.121, 1.38), (8.156, 6.039), (2.615, 2.077), (-0.822, 9.342)]

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Homework12 > Homework12_Gift_Jarvis.py > read_points

```
57 def graham_scan(points: Iterable[Point]) -> List[Point]:
58     ...
84
85     if not filtered:
86         return [anchor]
87
88     hull: List[Point] = [anchor]
89     for p in filtered:
90         while len(hull) >= 2 and cross(hull[-2], hull[-1], p) <= 0:
91             hull.pop()
92             hull.append(p)
93
94     if len(hull) >= 3 and all(abs(cross(hull[i-2], hull[i-1], hull[i])) < 1e-
95         ends = [anchor, max(filtered, key=lambda q: dist2(q, anchor))]
96         ends = unique_points(sorted(ends))
97         return ends
98     return hull
99
100 # ----- Jarvis March -----
101
102 def jarvis_march(points: Iterable[Point]) -> List[Point]:
103     pts = unique_points(points)
104     n = len(pts)
105     if n <= 1:
106         return pts[:]
107
108     start = leftmost_lowest(pts)
109     hull: List[Point] = []
110     p = start
111     while True:
112         hull.append(p)
113         q = pts[0] if pts[0] != p else pts[1]
114         for r in pts:
115             if r == p or r == q:
116                 continue
117             ori = cross(p, q, r)
118             if ori > 0:
119                 q = r
120             elif abs(ori) < 1e-15 and dist2(p, r) > dist2(p, q):
121                 q = r
122         p = q
123     if p == start:
124         break
```

powershell ×

Processing: puntos-n10.txt

Points (n=10): [(-2.423, -8.469), (5.721, 9.354), (6.766, -3.823), (4.129, 6.744), (5.371, -5.404), (-8.101, 0.904), (-7.121, 1.38), (8.156, 6.039), (2.615, 2.077), (-0.822, 9.342)]

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2.Advanced Algorithms

Homework12_Gift_Jarvis.py

Homework12 > Homework12_Gift_Jarvis.py > read_points

102 def jarvis_march(points: Iterable[Point]) -> List[Point]:

123 if p == start:

124 break

125

126 if len(hull) > 2 and all(abs(cross(hull[0], hull[1], r)) < 1e-15 for r in

127 a = min(pts, key=lambda x: (x[0], x[1]))

128 b = max(pts, key=lambda x: (x[0], x[1]))

129 return [a, b] if a != b else [a]

130 return hull

131

132 def format_points(pts: Iterable[Point]) -> str:

133 return "[" + ", ".join(f"({x:.6g}, {y:.6g})" for x, y in pts) + "]"

134

135 def plot_convex_hull(points: List[Point], hull: List[Point], title: str, file

136 fig, ax = plt.subplots(figsize=(10, 8))

137

138 if points:

139 px, py = zip(*points)

140 ax.scatter(px, py, c='blue', s=50, alpha=0.6, label='Points', zorder=

141

142 if len(hull) >= 2:

143 hx, hy = zip(*hull)

144 ax.plot(list(hx)+[hx[0]], list(hy)+[hy[0]], 'r-', linewidth=2, label=

145 ax.scatter(hx, hy, c='red', s=100, marker='^', label='Hull Vertices',

146 ax.add_patch(Polygon(hull, alpha=0.2, facecolor='red', edgecolor='non

147 elif len(hull) == 1:

148 ax.scatter([hull[0][0]], [hull[0][1]], c='red', s=100, marker='^', la

149

150 ax.set_xlabel('X'); ax.set_ylabel('Y')

151 ax.set_title(title, fontsize=14, fontweight='bold')

152 ax.legend(loc='best'); ax.grid(True, alpha=0.3); ax.axis('equal')

153

154 if points:

155 x_min, x_max = min(p[0] for p in points), max(p[0] for p in points)

156 y_min, y_max = min(p[1] for p in points), max(p[1] for p in points)

157 mx = (x_max - x_min) * 0.1 or 1

158 my = (y_max - y_min) * 0.1 or 1

159 ax.set_xlim(x_min - mx, x_max + mx)

160 ax.set_ylim(y_min - my, y_max + my)

161

162 plt.tight_layout()

163 plt.savefig(filename, dpi=150, bbox_inches='tight')

powershell

Processing: puntos-n10.txt

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Hull (h=7): [(-5.084, -17.237), (-17.786, -15.884), (-18.808, 0.094), (-14.452, 17.516), (-7.535, 16.486), (14.789, 10.899), (19.759, -14.866)]

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Homework12_Gift_Jarvis.py

Homework12 > Homework12_Gift_Jarvis.py > read_points

```
135 def plot_convex_hull(points: List[Point], hull: List[Point], title: str, file
136
163 plt.savefig(filename, dpi=150, bbox_inches='tight')
164 print(f" Graph saved as: {filename}")
165 plt.close()
166
167
168 def discover_txt_files(default_dir: str, pattern: str | None) -> list[str]:
169     if pattern:
170         return sorted(glob.glob(pattern))
171     return sorted(glob.glob(os.path.join(default_dir, "*.txt")))
172
173 def main():
174     try:
175         script_dir = os.path.dirname(os.path.abspath(__file__))
176     except NameError:
177         script_dir = os.getcwd()
178     pattern = sys.argv[1] if len(sys.argv) >= 2 else None
179     txt_files = discover_txt_files(script_dir, pattern)
180
181     if not txt_files:
182         where = pattern or os.path.join(script_dir, "*.txt")
183         print(f"No input files found for: {where}")
184         sys.exit(1)
185
186     print(f"Found {len(txt_files)} file(s).")
187     print("=" * 80)
188
189     for file_path in txt_files:
190         filename = os.path.basename(file_path)
191         base = os.path.splitext(filename)[0]
192         print(f"\nProcessing: {filename}")
193         print("-" * 80)
194
195         pts = read_points(file_path)
196         if not pts:
197             print(f" No points found in {filename}")
198             continue
199
200         print(f"\nPoints (n={len(pts)}): {format_points(pts)}")
201
202         print("\n--- Graham Scan ---")
203         hull = graham_scan(pts)
```

powershell

```
Processing: puntos-n10.txt
-----
Points (n=10): [(-2.423, -8.469), (5.721, 9.354), (6.766, -3.823), (4.129, 6.744), (5.371, -5.404),
(-8.101, 0.904), (-7.121, 1.38), (8.156, 6.039), (2.615, 2.077), (-0.822, 9.342)]

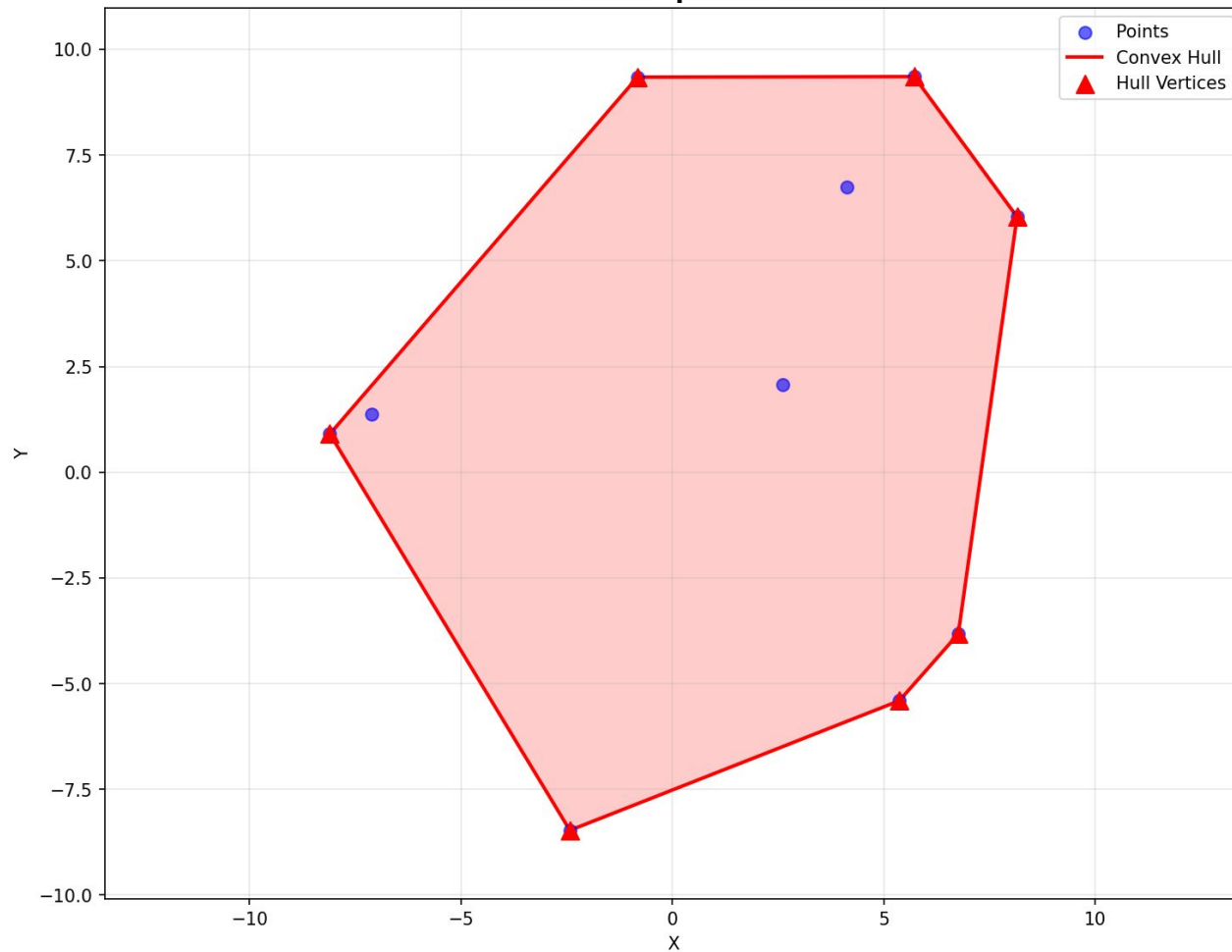
--- Graham Scan ---
Hull (h=7): [(-2.423, -8.469), (5.371, -5.404), (6.766, -3.823), (8.156, 6.039), (5.721, 9.354), (-
0.822, 9.342), (-8.101, 0.904)]
Ignoring fixed x limits to fulfill fixed data aspect with adjustable data limits.
Ignoring fixed y limits to fulfill fixed data aspect with adjustable data limits.
Graph saved as: d:\1.SQM\1.UNIVERSIDAD\5. QUINTO SEMESTRE\2.Advanced Algorithms\Homework12\punto
s-n10_graham_scan.png

--- Jarvis March ---
Hull (h=7): [(-2.423, -8.469), (-8.101, 0.904), (-0.822, 9.342), (5.721, 9.354), (8.156, 6.039), (
6.766, -3.823), (5.371, -5.404)]
Ignoring fixed x limits to fulfill fixed data aspect with adjustable data limits.
Ignoring fixed y limits to fulfill fixed data aspect with adjustable data limits.
Graph saved as: d:\1.SQM\1.UNIVERSIDAD\5. QUINTO SEMESTRE\2.Advanced Algorithms\Homework12\punto
s-n10_jarvis_march.png

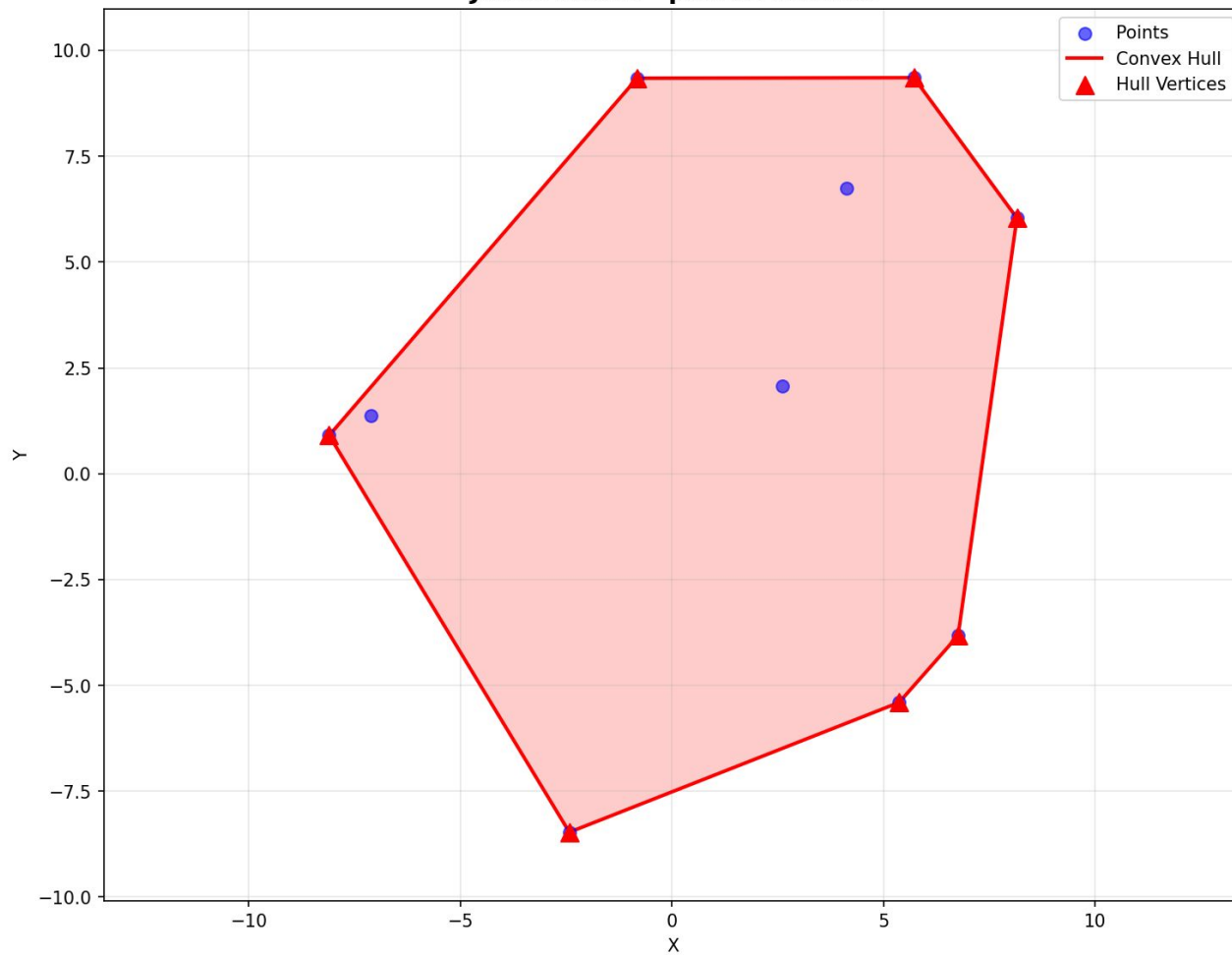
--- Graham Scan ---
Hull (h=7): [(-5.084, -17.237), (19.759, -14.866), (14.789, 10.899), (-7.535, 16.486), (-14.452, 1
7.516), (-18.808, 0.094), (-17.786, -15.884)]
Ignoring fixed y limits to fulfill fixed data aspect with adjustable data limits.
--- Graham Scan ---
Hull (h=7): [(-5.084, -17.237), (19.759, -14.866), (14.789, 10.899), (-7.535, 16.486), (-14.452, 1
--- Graham Scan ---
Hull (h=7): [(-5.084, -17.237), (19.759, -14.866), (14.789, 10.899), (-7.535, 16.486), (-14.452, 1
7.516), (-18.808, 0.094), (-17.786, -15.884)]
Ignoring fixed y limits to fulfill fixed data aspect with adjustable data limits.
Ignoring fixed x limits to fulfill fixed data aspect with adjustable data limits.
Graph saved as: d:\1.SQM\1.UNIVERSIDAD\5. QUINTO SEMESTRE\2.Advanced Algorithms\Homework12\punto
s-n20_graham_scan.png

--- Jarvis March ---
Hull (h=7): [(-5.084, -17.237), (-17.786, -15.884), (-18.808, 0.094), (-14.452, 17.516), (-7.535,
16.486), (14.789, 10.899), (19.759, -14.866)]
Ignoring fixed y limits to fulfill fixed data aspect with adjustable data limits.
Ignoring fixed x limits to fulfill fixed data aspect with adjustable data limits.
Graph saved as: d:\1.SQM\1.UNIVERSIDAD\5. QUINTO SEMESTRE\2.Advanced Algorithms\Homework12\punto
s-n20_jarvis_march.png
=====
(.venv) PS D:\1.SQM\1.UNIVERSIDAD\5. QUINTO SEMESTRE\2.Advanced Algorithms> 
```

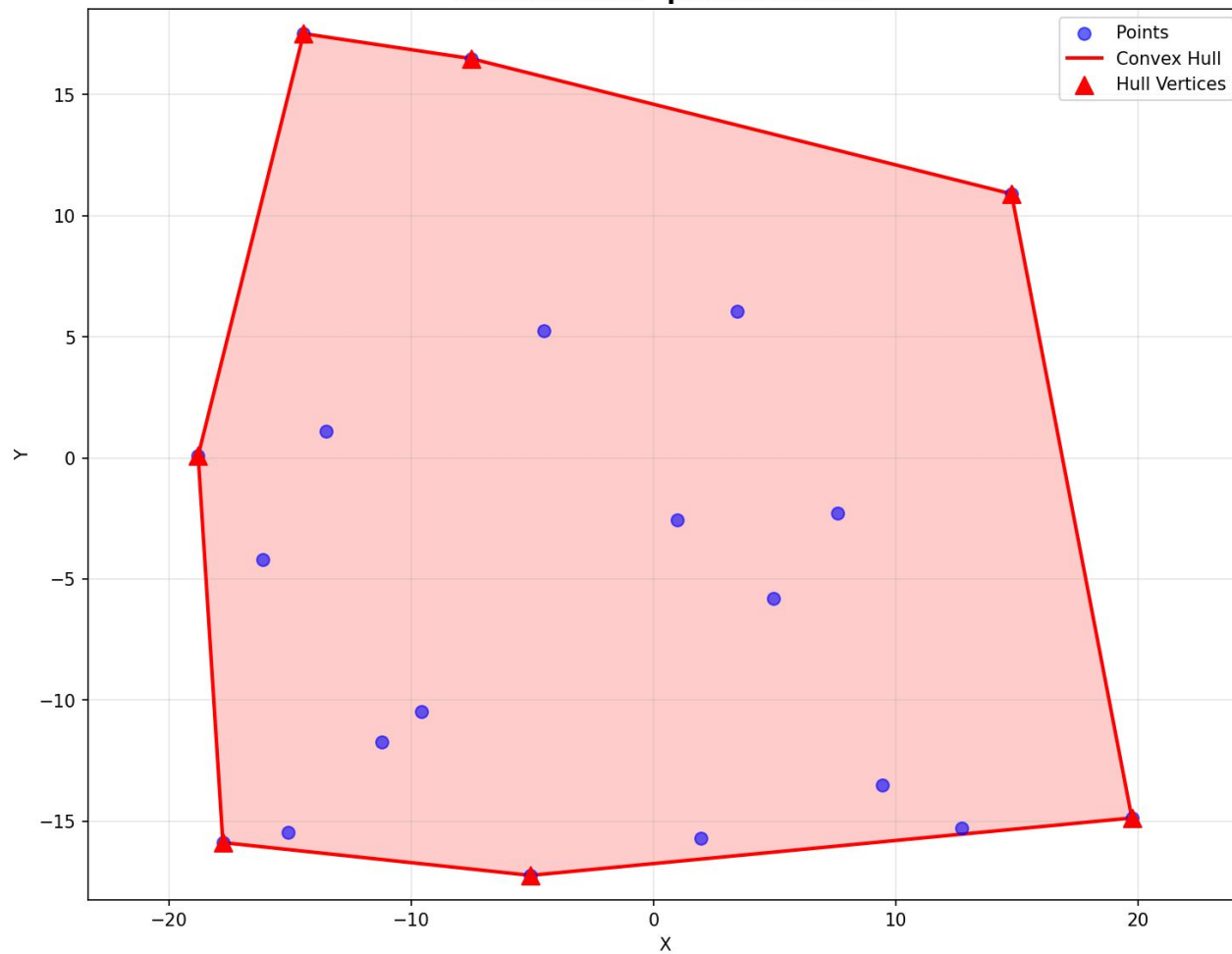

Graham Scan - puntos-n10.txt



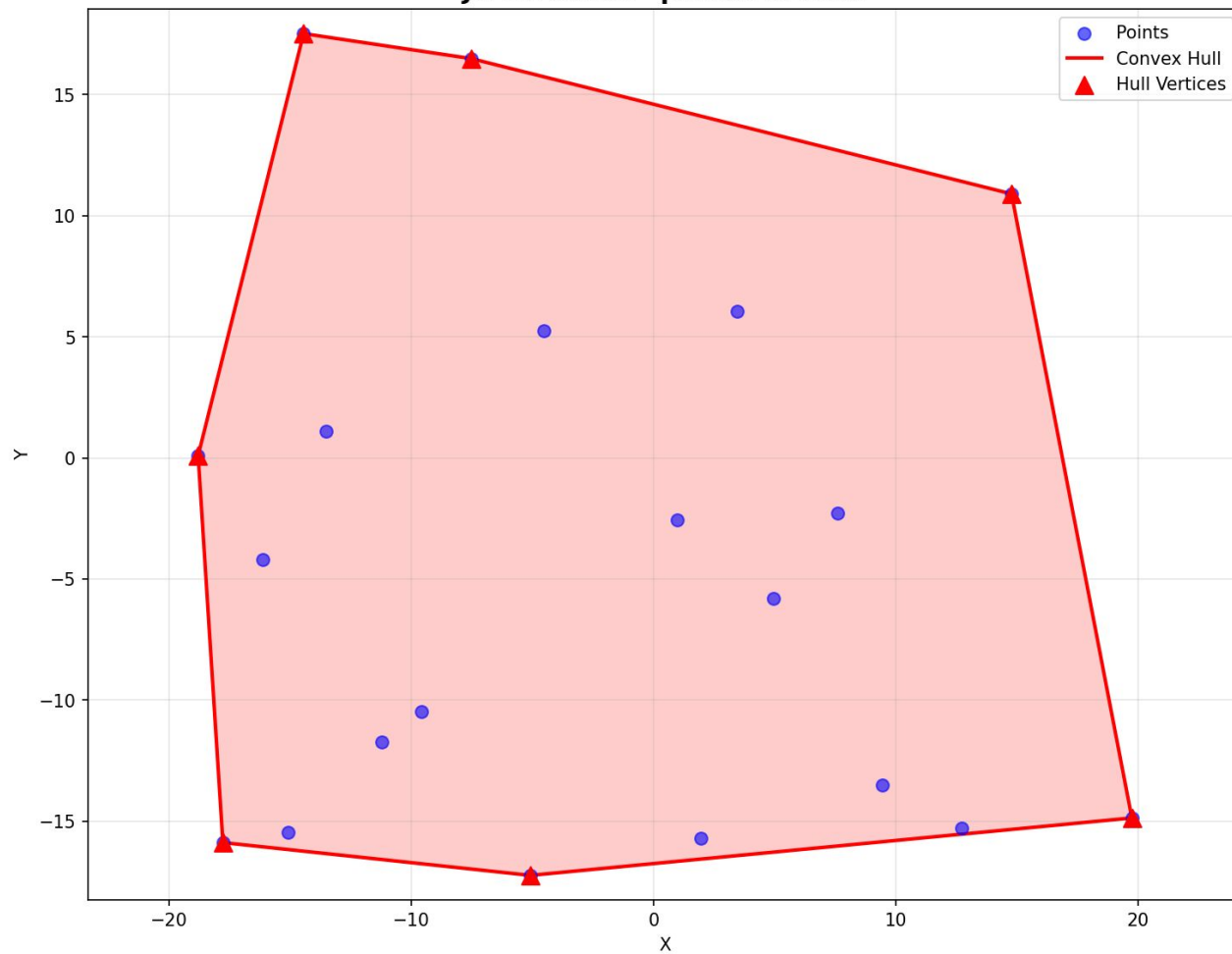
Jarvis March - puntos-n10.txt



Graham Scan - puntos-n20.txt



Jarvis March - puntos-n20.txt



<https://colab.research.google.com/drive/1XT17WAUIMplMIcWttz-zvIWGABLCDE3v?usp=sharing>