



# ADCG

2023, 20<sup>th</sup> September, Belgrade, Serbia

**Dobro došli! Welcome!**



# *JGEX*

## *Open Source Prover in the Attic*

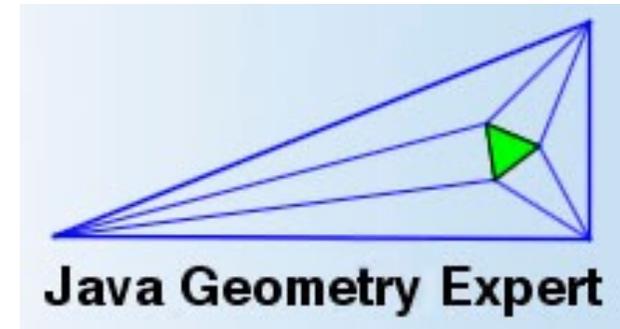
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**THE PRIVATE UNIVERSITY COLLEGE OF EDUCATION OF THE DIOCESE OF LINZ  
LINZ, AUSTRIA**

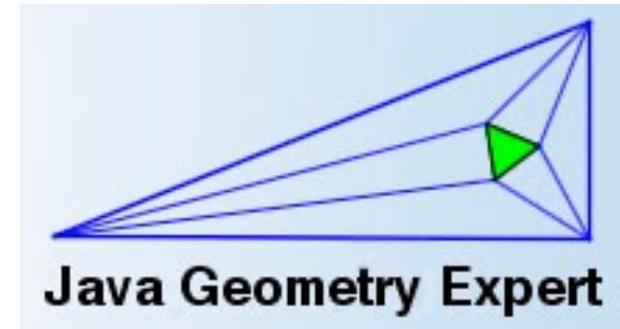
# Overview

- Abstract
- History and development of (J)GEX
- Description of JGEX's roots and development
- Open-sourcing of JGEX in 2016
- Popularity and contributions



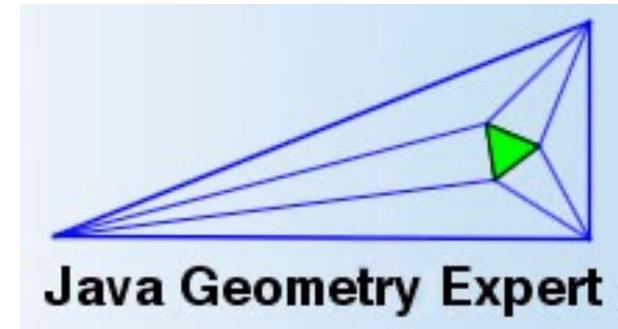
# Abstract

The well known JGEX program became open source a few years ago, but seemingly, further development of the program can only be done without the original authors. In our project, we are looking at whether it is possible to continue such a large project as a newcomer without the involvement of the original authors. Is there a way to internationalize, fix bugs, improve the code base, add new features? In other words, to save a relic found in the attic and polish it into a useful everyday tool.



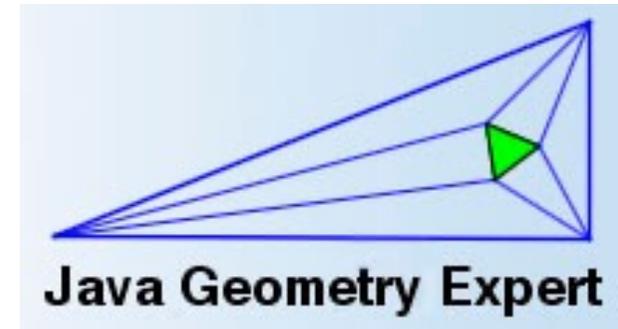
# History

- A mature geometry reasoning tool developed by Chou, Gao and Ye
- Over 100,000 lines of Java code
- Open-sourced in 2016
  - GPL and non-commercial



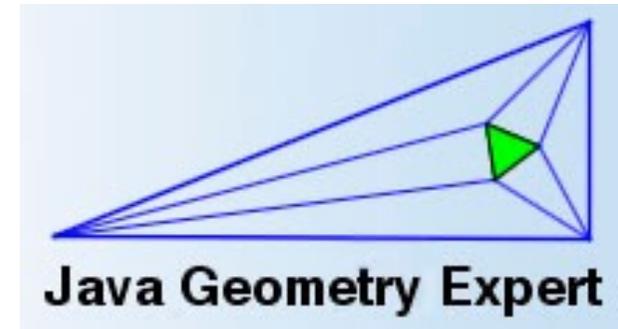
# Motivation for further development

- Language support
- Modern interface
- Updated algorithms
- Minor bug fixes
- Importance of an error-free tool
  - Theorem proving for education

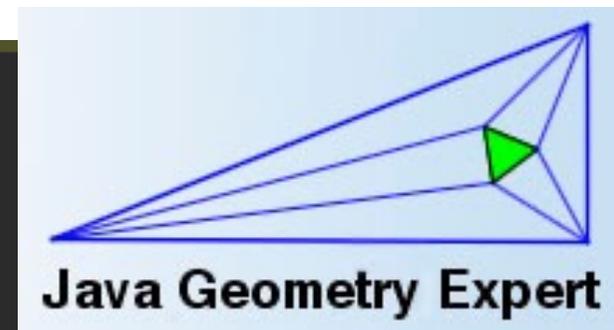


# Research Scope

- Translating JGEX into Serbian
- Improving user experience
- Challenges:
  - Lack of documentation (for users and programmers)
  - Enormous translation work
  - Quality assurance by native speakers

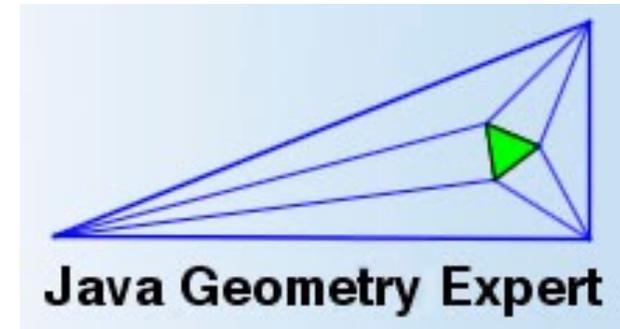


```
1 Serbian
2 Font: Dialog # 0 # 14
3
4 * File Menu
5 0 # File # Datoteka
6 1 # New # Novo
7 2 # Open # Otvori
8 3 # Save # Sačuvaj
9 4 # Save as... # Sačuvaj kao...
10 5 # Save as PS # Sačuvaj kao PS
11 6 # Save as Text # Sačuvaj kao tekst
12 7 # Print # Štampaj
13 8 # Exit # Izlaz
14 9 # Select # Izaberi
15 10 # Move # Pomeri
16 11 # Geometry Expert # Ekspert za geometriju
17 12 # Save as Image # Sačuvaj kao sliku
18 13 # Save as Animated Image # Sačuvaj kao animaciju
19
20 14 # Save as PDF # Sačuvaj kao PDF
21 15 # Save Proof as Animated Image # Sačuvaj dokaz kao animaciju
22 * End of File Menu
23
```



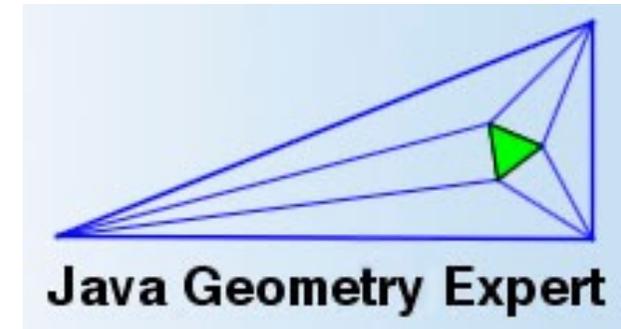
# Translation

- Adding German, Portuguese and Serbian
- Technical process:
  - Create CSV text files
- Challenges:
  - Missing tooltips
  - Untranslated phrases
  - Spelling errors (English)
- Future improvement:
  - Consideration of alternative translation systems (e.g., gettext)



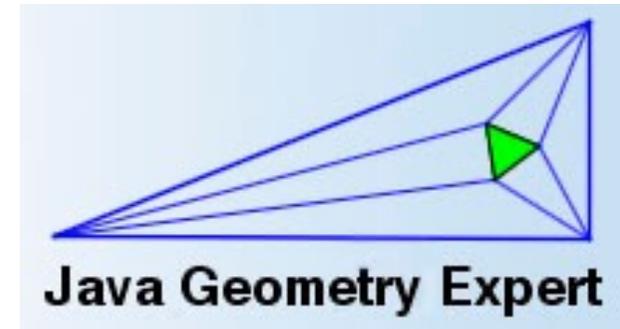
# Modern Interface

- Usability feedback
- Proposed Solutions:
  - Tutorials
  - Simplified views
  - Workflow-based design
- Platform accessibility



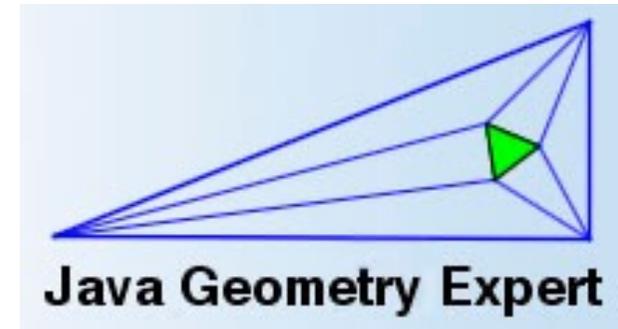
# State-of-the-Art Mathematics

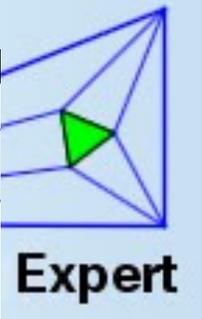
- Gröbner basis method
- Comparison with Wu's method
- Importance of degeneracy conditions



# Bugs and Improvements

- Issues with angle representation
- Improving proof protocols
- Structured proof visualization
- Possibilities for improving the proof presentation
  - GDD method(s)





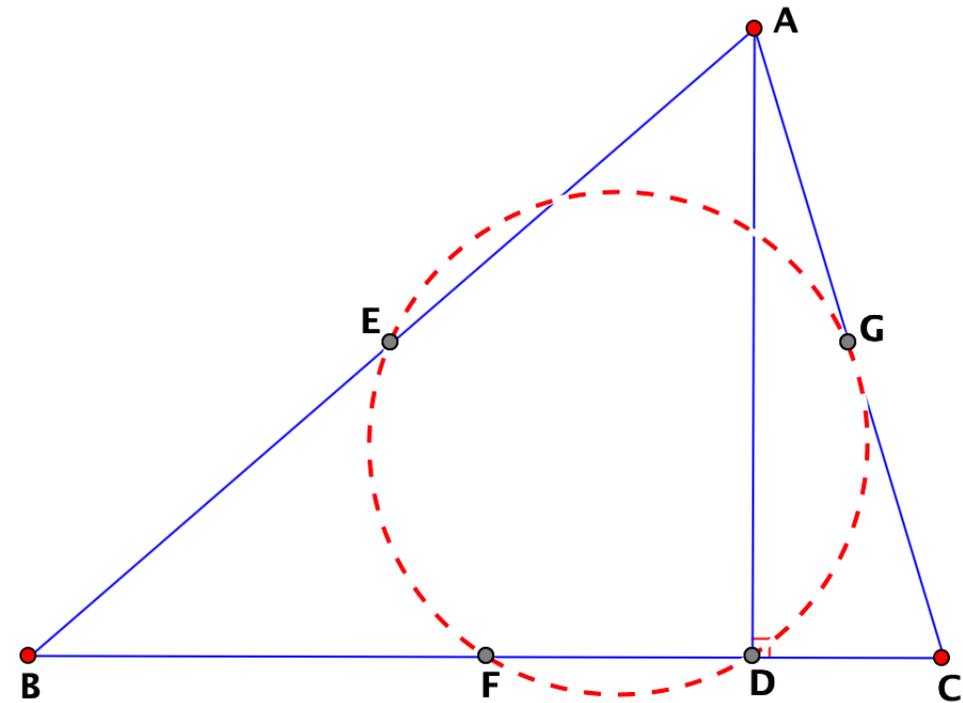
File Examples Construct Constraint Action Prove Lemmas Option Help



▼ GDD

- Fixpoint
  - lines (3)
  - parallel lines (3)
  - perpendicular lines (2)
  - midpoints (3)
  - circles (3)
    - circle[E, ABD]
    - circle[G, ACD]
    - circle[F, BCD]
  - congruence (13)
  - similar (1)
  - ratio segments (16)

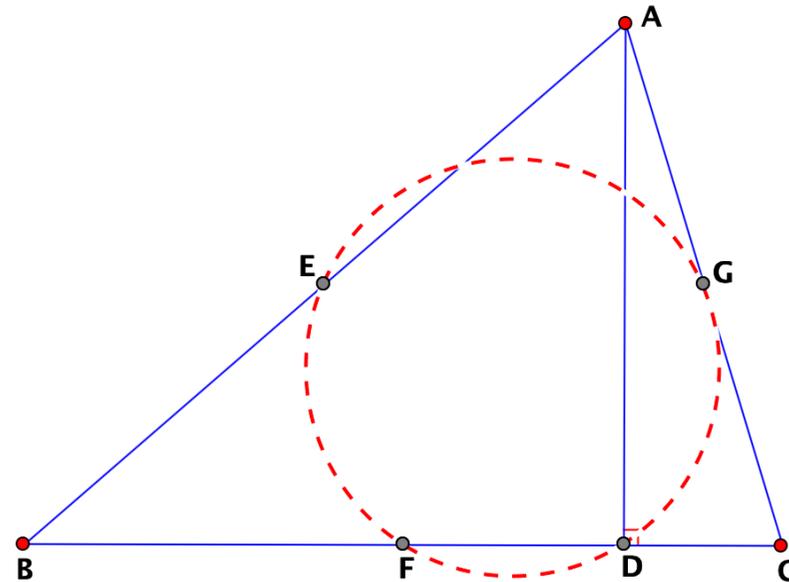
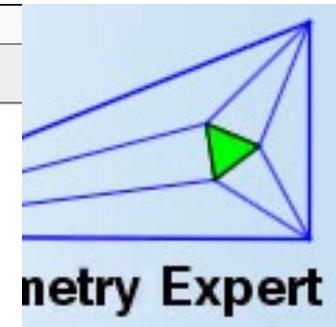
- Prove
- Prove in New Tab
- Refresh
- Search A Fact



File Examples Construct Constraint Action Prove Lemmas Option Help

T GDD

- 1. cyclic(D,E,F,G) (r13)
  - 2.  $\angle[DFE] = \angle[DGE]$ 
    - 3. tri DEG = tri EBF
      - 4. tri AEG = tri EBF (r28)
        - 6. AG = EF
          - 11. AC/EF = 2/1 (r35)
            - midp(F,CB) (by HYP)
            - midp(E,BA) (by HYP)
          - 12. AG/AC = 1/2
            - midp(G,AC) (by HYP)
        - 7. EG = BF
          - 13. BC/EG = 2/1 (r35)
            - midp(G,AC) (by HYP)
            - midp(E,BA) (by HYP)
          - 14. BF/BC = 1/2
            - midp(F,CB) (by HYP)
        - 8. AE = EB
          - midp(E,BA) (by HYP)
      - 5. tri AEG = tri DEG (r28)
        - 9. AG = DG (r36)
          - midp(G,AC) (by HYP)
          - DA  $\perp$  DC (by HYP)
          - EG = EG (by HYP)
        - 10. AE = DE (r36)
          - midp(E,BA) (by HYP)
          - DB  $\perp$  DA (by HYP)



File Examples Construct Constraint Action Prove Lemmas Option Help

New ^N

Open ^O

Save ^S

Save as... ^S

Save as Text ^T

Save as PS

Save as PDF

Save as Image

Save as Animated Image

Save Proof as Animated Image

**Save GDD Proof as GraphViz File**

Print ^P

Exit ^X

GDD

13.  $BC/EG = 2/1$  (r35)  
 midp(G,AC) (by HYP)  
 midp(E,BA) (by HYP)

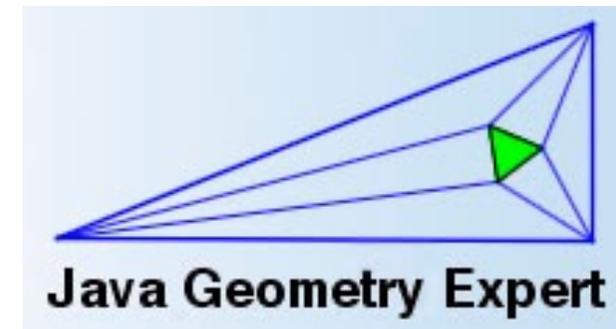
14.  $BF/BC = 1/2$   
 midp(F,CB) (by HYP)

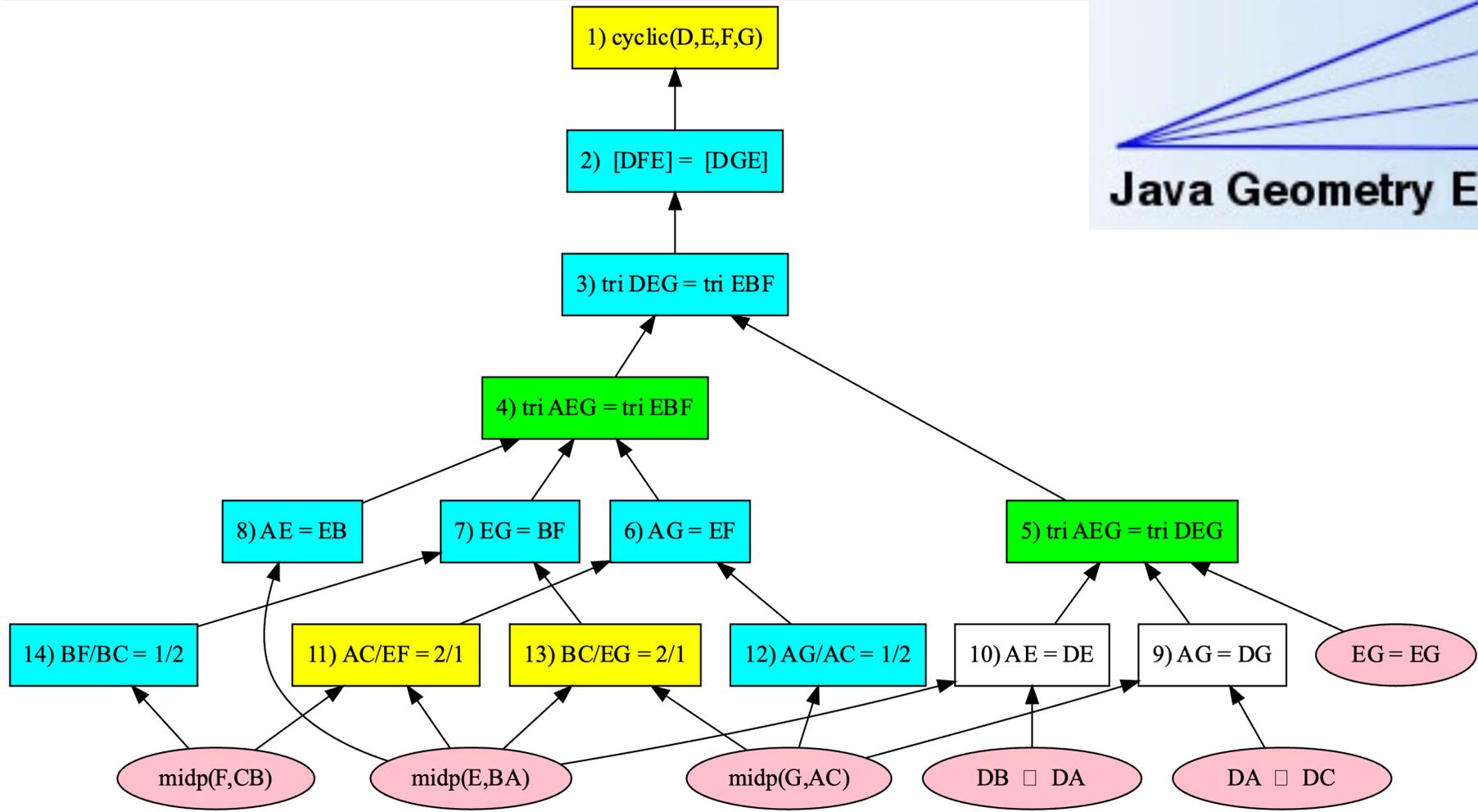
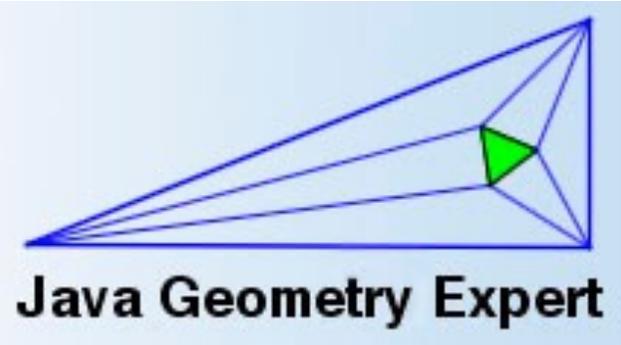
8.  $AE = EB$   
 midp(E,BA) (by HYP)

5. tri AEG = tri DEG (r28)

9.  $AG = DG$  (r36)  
 midp(G,AC) (by HYP)  
 $DA \perp DC$  (by HYP)  
 $EG = EG$  (by HYP)

10.  $AE = DE$  (r36)  
 midp(E,BA) (by HYP)  
 $DB \perp DA$  (by HYP)

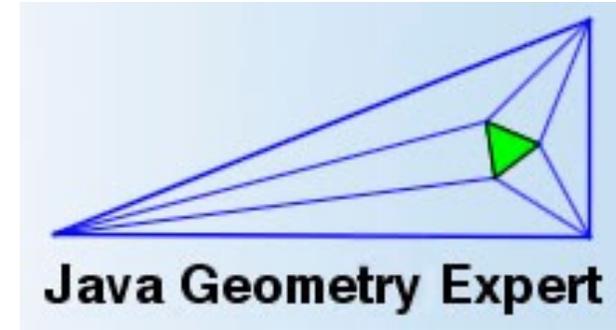
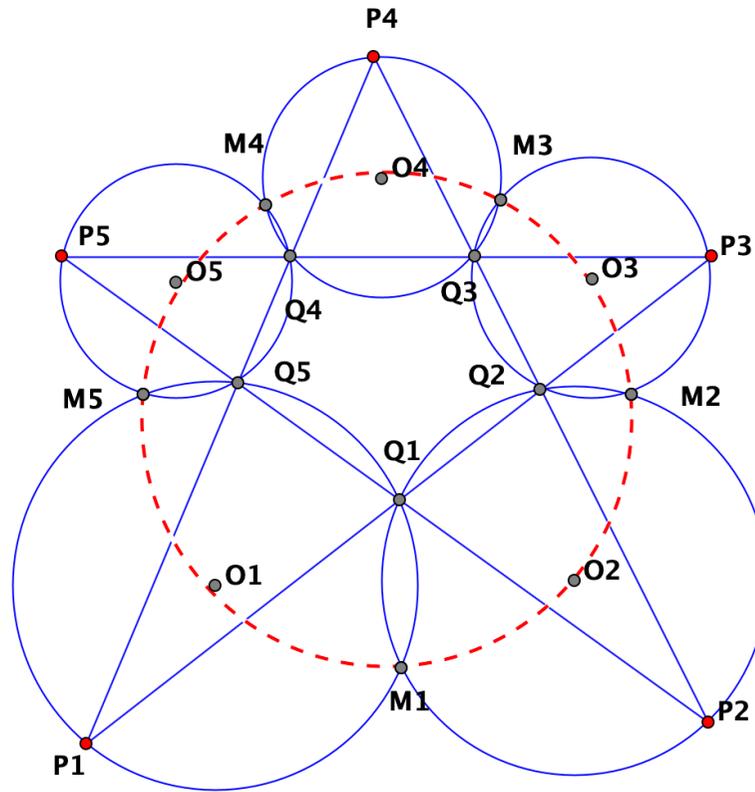






▼ GDD

- Fixpoint
  - > lines (5)
  - > perpendicular lines (5)
  - > circles (11)
    - circle[O1, P1Q1Q5M1M5]
    - circle[O2, P2Q1Q2M1M2]
    - circle[O3, P3Q2Q3M2M3]
    - circle[O4, P4Q3Q4M3M4]
    - circle[O5, P5Q4Q5M4M5]
    - circle[P1P4Q2M1M3]
    - circle[P1P3Q4M3M5]
    - circle[P2P4Q5M1M4]
    - circle[P2P5Q3M2M4]
    - circle[P3P5Q1M2M5]
    - circle[M1M2M3M4M5]
  - > congruent segments (5)
  - > congruent angles (162)
  - > similiar triangles (30)
  - > congruent triangles (5)
  - > ratio segments (75)



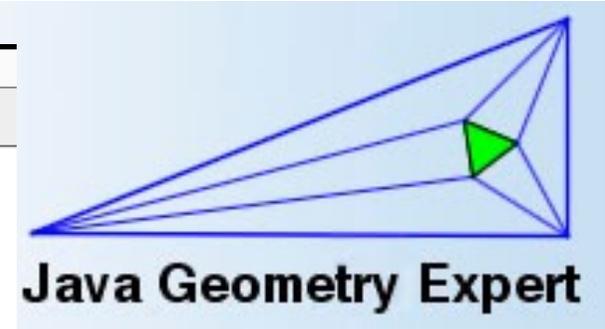
File Examples Construct Constraint Action Prove Lemmas Option Help

Please select four points

M1    M2    M3    M4    M5

OK   Cancel

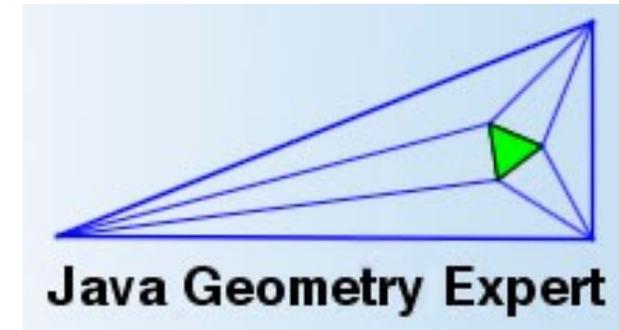
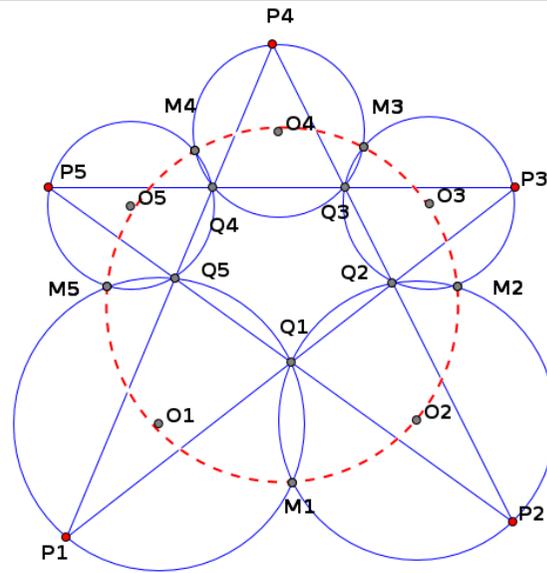
- circle[P1P4Q2M1M3]
- circle[P1P3Q4M3M5]
- circle[P2P4Q5M1M4]
- circle[P2P5Q3M2M4]
- circle[P3P5Q1M2M5]
- circle[M1M2M3M4M5]**
- > congruent segments (5)
- > congruent angles (162)
- > similiar triangles (30)
- > congruent triangles (5)
- > ratio segments (75)

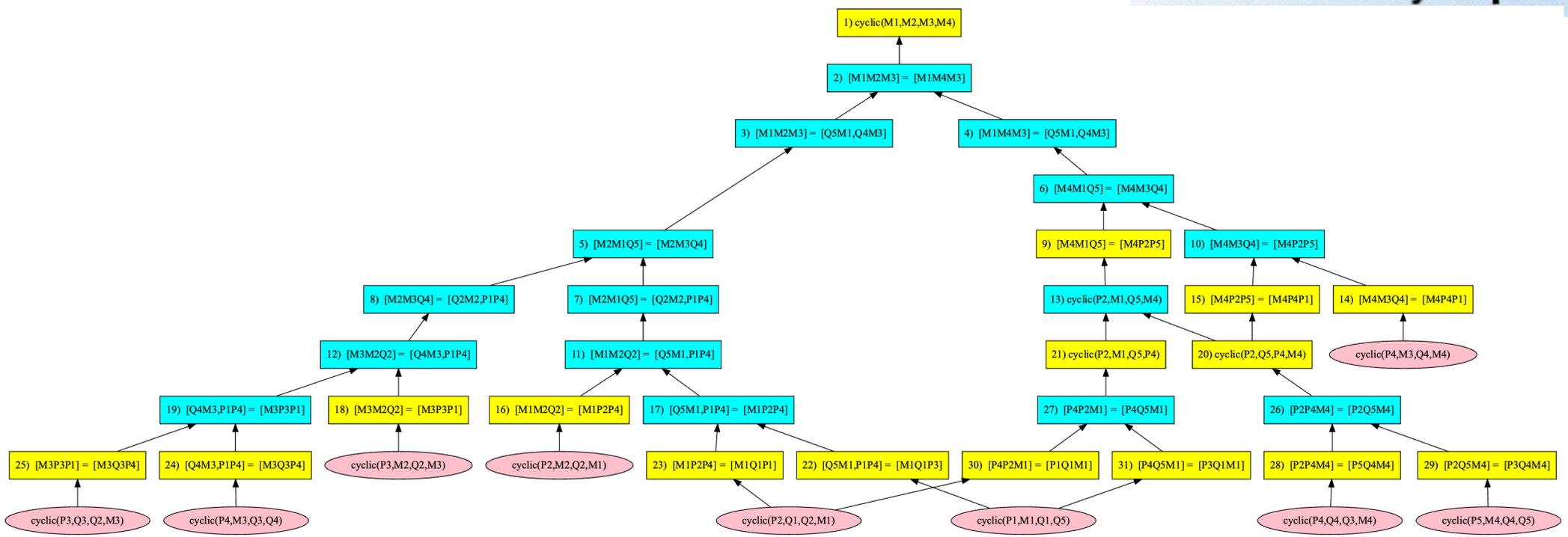
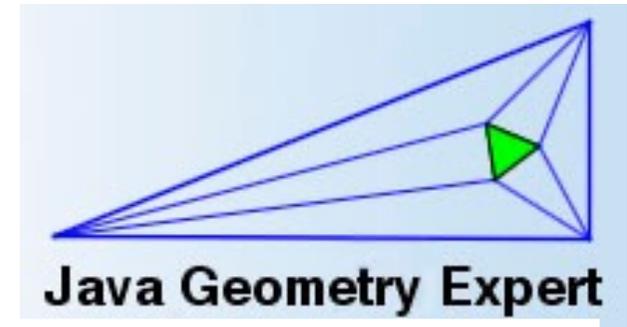


```

GDD
1. cyclic(M1,M2,M3,M4) (r13)
2.  $\angle[M1M2M3] = \angle[M1M4M3]$ 
3.  $\angle[M1M2M3] = \angle[Q5M1, Q4M3]$ 
4.  $\angle[M2M1Q5] = \angle[M2M3Q4]$ 
5.  $\angle[M2M1Q5] = \angle[Q2M2, P1P4]$ 
6.  $\angle[M1M2Q2] = \angle[Q5M1, P1P4]$ 
7.  $\angle[M1M2Q2] = \angle[M1P2P4]$  (r13)
8. cyclic(P2, M2, Q2, M1) (laut Annahme)
9.  $\angle[Q5M1, P1P4] = \angle[M1P2P4]$ 
10.  $\angle[Q5M1, P1P4] = \angle[M1Q1P3]$  (r13)
11. cyclic(P1, M1, Q1, Q5) (laut Annahme)
12.  $\angle[M1P2P4] = \angle[M1Q1P1]$  (r13)
13. cyclic(P2, Q1, Q2, M1) (laut Annahme)
14.  $\angle[M2M3Q4] = \angle[Q2M2, P1P4]$ 
15.  $\angle[M3M2Q2] = \angle[Q4M3, P1P4]$ 
16.  $\angle[M3M2Q2] = \angle[M3P3P1]$  (r13)
17. cyclic(P3, M2, Q2, M3) (laut Annahme)
18.  $\angle[Q4M3, P1P4] = \angle[M3P3P1]$ 
19.  $\angle[Q4M3, P1P4] = \angle[M3Q3P4]$  (r13)
20. cyclic(P4, M3, Q3, Q4) (laut Annahme)
21.  $\angle[M3P3P1] = \angle[M3Q3P4]$  (r13)
22. cyclic(P3, Q3, Q2, M3) (laut Annahme)
23.  $\angle[M1M4M3] = \angle[Q5M1, Q4M3]$ 
24.  $\angle[M4M1Q5] = \angle[M4M3Q4]$ 
25.  $\angle[M4M1Q5] = \angle[M4P2P5]$  (r13)
26. cyclic(P2, M1, Q5, M4)
27.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
28.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
29. cyclic(P4, M3, Q4, M4) (laut Annahme)
30.  $\angle[M4P2P5] = \angle[M4P4P1]$  (r13)
31.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
32.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
33.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
34.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
35.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
36.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
37.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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44.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
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55.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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57.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
58.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
59.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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72.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
73.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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75.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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77.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
78.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)
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83.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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95.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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97.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
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99.  $\angle[M4M3Q4] = \angle[M4P4P1]$  (r13)
100.  $\angle[M4M3Q4] = \angle[M4P2P5]$  (r13)

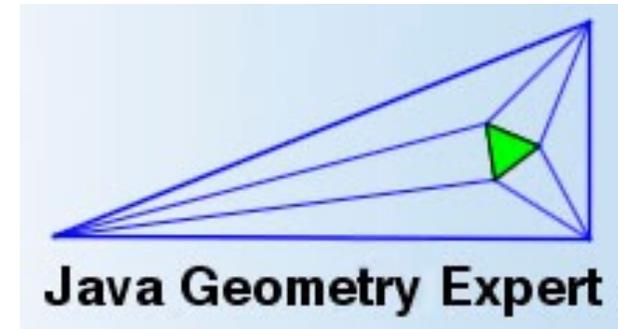
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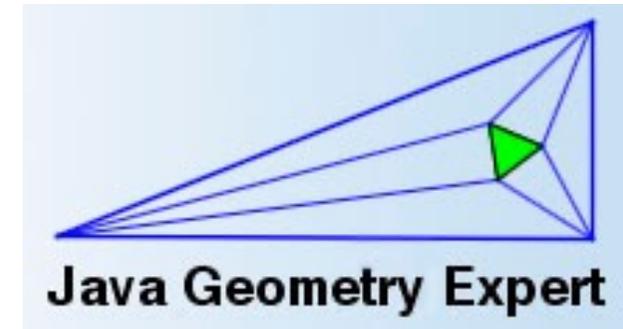
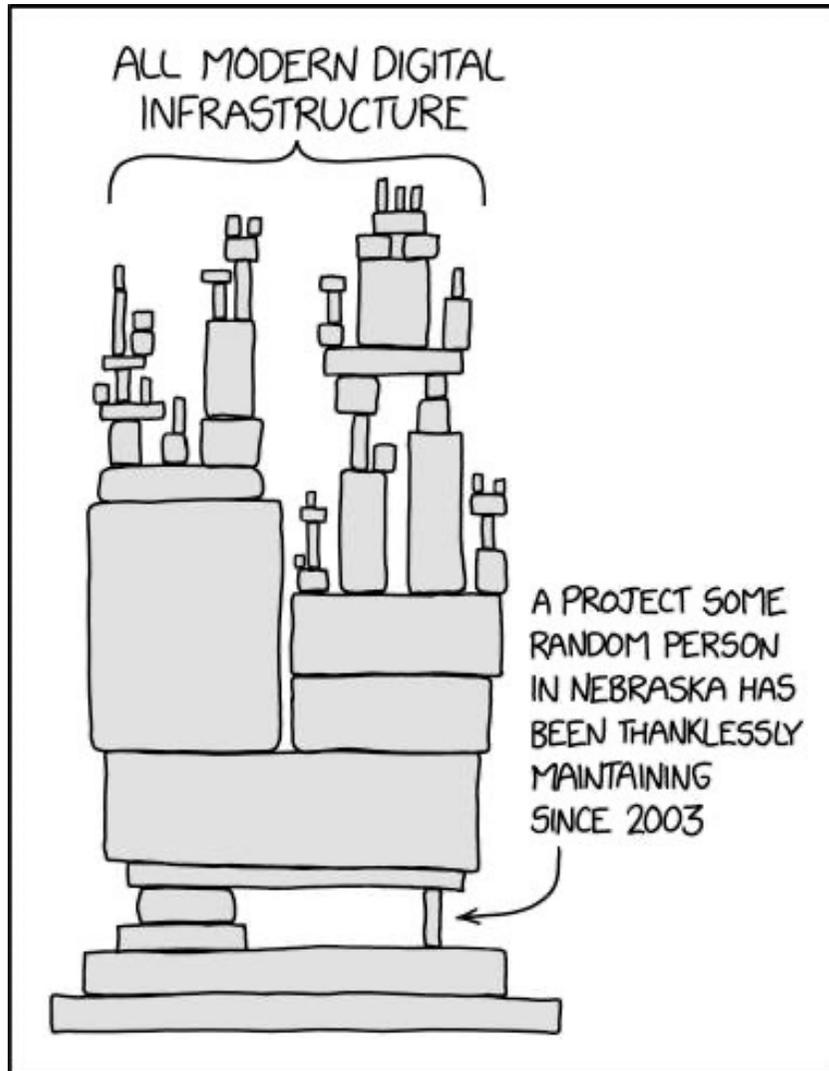




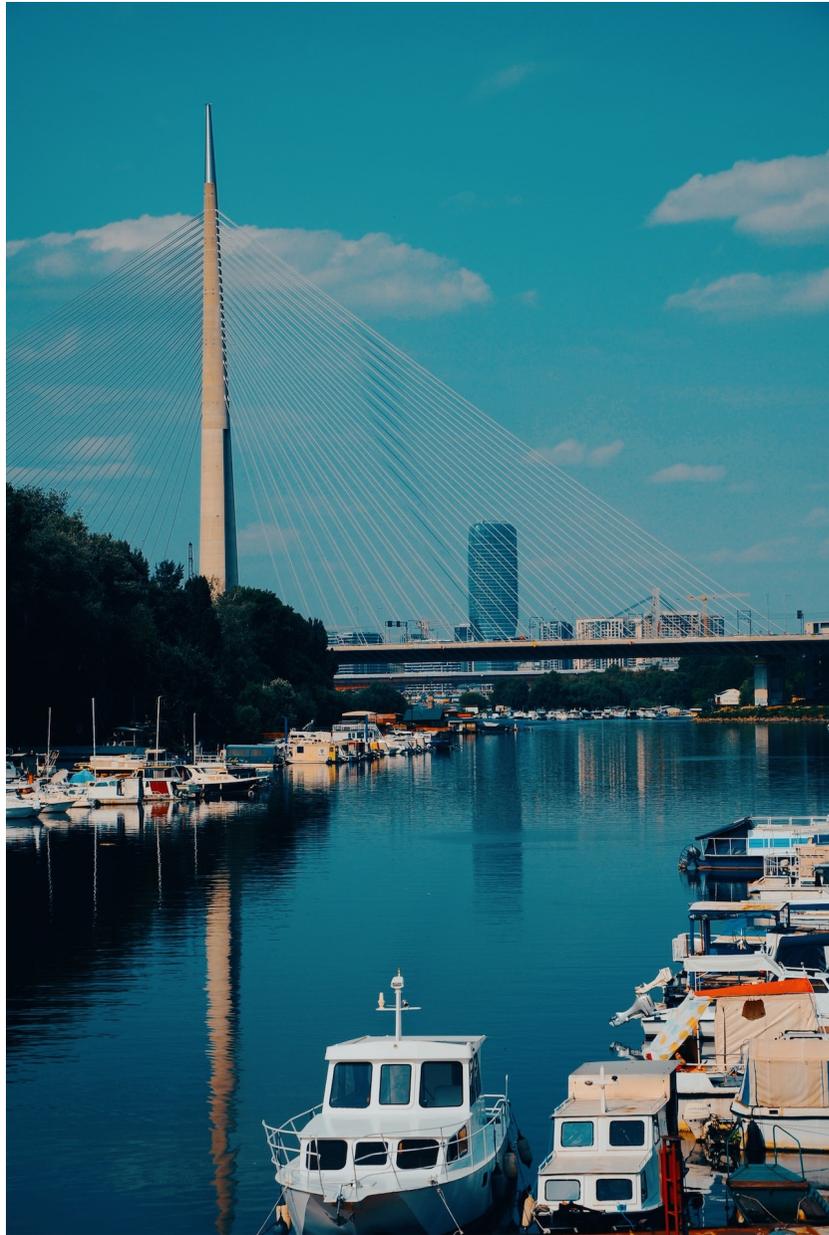
# Conclusion

- Possibility of continuing and enhancing JGEX
- Challenges:
  - Technical issues
  - Lack of documentation
  - Code quality
- Potential:
  - Extending automated geometry reasoning for education





<https://imgs.xkcd.com/comics/dependency.png>



**Hvala vam!**

**Thank You  
for Your attention!**