# Dynamic Euclid:
# Using GeoGebra to Construct and Present Geometric Proofs

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Image: Raphael, *School of Athens*    http://commons.wikimedia.org/wiki/File:Raffael_058.jpg

# Proof vs. Verification

"A proof is a theoretical confirmation that a statement (for example, 'the bisector lines of a triangle are concurrent') is always true.

A verification is usually an experiment, that the statement is indeed true, by choosing a large set of examples."

- Zoltán Kovács (2012, para. 2)



Image: http://commons.wikimedia.org/wiki/File:Euclid.jpg

"At the age of 12 I experienced a second wonder of a totally different nature in a little book dealing with Euclidean plane geometry.… Here were assertions, as for example, the intersection of the three altitudes of a triangle in one point, which – though by no means evident – could nevertheless be proved with such certainty that any doubt appeared out of the question."
- Albert Einstein
(as cited in Sagan, 1979, p. 20)
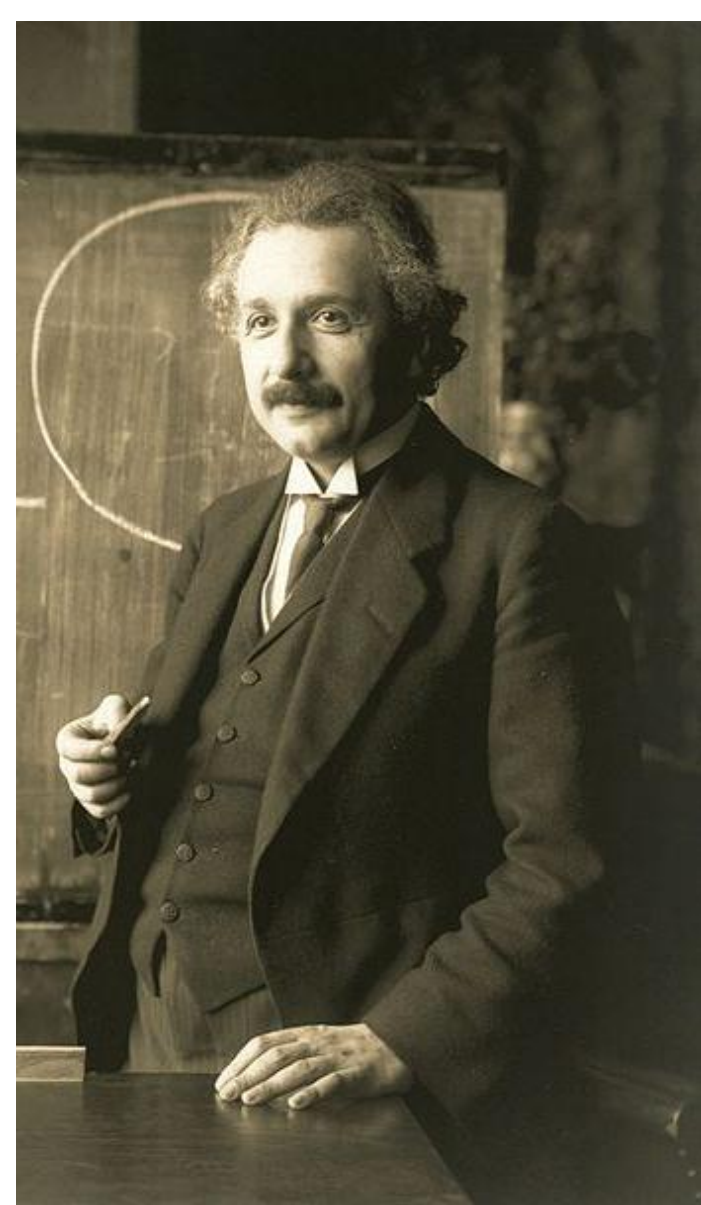
- Website:        http://www.geogebra.org
- Licensed under Creative Commons
  - Markus Hohenwarter
    - Creator and project leader since 2001
- Available for Windows / Mac / Linux / Chrome / Web
- Pricing: Free for noncommercial use

Image: Screen-capture from http://www.geogebra.org/cms/en

GeoGebra
5 Beta Release

- Currently in Beta
  - Commands and outputs are subject to change
- New features available in GeoGebra 5.0
  - Proof commands
  - 3D construction
  - Turtle
- Available for download at
  http://www.geogebra.org/forum/viewtopic.php?f=52&t=19846

Image: Screen-capture of GeoGebra software load screen

# Proofs in GeoGebra

- "Are" commands

  AreEqual[ <Object>, <Object> ]
  AreCollinear[ <Point>, <Point>, <Point> ]
  AreConcurrent[ <Line>, <Line>, <Line> ]
  AreConcyclic[ <Point>, <Point>, <Point>, <Point> ]
  AreParallel[ <Line>, <Line> ]
  ArePerpendicular[ <Line>, <Line> ]

  – Numerical calculation verification

# Proofs in GeoGebra

- "Prove" command

  Prove[ <Boolean Expression> ]

  – Uses symbolic methods, not numeric computations
  – Determine "true" or "false" in general
    - Yields "true" if a statement is always true
    - Yields "false" if a statement is not always true
  – More information:
    http://wiki.geogebra.org/en/Prove_Command

# Proofs in GeoGebra

- "ProveDetails" command

ProveDetails[ <Boolean Expression> ]

  – Uses symbolic methods
  – Lists non-degenerate conditions
  – More information: http://wiki.geogebra.org/en/ProveDetails_Command

# Classroom Ideas

Ask students to explore the GeoGebra proof commands

# Classroom Ideas

Ask students to construct figures to demonstrate theorems



Theorem:
If a point lies outside a line, then exactly one plane contains both the point and the line.
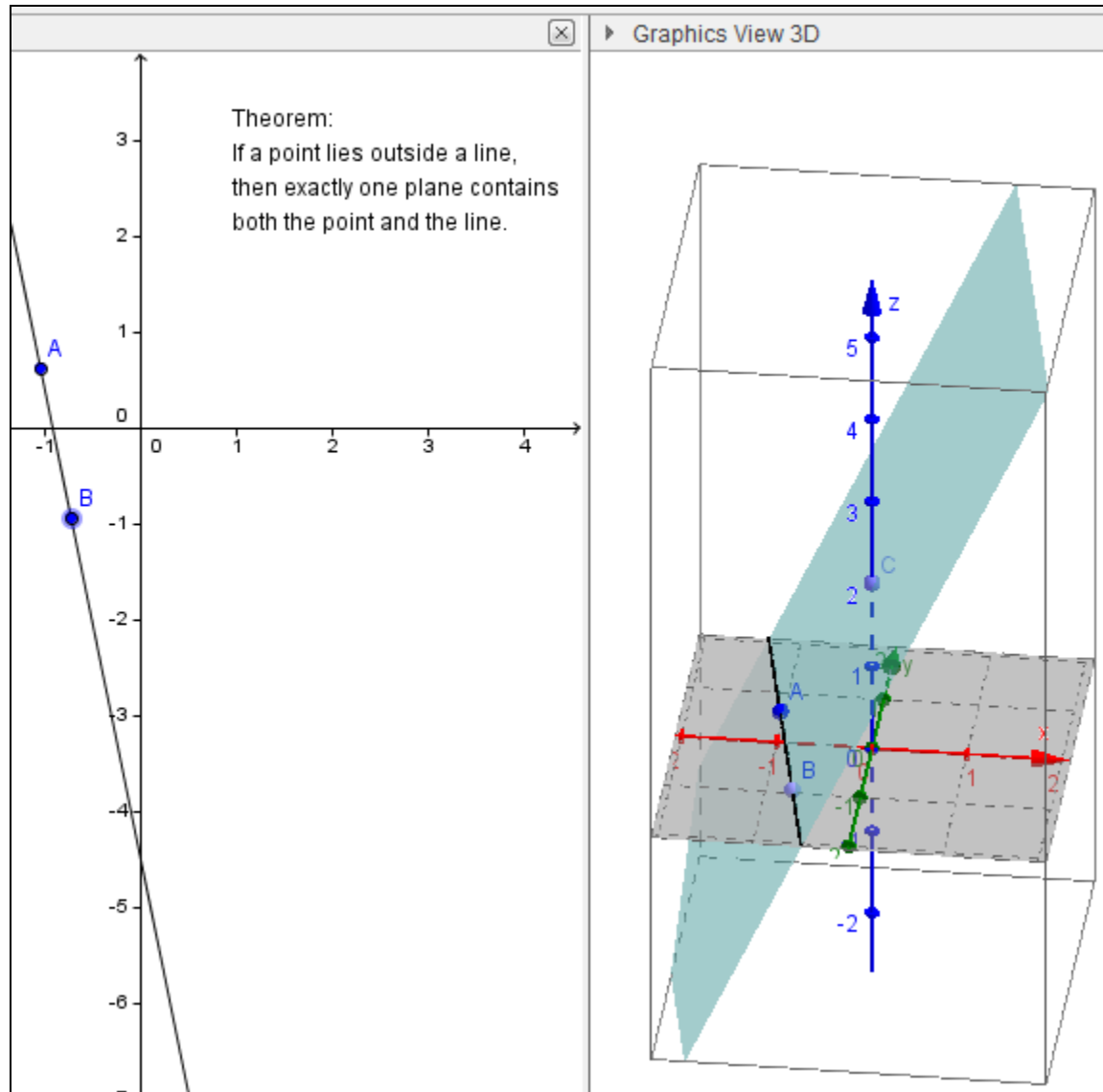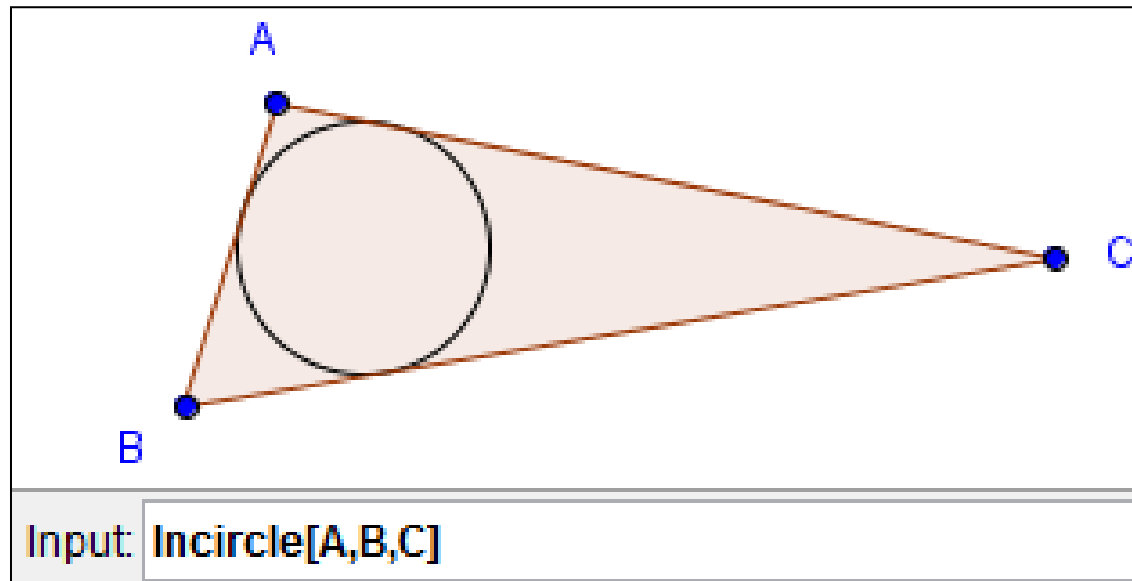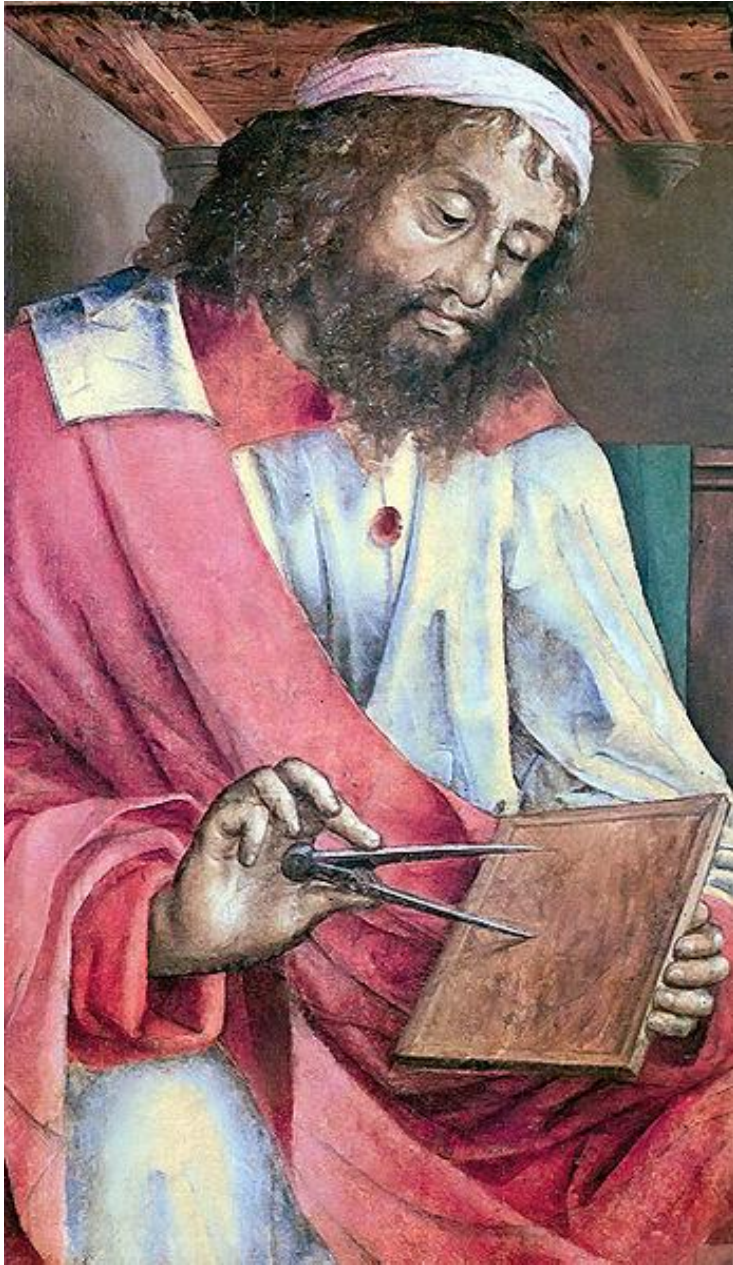
# Classroom Ideas

Construct and investigate the properties of the Euler line
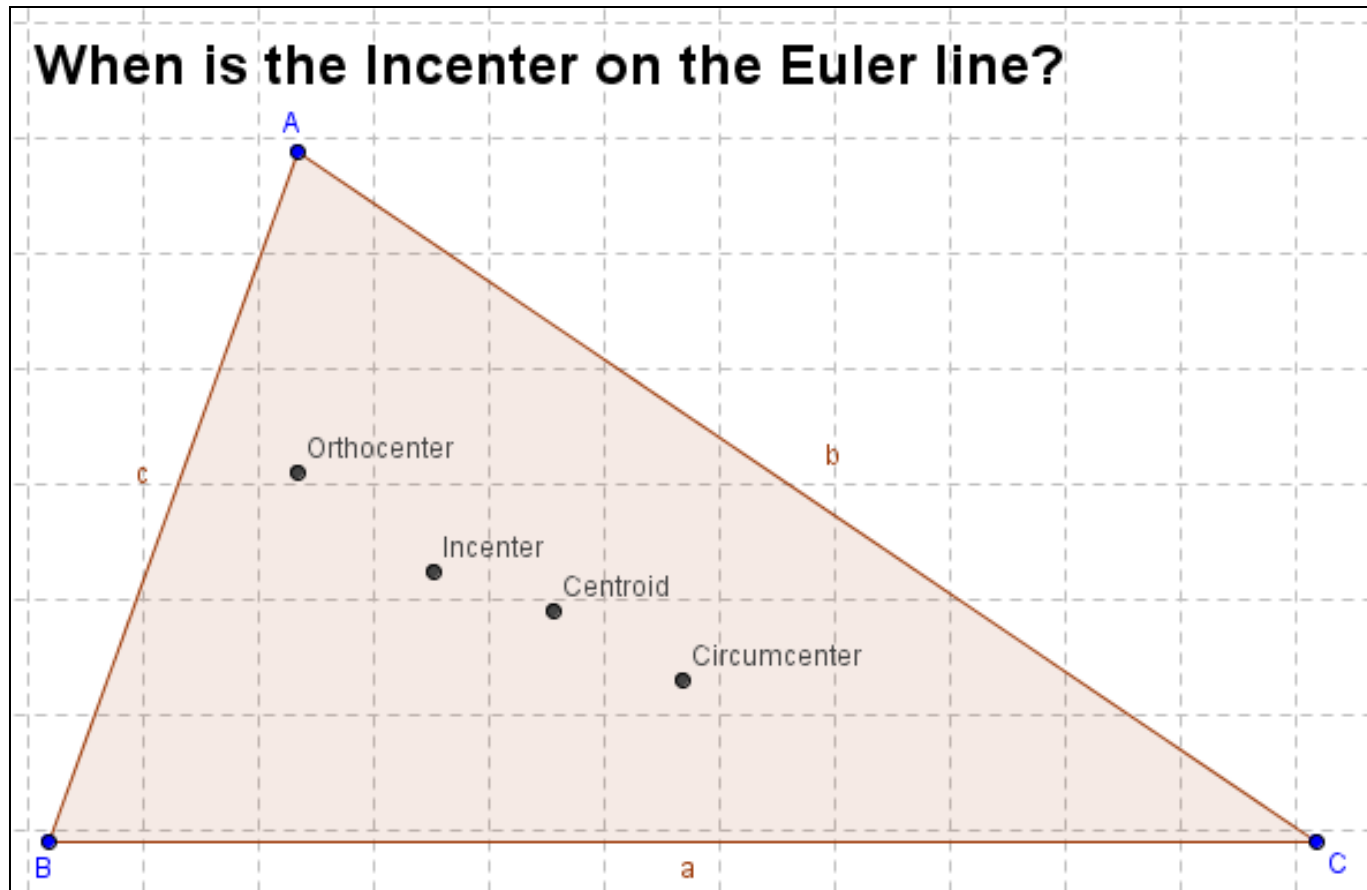
# Classroom Ideas

- Ask students to construct a given figure using only Euclidean tools
  - For example, students can try to match the figure produced by GeoGebra's "incircle" command
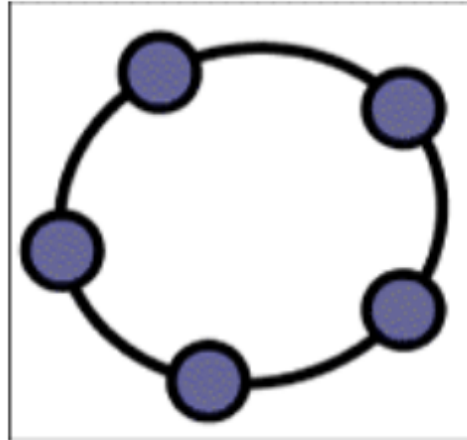
# Recommended Resources

Image: Justus van Gent, *Euclid of Megara*       http://commons.wikimedia.org/wiki/File:Euklid.jpg

# Wake's Geogebra Applets



This website is geared towards the curriculum of high school math (specifically ML) and has Geogebra applets for most of the important theorems and concepts in a high school geometry class. Have fun looking around and enjoy your time!!!

Chapter 1 - Basic Geometry: *Points, Lines, Angles, and Areas*
Chapter 2 - Parallelism: *Transversals, Parallels, and Perpendiculars*
Chapter 3 - Triangle Congruence: *SSS, SAS, ASA, AAS, HL and Properties*
Chapter 4 - Circles: *Properties, Inscribed Angles, and Arcs*
Chapter 5 - Quadrilaterals: *Parallelograms, Trapezoids, and Kites*
Chapter 6 - Similarity: *Polygons and Triangles*
Chapter 7 - Trigonometry: *Pythagorean Theorem, Sine, Cosine, and Tangent*
Chapter 8 - Polygons: *Angle Sum, Arc Length, and Sector Area*
Chapter 9 - Constructions: *Copying and Bisecting*
Chapter 10 - Transformations: *Rotations, Reflections, and Translations*

Image: Screen-capture from http://wakeggb.pbworks.com

# YouTube video:
# Theorem Proving with GeoGebra
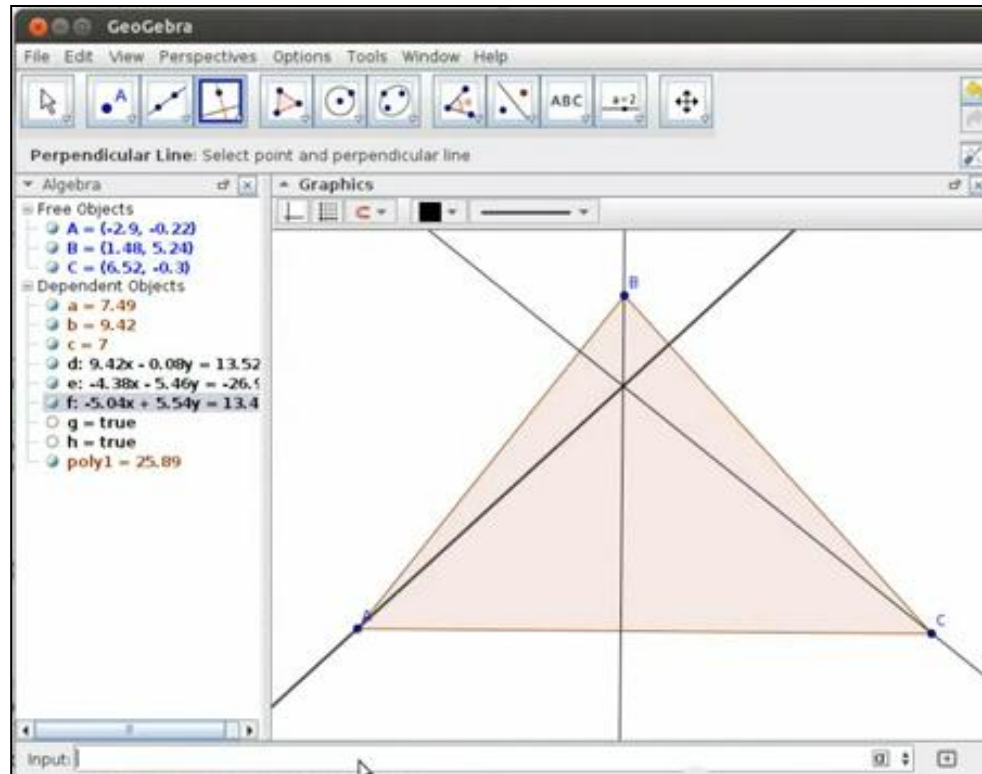


Image: Screen-capture of

"Theorem proving in GeoGebra" – Zoltán Kovács

http://www.youtube.com/watch?v=7aDe0YMm-OE

# GeoGebraTube.org


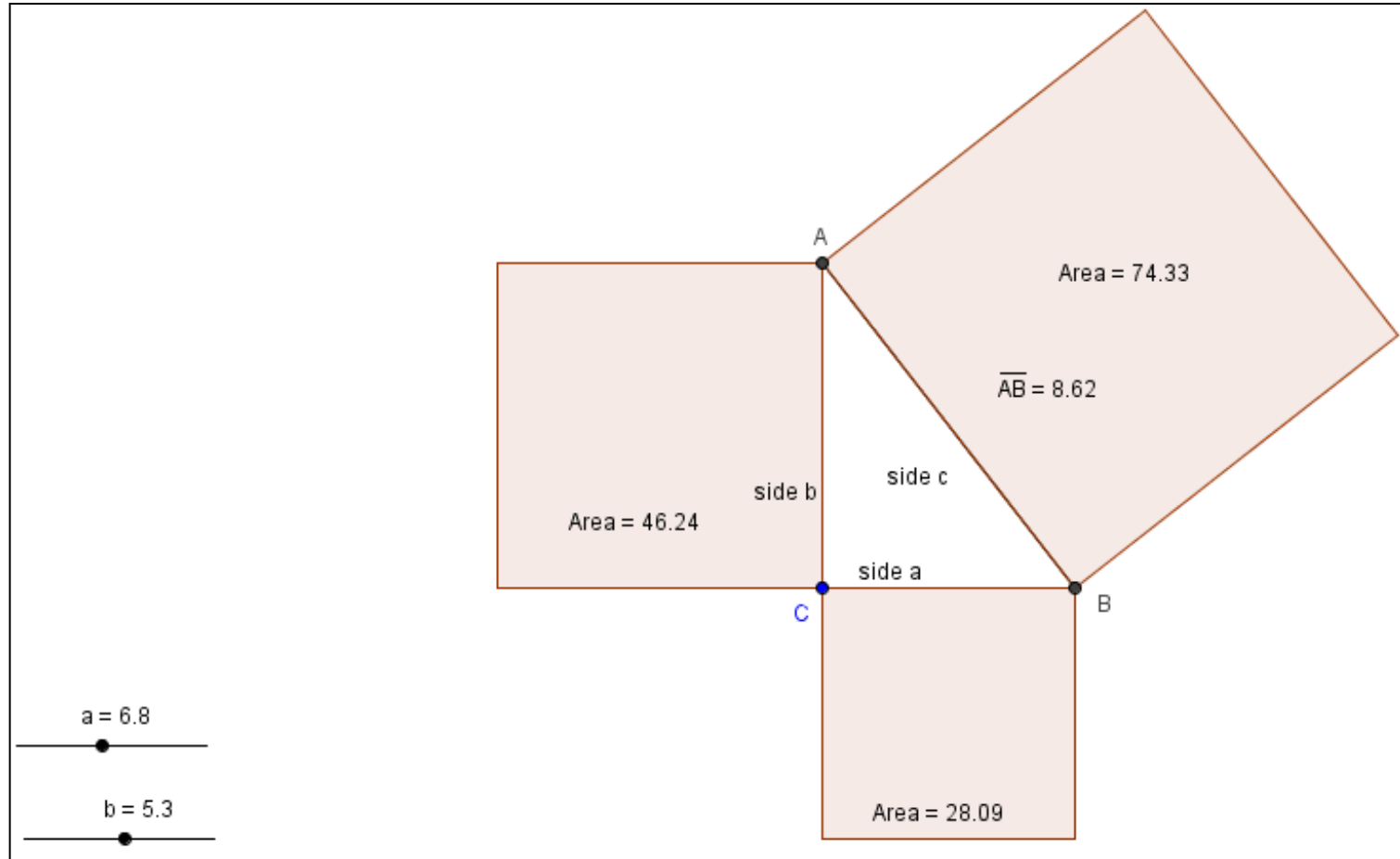
Image: Screen-capture of "Proof of Pythagorean Theorem" by David Cox

http://www.geogebra.org/en/upload/files/english/David%20Cox/Proof_of_Pythoagorean_Theorem.html
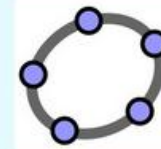
Image: Screen-capture of
http://www.kickstarter.com/projects/geogebra/geogebra-for-the-ipad

# North American
# GeoGebra Conference



GeoGebra Institute of Ohio

North American Conference • Miami University, Oxford OH • August 3-4, 2013

- Keynote presentation by Markus Hohenwarter

- Free registration ($5 per day donation requested)

Image: Screen-capture from
https://sites.google.com/site/ggbmidwest2013/home

# References

GeoGebra. (2012). Release notes GeoGebra 5.0. Available from http://wiki.geogebra.org/en/Release_Notes_ GeoGebra_5.0

Hohenwarter, M. (2002). GeoGebra [Software]. Available from http://www.geogebra.org/cms/

Kovács, Z. (2012). *Theorem proving.* Retrieved from http://blog.geogebra.org/2012/05/theorem-proving/

Sagan, C. (1979). *Broca's brain: Reflections on the romance of science*. New York, NY: Random House.

# Contact Information & Materials
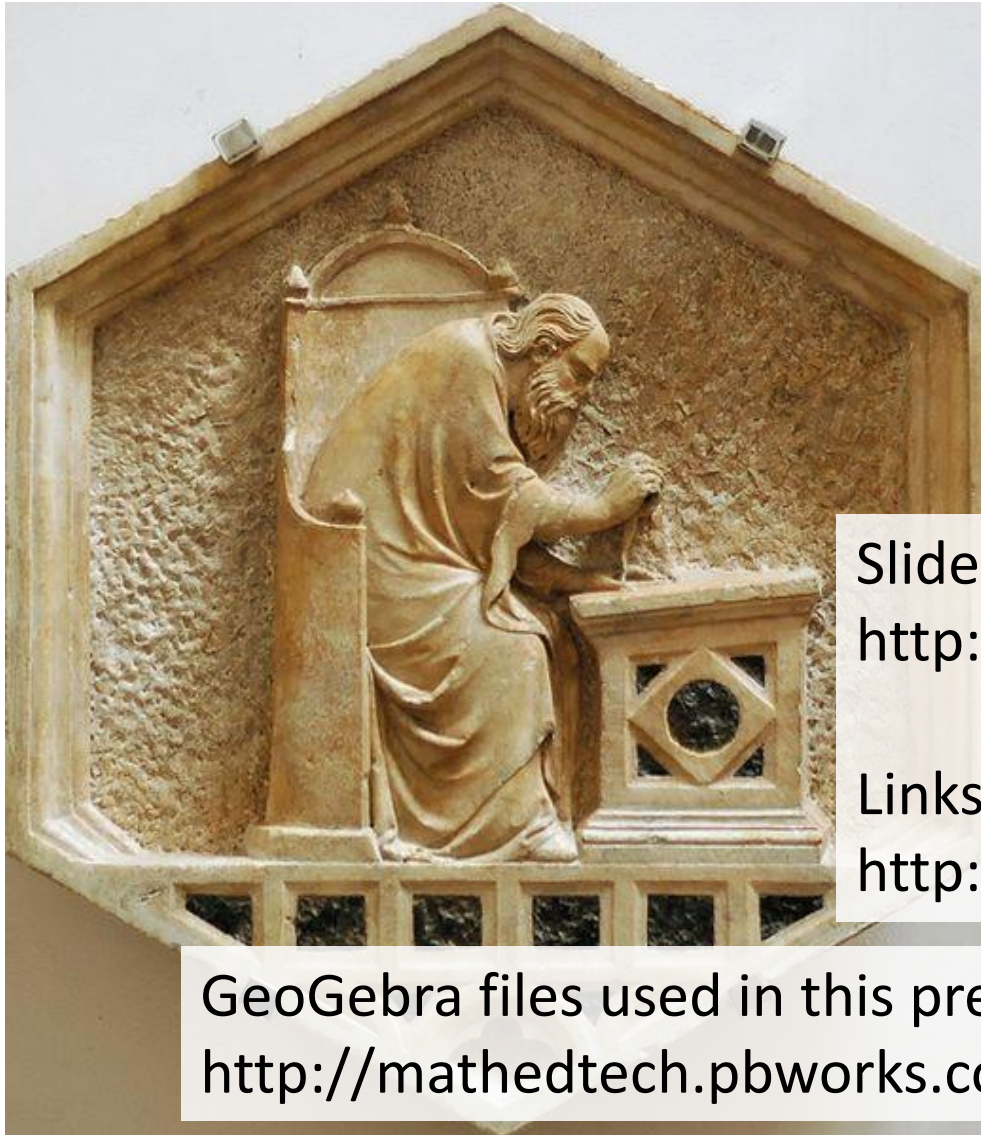


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Slides:
http://tinyurl.com/nctm2013geogebra

Links to math websites & tools:
http://tinyurl.com/mathedtech

GeoGebra files used in this presentation:
http://mathedtech.pbworks.com/w/page/48008052/GeoGebra

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