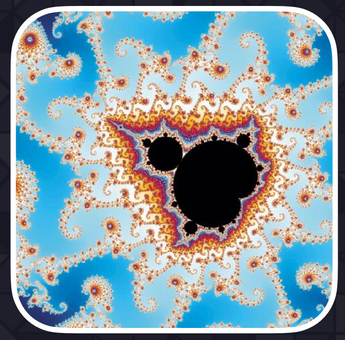
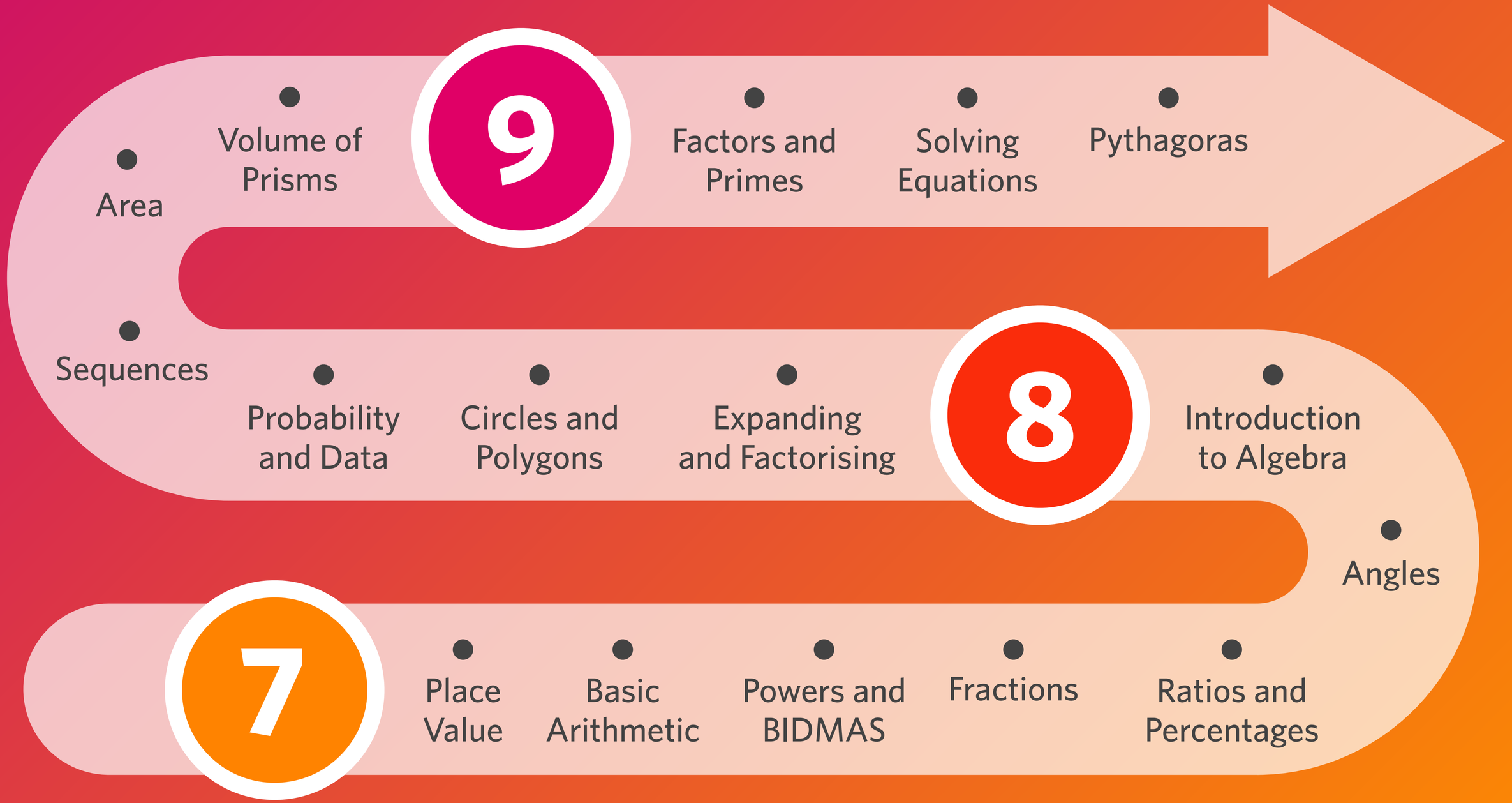


Discovering Mathematics

#MathsConf23 – 20 June 2020

Philipp Legner, @MathigonOrg

Mathigon.org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Area
Volume of Prisms
Factors and Primes
Solving Equations
Pythagoras
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Sequences
Probability and Data
Circles and Polygons
Expanding and Factorising
Introduction to Algebra
Angles
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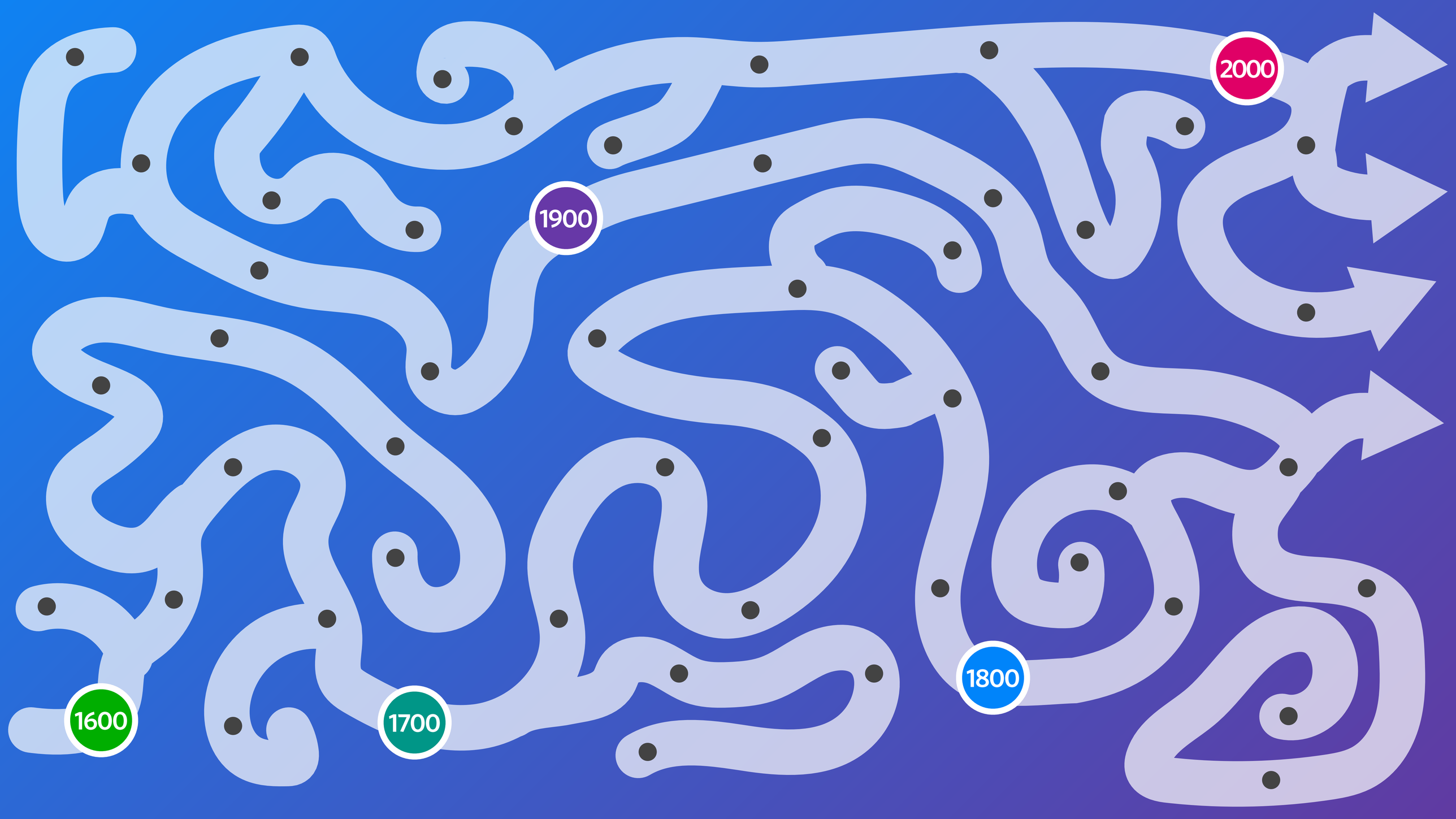
Place Value
Basic Arithmetic
Powers and BIDMAS
Fractions
Ratios and Percentages


1600
1700
1800
1900
2000

October 2019

nature

Highlight negative results to improve science

October 2013

The Economist

Problems with scientific research

How science goes wrong

Confidence

It's ok to make mistakes

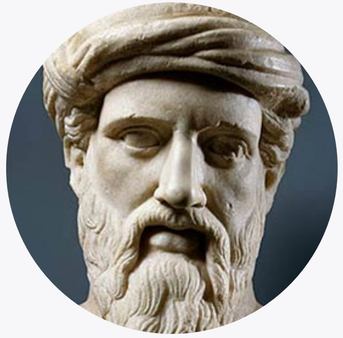
It takes time to understand new ideas

Creativity

Solve realistic, real-life problems

Explore, discover, and question assumptions

Number Systems



Pythagoras
c. 600 BCE

Brahmagupta
c. 600 CE

Fibonacci
1175 – 1250

Descartes
1596 – 1650

-1000 0 1000 2000

Rhind Papyrus
1550 BCE

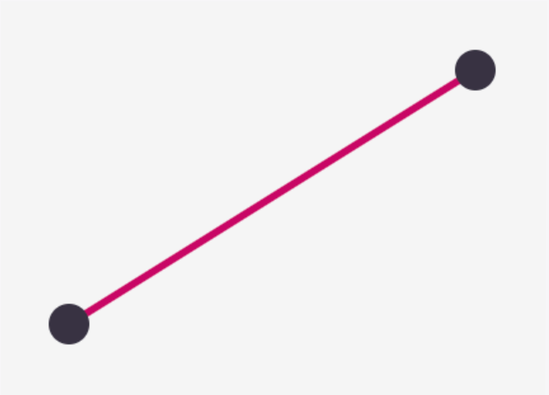
Diophantus
c. 250 CE

Al-Khwarizmi
780 – 850

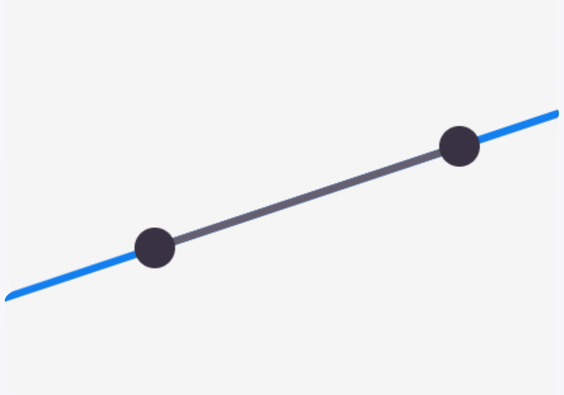
Cardano
1501 – 1576

Cantor
1845 – 1918

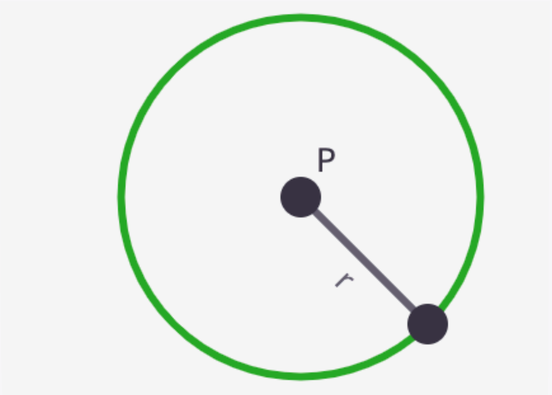
Euclidean Geometry



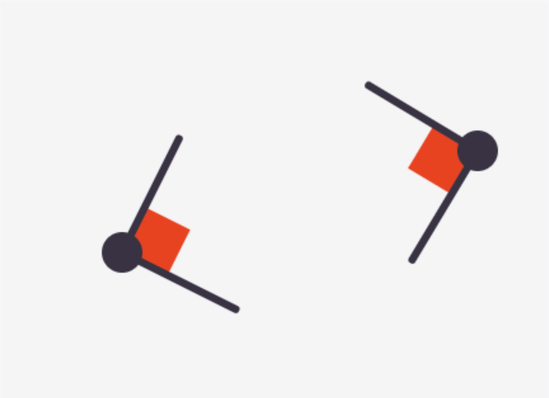
Axiom 1



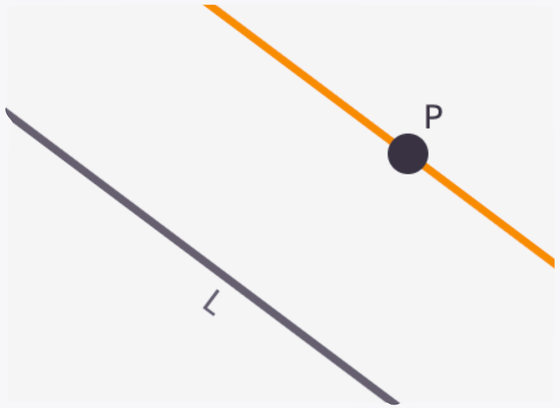
Axiom 2



Axiom 3

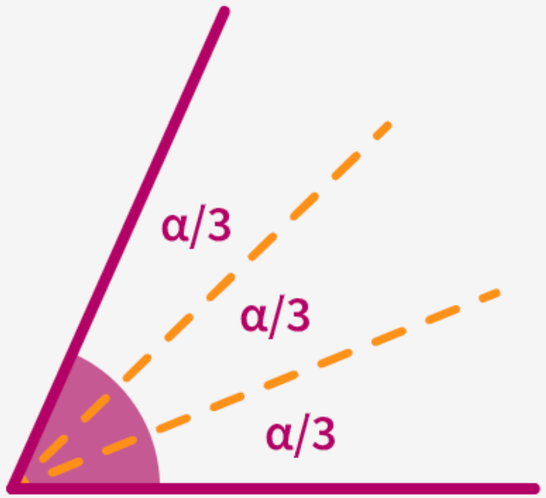


Axiom 4

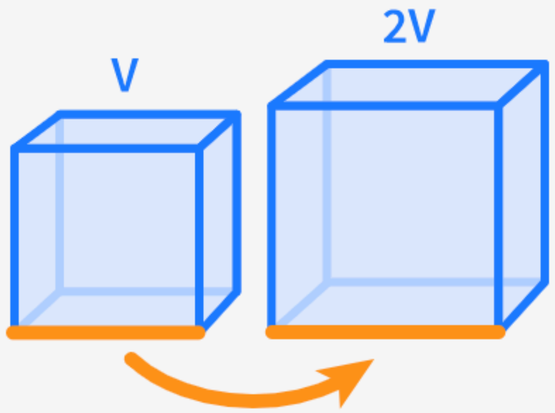


Axiom 5

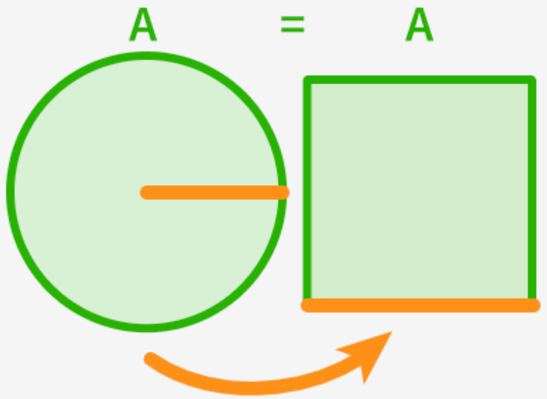
Euclidean Geometry



Trisecting the Angle



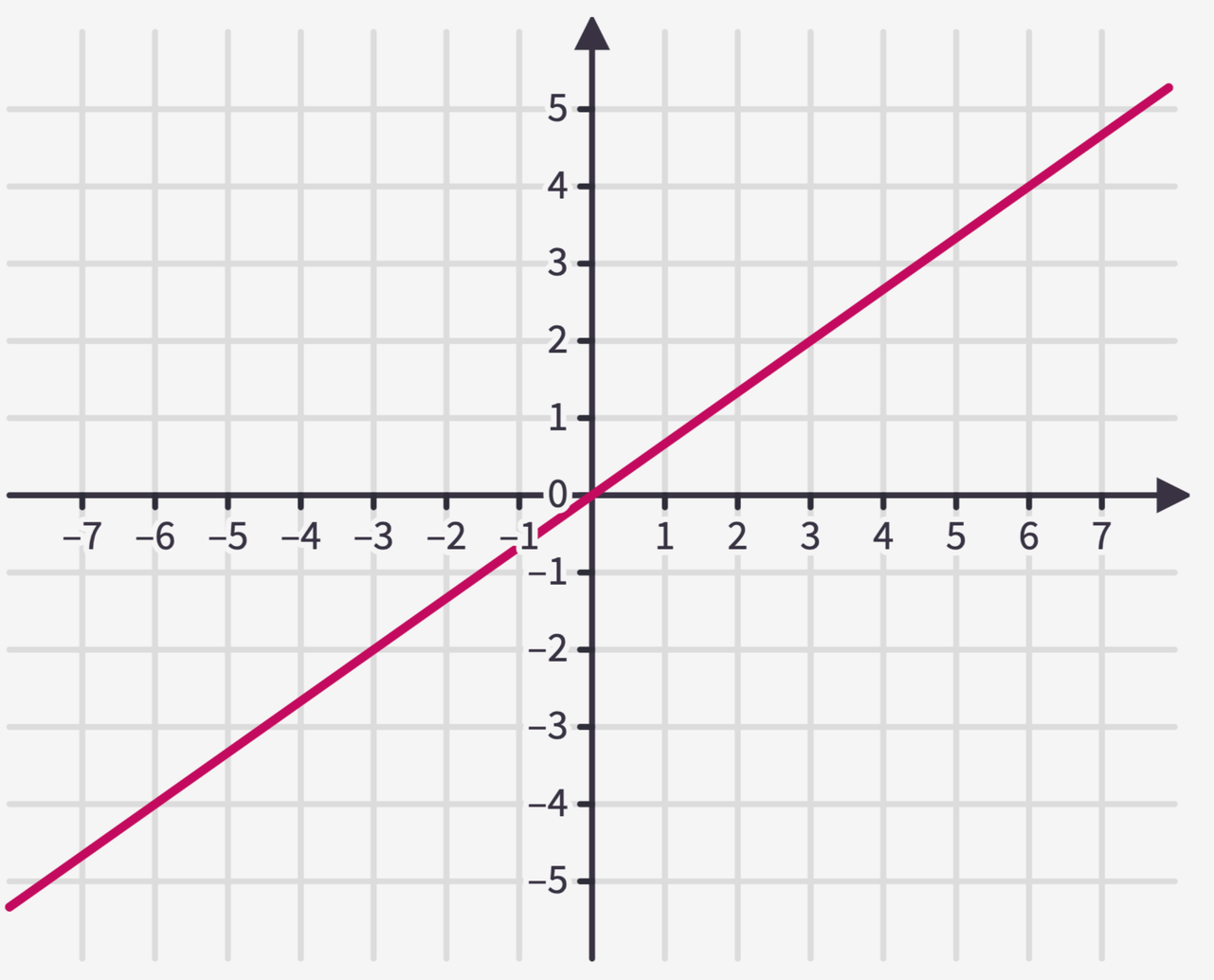
Doubling the Cube



Squaring the Circle

Euclidean Geometry

René Descartes
1596 - 1650

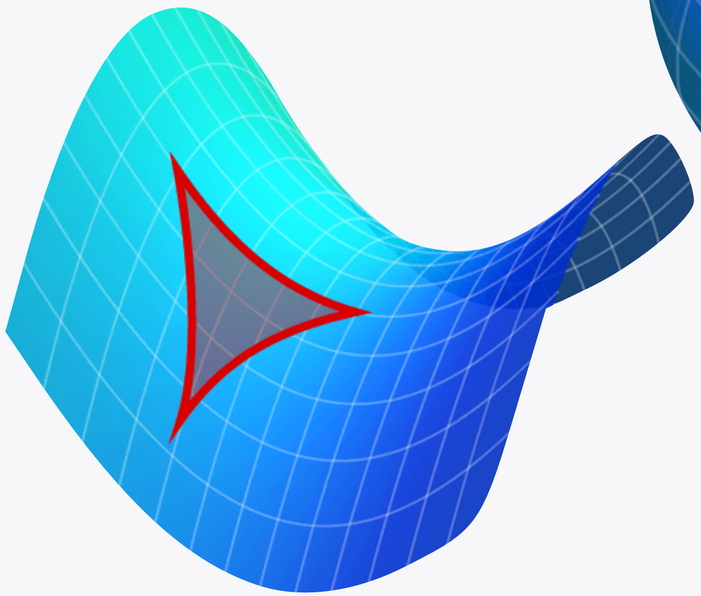


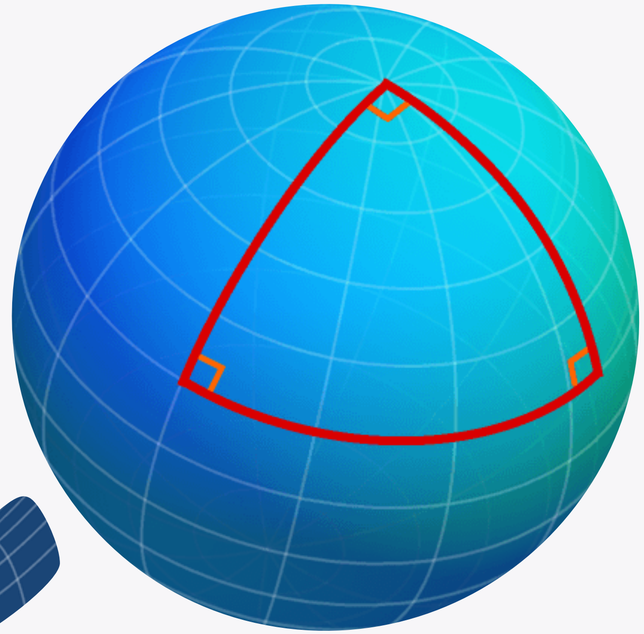
Non-Euclidean Geometry

C. F. Gauss
1777 – 1855

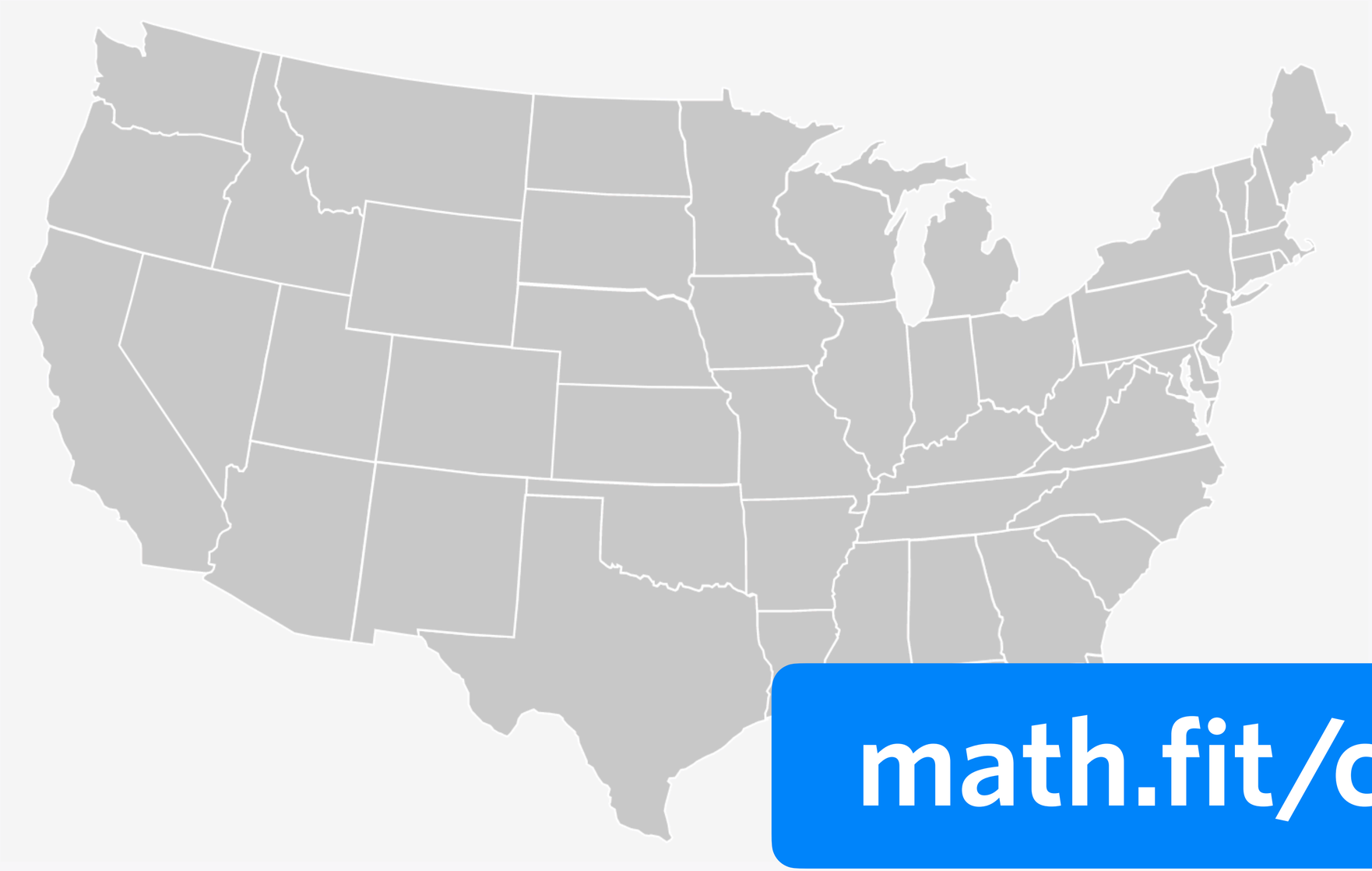
János Bolyai
1802 – 1860

Nikolai Lobachevsky
1792 – 1856

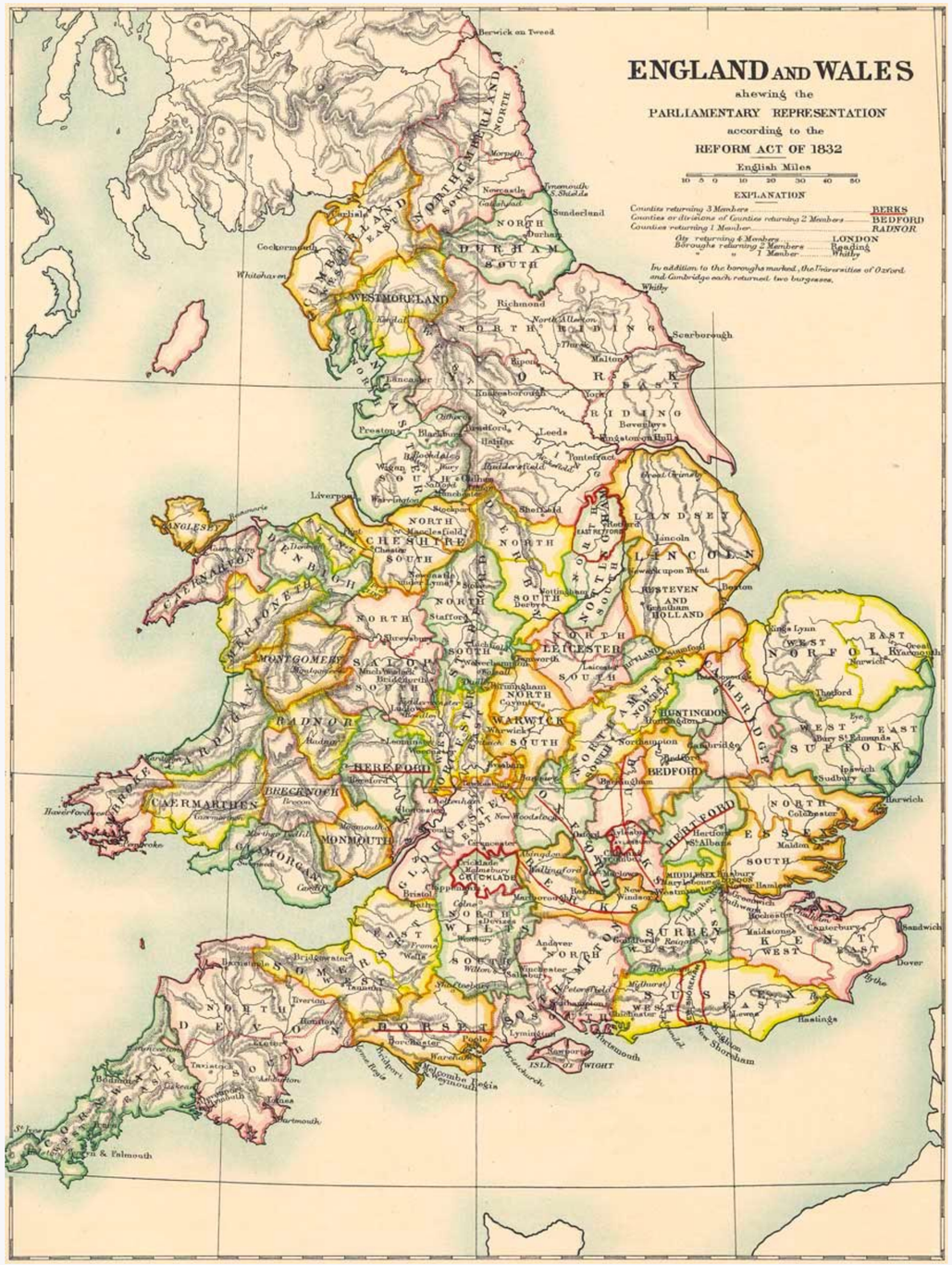




Map Colouring



math.fit/conf



Map Colouring

1852 – Problem by Francis Guthrie

1879 – Proof by Alfred Kempe

1880 – Another proof by
Peter Guthrie Tait

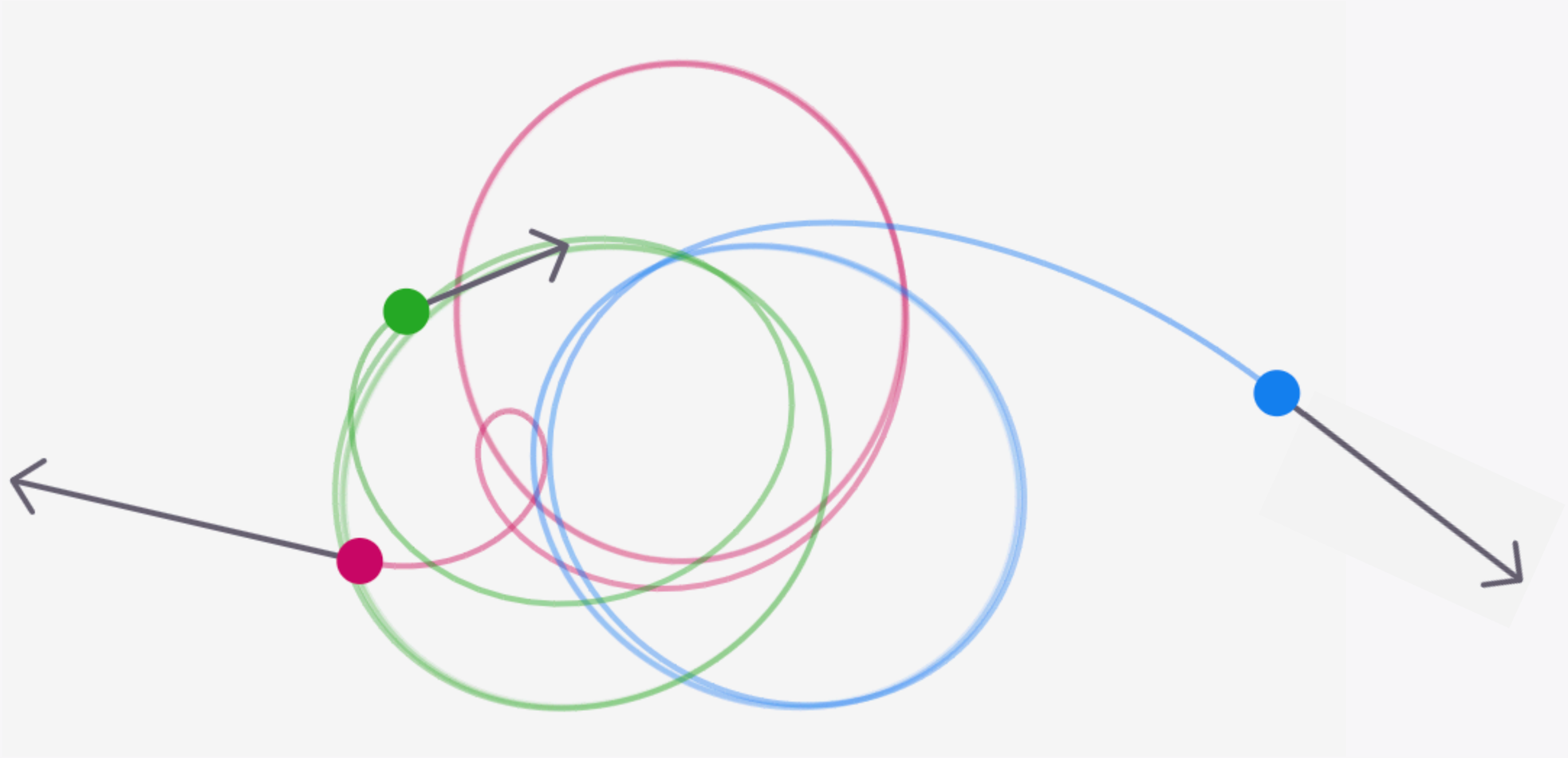
1890 – Kempe's proof is wrong

1891 – Tait's proof is wrong

Map Colouring

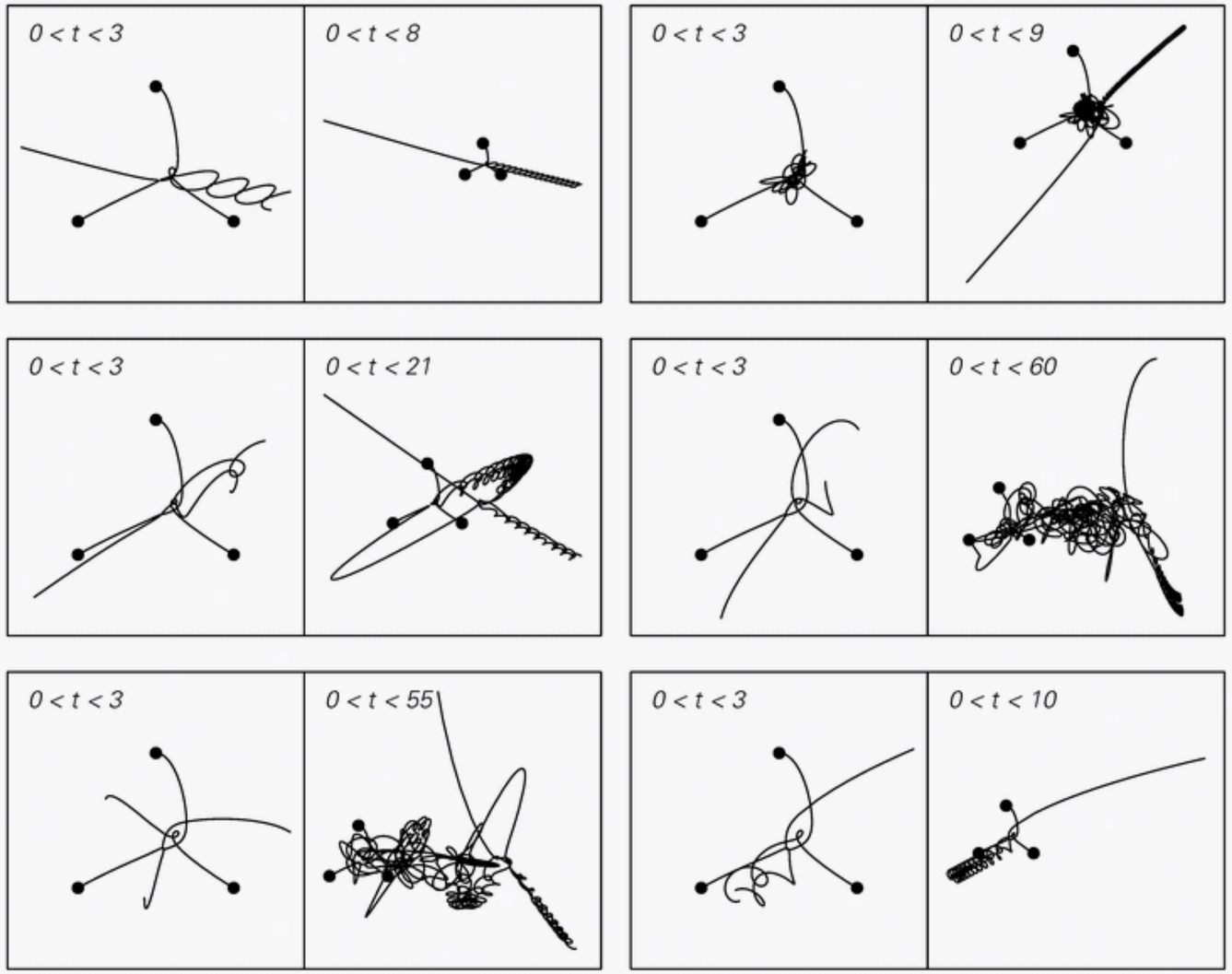
1976 – Kenneth Appel and Wolfgang Haken find a proof using computers

Three Body Problem



Three Body Problem

Henri Poincaré
1854 – 1912



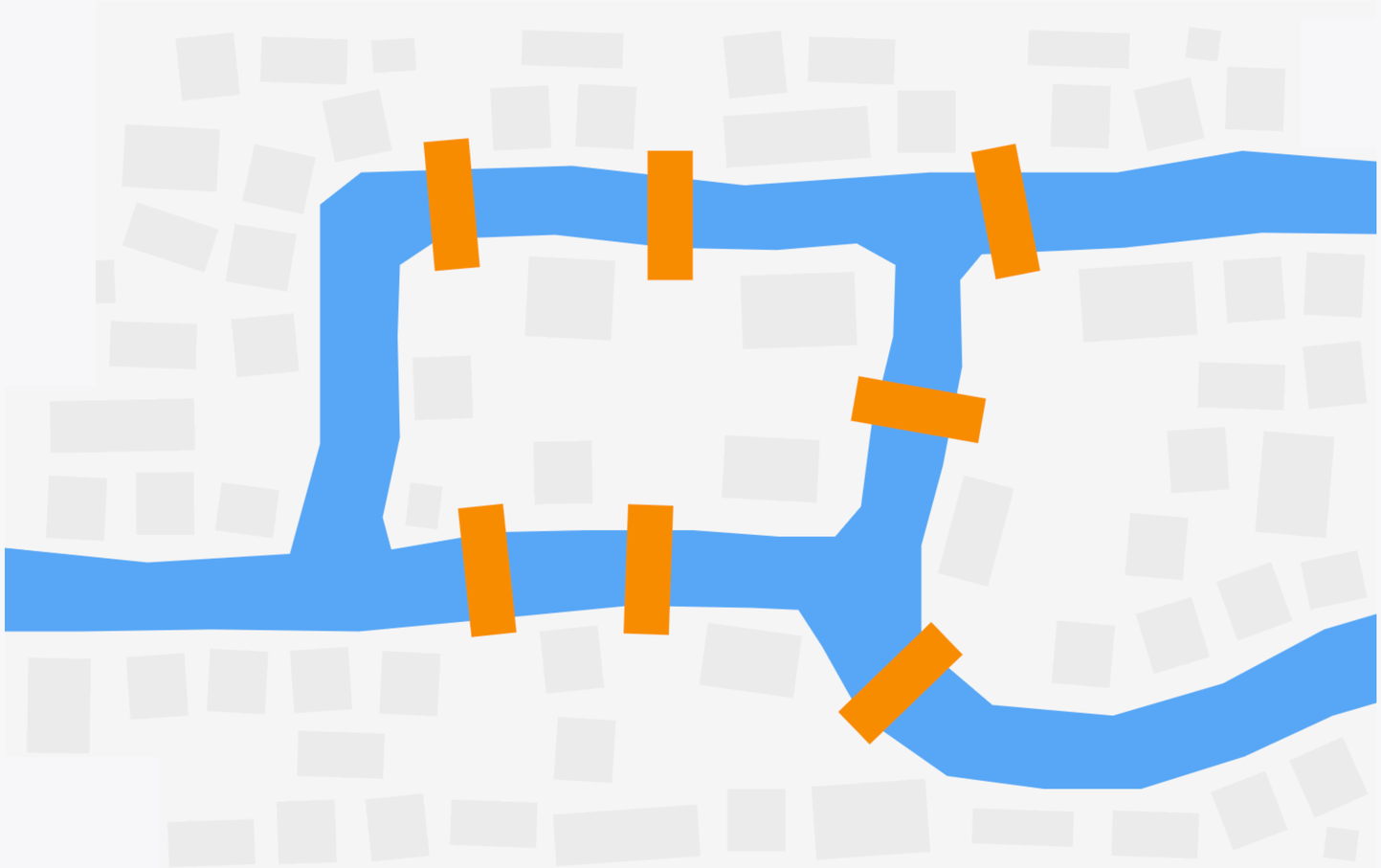
Fermat's Last Theorem

Andrew Wiles
born 1953

$$x^n + y^n = z^n$$

Königsberg Bridges

Leonhard Euler
1707 – 1783



Problem-Solving Strategies

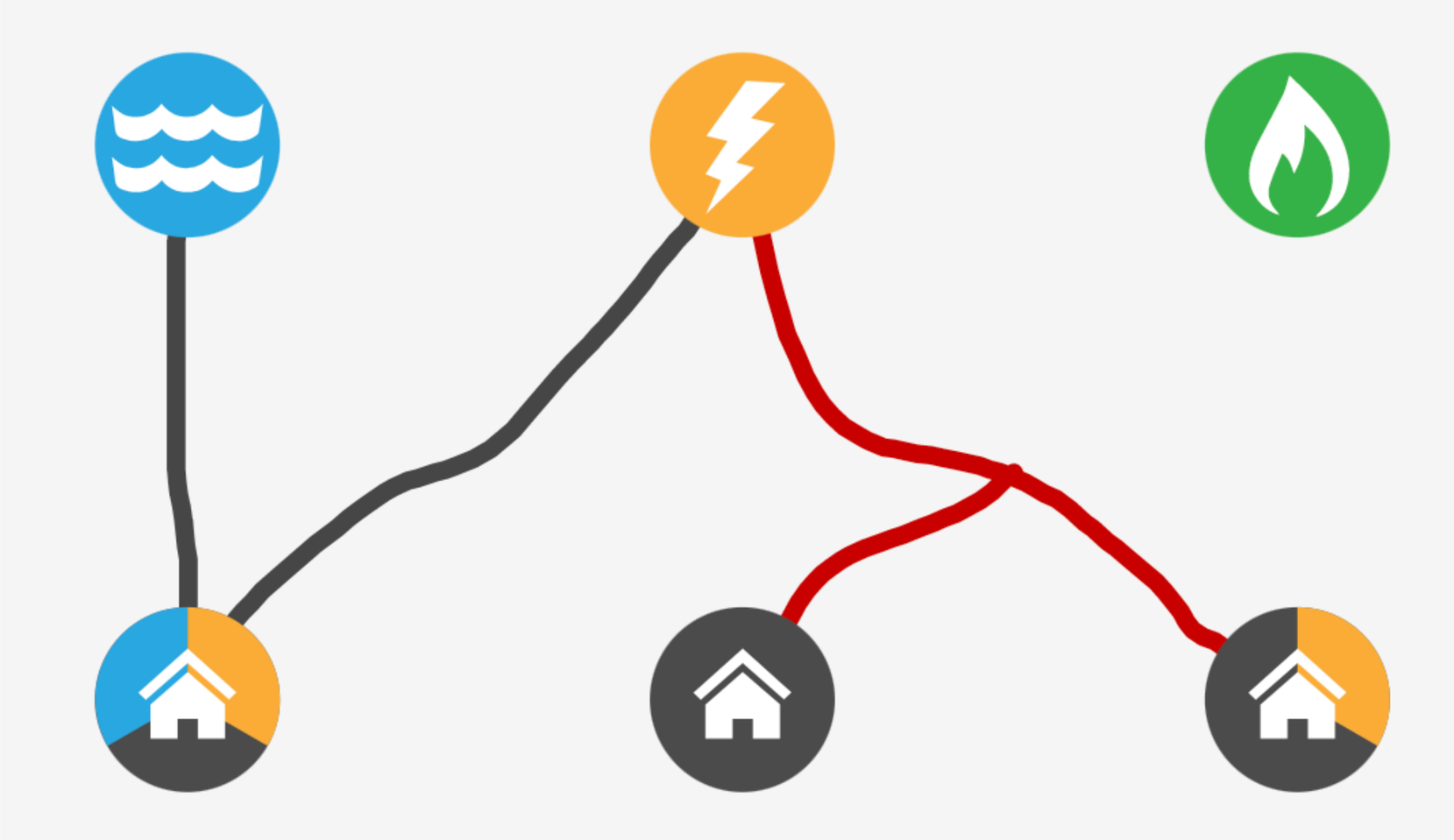
Try many examples

- simpler versions
- edge cases

Abstraction and new representations

Make new connections

Three Utilities



Problem-Solving Strategies

Ask the right questions

Is there even a solution?

Try many examples
- simpler versions
- edge cases

Abstraction and new representations

Make new connections

Examine assumptions

Approximate and simplify

Justify and critique

Perfect Numbers

6 = 1 + 2 + 3

28 = 1 + 2 + 4 + 7 + 14

496

8,128

33,550,336

8,589,869,056

137,438,691,328

2,305,843,008,139,952,128

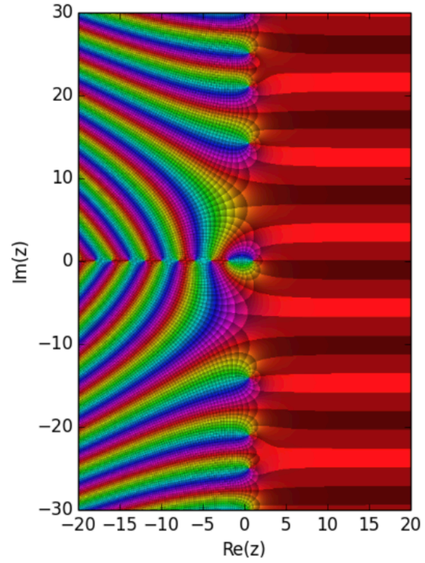
List of unsolved problems in mathematics

From Wikipedia, the free encyclopedia

This is a dynamic list and may never be able to satisfy particular standards for completeness. You can help by expanding it with reliably sourced entries.

Since the Renaissance, every century has seen the solution of more mathematical problems than the century before, yet many mathematical problems, both major and minor, still remain unsolved.[1] These unsolved problems occur in multiple domains, including physics, computer science, algebra, analysis, combinatorics, algebraic, differential, discrete and Euclidean geometries, graph, group, model, number, set and Ramsey theories, dynamical systems, partial differential equations, and more. Some problems may belong to more than one discipline of mathematics and be studied using techniques from different areas. Prizes are often awarded for the solution to a long-standing problem, and lists of unsolved problems (such as the list of Millennium Prize Problems) receive considerable attention.

This article is a composite of unsolved problems derived from many sources, including but not limited to lists considered authoritative. It does not claim to be comprehensive, it may not always be quite up to date, and it includes problems which are considered by the mathematical community to be widely varying in both difficulty and centrality to the science as a whole.



The Riemann zeta function, subject of the celebrated and influential unsolved problem known as the Riemann hypothesis

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1 Lists of unsolved problems in mathematics
  1.1 Millennium Prize Problems
2 Unsolved problems
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  2.4 Dynamical systems
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    2.5.1 Combinatorial games
    2.5.2 Games with imperfect information
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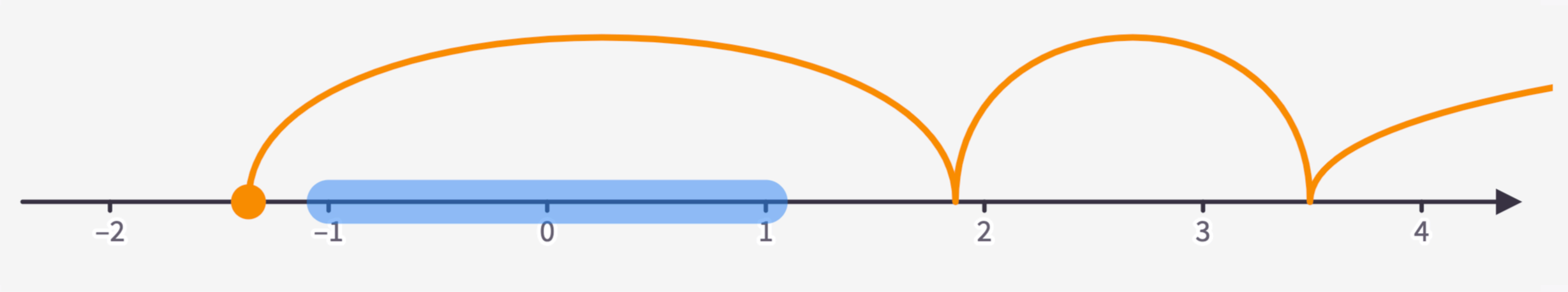
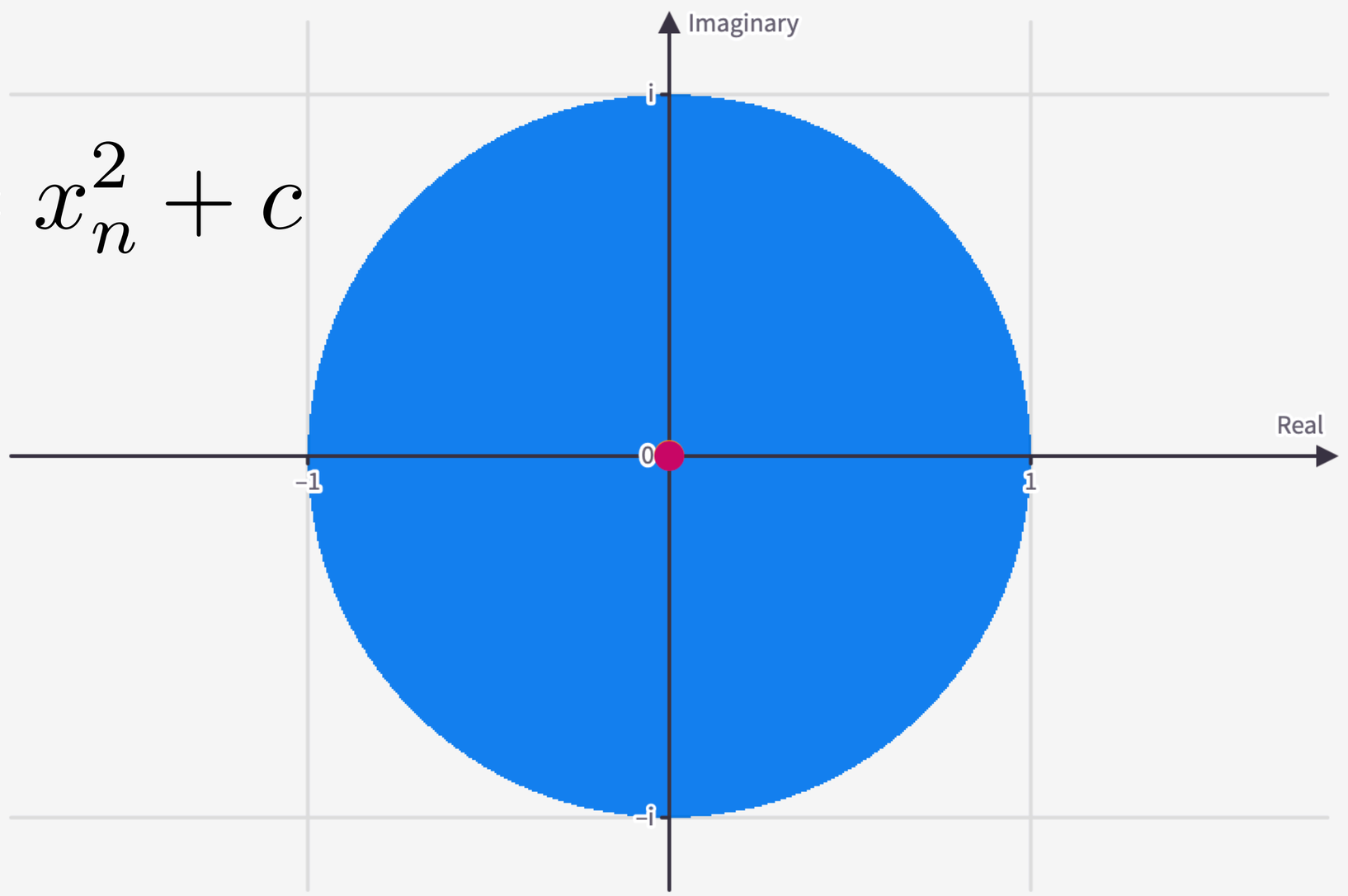
Sequences

$$x_{n+1} = x_n^2$$



Complex Sequences

$$x_{n+1} = x_n^2 + c$$



Julia Sets

Julia Sets

The Mandelbrot Set

Bernoit Mandelbrot
1924 – 2010

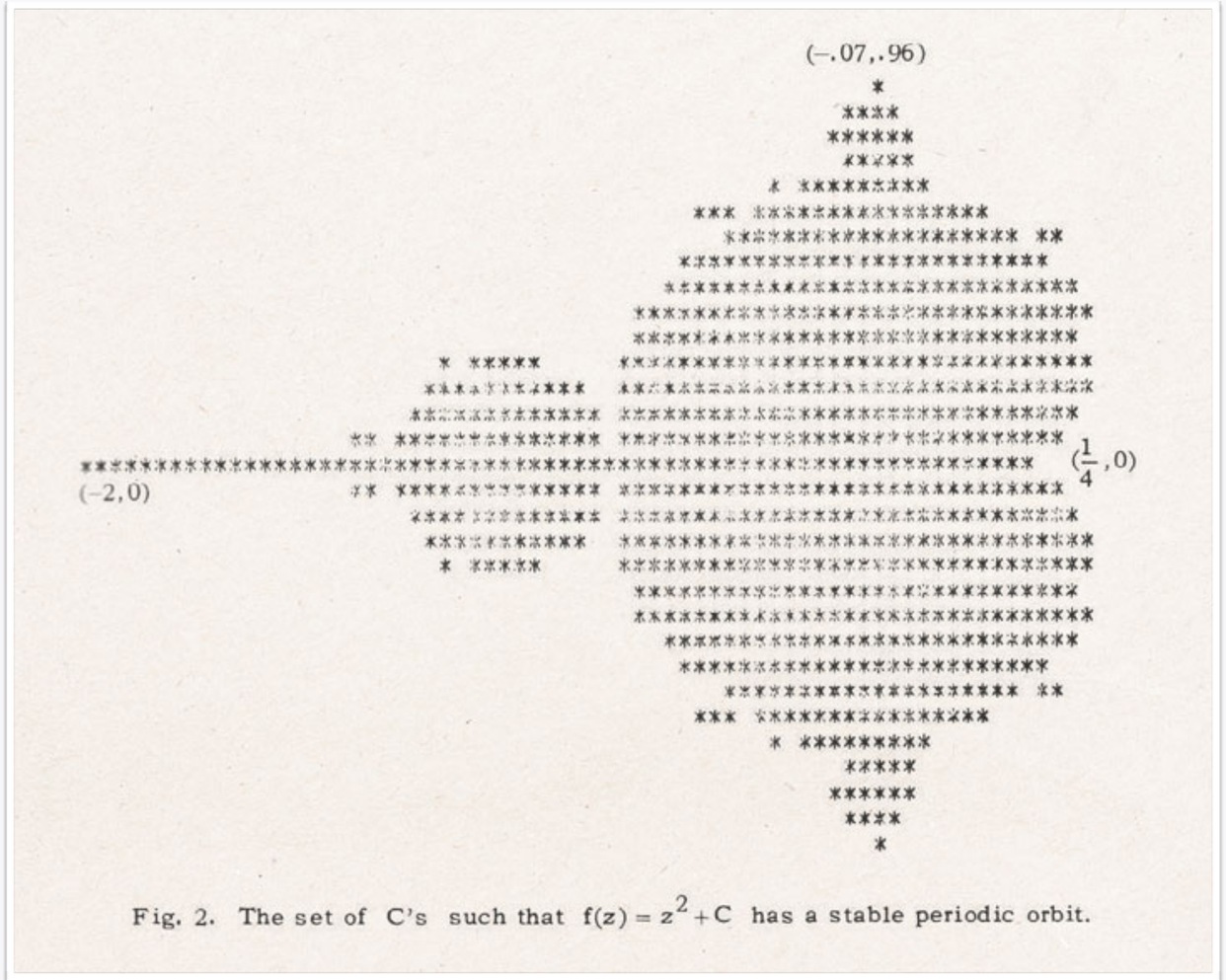


Fig. 2. The set of C's such that $f(z) = z^2 + C$ has a stable periodic orbit.

Thanks for listening!

philipp@mathigon.org

@MathigonOrg