Leonhard Euler
Leonhard Euler

• 1707-1783
• Contemporary with
  – Benjamin Franklin
  – George Washington
  – Robespierre
• Father was a Protestant clergyman, as were many of his maternal relatives.
Leonhard Euler

• Of course, his father hoped Leonhard would become a clergyman as well.
• Extraordinary memory.
  – Orations, poems, literary works
  – Tables of prime powers
• Prodigious mental calculator.
Leonhard Euler

• Entered the University of Basel at age 14, met Johann Bernoulli, who became his guide, suggesting things to read and answering questions.

• “I was given permission to visit [Johann Bernoulli] freely every Saturday afternoon and he kindly explained to me everything I could not understand.”
Leonhard Euler

• Earned a Master’s degree in Philosophy at about age 16. He then enrolled in divinity school, but.....

• “I had to register in the faculty of theology, and I was to apply myself...to the Greek and Hebrew languages, but not much progress was made, for I turned most of my time to mathematical studies, and by my happy fortune the Saturday visits to Johann Bernoulli continued.”

• Johann Bernoulli helped convince Euler’s father that Leonhard should study mathematics (they were in fact old college chums, having both lived in Jacob Bernoulli’s house during their time at Basel).
Leonhard Euler

• In 1726, published his first paper.
• At age 20, he earned recognition in an international science competition for his analysis of the placement of masts on a sailing ship.
• He’d probably never seen a sailing ship.
Leonhard Euler

• Was offered a position at the St. Petersburg Academy, where his friend Daniel Bernoulli was teaching mathematics.

• The position was in physiology & medicine, about which he knew nothing, but jobs were scarce.

• As it turned out, he was appointed to the faculty of physics, rather than physiology.
Leonhard Euler

• In 1722, Daniel Bernoulli left to take a position in Switzerland, and Euler took his post in mathematics.
• Now feeling secure, he married Katharina Gsell, the daughter of a Swiss painter living in Russia.
• They had a long and happy marriage, and 13 children. Unfortunately, only five lived to adulthood.
Leonhard Euler

• We are told that
  “he assembled the whole family every evening, and read a chapter of the Bible, which he accompanied with an exhortation. Theology was one of his favorite studies, and the doctrines which he held were the most rigid doctrines of Calvinism.”

• Euler claimed that he made some of his greatest mathematical discoveries while holding a baby in his arms with other children playing round his feet.
Leonhard Euler

• Worked as a consultant on a wide variety of projects, from preparing maps to testing designs for fire engines.

• He didn’t however, agree to cast a horoscope for the Czar. (Good job, Leonhard!)

• Began to lose eyesight in his right eye in about 1738. He blamed it on working too hard on maps, but it was more likely caused by an infection.
Leonhard Euler

• In 1741, because of political unease in Russia, he took an offer to become a member of the Berlin Academy, where he remained for a quarter of a century.

• Eventually personality conflicts arose between Euler and Frederick the Great as well as Voltaire (another member of the Academy). Both considered Euler to be too unsophisticated.
Leonhard Euler

• In 1766, Euler returned to the St. Petersburg Academy, with whom he had maintained a very cordial relationship during his time in Berlin.

• By 1771, Euler had lost the sight in his other eye, making it impossible for him to read anything other than very large characters.

• In 1773, his wife died.
Leonhard Euler

- Faced with these tragedies, he increased his scholarly output. By having papers read to him, and by dictating his papers to scribes, he managed to write (among other things) a 775-page treatise on the movement of the moon, and a three-volume development of integral calculus.

- In 1775, he wrote an average of one mathematical paper per week.
Leonhard Euler

• Three years after his wife’s death, he married her half-sister.
• He died of a massive brain hemorrhage on September 18, 1783. He had spent the day with his grandchildren, took up some mathematical questions on the flight of hot-air balloons, and making some calculations on the orbit of Uranus.
Euler’s Work

• He published 560 books and papers while alive
• Over next 47 years, papers published posthumously brought the total up to 771
• More discoveries over the years put the total at 856, plus another 31 with his oldest son, who served as one of his scribes after he lost his sight.
Euler’s Work

• The most prolific mathematician who ever lived.

• His collected works, the *Opera Omnia*, runs over 25,000 pages and would require a forklift to move.
Euler’s Work

Mathematical Notation: Euler introduced

• the concept of a function and the notation f(x)
• the modern notation for trig functions
• the base for the natural log, aka Euler's number, or e.
• the use of $\sum$ for summation
• the use of $i$ for the imaginary unit
• Scientific notation

• And he popularized the use of $\pi$ for the ratio of the circumference of a circle and its diameter.
Euler’s Work

• In Analysis:
  – power series (Basel Problem)
  – exponential functions and logarithms as a way of analytic proof
  – proved the Prime Number Theorem using harmonic series
  – Continued fractions
  – Developed what we know as Euler approximations

• His works in graph theory led to the origin of topology
• Made contributions to physics and astronomy
  o Euler-Bernoulli beam equation (used in engineering)
  o calculations led to development of longitude tables
  o optics - wave theory of light
Euler’s Work

Euler also studied the application of math in music and tried to incorporate musical theory into mathematics. This was rejected by the community because it was considered "too mathematical for musicians and too musical for mathematicians".
Euler’s Work

• "Charted new direction for whole areas of mathematics, from the calculus of variation, to graph theory, to complex analysis, to differential equations."

• "Virtually every branch of mathematics has theorems of major significance that are attributed to Euler."

• "There is ample precedent for naming laws and theorems for persons other that their discoverers, else half of analysis would be named for Euler."
Euler’s Work

- "Euler's mathematical writings are the first that look truly modern to today's reader; this, of course, is not because he chose a modern notation but because his influence was so persuasive that all subsequent mathematicians adopted his style, notation, and format."
Euler’s Work

Some of the discoveries of Euler that we still use today include:

- Euler's triangle (vertices are the midpoints of the segments joining the orthocenter with the respective vertices)
- The Euler characteristic \(V+F-E = 2\)
- Euler circuits and paths (7 bridges of Konigsburg)
- Euler's Identity \(e^{i\pi} + 1 = 0\)
- The Euler constant (gamma)- the limiting difference between the harmonic series and the natural logarithm.
- The Euler line in geometry (orthocenter, circumcenter, centroid, and center of nine-point circle)
Königsberg