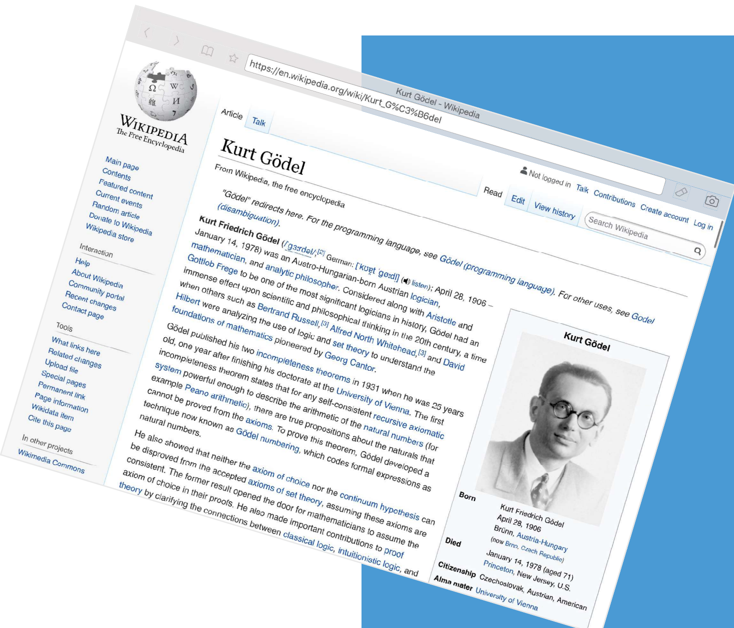
Lecture 2: Basics of Probability Theory

Professor Ilias Bilionis

The obvious rule of probability

The obvious rule

The **obvious rule:** $$p(A \mid I) + p(\neg A \mid I) = 1$$



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Kurt Gödel - Wikipedia

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Kurt Gödel

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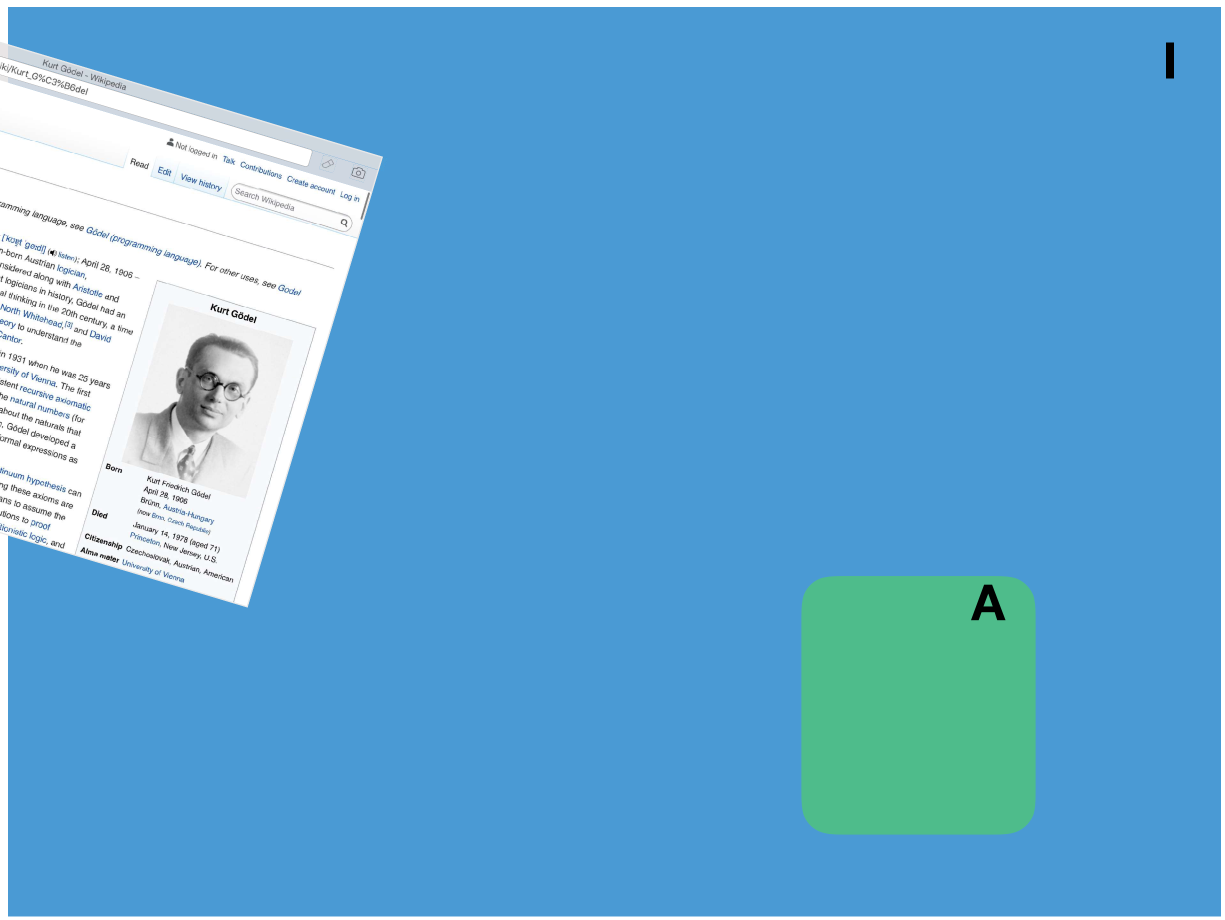
"Gödel" redirects here. For the programming language, see Gödel (programming language). For other uses, see Godel (disambiguation).

Kurt Friedrich Gödel (/ˈɡɜːrdəl/;[2] German: [ˈkʊʁt ˈɡøːdl̩] (listen); April 28, 1906 – January 14, 1978) was an Austro-Hungarian-born Austrian logician, mathematician, and analytic philosopher. Considered along with Aristotle and Gottlob Frege to be one of the most significant logicians in history, Gödel had an immense effect upon scientific and philosophical thinking in the 20th century, a time when others such as Bertrand Russell,[3] Alfred North Whitehead,[3] and David Hilbert were analyzing the use of logic and set theory to understand the foundations of mathematics pioneered by Georg Cantor.

Gödel published his two incompleteness theorems in 1931 when he was 25 years old, one year after finishing his doctorate at the University of Vienna. The first incompleteness theorem states that for any self-consistent recursive axiomatic system powerful enough to describe the arithmetic of the natural numbers (for example Peano arithmetic), there are true propositions about the naturals that cannot be proved from the axioms. To prove this theorem, Gödel developed a technique now known as Gödel numbering, which codes formal expressions as natural numbers.

He also showed that neither the axiom of choice nor the continuum hypothesis can be disproved from the accepted axioms of set theory, assuming these axioms are consistent. The former result opened the door for mathematicians to assume the axiom of choice in their proofs. He also made important contributions to proof theory by clarifying the connections between classical logic, intuitionistic logic, and

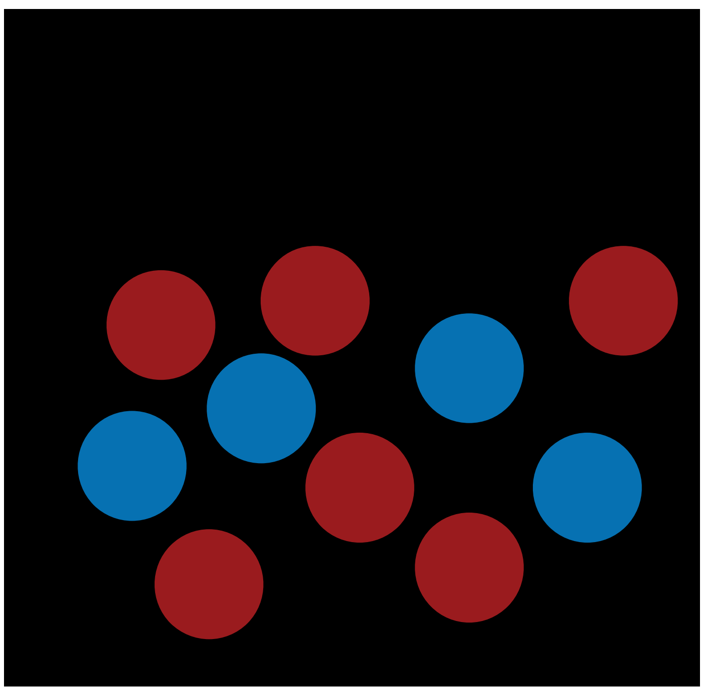
Kurt Gödel	
Born	Kurt Friedrich Gödel April 28, 1906 Brünn, Austria-Hungary (now Brno, Czech Republic)
Died	January 14, 1978 (aged 71) Princeton, New Jersey, U.S.
Citizenship	Czechoslovak, Austrian, American
Alma mater	University of Vienna

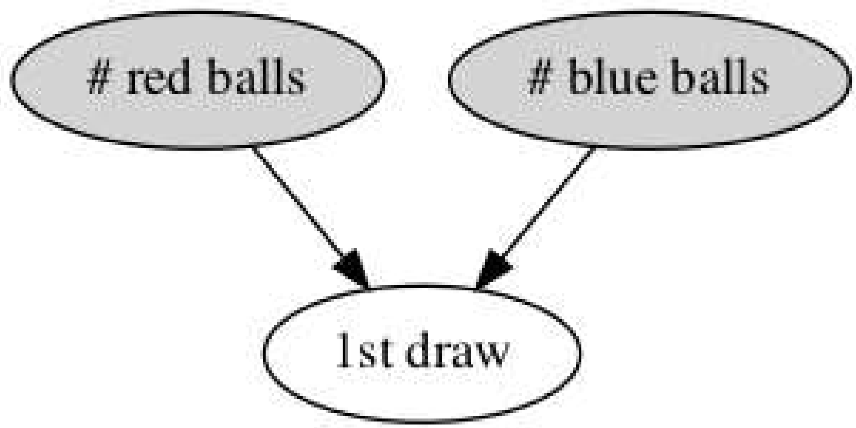


Example: Drawing balls from a box without replacement

Consider the following example of prior information I:

We are given a box with 10 balls 6 of which are red and 4 of which are blue. The box is sufficiently mixed so that when we get a ball from it, we don't know which one we pick. When we take a ball out of the box, we do not put it back.





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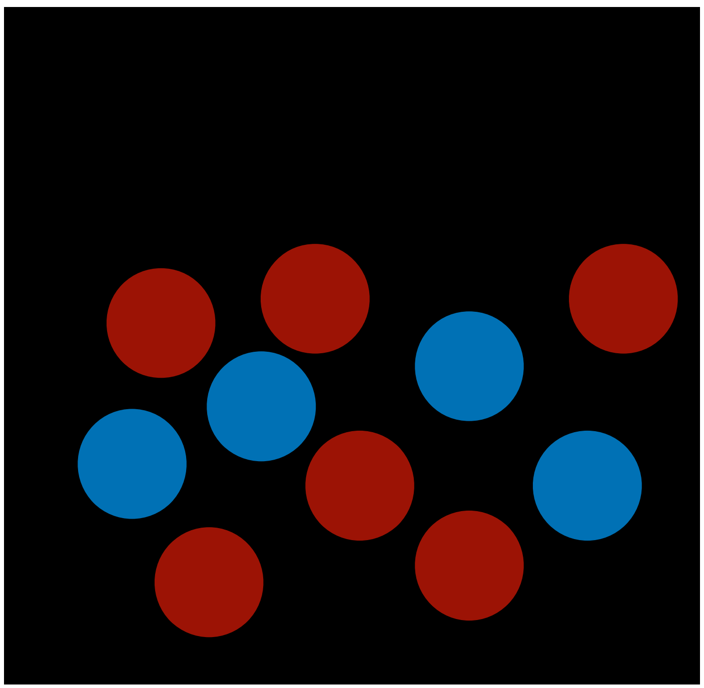

Let B_1 be the sentence:

The first ball we draw is blue.

Let's compute a probability:

$$p(B_1 | I) = \frac{4}{10}$$

Insufficient Reason

Laplace.

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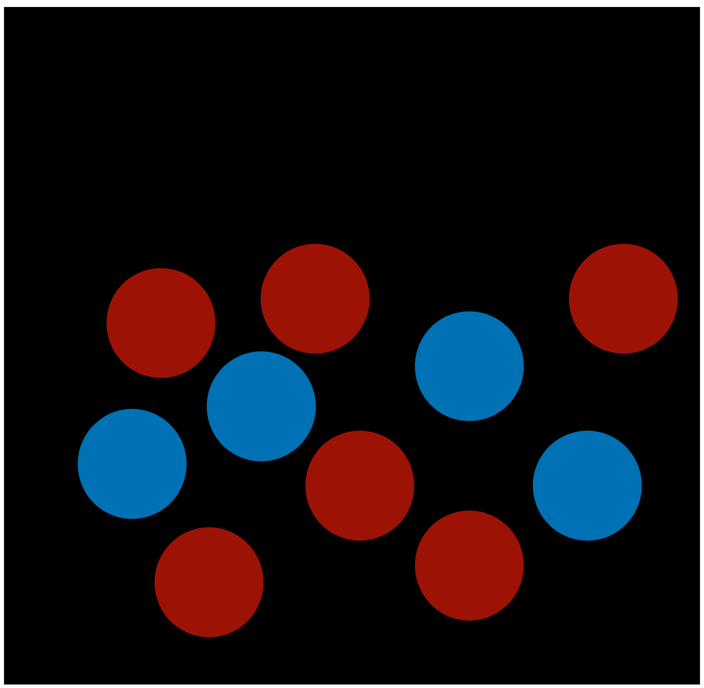

$$p(B_1 \mid I) = 0.4$$

What is the probability that we get a red ball ($\neg B_1 \equiv R_1$ is true)?

$$p(R_1 \mid I) = p(\neg B_1 \mid I) \overset{ob.}{\underset{R.}{=}} 1 - p(B_1 \mid I)$$

$$= 1 - 0.4 = 0.6$$

$$p(R_1 \mid I) = \frac{6}{10}$$