proof of Bayes' Theorem

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Owner	ariels (338)
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The proof of Bayes' theorem is no more than an exercise in substituting the definition of conditional probability into the formula, and applying the total probability theorem.

$$\frac{\mathbb{P}\{B\}\,\mathbb{P}\{E|B\}}{\sum_i \mathbb{P}\{A_i\}\,\mathbb{P}\{E|A_i\}} = \frac{\mathbb{P}\{E\cap B\}}{\sum_i \mathbb{P}\{E\cap A_i\}} == \frac{\mathbb{P}\{E\cap B\}}{\mathbb{P}\{E\}} = \mathbb{P}\{B|E\}\,.$$