

# The Binomial Formula

$$\frac{n!}{k!(n-k)!} p^k (1-p)^{n-k}$$

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Suppose that genders of successive children are independent. Four children.

Suppose that chance of boy = 1/2. What is the chance of BBGG? BGBG? BGGG?

Suppose that chance of boy = 1/3. What is the chance of BBGG? BGBG? BGGG?

How many ways can you have three boys?

**BBBG BBGB BGGB GBBB**

What's the chance of having three boys?

(# ways) x probability of each way

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Possible families: listed in birth order

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      B _____ G
    BB _____ BG _____ GG
      BBG      BGG
      BGB      GBG
BBB _____ GBB _____ GGB _____ GGG
      BBGG
      BGGG
BBBG      BGGG      BGGG
BBGB      BGGB      GBGG
BBGB      GBGB      GGBG
BBB _____ GBBB _____ GGBB _____ GGBB _____ GGGG
  
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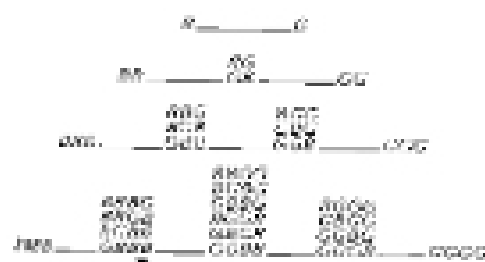
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If there are 4 children, there are 4 ways to have 3 boys.  
 If chance of a boy =  $\frac{1}{3}$ , chance of 3 boys in 4 children is

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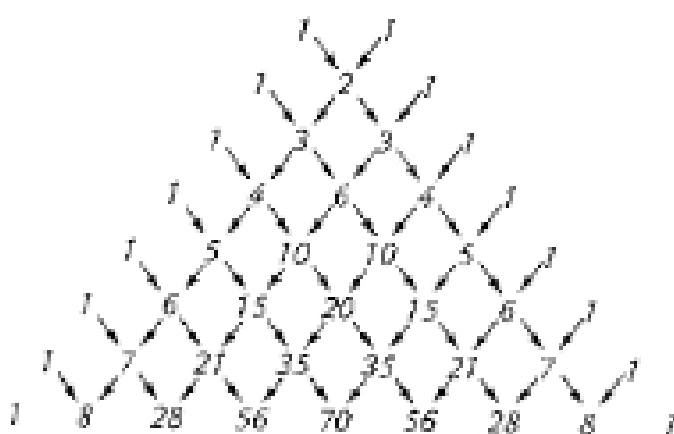
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### Pascal's Triangle




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### Blaise Pascal (1623-1662)



A brilliant mathematician and physicist interested in probability and in the infinite. Also a mystic.

When his contemporaries resisted using infinitely small and infinitely large objects in math, he said, "The heart intervenes to make things clear."

Pascal's wager: "Let us weigh the gain and the loss in wagering that God is. If you gain, you gain all. If you lose, you lose nothing. Wager then, without hesitation that he is."

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## More quotations from Pascal

- Had Cleopatra's nose been shorter, the whole history of the world would have been different.
- Man is only a reed, the weakest thing in nature, but a thinking reed.
- The heart has its reasons, which reason knows nothing of.
- I have made this letter longer than usual, because I lack the time to make it short.

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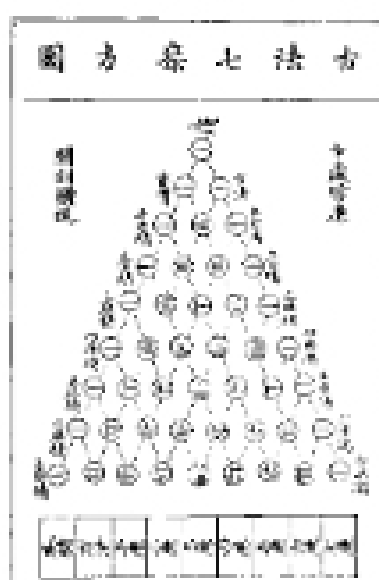
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## Chu Shih-Chieh's Triangle



From Six Year Ya Chien  
by Chu Shih-Chieh,  
ca.1600 in China

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## The Formula

Two possible outcomes: call them "success" and "failure."

The number of ways of having 3 successes in 4 trials (SSSF SSFS SFSS FSSS):

$$\frac{4 \times 3 \times 2 \times 1}{(\cancel{3 \times 2 \times 1}) \times 1} = \frac{4!}{3! \times 1!} = 4$$

↑
(# trials)!

You can cancel
(#successes)! x (#failures)!

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