Puzzle 17 | (Ratio of Boys and Girls in a Country where people want only boys)

In a country, all families want a boy. They keep having babies till a boy is born. What is the expected ratio of boys and girls in the country?

Solution:

Assumptions: Probability of having a boy or girl is same. Also, the probability of next kid being a boy doesn't depend on history.

The problem can be solved by counting expected number of girls before a baby boy is born.

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Let NG be the expected no. of girls before a boy is born

Let p be the probability that a child is girl and (1-p)
be probability that a child is girl.

NG can be written as sum of following infinite series.

NG = 0*p + 1*p*(1-p) + 2*p*p*(1-p) + 3*p*p*p*(1-p) + 4*p*p*p*p*(1-p) +.....

Putting p = 1/2 and (1-p) = 1/2 in above formula.

NG    = 0*(1/2) + 1*(1/2)^2 + 2*(1/2)^3 + 3*(1/2)^4  +  4*(1/2)^5 + ...
1/2*NG = 0*(1/2)^2 + 1*(1/2)^3 + 2*(1/2)^4 + 3*(1/2)^5  +  4*(1/2)^6 + ...

NG - NG/2 =  1*(1/2)^2 + 1*(1/2)^3 + 1*(1/2)^4 + 1*(1/2)^5  +  1*(1/2)^6 + ...

Using sum formula of infinite geometrical progression with
ratio less than 1
NG/2 = (1/4)/(1-1/2) = 1/2

NG = 1
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So Expected Number of number of girls = 1

Since the expected number of girls is 1 and there is always a baby boy, the expected ratio of boys and girls is 50:50