* Pascal triangle :

$$
\begin{array}{ccccccccc}
 & & & & 1 & & & & \\
 & & & 1 & & 1 & & & \\
 & & 1 & & 2 & & 1 & & \\
 & 1 & & 3 & & 3 & & 1 & \\
1 & & 4 & & 6 & & 4 & & 1
\end{array}
$$

(5)

Notice: 1. 2 number in row N make a number in row n+1

2. Number on row n+1, index r ($0 \le r \le n$) can be expressed as $\binom{n}{r}$

Consider row $n+1=5$: $\binom{4}{0}=1$, $\binom{4}{1}=4$, $\binom{4}{2}=6, \ldots$

-> * Pascal's identity: $\binom{n+1}{r} = \binom{n}{r-1} + \binom{n}{r}$

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* Binomial theorem:

$$(x+y)^n = \sum_{r=0}^{n} \binom{n}{r} x^r y^{n-r}$$

* Special cases: $\sum_{r=0}^{n} \binom{n}{r} = 2^n$ (sum of a row is 2^x)

$\sum_{r=0}^{n} (-1)^r \binom{n}{r} = 0$ (sum of a row with alternate signs is 0)

* Note: If p is probability of event happening

q = 1-p ______ not happening

-> The probabity in N trials there are r successes is the r^{th} term in binomial expansion of $(p+q)^N$

a.k.a. $\binom{N}{r} p^r q^{n-r}$

$\binom{13}{5} (2x)^8 (3y^2)^5$