Assume that we go up the thirteen steps only by 1 step, and that we do not take steps two-at-a-time.
This is equivalent to asking how many ways are there to order a sequence of 13 ones.
There are only ${}_{13}C_0$, or only 1 way to go up the steps.

Now, assume that we go up the thirteen steps, and this time we only have one step that is two-at-a-time.
This is equivalent to asking how many ways are there to order a sequence of 11 ones and 1 two.
There are ${}_{12}C_1$, or 12 ways to get up the steps.

We continue with going up the steps, two of the steps being two-at-a-time.
This is equivalent to asking how many ways are there to order a sequence of 9 ones and 2 twos.
There are ${}_{11}C_2$, or 55 ways to get up the steps.

Following the same logic,
For three of the steps being two-at-a-time, there are ${}_{10}C_3$, or 120 ways to get up the steps.
For four of the steps being two-at-a-time, there are ${}_{9}C_4$, or 126 ways to get up the steps.
For five of the steps being two-at-a-time, there are ${}_{8}C_5$, or 56 ways to get up the steps.
For six of the steps being two-at-a-time, there are ${}_{7}C_6$, or 7 ways to get up the steps.
And there are no more cases available.

Thus, the total number of ways is 1 + 12 + 55 + 120 + 126 + 56 + 7, or 377 ways in total.

Generalising the Result:

We could express the number of ways to get up the steps for each case based on the number of two-at-a-time steps, which we will call α, and the total number of steps, which we will call β: ${}_{\beta-\alpha}C_{\alpha}$. α and β are both integers in this case.

By definition of a combination, the number to the left, in this case β-α, has to be equal or greater than the number on the right, or in this case, α: $\beta-\alpha \geq \alpha$. Adding α to both sides and dividing by 2, we get $\alpha \leq \beta/2$. Thus, the number of two-at-a-time steps possible in a series of β steps is $0 \leq \alpha \leq \beta/2$, but since α is always an integer, we can use the floor function on the inequality, $0 \leq \alpha \leq \lfloor \beta/2 \rfloor$.

Now, the total number of ways to get up the steps is just the sum of the number of ways for each case, so we calculate the following summation:

$$\sum_{\alpha=0}^{\lfloor \beta/2 \rfloor} {}_{\beta-\alpha}C_{\alpha} = F(\beta+1)$$

The summation, for any total number of steps β greater than zero, is equivalent to the (β+1)th Fibbonacci number F(β+1), the proof of which will not be shown here, but it can be proved using induction and the theorem ${}_{n}C_{m} + {}_{n}C_{m+1} = {}_{n+1}C_{m+1}$ or Zeckendorf's theorem. One can calculate the Fibbonacci number F(n) using Binet's formula:

$$\frac{(1+\sqrt{5})^n - (1-\sqrt{5})^n}{2^n \sqrt{5}},$$