

**What is...the symmetric group?**

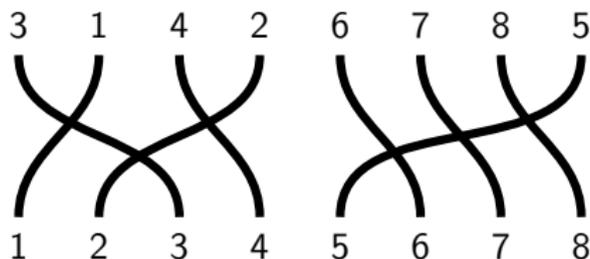
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Or: Why strings can shuffle numbers

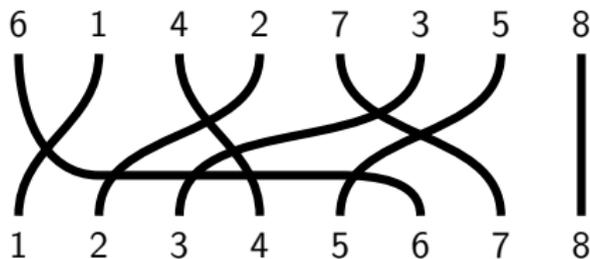
## A game with strings

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Connect eight points at the bottom with eight points at the top:



or

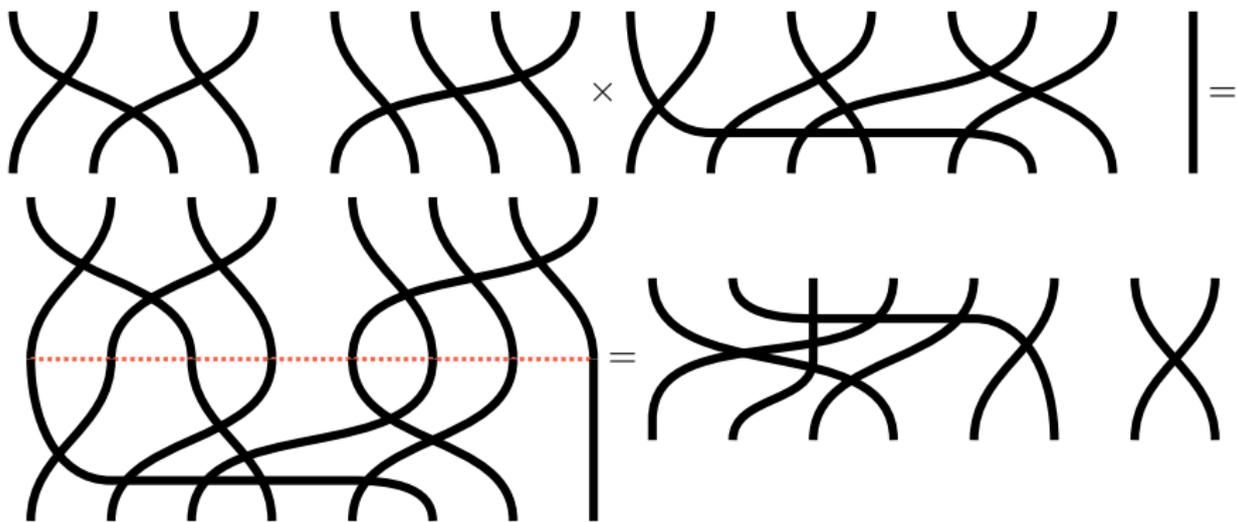


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You just invented the symmetric group  $S_8$

## Multiplication is stacking

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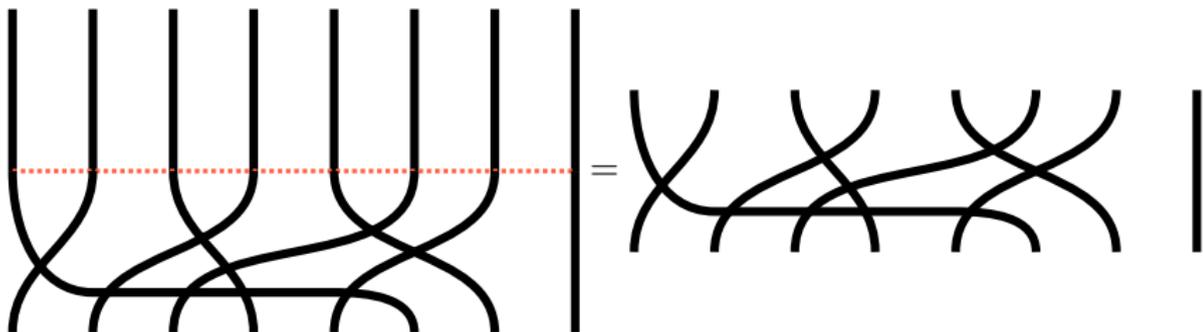
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My multiplication rule for  $gh$  is “stack  $g$  on top of  $h$ ”

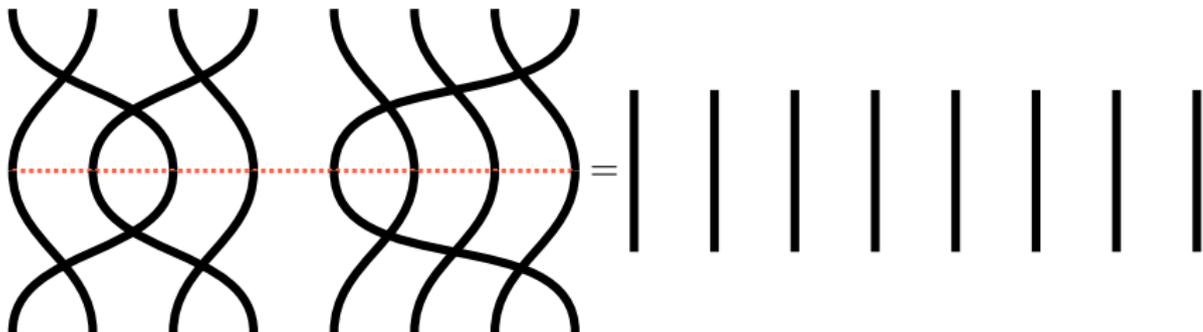
# Its a group!

► We clearly have  $g(hf) = (gh)f$  **Associativity**

► There is a do nothing operation  $1g = g = g1$  **Unit**



► There is an undo operation  $gg^{-1} = 1 = g^{-1}g$  **Inverse**

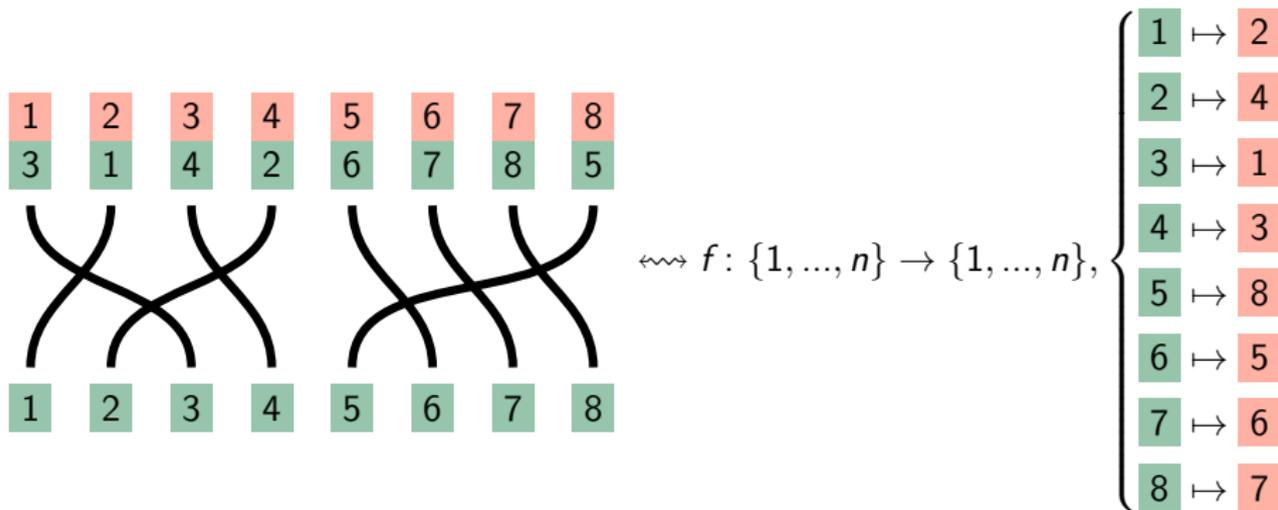


## For completeness: A formal definition

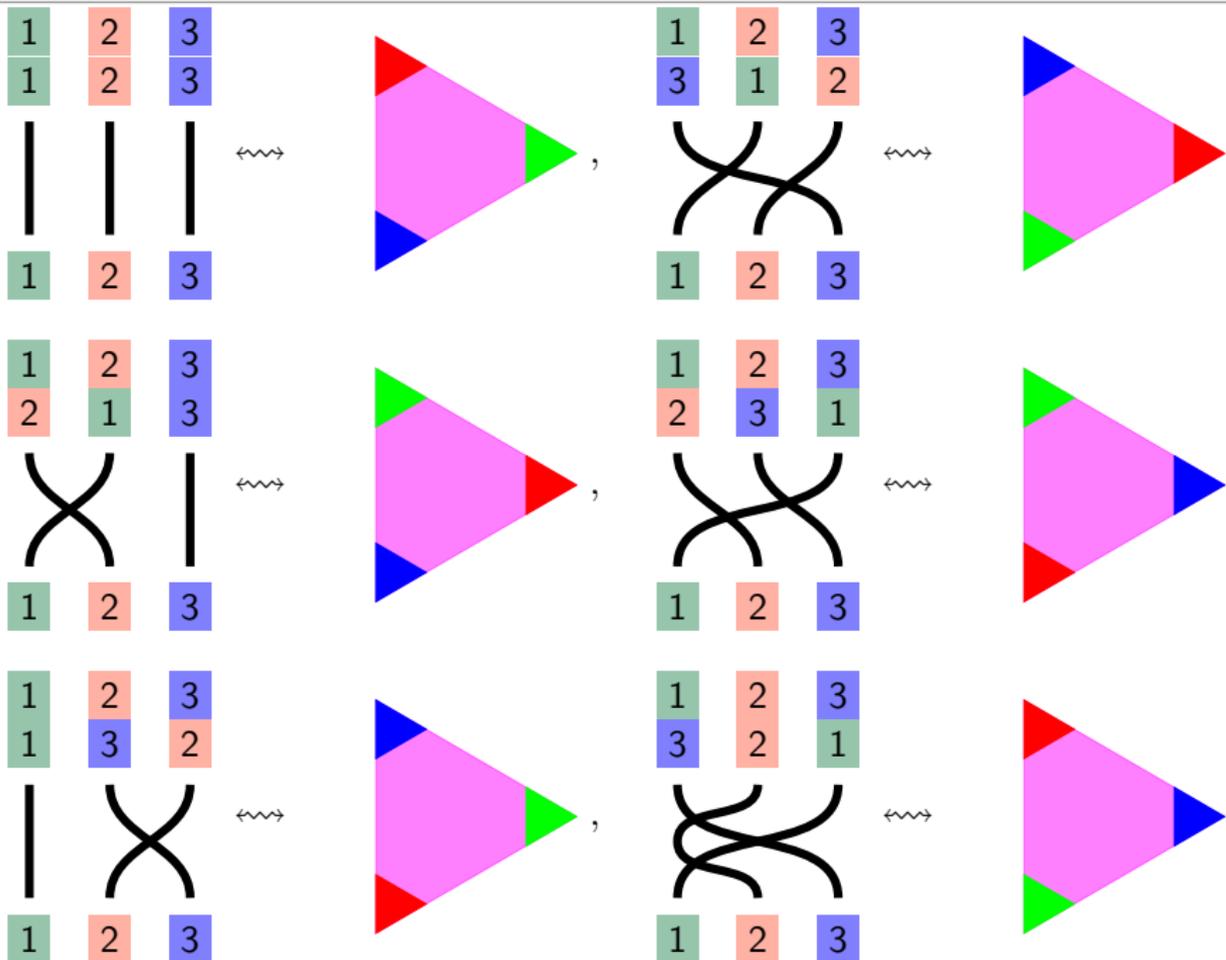
The symmetric group  $S_n$  on  $n$  strings is the set of all bijections **permutations**

$$f: \{1, \dots, n\} \rightarrow \{1, \dots, n\}$$

with multiplication being composition of maps



# Symmetry groups of the $n$ -simplex



**Thank you for your attention!**

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I hope that was of some help.