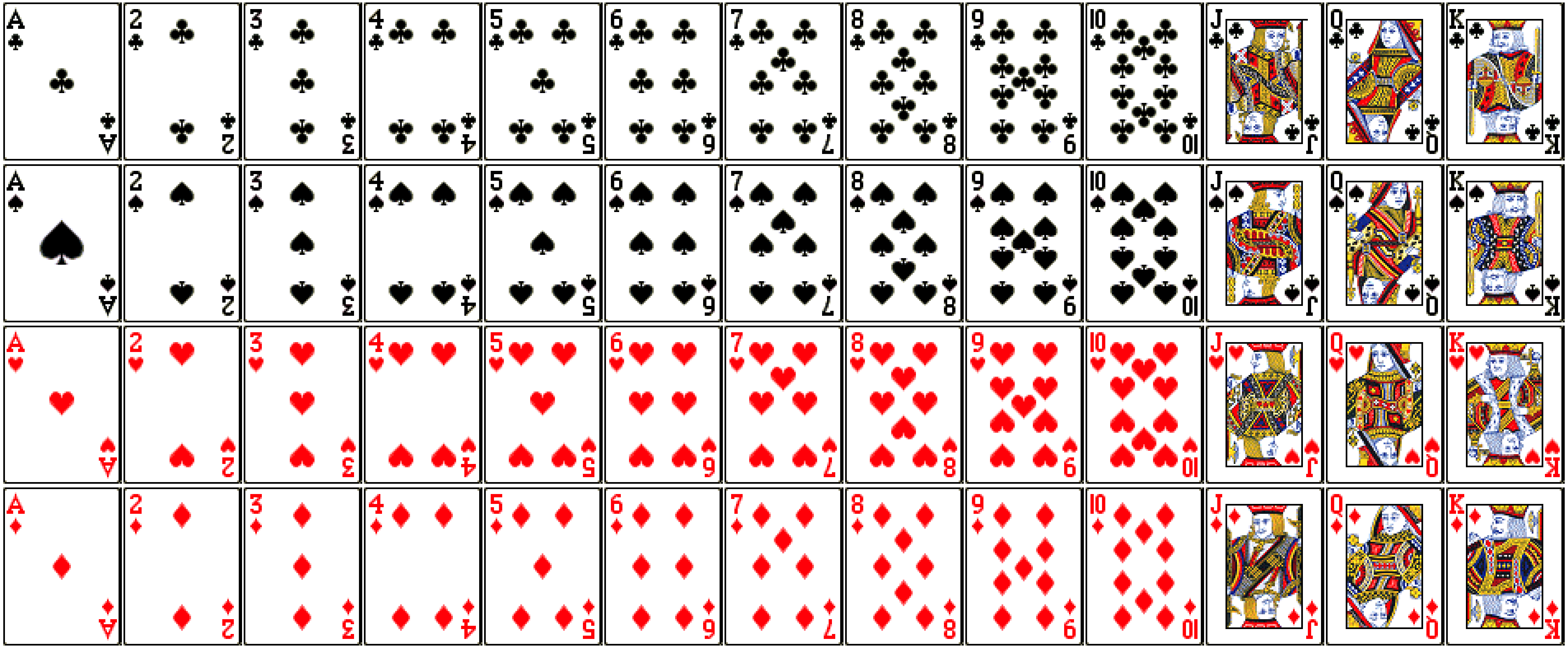
12.2 Fundamental Counting Principle



THE FUNDAMENTAL COUNTING PRINCIPLE (FCP) If we want to perform a series of tasks and the first task can be done in a ways, the second can be done in b ways, the third can be done in c ways, and so on, then all the tasks can be done in $a \times b \times c \times \cdots$ ways.

At an Ice Cream shop they have 5 different flavors of ice cream and you can pick one of 4 toppings.

How many choices do you have?

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How many choices do you have?

5 choices of flavors,
4 choices of toppings

$5x4 = 20$

How many ways can you flip 4 coins?

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The 1st coin can be flipped 2 ways.
The 2nd coin can be flipped 2 ways.
The 3rd coin can be flipped 2 ways.
The 4th coin can be flipped 2 ways.

$$2 \times 2 \times 2 \times 2 = 16 \text{ ways.}$$

four tasks—each done in two ways

Someone wants to know how many different outfits they can make with 3 coats, 5 pants, 7 shirts, and 4 ties.

How many different outfits?

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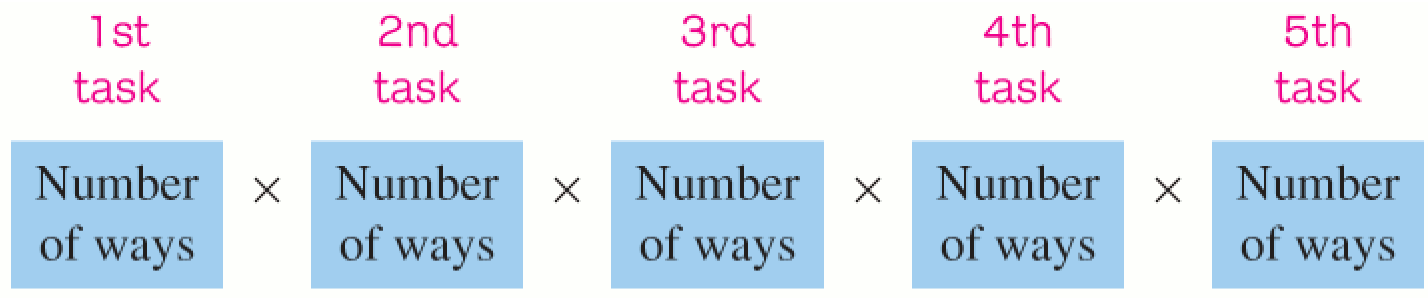
Task	Number of Ways to Perform Task
Select coat	3
Select pants	5
Select shirt	7
Select tie	4

$$3 \times 5 \times 7 \times 4 = 420 \text{ outfits}$$

number of coats . . . times number of pants . . . times number of shirts . . . times number of ties

A useful way to keep track of the different number of ways to do each task is called a **slot diagram**.



We'll use underscores for the slots.

Example:

The combination for a keypad is 5 digits long. Suppose that you any digit (0-9) for the numbers.

How many different combinations are there?

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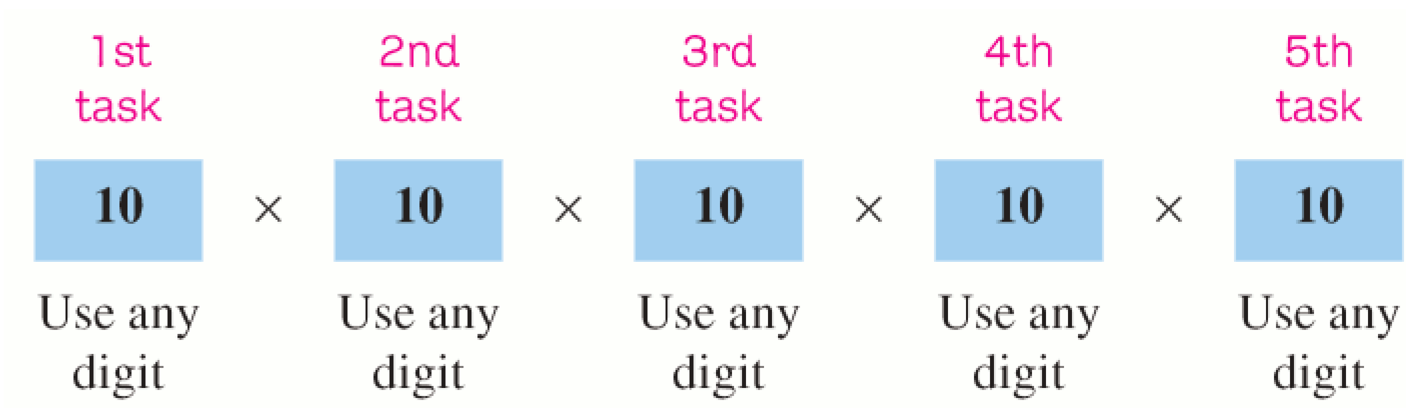

There are 10x10x10x10x10 = 100000 combinations.

Example:

The combination for a keypad is 5 digits long. Suppose that you any digit (0-9) for the numbers. Now, the first digit cannot be 0.

How many different combinations are there?

Example:

The combination for a keypad is 5 digits long. Suppose that you any digit (0-9) for the numbers. Now the first digit cannot be 0.

There are 9x10x10x10x10 = 90000 combinations.

Example: A license plate has 3 letters followed by three numbers.

How many different license plates are there?

Example: A license plate has 3 letters followed by three numbers.

How many different license plates are there?

$\underline{26} \times \underline{26} \times \underline{26} \times \underline{10} \times \underline{10} \times \underline{10}$

$= 17{,}576{,}000$

Example: A license plate has 3 letters followed by three numbers. Every letter and number must now be unique.

How many different license plates are there?

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How many different license plates are there?

$\underline{26} \times \underline{25} \times \underline{24} \times \underline{10} \times \underline{9} \times \underline{8}$

$= 11{,}232{,}000$