

# MatheMagic

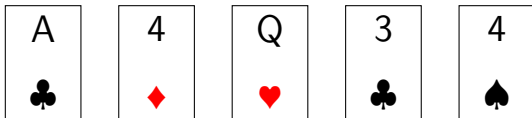
Winter 2019

MAT187 Calculus 2

## Figuring out the trick...

The volunteer selects any 5 cards from the whole deck.

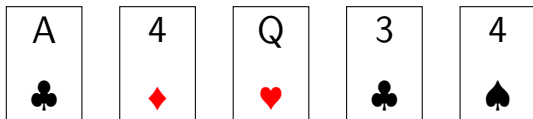
**Example.**



# Figuring out the trick...

The volunteer selects any 5 cards from the whole deck.

**Example.**



- 1 Which suit does the assistant pick for the hidden card?
- 2 What was your reasoning?  
Can you always pick a suit using that reasoning,  
independently of which 5 cards are chosen by the volunteer?

# Figuring out the trick...

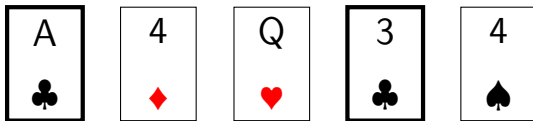
## Pigeonhole Principle

If we have  $p$  pigeons and  $h$  holes with  $p > h$ , then there is (at least) one hole with (at least) two pigeons.

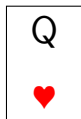
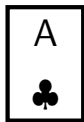
- 3 Can you use the Pigeonhole Principle to show that there is always (at least) one suit that will work?



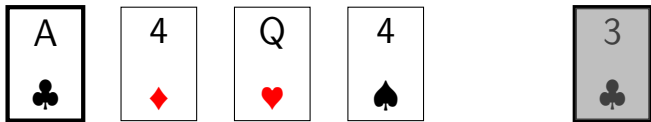
# Figuring out the trick...



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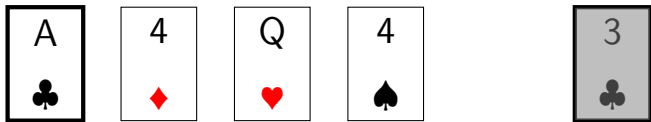


## Figuring out the trick...



- 4 How many cards are there for the magician to guess?
- 5 How many different ways can we arrange the remaining **three** cards?

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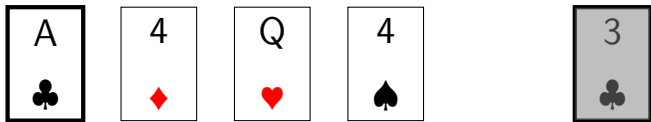


Problem



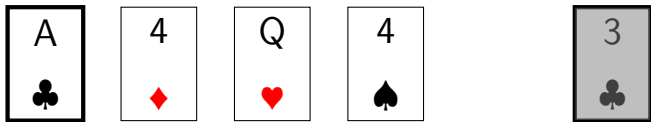


## Figuring out the trick...



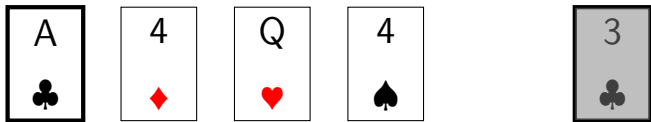
- 6 We need to use the key card to help the magician find the hidden one. How?

## Figuring out the trick...



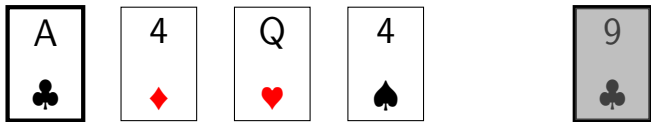
- 6 We need to use the key card to help the magician find the hidden one. How?
- 7 The key card is an Ace (1) and the hidden card is a 3. How can the assistant use the other **three** cards to tell the magician that the hidden card is 2 numbers higher than the key card?

## Figuring out the trick...



- 8 Order the remaining **three** cards: Low, Middle, High.
- 9 Encode the numbers 1–6 using different combinations.
- 10 How would the assistant order the cards to show the magician?

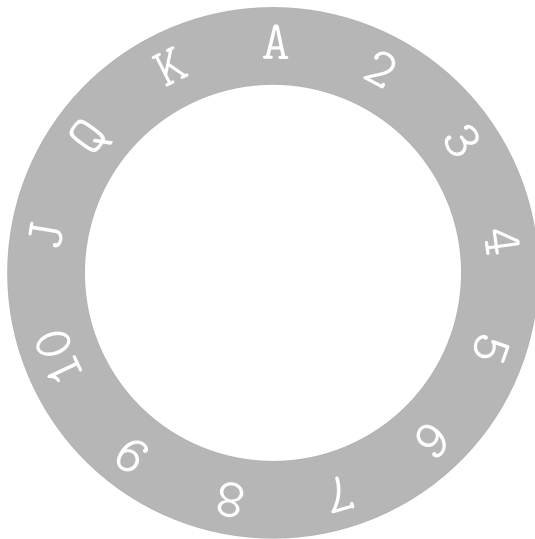
## Figuring out the trick...



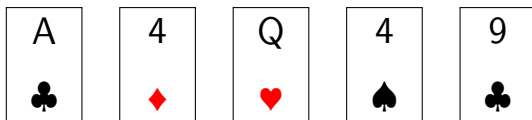
Now the hidden card (9) is 8 numbers away from the key card (1).

- 8 How would the assistant order the cards to show the magician?

Figuring out the trick...



## Figuring out the trick...



- 9 What is the hidden card?
- 10 What is the key card?
- 11 In what order does the assistant show the **four** cards to the magician?