

# Sample Space and Events, chapter 2.2

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August 27, 2013

# Sample space

## Definition

A sample space  $S$  is a set that includes all possible outcomes for a random experiment listed in a mutually exclusive and exhaustive way.

Mutually exclusive: Outcomes do not overlap.

Exhaustive way: set contains all possible outcomes.

# Sample space

## Example

Suppose a six-sided die is rolled and the number on the upper face is observed.

$S^* = \{1, 2, 3, 4, 5, 6, \text{even}, \text{odd}\}$  is not a sample space since it is not mutually exclusive. For example 2 and even overlap.

$S^* = \{1, 2, 3, 4, 6\}$  is not a sample space since it is missing 5.

Sample spaces:

$$S_1 = \{1, 2, 3, 4, 5, 6\}$$

$$S_2 = \{\text{even}, \text{odd}\}$$

# Events

We are interested in a particular outcome or a set of outcomes. These are the events of interest.

## Definition

An event is any subset of a sample space.

## Example

A is the event of "rolling a 6".  $A = \{6\}$

B is the event of "rolling a number greater than 3".  $B = \{4, 5, 6\}$

C is the event of "observing an odd number".  $C = \{1, 3, 5\}$

$\emptyset$  is the empty set or the nullset. It contains no outcomes.  $\emptyset$  is a subset of every set and is therefore an event.

The sample space,  $S$ , is an event in every experiment.

# Events

## Example

$D$  is the event of "observing a seven" in rolling a die.  $D = \{7\}$ .

We say that an event,  $A$ , has occurred if the outcome of an experiment is contained in the event  $A$ .

## Example

Suppose we roll a die. Let  $A$  be the event of "observing a 4".

Let  $B$  be the event of "observing a number smaller than 4".

Let  $C$  be the event of "observing an even number".

Then  $A = \{4\}$ .

$B = \{1, 2, 3\}$

$C = \{2, 4, 6\}$

Suppose the die shows a 4 on the upper face. Then the event  $A$  and  $C$  have occurred.



If a set has  $n$  elements, it has  $2^n$  possible subsets.  
Thus, if a sample space has  $n$  outcomes, it has  $2^n$  possible events.

### Example

Roll a dice. There are 6 outcomes and  $2^6 = 64$  possible events.