⚠️ Lagunita is retiring and will shut down at 12 noon Pacific Time on March 31, 2020. A few courses may be open for self-enrollment for a limited time. We will continue to offer courses on other online learning platforms; visit http://online.stanford.edu.

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Probability Rules: Disjoint Events

Learning Objective: Apply probability rules in order to find the likelihood of an event.

We are now moving to rule 4, which deals with another situation of frequent interest, finding P(A **or** B), the probability of one event **or** another occurring. Before we get to the actual rule, however, we need some clarifications and definitions.

When a parent says to his or her child in a toy store "Do you want toy A or toy B?", this means that the child is going to get only one toy and he or she has to choose between them. Getting both toys is usually not an option.

In contrast,

In probability, "OR" means either one or the other or both.

and so,

P(A or B) = P(event A occurs or event B occurs or both occur)

Having said that, it should be noted that there are some cases where it is simply impossible for the two events to both occur at the same time, in which case we don't have to worry about the possibility that both occur when we try to find P(A or B). The distinction between events that can happen together and those that cannot is an important one.

Here are two examples:

Example

Consider the following two events:

A—a randomly chosen person has blood type A, and

B—a randomly chosen person has blood type B.

In rare cases, it is possible for a person to have more than one type of blood flowing through his or her veins, but for our purposes, we are going to assume that each person can have only one blood type. Therefore, it is impossible for the events A and B to occur together.

On the other hand ...

Example

Consider the following two events:

A—a randomly chosen person has blood type A

B—a randomly chosen person is a woman.

In this case, it **is possible** for events A and B to occur together.

Definition: Two events that cannot occur at the same time are called **disjoint** or **mutually exclusive.** (We will use disjoint.)

We can therefore say that in the first example events A and B are disjoint, and in the second example they are not disjoint. Using Venn diagrams, we can visualize two events that are disjoint and compare them to two events that are not:

A and B are Disjoint
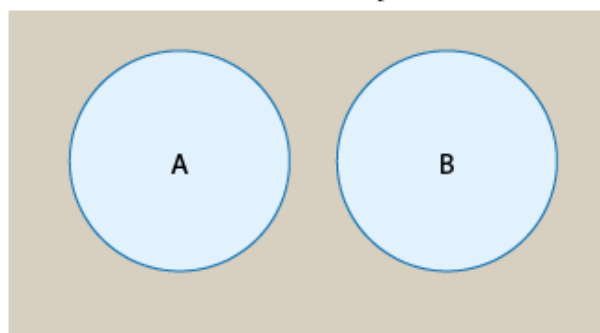
A and B are NOT Disjoint
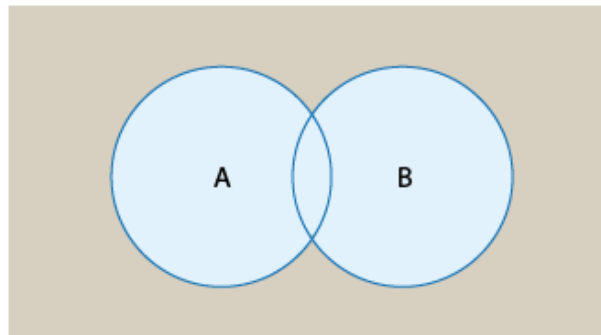
The Venn diagrams suggest that another way to think about disjoint versus not disjoint events is that disjoint events **do not overlap**. They do not share any of the possible outcomes, and therefore cannot happen together. On the other hand, events that are not disjoint are overlapping in the sense that they share some of the possible outcomes and therefore can occur at the same time.

The purpose of the following activity is to strengthen your intuition and understanding about disjoint versus not disjoint events.

Scenario: Couple Planning to Have Three Children

Recall the couple that is planning to have 3 children, where the sample space S of all possible outcomes is:

S={BBB, BBG, BGB, GBB, GGB, GBG, BGG, GGG}

Learn By Doing (1/1 point)

Consider the following two events: A—the middle child is a girl C—the three children are of the same gender In the box below, answer the following: i. What are the possible outcomes for each of these events? ii. Do the events share any of the outcomes? (i.e., is there an overlap between the two events?) iii. Based on ii, are the events disjoint or not?

Your Answer:

A: BGB, GGB, BGG, GGG
C: GGG, BBB

They overlap on GGG

No, they're not disjoint

Our Answer:

i. Here are the possible outcomes in each of the events: A={BGB, GGB, BGG, GGG} C={BBB, GGG} ii. The two events overlap; they have the outcome GGG in common. iii. Based on ii, the events are not disjoint since, they can happen together, if the couple ends up having three girls.

[Resubmit]   [Reset]

Learn By Doing (1/1 point)

Consider the following two events: A—exactly one of the three children is a girl C—exactly one of the three children is a boy. In the box below, answer the following: i. What are the possible outcomes for each of these events? ii. Do the events share any of the outcomes? (i.e., is there an overlap between the two events?) iii. Based on ii, are the events disjoint or not?

Your Answer:

A: BGG, GBG, GGB
B: GBB, BGB, BBG

No common outcomes.

Therefore, they're disjoint.

Our Answer:

i. Here are the possible outcomes in each of the events: A={GBB, BGB, BBG} C={BGG, GBG, GGB} ii. The events do not overlap; they have no outcome in common. iii. Based on ii, the events are disjoint—they can never occur together.

[Resubmit]   [Reset]

Scenario: One Boy and One Girl

A couple decides to have children until they have one boy and one girl, but they will not have more than three children. The sample space of possible outcomes is S = {GB, BG, BBG, GGB, BBB, GGG}.

Consider the following events:

A–the couple has one boy

C–the couple has three children

D–all of the children are the same gender

Did I Get This

1/1 point (graded)
Is the following pair of events disjoint?

A and C

○   disjoint

●   not disjoint ✔

Answer
Correct:
The events A and C are not disjoint because the outcome GGB is in both sample spaces. The sample space for event A is {GB, BG, GGB}. The sample space for event C is {GGB, BBG, BBB, GGG}.

Submit

Did I Get This

1/1 point (graded)
Is the following pair of events disjoint?

A and D

●   disjoint ✔

○   not disjoint

Answer
Correct:
Events A and D are disjoint because their sample spaces do not share any outcomes. The sample space for event A is {GB, BG, GGB}. The sample space for event D is {BBB, GGG}.

Submit

Did I Get This

1/1 point (graded)
Is the following pair of events disjoint?

C and D

○   disjoint

◉   not disjoint ✔

Answer
Correct:
The events C and D are not disjoint because their sample spaces both contain the outcomes BBB and GGG. The sample space for event C is {GGB, BBG, BBB, GGG}. The sample space for event D is {BBB, GGG}.

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