Conditional Probability

The following table was gathered from the National Diabetes Statistics Report, 2020
From the Center of Disease Control. We have some important definitions to consider in using this information.

https://www.cdc.gov/diabetes/library/features/diabetes-stat-report.html

Conditional Probabilities are a fabulous tool in using probabilities to compare independent groups.

Probability of an event A given B

$$P(A|B) = \frac{P(A \text{ and } B)}{P(B)}$$

The following is a table created illustrating the results of the CDC report on the number of existing Diabetes cases with the number of undiagnosed cases for Diabetes. The table is illustrated below and everyone in the table has Diabetes (either type I or type 2).

Age versus Diagnosis Type

Age	Diagnosed Diabetes	Undiagnosed Diabetes	Total
18 to 44	30	11	41
45 to 64	138	36	174
65 or older	214	54	268
Total	382	101	483

If you select a person from this table at random, what's the probability the person:
Approximate to the Thousandths

1. Diagnosed?
2. Diagnosed **given that** the person is aged 18 to 44 years?
3. Diagnosed **given that** the person is aged 45 to 64 years?
4. Diagnosed **given that** the person is 65 or older?
5. Which group was most likely to be diagnosed? Why?
6. Which group was least likely to be diagnosed? Why?
7. Undiagnosed?
8. Undiagnosed **given that** the person is aged 18 to 44 years?
9. Undiagnosed **given that** the person is aged 45 to 64 years?
10. Undiagnosed **given that** the person is 65 or older?
11. Which group was most likely to be undiagnosed? Why?
12. Which group was least likely to be undiagnosed? Why?

The following is a table created illustrating the results of the CDC report on the number of existing Diabetes cases with the number of undiagnosed cases for Diabetes. The table is illustrated below and everyone in the table has Diabetes (either type I or type 2).

Sex versus Diagnosis Type

Sex	Diagnosed Diabetes	Undiagnosed Diabetes	Total
Men	110	31	141
Women	95	25	120
Total	205	56	261

Assuming this table represented a random sample, answer the following questions.

If you select a person at random, what's the probability the person:
Approximate to the Thousandths

13. Diagnosed?
14. Diagnosed **given that** the person is a man?
15. Diagnosed **given that** the person is a woman?
16. Which group was most likely to be diagnosed? Why?
17. Which group was least likely to be diagnosed? Why?
18. Undiagnosed?
19. Which group was most likely to be undiagnosed? Why?
20. Which group was least likely to be undiagnosed? Why?

The following is a table created illustrating the results of the CDC report on the number of existing Diabetes cases with the number of undiagnosed cases for Diabetes. The table is illustrated below and everyone in the table has Diabetes (either type I or type 2).

Race/Ethnicity versus Diagnosis Type

Race-Ethnicity	Diagnosed Diabetes	Undiagnosed Diabetes	Total
White (non-Hispanic)	94	25	119
Black (non-Hispanic)	133	30	163
Asian (Non-Hispanic)	112	46	158
Hispanic	103	35	138
Total	442	136	578

Assuming this table represented a random sample, answer the following questions.

If you select a person at random, what's the probability the person:
Approximate to the Thousandths

21. Diagnosed?
22. Diagnosed **given that** the person is White (non-Hispanic)?
23. Diagnosed **given that** the person is Black (non-Hispanic)?
24. Diagnosed **given that** the person is Asian (non-Hispanic)?
25. Diagnosed **given that** the person is Hispanic?
26. Which group was most likely to be diagnosed? Why?
27. Which group was least likely to be diagnosed? Why?
28. Undiagnosed?
29. Undiagnosed **given that** the person is White (non-Hispanic)?
30. Undiagnosed **given that** the person is Black (non-Hispanic)?
31. Undiagnosed **given that** the person is Asian (non-Hispanic)?
32. Undiagnosed **given that** the person is Hispanic?
33. Which group was most likely to be undiagnosed? Why?
34. Which group was least likely to be undiagnosed? Why?

AB705 is a State Law that allows students to take transfer level English, and Mathematics courses, without first assessing the skills sets required to succeed in those courses. The new model assumes students have the necessary skill sets and claims that additional measures such as High Scholl GPA are better predictors of student success. AB705 mandated that all Community Colleges initiate the new assessment measures in Fall 2020. The following data was gathered from the Los Angeles Community College District on Ethnicity and student success in Math 227 for Fall 2020.

https://assessment.cccco.edu/ab-705-implementation

Fall 2019 Math 227 Student Success Course Outcomes by Ethnicity

Ethnicity	Successful A or B or C	D	F	W	Drop	Total
American Indian	8	1	2	2	0	13
Asian	388	18	53	97	1	557
Black	460	70	209	311	11	1061
Filipino	172	25	41	58	1	297
Hispanic	2652	505	1485	2124	41	6807
Multiethnic	127	8	37	81	3	256
Pacific Islander	11	2	6	9	0	28
White	532	50	123	229	11	945
Unknown	202	17	53	75	5	352
Total	4552	696	2009	2986	73	10316

If you select a person at random from this table, what's the probability the person was: **Approximate to the Thousandths**

35. Successful?
36. Successful **given that** the person is Asian?
37. Successful **given that** the person is Black?
38. Successful **given that** the person is Hispanic?
39. Successful **given that** the person is White?
40. Failed?
41. Earned a D grade?
42. Unsuccessful (D or F or W or Drop)?
43. Which ethnicity is more likely to be successful? Explain why?
44. Which ethnicity is least likely to be successful? Explain why?

Fall 2019 Math 227 Student Success Course Outcomes by Sex

Sex	Successful A or B or C	D	F	W	Drop	Total
Female	2879	431	1199	1767	46	6322
Male	1673	265	810	1219	27	3994
Total	4552	696	2009	2986	73	10316

If you select a person at random from this table, what's the probability the person was: **Approximate to the Thousandths**

45. Successful?
46. Successful **given that** the student is a female?
47. Successful **given that** the person is a male?
48. Failed?
49. Unsuccessful (D or F or W or Dropped)?
50. Failed **given that** the person is a female?
51. Failed **given that** the person is a male?
52. Unsuccessful **given that** the person is a female?
53. Unsuccessful **given** that the person is a male?
54. Which sex is more likely to be successful? Explain why?
55. Which sex is least likely to be successful? Explain why?

Fall 2018 Math 227 Student Success Course Outcomes by Ethnicity

Ethnicity	Successful	D	F	W	Drop	Total
American Indian	3	0	4	3	0	10
Asian	314	14	42	65	2	437
Black	228	36	78	135	4	481
Filipino	120	9	23	38	1	191
Hispanic	1903	295	719	1029	10	3956
Multiethnic	61	7	19	26	0	113
Pacific Islander	6	0	1	5	0	12
White	363	28	45	123	3	562
Unknown	137	16	29	60	1	243
Total	3135	405	960	1484	21	6005

If you select a person at random from this table, what's the probability the person was: **Approximate to the Thousandths**

56. Successful?
57. Successful **given that** the person is Asian?
58. Successful **given that** the person is Black?
59. Successful **given that** the person is Hispanic?
60. Successful **given that** the person is White?
61. Failed?
62. Earned a D grade?
63. Unsuccessful (D or F or W or Drop)?

64. Which ethnicity is more likely to be successful? Explain why?
65. Which ethnicity is least likely to be successful? Explain why?

Fall 2018 Math 227 Student Success Course Outcomes by Sex

Sex	Successful A or B or C	D	F	W	Drop	Total
Female	1947	240	587	919	14	3707
Male	1188	166	373	564	7	2298
Total	3135	406	960	1483	21	6005

If you select a person at random from this table, what's the probability the person was: **Approximate to the Thousandths**

66. Successful?
67. Successful **given that** the student is a female?
68. Successful **given that** the person is a male?
69. Failed?
70. Unsuccessful (D or F or W or Dropped)?
71. Failed **given that** the person is a female?
72. Failed **given that** the person is a male?
73. Unsuccessful **given that** the person is a female?
74. Unsuccessful **given** that the person is a male?
75. Which sex is more likely to be successful? Explain why?
76. Which sex is least likely to be successful? Explain why?

Quality of Education for STEM Careers

https://www.pewsocialtrends.org/2018/01/09/women-and-men-in-stem-often-at-odds-over-workplace-equity/

The following two tables compare the beliefs of Americans regarding the quality of Education of STEM Education at various levels in 2018.

US Adults who rate the US when it comes to STEM Education at each level

	Above Average	Average	Below Average	Total
K12 Public Schools	25	44	31	100
Undergraduate	35	47	18	100
Graduate	38	44	18	100
Total	98	91	67	300

77. Which level is more likely to be considered above average?
$p(above\ average|K12), p(above\ average|Undergraduate), p(above\ average|Graduate)$

78. Which level is more likely to be considered average?
$p(average|K12), p(average|Undergraduate), p(average|Graduate)$

79. Which level is more likely to be considered below average?
$p(below\ average|K12), p(below\ average|Undergraduate), p(below\ average)$

US STEM Degree holders who rate the US when it comes to STEM Education at each Level

	Above Average	Average	Below Average	Total
K12 Public Schools	13	36	51	100
Undergraduate	52	35	13	100
Graduate	62	29	9	100
Total	127	100	73	300

80. Which level is more likely to be considered above average?
Compute
$p(above\ average|K12), p(above\ average|Undergraduate), p(above\ average|Graduate)$ and compare likelihood.

81. Which level is more likely to be considered average?
Compute $p(average|K12), p(average|Undergraduate), p(average|Graduate)$ and compare likelihood.

82. Which level is more likely to be considered below average?
Compute
$p(below\ average|K12), p(below\ average|Undergraduate), p(below\ average|Graduate)$ and compare likelihood.

Guns and Violence Against Women

https://everytownresearch.org/reports/guns-intimate-partner-violence/

The following table represents Intimate Partner Violence (IPV) against women based on ethnicity. These are reported cases of violence by women of various ethnic groups committed by their intimate partners in 2019.

Intimate Partner Violence (IPV)

	Black Women/ African American	American Indian Alaska Native Women	Hispanic	White Women	Other	Total
Experienced IPV	55	4	49	239	19	366
Not Experienced IPV	69	4	83	444	34	634
Total	124	8	132	683	53	1000

If you select a woman at random, what's the probability the woman:

83. Experienced IPV **given that** the woman is Black/African American?
84. Experienced IPV **given that** the woman is American Indian?
85. Experienced IPV **given that** the woman is Hispanic?
86. Experienced IPV **given that** the woman is White?
87. Which ethnic group is more likely to be victim of IPV?

False Positives and False Negatives; True Positives and True Negatives

Unfortunately, people develop inflictions with various viruses and develop illnesses. We often seek to test individuals for those inflictions and illnesses. We also test individuals for various other medical conditions or for possible drug use. Every test has a certain degree of accuracy that we should be made aware of and consider. Tests have various error rates that are defined below to help us understand aspects of testing that we should be aware.

Def False Positive (FPR)
The likelihood of incorrectly testing + for an infliction when you actually are not infected.

$$P(test + |not\ Infected)$$

Def False Negative (FNR)
The likelihood of incorrectly Testing – for an infliction when you are actually infected.

$$P(test - |nfected)$$

Def True Negative (TNR)
The likelihood of correctly testing – when you really are not infected.

$$P(test - |not\ infected)$$

Def True Positive (TPR)
The likelihood of correctly testing + when you are really infected.

$$P(test + |infected)$$

Def Prevalence
The likelihood that a person has an illness or infliction.

$$P(infected)$$

False- Positive HIV Tests Results

The following table is based on information from the CDC for people who engage in "at risk" behavior and have a higher prevalence rate.

https://www.cdc.gov/hiv/pdf/testing/cdc-hiv-factsheet-false-positive-test-results.pdf

	Has HIV Virus	Not Have HIV Virus	Total
Test +	180	40	220
Test -	20	9760	9780
Total	200	9800	10000

Compute the following rates by selecting a person at random from this table.

88. False Positive Rate.
89. False Negative Rate.
90. True Positive Rate.
91. True Negative Rate.

Breast Cancer in Women

https://brownmath.com/stat/falsepos.htm

The following information was obtained from a study on the effectiveness of Core-Needle and Open Surgical biopsy for the diagnosis of Breast Lesions.

	Have Breast Cancer	Doesn't Have Breast Cancer	Total
Test +	25800	1400	27200
Test -	4200	68600	72800
Total	30000	70000	100000

Compute the following rates by selecting a person at random from this table.

92. False Positive Rate.
93. False Negative Rate.
94. True Positive Rate.
95. True Negative Rate.

SARS-CoV-2 IgG antibody tests for COVID-19

The concepts of Sensitivity and Specificity for testing for Covid-19 vary by type of tests that are used. There are various types of tests that have particular benefits and drawbacks. You can read about some of them from information posted by ARUP Laboratories.

https://www.aruplab.com/news/4-21-2020/How-Accurate-Are-COVID-19-Tests

The following table summarized information found from ARUP Laboratories and represents a information about a test that detects IgG antibodies specific to the S1 domain of the spike protein of SARS-CoV-2.

https://www.aruplab.com/infectious-disease/coronavirus/testing

Performance of IgG antibody test

	Infected	**not Infected**	**Total**
test +	88	4	92
test -	0	1066	1066
Total	88	1070	1158

Compute the following rates by selecting a person at random from this table.

96. False Positive Rate.
97. False Negative Rate.
98. True Positive Rate.
99. True Negative Rate.

The following table summarized information found from ARUP Laboratories and represents a information about a test that detects IgG antibodies specific to the nucleocapsid protein of SARS-CoV-2.

https://www.aruplab.com/infectious-disease/coronavirus/testing

	Infected	**not Infected**	**Total**
test +	27	0	27
test -	3	80	83
Total	30	80	110

Compute the following rates by selecting a person at random from this table.

100. False Positive Rate.
101. False Negative Rate.
102. True Positive Rate.
103. True Negative Rate.