

THE PROBABILITY SCALE

PROBABILITY OF BEING BORN ON A TUESDAY

PROBABILITY OF FAIR COIN LANDING ON HEADS

PROBABILITY OF CHOOSING A BLACK BALL FROM THE BAG

PROBABILITY OF ROLLING A SEVEN

PROBABILITY THAT A MULTIPLE OF 10 WILL BE AN EVEN NUMBER

IMPOSSIBLE UNLIKELY 50/50 OR EVEN LIKELY CERTAIN

SPIN THE SPINNER TWICE

THE FIRST SPIN HAS NO IMPACT ON THE SECOND SPIN
THE SPINS ARE INDEPENDENT

PROBABILITIES FOR THE SECOND SPIN STAY THE SAME

BLACK AND BLACK
MULTIPLY THE PROBABILITIES

PROBABILITY OF BLACK → BLACK = $\frac{3}{8} \times \frac{3}{8} = \frac{9}{64}$

PROBABILITY OF BLACK → WHITE = $\frac{3}{8} \times \frac{5}{8} = \frac{15}{64}$

PROBABILITY OF WHITE → BLACK = $\frac{5}{8} \times \frac{3}{8} = \frac{15}{64}$

PROBABILITY OF WHITE → WHITE = $\frac{5}{8} \times \frac{5}{8} = \frac{25}{64}$

PROBABILITY OF THE SAME COLOUR TWICE = OR = $\frac{9}{64} + \frac{25}{64} = \frac{34}{64} = \frac{17}{32} = 53.1\%$

PROBABILITY OF A SINGLE EVENT

ROLL A FAIR DIE ONCE

THE PROBABILITY OF AN EVENT = $\frac{\text{NUMBER OF OUTCOMES WHERE THE EVENT OCCURS}}{\text{TOTAL NUMBER OF EQUALLY LIKELY OUTCOMES}}$

ESTIMATE HOW MANY TIMES YOU WOULD ROLL MORE THAN 4 IF YOU ROLL THE DIE 150 TIMES

PROBABILITY OF ROLLING MORE THAN 4 = $\frac{2}{6} = \frac{1}{3}$

$\frac{1}{3} \times 150 = 50$

PROBABILITY OF TWO HEADS AND ONE TAIL IN ANY ORDER

8 EQUALLY LIKELY OUTCOMES

THROW 3 FAIR COINS

LIST OUTCOMES

PROBABILITY OF COMBINED EVENTS

PROBABILITY OF SUM OF SCORES GREATER THAN 7

PROBABILITY OF SUM OF 8, 9 OR 10 = $\frac{6}{24} = \frac{1}{4} = 0.25$

VENN DIAGRAMS

EVERYONE IS IN THE RECTANGLE

A AND J DO BOTH

B DOES NEITHER

THE PROBABILITY THAT A RANDOM STUDENT FROM THE CLASS PLAYS SPORT BUT NOT MUSIC = $\frac{5}{12}$

12 STUDENTS IN THE CLASS

HOW STUDENTS COME TO SCHOOL

| | | | | |
|-------|------|-----|-------|-------|
| | WALK | BUS | CYCLE | TOTAL |
| BOYS | 42 | 70 | 29 | 141 |
| GIRLS | 59 | 37 | 13 | 109 |
| TOTAL | 101 | 107 | 42 | 250 |

THE PROBABILITY A RANDOM STUDENT IS A BOY WHO CYCLES = $\frac{29}{250}$

PROBABILITIES SUM TO ONE

THE PROBABILITIES OF ALL THE POSSIBLE OUTCOMES MUST SUM TO 1

CHOOSE A BALL AT RANDOM FROM THE BAG

PROBABILITY OF CHOOSING A BLACK BALL = $\frac{2}{9}$

PROBABILITY OF NOT CHOOSING A BLACK BALL = $1 - \frac{2}{9} = \frac{7}{9}$

RESULT: WIN 0.6, DRAW 0.15, LOSE ?

PROBABILITY OF LOSING = $1 - 0.6 - 0.15 = 0.25$

TREE DIAGRAMS

CHOOSE TWO BALLS FROM THE BAG (WITHOUT REPLACING THE FIRST ONE)

THE FIRST CHOICE IMPACTS THE SECOND CHOICE
THE CHOICES ARE DEPENDENT

PROBABILITIES FOR THE SECOND CHOICE CHANGE DEPENDING ON THE FIRST CHOICE

PROBABILITY OF BLACK → BLACK = $\frac{3}{8} \times \frac{2}{7} = \frac{6}{56}$

PROBABILITY OF BLACK → WHITE = $\frac{3}{8} \times \frac{5}{7} = \frac{15}{56}$

PROBABILITY OF WHITE → BLACK = $\frac{5}{8} \times \frac{3}{7} = \frac{15}{56}$

PROBABILITY OF WHITE → WHITE = $\frac{5}{8} \times \frac{4}{7} = \frac{20}{56}$

PROBABILITY OF THE SAME COLOUR TWICE = OR = $\frac{6}{56} + \frac{20}{56} = \frac{26}{56} = \frac{13}{28} = 46.4\%$

SPACE DIAGRAMS

ROLL THE DIE

SUM THE SCORES

| | | | | | | |
|---|-------|-------|-------|-------|-------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1+1=2 | 1+2=3 | 1+3=4 | 1+4=5 | 1+5=6 | 1+6=7 |
| 2 | 2+1=3 | 2+2=4 | 2+3=5 | 2+4=6 | 2+5=7 | 2+6=8 |
| 3 | 3+1=4 | 3+2=5 | 3+3=6 | 3+4=7 | 3+5=8 | 3+6=9 |
| 4 | 4+1=5 | 4+2=6 | 4+3=7 | 4+4=8 | 4+5=9 | 4+6=10 |

FREQUENCY TREES

THE PROBABILITY A RANDOMLY CHOSEN STUDENT IS FEMALE = $\frac{40+49}{192} = \frac{89}{192}$

YEAR 12: MALE (65), FEMALE (40)

YEAR 13: MALE (38), FEMALE (49)

RELATIVE FREQUENCY

THEORETICAL PROBABILITY

PROBABILITY OF WIN = $\frac{2}{5} = 40\%$

ASSUMING ALL SECTORS HAVE AN EQUAL CHANCE

EXPERIMENTAL PROBABILITY

ESTIMATING THE PROBABILITY FROM REPEATED TRIALS

| | | | | | |
|--------------------|-----|-----|-----|-------|-------|
| NUMBER OF WINS | 5 | 18 | 42 | 196 | 403 |
| NUMBER OF TRIALS | 10 | 50 | 100 | 500 | 1000 |
| RELATIVE FREQUENCY | 50% | 36% | 42% | 39.2% | 40.3% |

RELATIVE FREQUENCY = $\frac{\text{NUMBER OF WINS}}{\text{NUMBER OF TRIALS}} = \frac{18}{50}$

MORE TRIALS → MORE RELIABLE THE ESTIMATE

MEAN, MEDIAN, MODE

MEASURE THE CENTRE OF THE DATA

RANGE MEASURES THE SPREAD OF THE DATA

FROM A LIST OF DATA

MEAN, MEDIAN, MODE + RANGE

FROM A FREQUENCY TABLE

| GOALS SCORED | FREQUENCY |
|--------------|-----------|
| 0 | 3 |
| 1 | 10 |
| 2 | 12 |
| 3 | 8 |
| 4 | 5 |
| 5 | 2 |

RANGE = 5 - 0 = 5

MODE = 2 (OCCURS 12 TIMES)

ADD UP THE FREQUENCIES TO FIND THE TOTAL NUMBER OF DATA ITEMS = 40

TOTAL GOALS SCORED = 88

MEAN = $\frac{\text{TOTAL GOALS SCORED}}{\text{NUMBER OF MATCHES PLAYED}} = \frac{88}{40} = 2.2$ GOALS/GAME

FROM A GROUPED FREQUENCY TABLE

ESTIMATE USING THE MID-POINTS OF EACH INTERVAL

| HEIGHT, h (cm) | FREQUENCY | MID-POINT x FREQ. |
|----------------|-----------|-------------------|
| 130 < h < 140 | 2 | 135 x 2 = 270 |
| 140 < h < 150 | 5 | 145 x 5 = 725 |
| 150 < h < 160 | 11 | 155 x 11 = 1705 |
| 160 < h < 170 | 9 | 165 x 9 = 1485 |
| 170 < h < 180 | 3 | 175 x 3 = 525 |

MODAL CLASS: THE MOST COMMON INTERVAL OCCURS 11 TIMES = 150 < h < 160

NUMBER OF STUDENTS = 30

TOTAL HEIGHT = 4710

ESTIMATE OF MEAN = $\frac{4710}{30} = 157$ cm

SCATTER GRAPHS

DISPLAY PAIRS FROM TWO SETS OF DATA

| STUDENT | A | B | C | D | E | F | G |
|---------------|------|------|------|------|------|------|------|
| HEIGHT (cm) | 132 | 139 | 151 | 157 | 165 | 173 | 180 |
| HANDSPAN (cm) | 17.7 | 19.2 | 20.9 | 19.7 | 21.5 | 17.8 | 21.8 |

HANDSPAN = 23.2 cm

LESS RELIABLE PREDICTION AS HEIGHT 190 cm IS OUTSIDE THE RANGE OF THE DATA SET

EXTRAPOLATION

HANDSPAN = 19.6 cm

MORE RELIABLE PREDICTION AS HEIGHT 150 cm IS INSIDE THE RANGE OF THE DATA SET

PREDICT HANDSPAN FOR HEIGHT OF 150 cm

USE THE LINE OF BEST FIT

PREDICT HANDSPAN FOR HEIGHT OF 190 cm

CAUSATION

CORRELATION NOT CAUSATION

ICE CREAM SALES

SUNGLASSES SALES

OUTLIER

A POINT WHICH DOES NOT FIT THE PATTERN OF THE REST OF THE DATA

COLLECTING DATA

DISCRETE DATA

PRIMARY DATA

CONTINUOUS DATA

SECONDARY DATA

POPULATION

SAMPLE

BUT... SAMPLE IS ONLY A SELECTION OF OPINIONS AND CAN BE BIASED

BAR CHART

WHAT IS YOUR FAVOURITE TYPE OF PIZZA?

| PIZZA | TALLY | FREQ. |
|-------------|------------------|-------|
| MARGHERITA | HHH HHT IIII | 14 |
| PEPPERONI | HHH IIII | 9 |
| BBQ CHICKEN | HHH HHT HHT IIII | 18 |
| HAWAIIAN | III | 3 |
| OTHER | HHH I | 6 |

FREQUENCY TABLE

| PIZZA | FREQUENCY |
|-------------|-----------|
| MARGHERITA | 14 |
| PEPPERONI | 9 |
| BBQ CHICKEN | 18 |
| HAWAIIAN | 3 |
| OTHER | 6 |

PICTOGRAM

● = 4 PEOPLE

ANGLE

100.8°

64.8°

129.6°

21.6°

43.2°

360°

PIE CHART

REPRESENTING DATA

HISTOGRAMS

THE HEIGHTS OF 120 STUDENTS IN A SCHOOL ARE RECORDED

| HEIGHT, h (cm) | FREQUENCY |
|----------------|-----------|
| 130 ≤ h < 140 | 5 |
| 140 ≤ h < 150 | 13 |
| 150 ≤ h < 160 | 20 |
| 160 ≤ h < 170 | 39 |
| 170 ≤ h < 180 | 28 |
| 180 ≤ h < 190 | 15 |

CUMULATIVE FREQUENCY

| HEIGHT, h (cm) | CUMULATIVE FREQUENCY |
|----------------|----------------------|
| h < 140 | 5 |
| h < 150 | 18 |
| h < 160 | 38 |
| h < 170 | 77 |
| h < 180 | 105 |
| h < 190 | 120 |

JOIN POINTS WITH SMOOTH CURVE

TO FIND THE UPPER QUARTILE: 3/4 OF 120 = 90

TO FIND THE MEDIAN: 1/2 OF 120 = 60

TO FIND THE LOWER QUARTILE: 1/4 OF 120 = 30

PLOT CUMULATIVE FREQUENCY AGAINST THE HIGHEST VALUE IN EACH CLASS

LOWER QUARTILE = 156 cm

MEDIAN = 166 cm

UPPER QUARTILE = 173 cm

CONDITIONAL PROBABILITY

THE PROBABILITY OF ONE EVENT GIVEN ANOTHER HAS ALREADY HAPPENED

FROM A TWO-WAY TABLE

| | | | | |
|-------|------|-----|-------|-------|
| | WALK | BUS | CYCLE | TOTAL |
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| TOTAL | 101 | 107 | 42 | 250 |

109 GIRLS

37 OF THESE TAKE THE BUS

PROBABILITY A STUDENT TAKES THE BUS GIVEN THEY ARE A GIRL = $\frac{37}{109}$

FROM A VENN DIAGRAM

7 PLAY SPORT

2 OF THESE ALSO PLAY MUSIC

PROBABILITY A STUDENT PLAYS MUSIC GIVEN THEY PLAY SPORT = $\frac{2}{7}$

SCATTER GRAPHS

STRONG NEGATIVE CORRELATION

WEAK NEGATIVE CORRELATION

NO CORRELATION

WEAK POSITIVE CORRELATION

STRONG POSITIVE CORRELATION

THE CONNECTION BETWEEN THE TWO SETS OF DATA

BAR CHART

TYPE OF PIZZA

PIE CHART

REPRESENTING DATA

CONDITIONAL PROBABILITY

THE PROBABILITY OF ONE EVENT GIVEN ANOTHER HAS ALREADY HAPPENED

FROM A VENN DIAGRAM

7 PLAY SPORT

2 OF THESE ALSO PLAY MUSIC

PROBABILITY A STUDENT PLAYS MUSIC GIVEN THEY PLAY SPORT = $\frac{2}{7}$

HISTOGRAMS

THE AREA OF EACH BAR IS EQUAL TO THE FREQUENCY OF THAT CLASS

30 x 0.6 = 18

BAR CHART

TYPE OF PIZZA

PIE CHART

REPRESENTING DATA

CONDITIONAL PROBABILITY

THE PROBABILITY OF ONE EVENT GIVEN ANOTHER HAS ALREADY HAPPENED

FROM A VENN DIAGRAM

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BAR CHART

TYPE OF PIZZA

PIE CHART

REPRESENTING DATA