

# Probability

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# Probability

Probability	meaning
0	the outcome will not happen
$1/4$	the outcome will happen 1 time in 4
$1/2$	the outcome is as likely to happen as not
$3/4$	the outcome will happen 3 times in 4
1	the outcome will happen

# Probabilities are numbers between 0 and 1

$$0 \leq \rho(x) \leq 1$$

- ▶ A physical quantity has a number of possible values.
- ▶ Example: the possible values of  $\Sigma_1$  are  $-1$  and  $1$ .
- ▶ In a given situation, or *state*, each possible value has a probability. Example:

$$\rho(-1) = \frac{3}{4}$$

$$\rho(1) = \frac{1}{4}$$

# Probabilities add to 1

- ▶ The probabilities for all of the possible values must add to one:

$$\sum_x \rho(x) = 1$$

- ▶ If the possible values  $x$  are  $-1$  and  $1$ , this equation says

$$\rho(-1) + \rho(1) = 1$$

## Mean value

Suppose there are 3 possible values of  $x$ : 6, 12, 24

$\rho(6)$	$\rho(12)$	$\rho(24)$	$\langle x \rangle$
$1/3$	$1/3$	$1/3$	14
$1/2$	$1/4$	$1/4$	12
$1/2$	$1/2$	0	9
1	0	0	6

Are there probabilities  $\rho(6)$ ,  $\rho(12)$ , and  $\rho(24)$  so that  $\langle x \rangle = 24$ ?  
How about  $\langle x \rangle = 25$ ?

$\rho(6)$	$\rho(12)$	$\rho(24)$	$\langle x \rangle$
?	?	?	24
?	?	?	25

# Uncertainty

Suppose there are 3 possible values of  $x$ : 6, 12, 24

$\rho(6)$	$\rho(12)$	$\rho(24)$	$\langle x \rangle$	$\langle x^2 \rangle$	$\sqrt{\langle (x - \langle x \rangle)^2 \rangle}$
1/3	1/3	1/3	14	252	$\sqrt{56} \approx 7.48$
1/2	1/4	1/4	12	198	$\sqrt{54} \approx 7.35$
1/2	1/2	0	9	90	3
1	0	0	6	36	0