# Probability Flowchart

Use this flowchart to convert between different kinds of probabilities.
In each example, the variables under consideration are *A*, *B*, *C*, *D*, and *E*.

**Joint probability**
Likelihood of a completely specified state of events
*Ex: P(ABCDE)*

Joint probability is a special case of marginal probability

Marginal probability is a sum of joint probabilities:

$$P(ABC) = \sum_d \sum_e P(ABCDE)$$

**Marginal probability**
Likelihood of an incompletely specified state of events
*Ex: P(A), P(AB), P(BDE)*

Marginal probabilities can factor if variables are independent:
$P(AB) = P(A)\,P(B)$ iff $A \perp\!\!\!\perp B$

Marginal probability is a product of conditional probabilities (using the chain rule):
$P(AB) = P(B|A)\,P(A) = P(A|B)\,P(B)$

Conditional probability is a ratio of marginal probabilities:

$$P(A|BC) = \frac{P(ABC)}{P(BC)}$$

**Conditional probability**
Likelihood of an event given some known information
*Ex: P(A|B), P(ABD|C), P(C|DE)*

Conditional probability can be simplified using assumptions about conditional independence:

$P(A|BC) = P(A|C)$ iff $A \perp\!\!\!\perp B|C$
(That is, if and only if *A* and *B* are conditionally independent given *C*)

Using a Bayes net, joint probability can be written as a product of conditional probabilities:

$$P(ABCDE) = \prod_{var\, V \in \{ABCDE\}} P(V|parents(V))$$

(This handout is available at http://web.mit.edu/jmn/www/6.034/probability-flowchart.pdf)