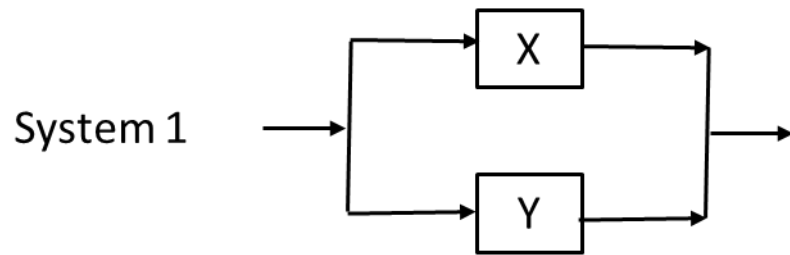# Probability in Systems

McMaster University

BRIGHTER WORLD

Probability in Systems

System could be:
- A circuit
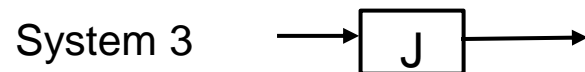- Business process
- Work flow
- Information flow

- Break down the system to a basic building block and apply the correct probability rule in order to combine probabilities in a system.
- Calculate total probability of a system.

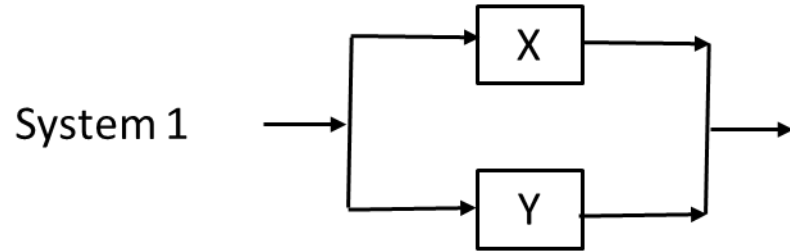System 1: EITHER X OR Y; General Addition Rule

System 2: BOTH A AND B; Independent Events and the Basic Multiplication Rule

System 3: Complementary Rule: $P(J) = 1 - P(\text{not } J) = P(J \text{ works}) = 1 - P(J \text{ fails})$

Probability in Systems

System 1

System 1
P(system works) = P(X works) OR P(Y works)

= P(X works) + P(Y works) – P(X works AND Y works)

(note that the probability of the system working is higher than either the probability of X or Y working alone, so we have a backup or fail-safe system in place).
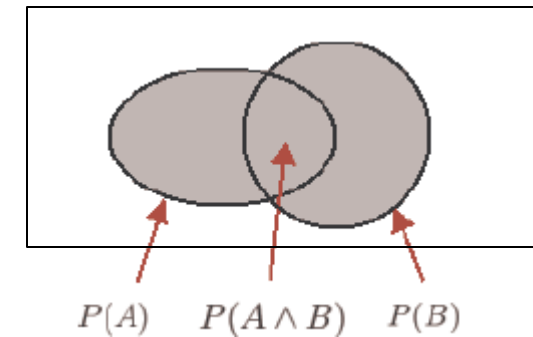
General Addition Rule: EITHER X OR Y Works

Addition law

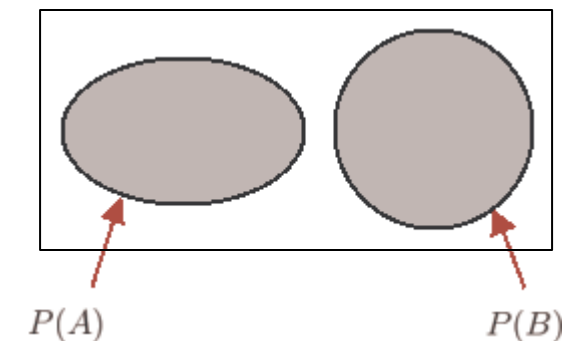- Deals with the chance of either of two events, or both, occurring (i.e. logical OR)

- General form for events A OR B:
$$P(A \vee B) = P(A) + P(B) - P(A \wedge B)$$

$P(A)$ $P(A \wedge B)$ $P(B)$

- Specific form for mutually exclusive (disparate, and therefore not independent) events:
$$P(A \vee B) = P(A) + P(B)$$

$P(A)$ $P(B)$

Probability in Systems
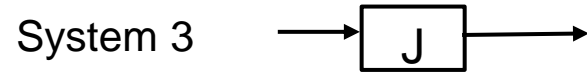
System 2 → A → B →

System 2
P(system works) = P(A works AND B works);
If independent then = P(A works)*P(B works)

(note that the probability of the system working is less than either A, B working alone; this is typical of a series or sequential system)

Independent Events and the Basic Multiplication Rule

BOTH A AND B Works

Probability in Systems

System 3

System 3
$P(J) = 1 - P(\text{not } J) = P(J \text{ works}) = 1 - P(J \text{ fails})$

Complementary Rule

J Works or does not Work.

End of Lecture: Review of Learning Objectives

➢ Describe the basic rules of probability and apply them

    ➢ Venn diagrams

    ➢ Frequentist definition

    ➢ Empirical and theoretical probabilities

➢ Mutually exclusive events and the additive rule of probability

➢ Independent events and the multiplication rule of probability

➢ Conditional probability

➢ Probability of Systems