VIII. Specifications (II)

Objectives

- To describe the Petri Nets formalism
- To discuss the Entity Relationship (ER) formalism
- To provide examples

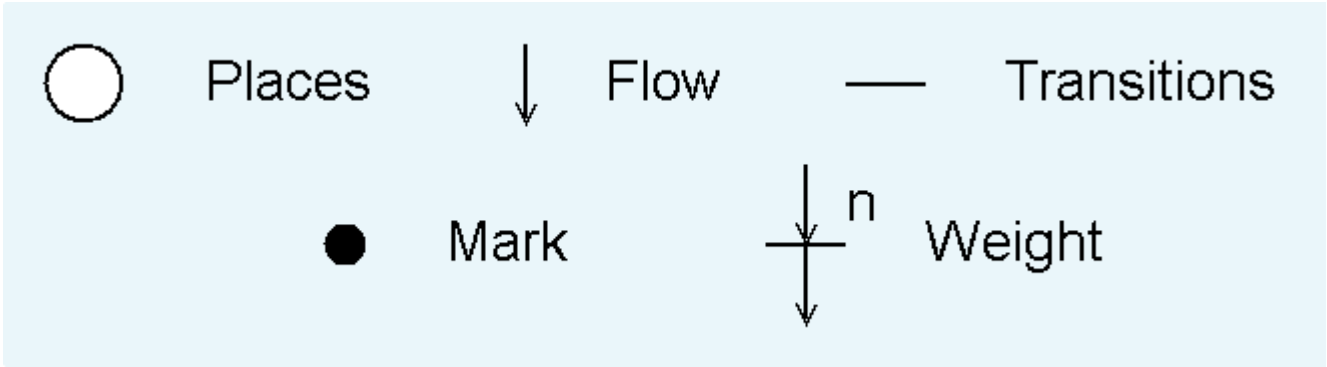
A resume from previous lesson

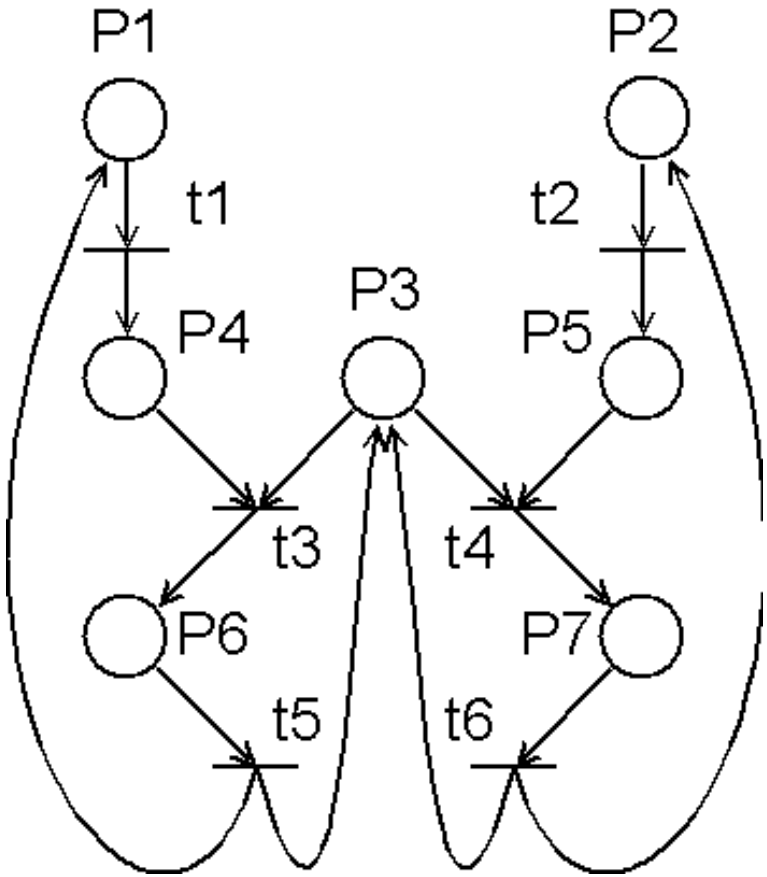
- Operational and descriptive model specifications
- DFD
- FSM
  - FSM characteristics and problems when general concurrency need to be represented.

Operational Specification - PN

- Petri nets are a formalism for specifying **systems that contain parallel or concurrent activities**.
- Mathematical model:
  - A Petri Net is defined by a quadruple (P, T, F, W) where:
    - P is a finite set of places
    - T is a finite set of transitions
    - $P \cup T \neq \emptyset$
    - $F \subseteq \{P \times T\} \cup \{T \times P\}$ is the flow relation
    - W: F --> N - {∅} is the weight function which associate a non zero natural value to each element of F (default value is 1)
  - M: P-->N marking function

PN generics

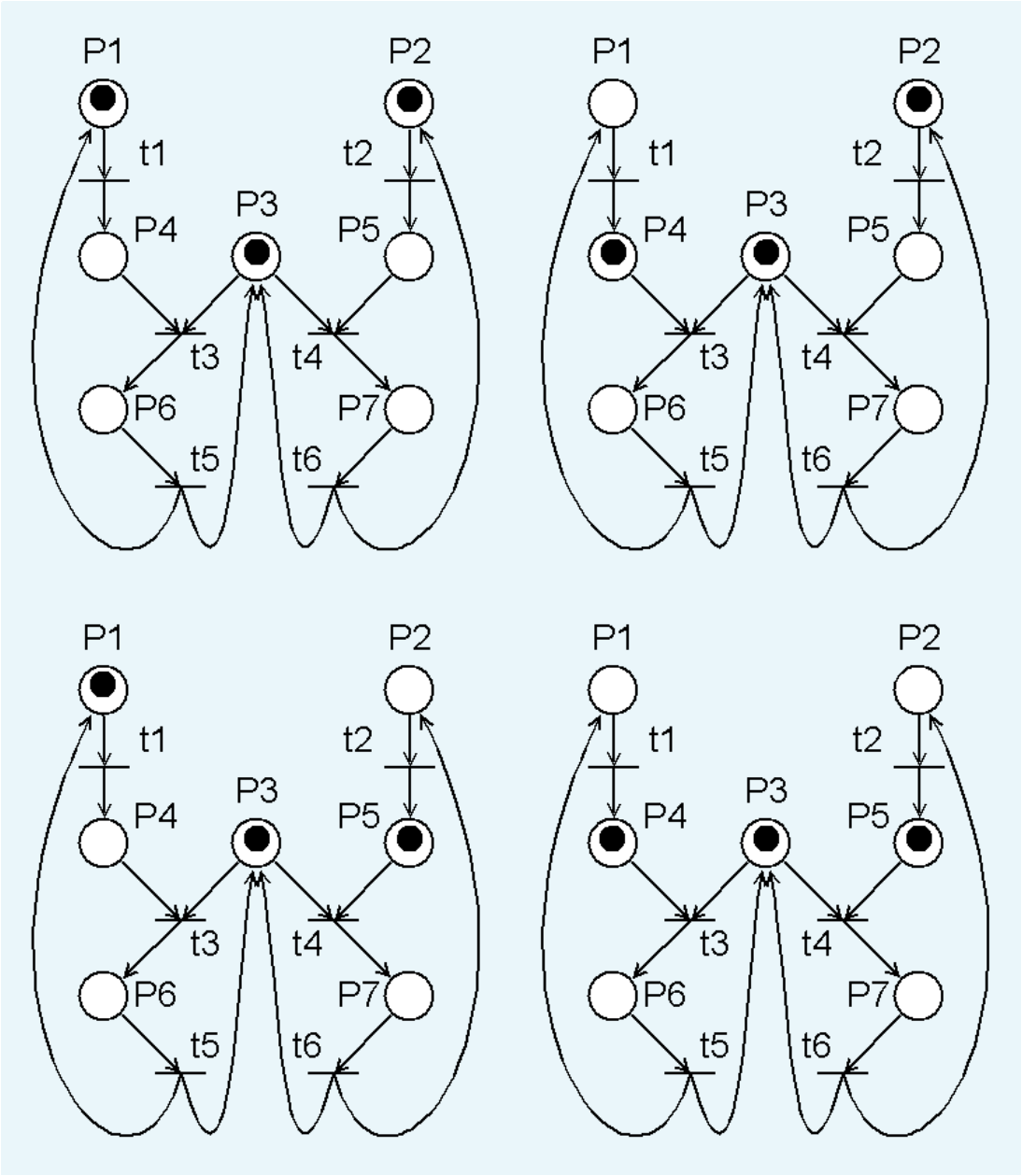

Places
Flow
Transitions
Mark
n
Weight


P1
P2
t1
t2
P3
P4
P5
t3
t4
P6
P7
t5
t6

PN generics

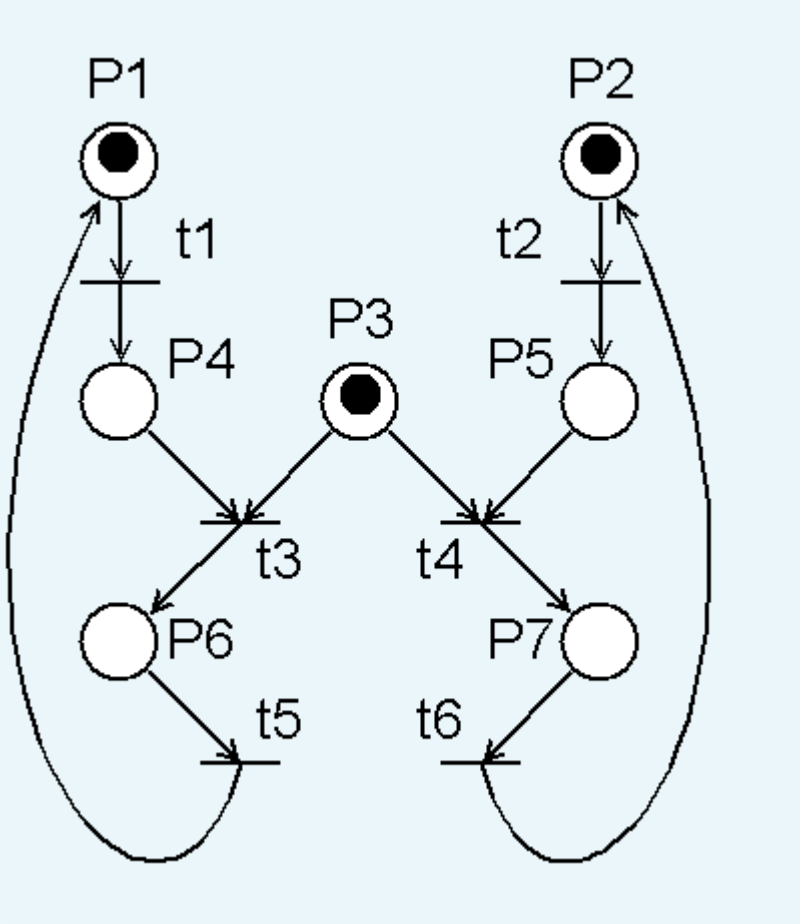
- Input and Output places
- A transition is said enabled if each of its input places contains a number of token **equal or greater to the weight of the flow** element connecting the input place to the transition
- Transition with no input places are always enabled
- PN are generally **non-deterministic automata**

PN examples

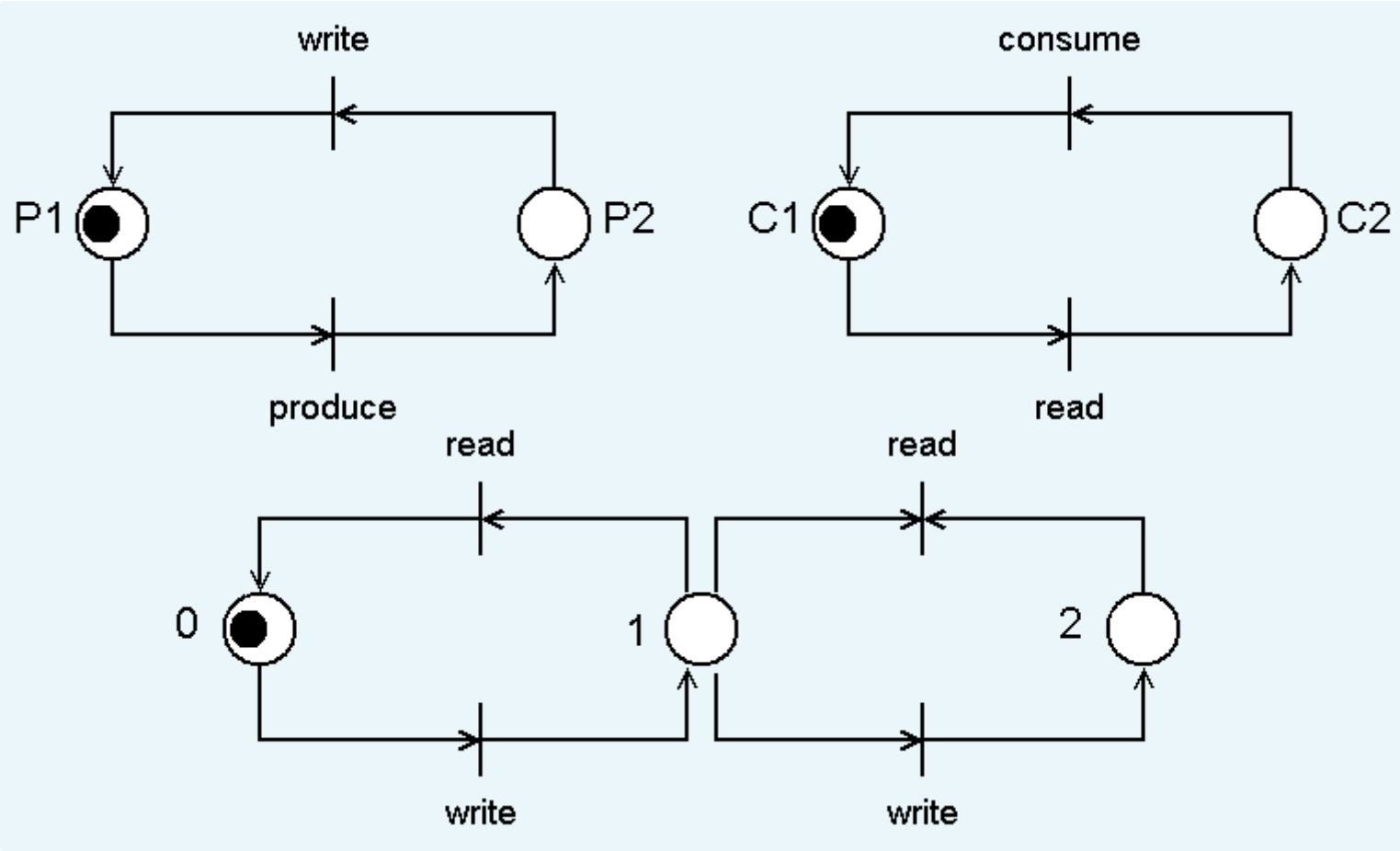


PN generics

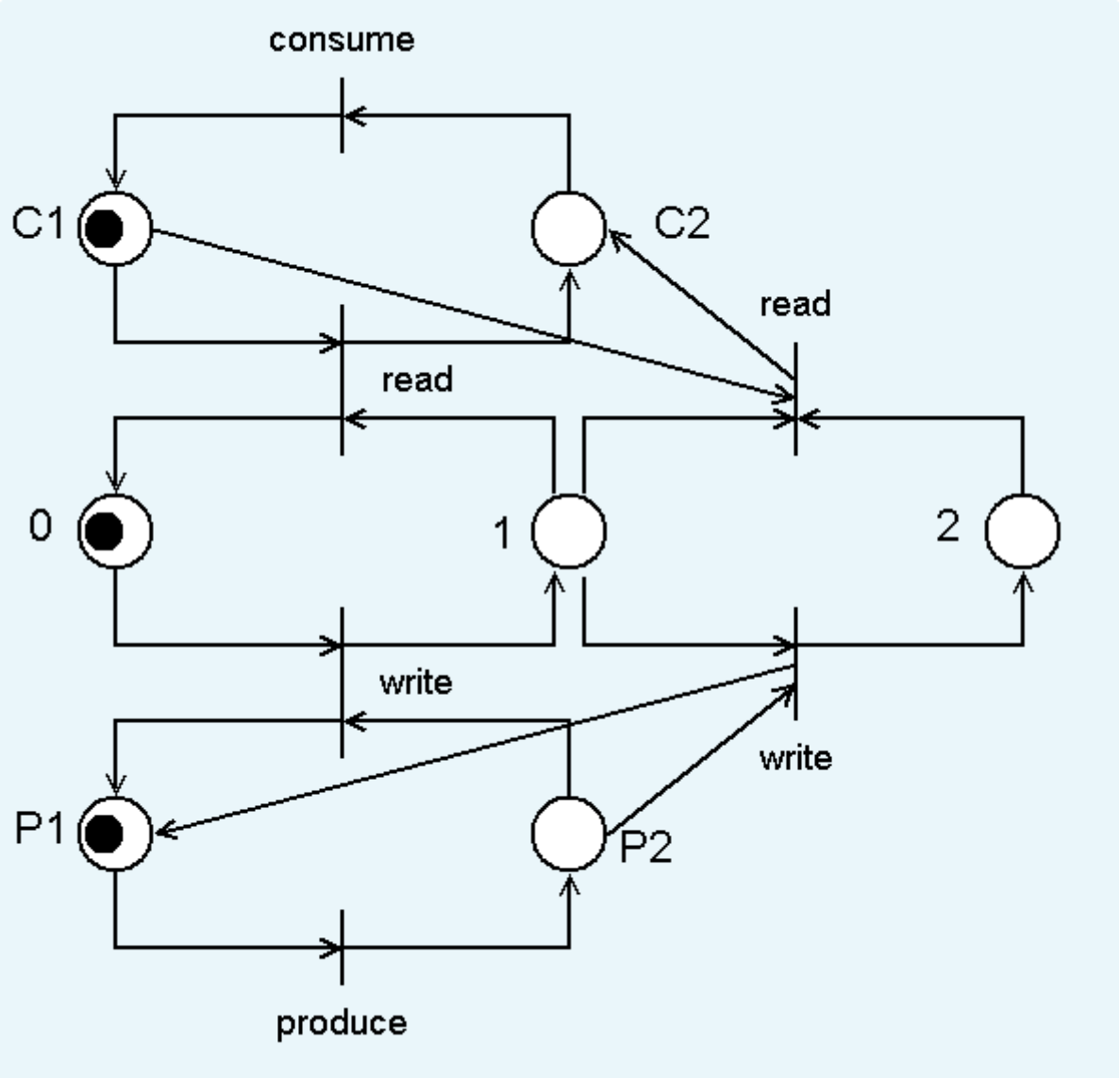
- PN does not impose any policy to avoid starvation of processes
- Places can be considered resources and token represent the availability of the resource
- PN can obviously show



PN producer/consumer/buffer



PN producer/consumer/buffer composed



Limitations and Extensions of Petri Nets

- Token are not content based
- Timing issues – time is not explicitly managed by the model
- Non determinism can be reduced defining priority functions

- Timed Petri nets – transitions have associated times of execution
- Coloured Petri Nets – introduce typed tokens and content management
- Stochastic Petri Nets – TPN with associate exponential distribution (isomorphic to Markov Chain)

Exercices

- A Mutual exclusion component
- Elevator
- Traffic Light
- Dining Philosopher (deadlock)
- Dining Philosopher (deadlock free)

  C:\Documents and Settings\pc\Desktop\PN\philosopher4.swf

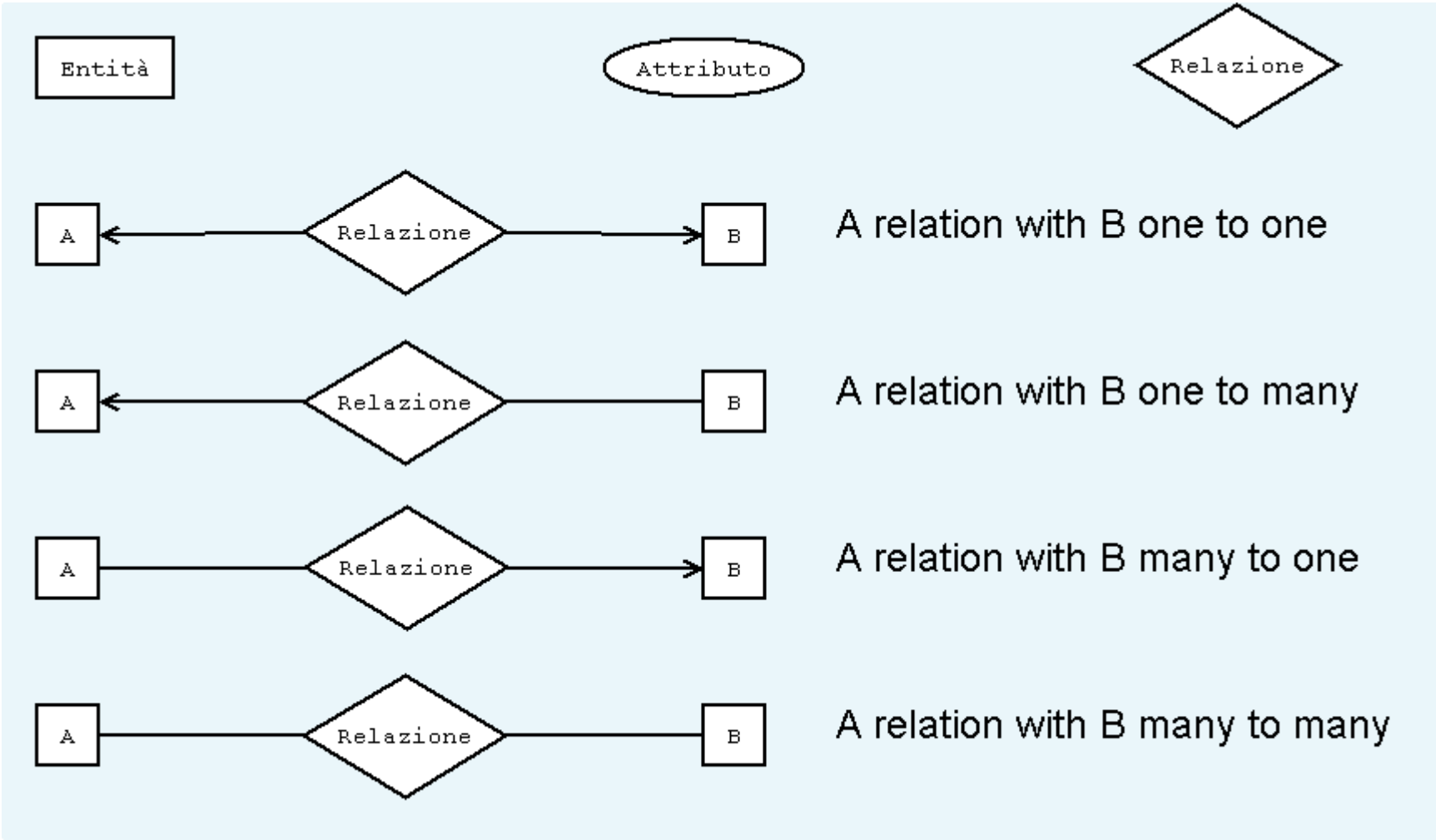
Descriptive Models

- Descriptive specification provide a specification of the system in terms of the properties of a system and not of its behaviour
- We will introduce three main approaches:
  - Semi-formal – Entity Relationship Diagrams
  - Formal based on logic
  - Formal based on algebraic formalism

Descriptive Models – ER

- Conceptual description of the structure of the data and their relations
  - DFD focus on the flow but does not specify structure
  - Which one to model first?
- Widely used notation for describing information systems
- Three main concepts are represented:
  - Entity
  - Attributes
  - Relations

ER graphical notation



ER limitation

- ER expressive power are rather limited and more complex concepts cannot be expressed
  - e.g. Relation on the cardinality of the relation (only one or many)
- In general ER are complemented with comments using formal logic or informal statement
- Class diagrams and ER
- ER are widely used given their simplicity

Key Points

- Operational specifications
  - Petri Nets
- Descriptive Specification
  - Entity relationship diagrams