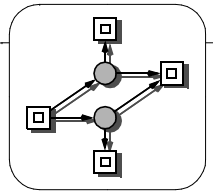
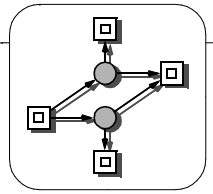


(INFORMAL) INTRODUCTION INTO PETRI NETS MODELLING



PETRI NETS, BASICS 1

(1) NODES

places

“passive elements”
conditions
states
“*chem. compounds*”

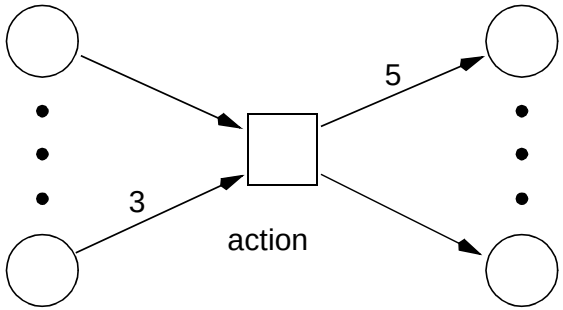
transitions

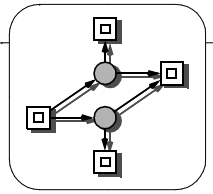
“active elements”
events
actions
“*chem. reactions*”

(2) ARCS

preconditions

postconditions





PETRI NETS, BASICS 2

(3) TOKENS

(moving objects,
vehicles, work pieces, control flow pointer,
dates,..., *units of substances (e. g. Mol)*, ...)

condition is not fulfilled

condition is (one times) fulfilled

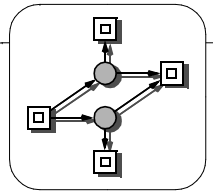
condition is n times fulfilled

(4) MARKING

(system state, *substance distribution*)

How many tokens are on each place?

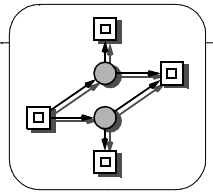
-> initial marking



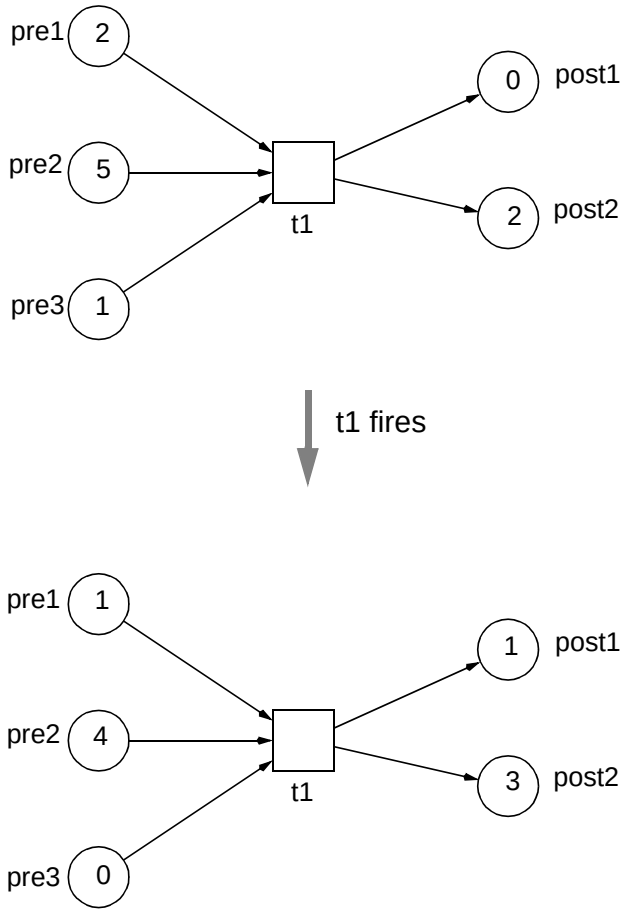
PETRI NETS, BASICS 3

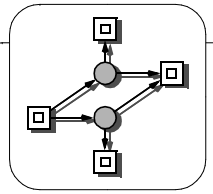
(5) FLOW OF TOKENS

- an action ***may*** happen, if
  - -> all preconditions are fulfilled (corresponding to the arc weights);
- **if** an action happens, **then**
  - -> tokens are removed from all preconditions (corresponding to the arc weights), and
  - -> tokens are added to all postconditions (corresponding to the arc weights);
- an action happens (firing of a transition)
  - -> atomic
  - -> time-less

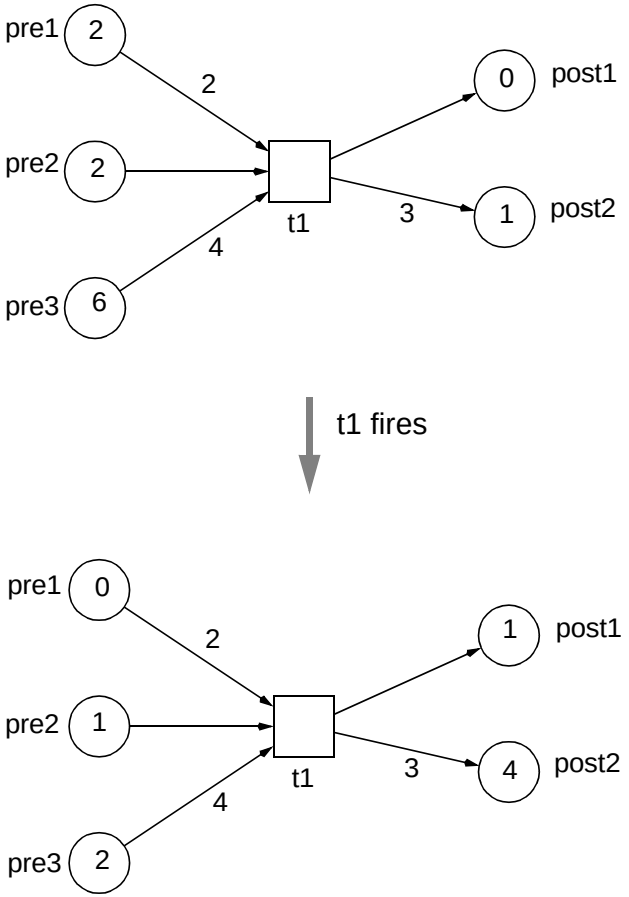


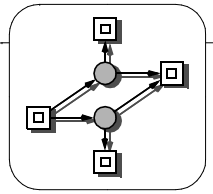
FIRING RULE, EXAMPLE 1





FIRING RULE, EXAMPLE 2

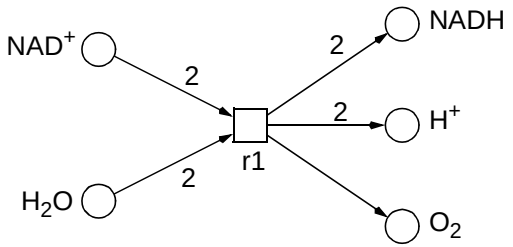




EXAMPLE 1, CHEMICAL REACTION EQUATIONS

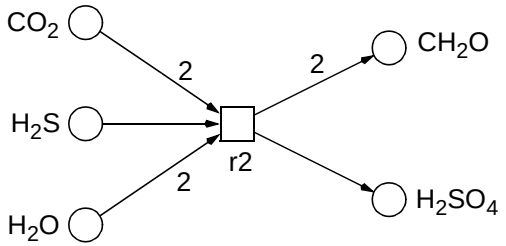
- **FOR LIGHT-INDUCED PHOSPHORYLATION**

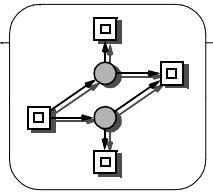
$$2\ NAD^+ + 2\ H_2O \rightarrow 2\ NADH + 2\ H^+ + O_2$$



- **FROM THE PHOTOSYNTHESIS**

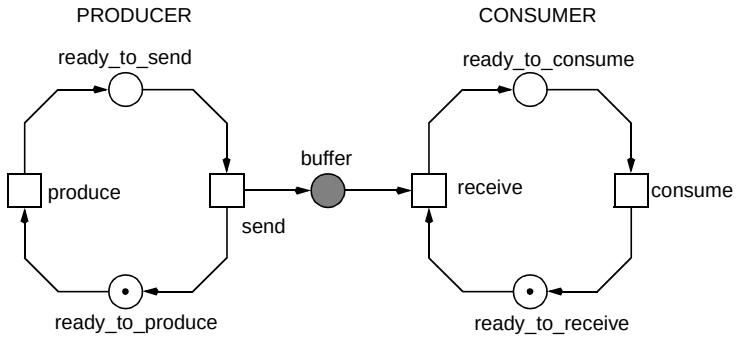
$$2\ CO_2 + H_2S + 2\ H_2O \rightarrow 2\ (CH_2O) + H_2SO_4$$



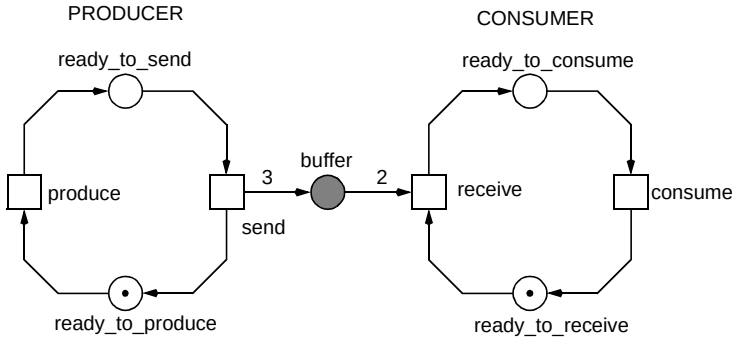


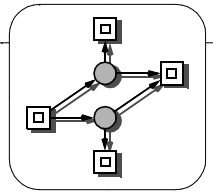
EXAMPLE 2, PRODUCER/CONSUMER, UNBOUNDED

- **SYSTEM WITHOUT ARC WEIGHTS**



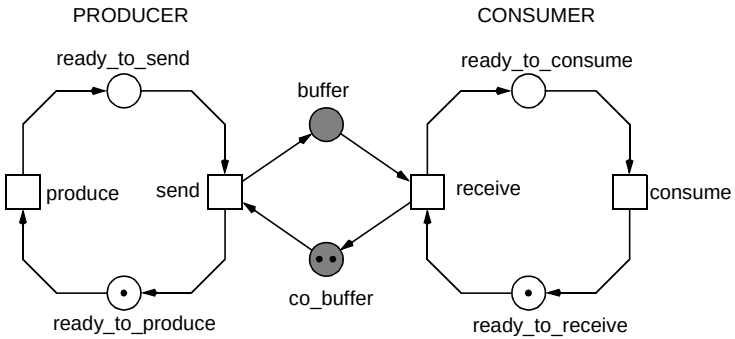
- **SYSTEM WITH ARC WEIGHTS**



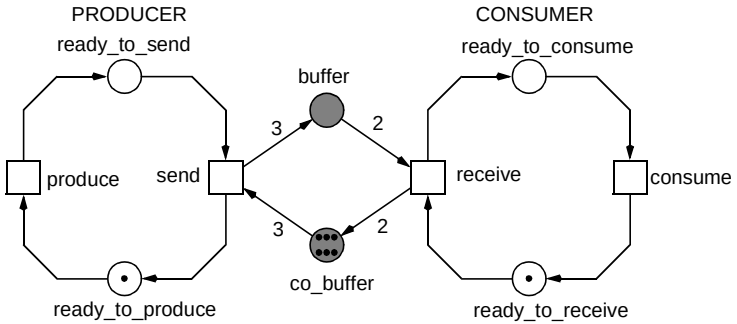


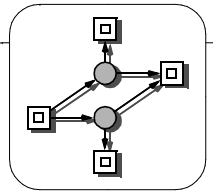
EXAMPLE 3, PRODUCER/CONSUMER, BOUNDED

❑ SYSTEM WITHOUT ARC WEIGHTS

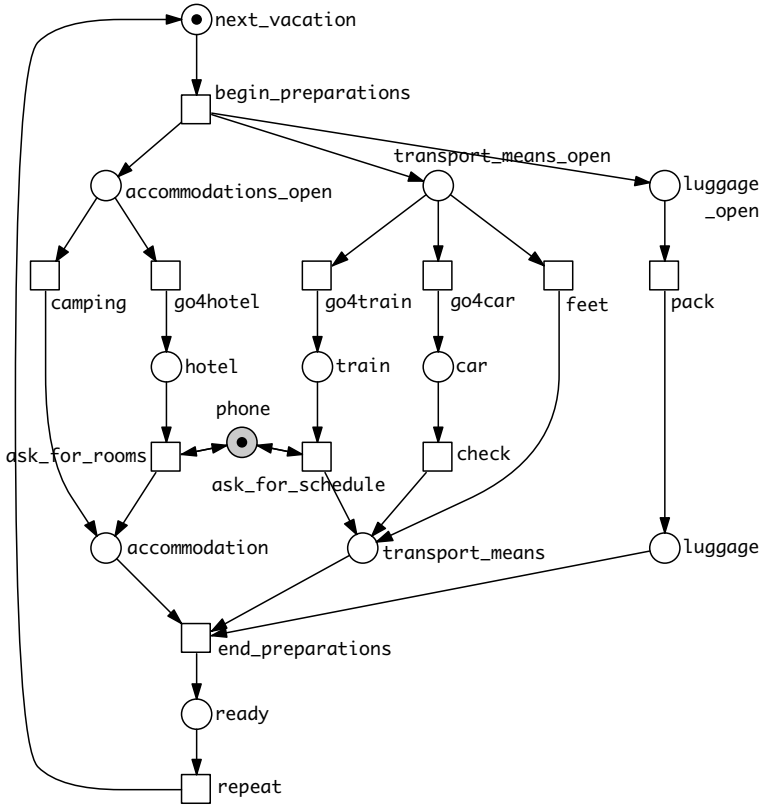


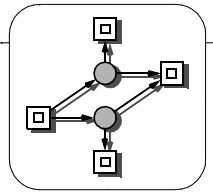
❑ SYSTEM WITH ARC WEIGHTS





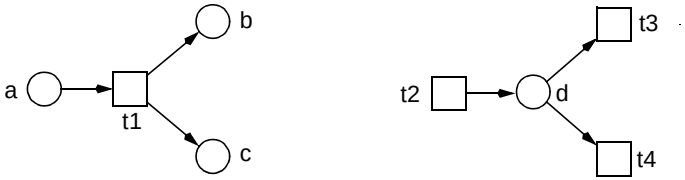
EXAMPLE 4, TRAVEL PREPARATION



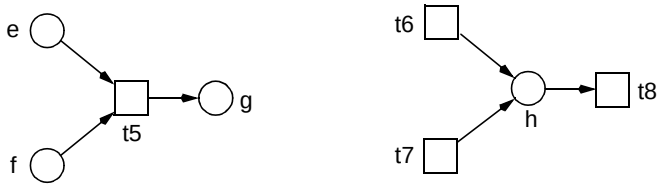


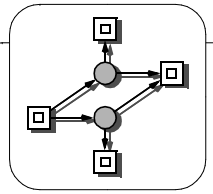
TYPICAL BASIC STRUCTURES 0

❑ FORWARD BRANCHING



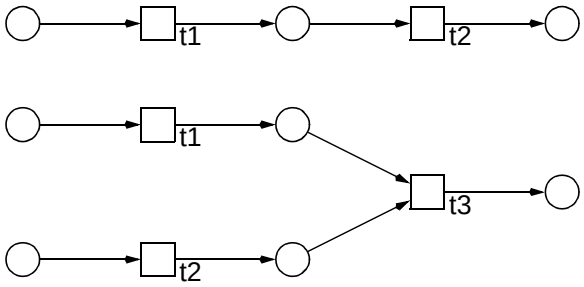
❑ BACKWARD BRANCHING



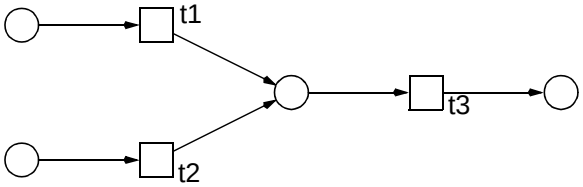


TYPICAL BASIC STRUCTURES 1

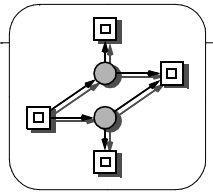
❑ NECESSARY CONDITION



❑ SUFFICIENT CONDITION

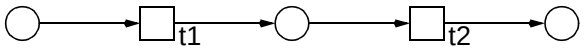


-> CAUSAL RELATION
"X HAS TO HAPPEN BEFORE Y"

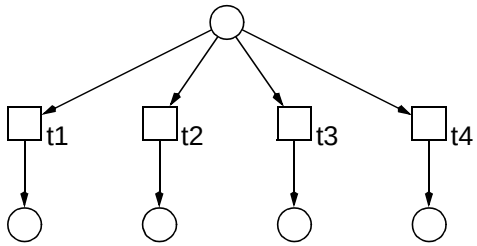


TYPICAL BASIC STRUCTURES 2

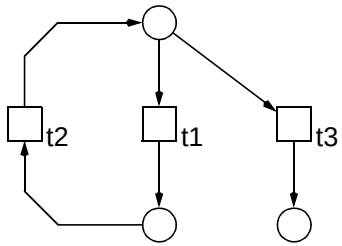
❑ SEQUENCE OF ACTIONS

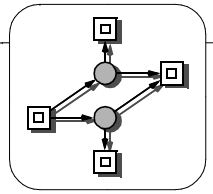


❑ BRANCHING / ALTERNATIVES



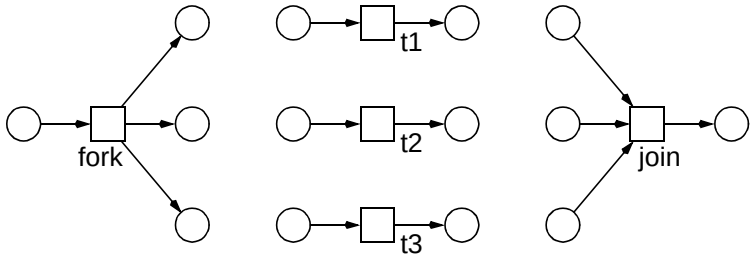
❑ REPETITION



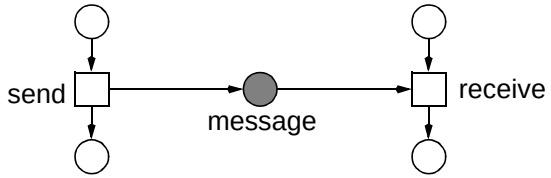


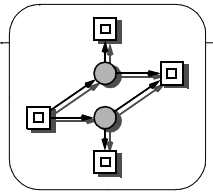
TYPICAL BASIC STRUCTURES 3

❑ CONCURRENCY



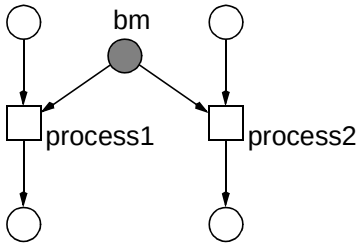
❑ COMMUNICATION / SYNCHRONISATION



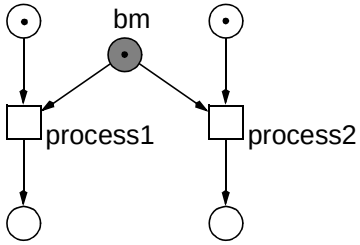


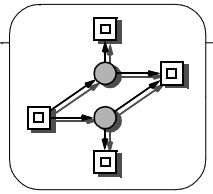
TYPICAL BASIC STRUCTURES 4

- **STATIC CONFLICT**



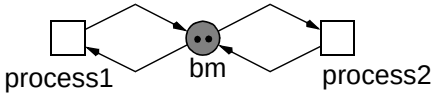
- **DYNAMIC CONFLICT**



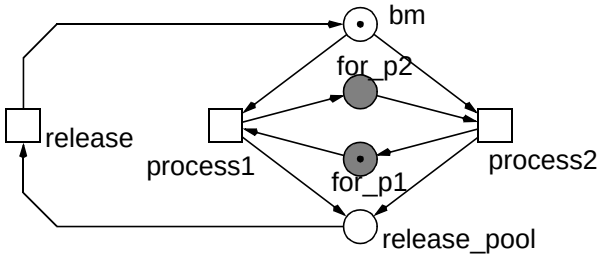


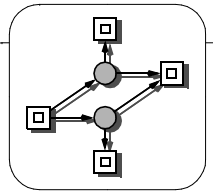
TYPICAL BASIC STRUCTURES 5

- **FREE OF DYNAMIC CONFLICTS, EX. 1**



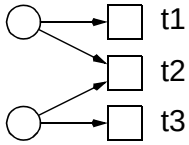
- **FREE OF DYNAMIC CONFLICTS, EX. 2**





TYPICAL BASIC STRUCTURES 6

- **CONFUSION**



- concurrency and conflict overlap
  -> *t1 # t2 and t2 # t3,*
  but t1 concurrent to t3

- **case 1**: t1 < t3
  -> *conflict t2 # t3 disappears,*
  firing of t3 does not involve a conflict decision

- **case 2**: t3 < t1
  -> *conflict t2 # t3 exists,*
  firing of t3 involves a conflict decision

- the interleaving sequences of concurrency
  may encounter different amount of decisions

- an observer outside of the system
  does not know whether a decision took place or not