Business Process Modeling

SOftEng
http://softeng.polito.it

Licensing Note

BP Aspects

- Process flow
  - ◆ Process modeling
    - – UML Activity Diagrams
    - – BPMN
- Information
  - ◆ Conceptual modeling
    - – UML Class diagrams
    - – (Entity-Relationships)
- Interaction
  - ◆ Functional modeling
    - – Use cases

SOftEng
http://softeng.polito.it

UML

- <u>U</u>nified <u>M</u>odeling <u>L</u>anguage
- Standardized by OMG
- Several diagrams
  - ◆ Class diagrams
  - ◆ Activity diagrams
  - ◆ Use Case diagrams
  - ◆ (Sequence diagrams)
  - ◆ (Statecharts)

> Conceptual modeling

> Process modeling

> Functional modeling

SOftEng
http://softeng.polito.it

Objective

- Describe, as precisely as possible, a process (or workflow)
- Communicate, document, analyze, validate the workflow
- Implement (execute) it
  - Only formal notations allow this step

SOftEng
http://softeng.polito.it

Issues

- Formal notations
  - Executable
  - But model can be very complex for high level of detail
- Semiformal
  - Not executable
  - But can be starting point for high level analysis

SOftEng
http://softeng.polito.it

Notations

- **Formal**
  - ◆ UML Activity Diagrams
  - ◆ BPMN
  - ◆ BPEL
- **Semi formal**
  - ◆ IDEF0
  - ◆ Data Flow Diagrams

Process Modeling

UML ACTIVITY DIAGRAM

Goal

- Capture
  - Activities

  - Rules

  - Responsibilities

Activity Diagram

- Extension of Statechart Diagram used to represent temporal sequence of activities and data flow
- Used to represent workflow process, or the inner service logic of an algorithm or function, process
- Parallel process representation and synchronization (fork – join)

Action

- Represents a task or operation that is performed by either a human or the IS

Receive Order

Send account information
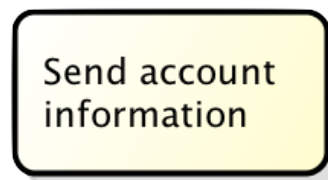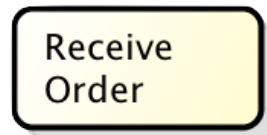
Terminal nodes

- Initial node
  - ◆ Represents the starting point of the process execution
  - ◆ Create a new token
- Final node
  - ◆ Indicate that the processing has completed
  - ◆ Destroy all tokens

Semantics

- A token flows through the diagram
- The token is created at the initial node
- The token comply with the process rules
- The token is eventually destroyed at end node

Basic patterns

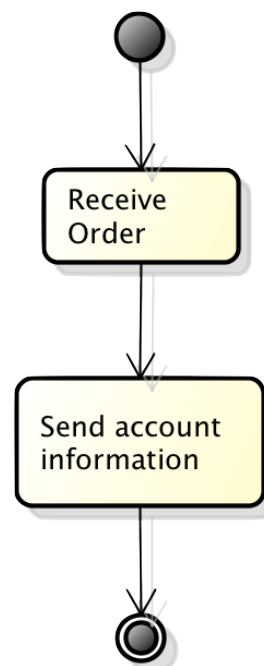- Sequence
- Parallel split
- Synchronization
- Exclusive choice
- Merge
- Multiple choice

Sequence

- An action in a process is enabled after the completion of a preceding action
  - Aka serialization
- It is the essential building block
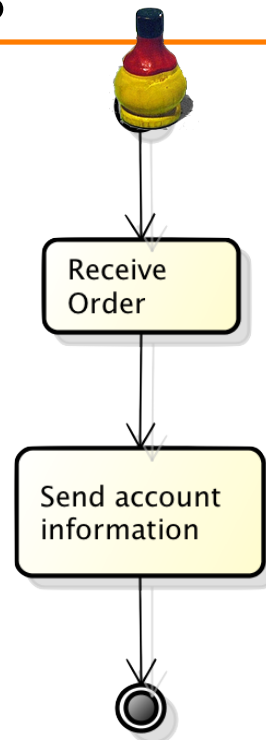 - Can be used to build a series of consecutive actions that take place in turn one after the other

Sequence

- The arc determines the order of execution

Sequence – Semantics

- A token flows through the diagram
- Following the arcs
- Stopping at actions
  - Performing actions

Parallel split

- From a certain point on a thread diverges into several parallel threads that can be executed concurrently
  - Aka fork, AND-split
- Represents
  - Actions taking place at the same time (concurrently)
  - Actions being performed without any specific order
    - Possibly even serialized

Parallel split
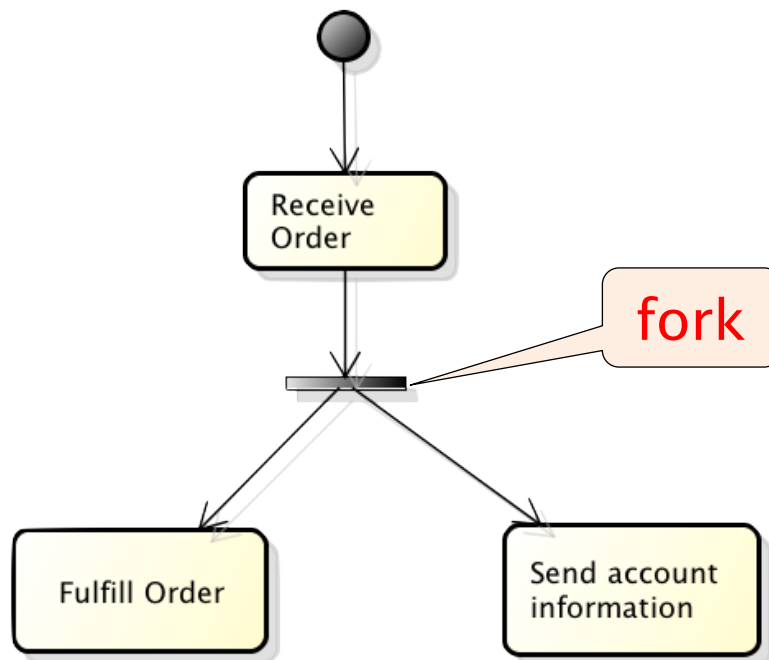
Parallel split– Semantics

- When the token reaches the fork it is duplicated as many times as there are outgoing arcs

Synchronization

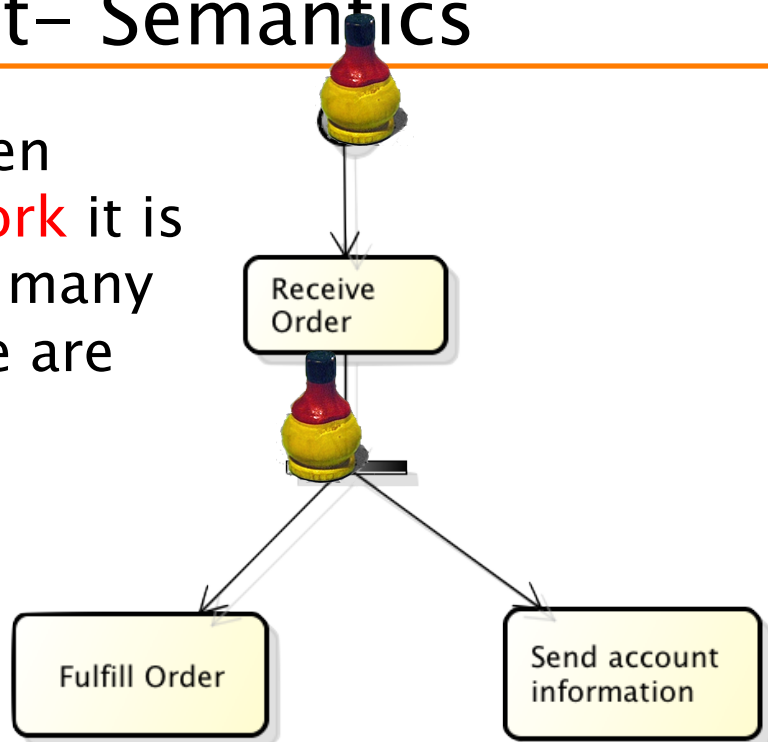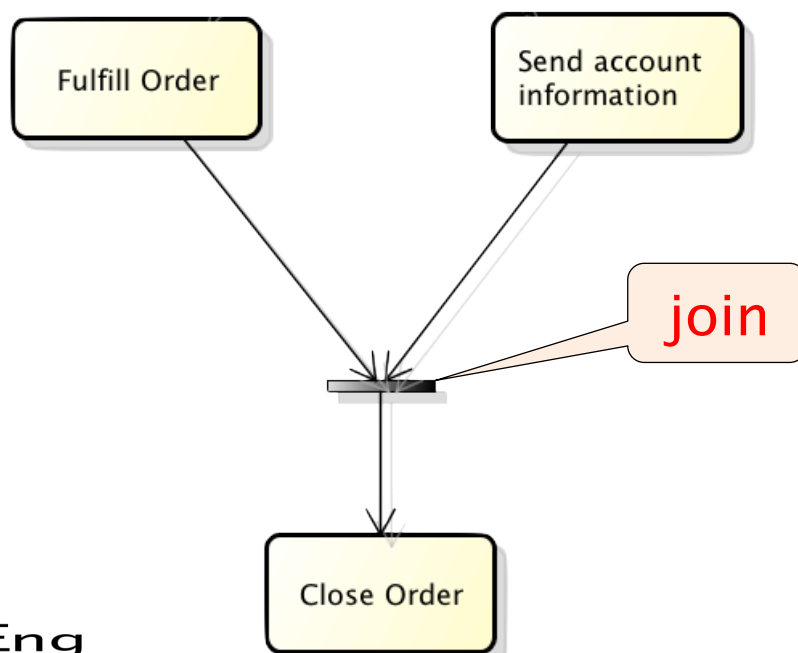- Define a synchronization point or rendezvous
  - After a group of actions have been executed in parallel
- Before proceeding with further activities all the previous one must be complete

SOftEng
http://softeng.polito.it

Synchronization

SOftEng
http://softeng.polito.it

Synchronization– Semantics

- When one token per incoming arc has reached the join, they are merged into a single token
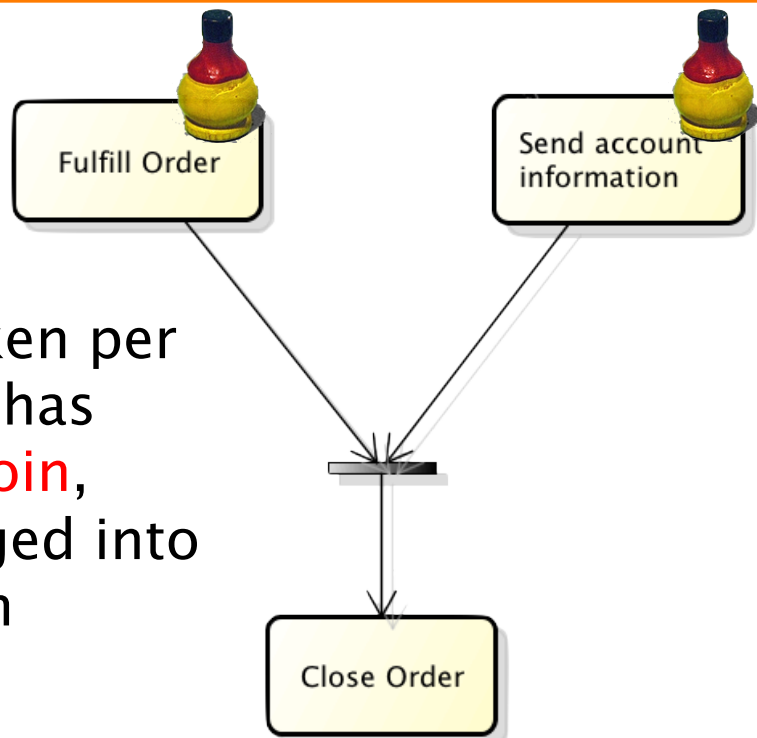
Exclusive choice

- A diversion of the thread into several alternative paths
  - ◆ Exactly one alternative is picked up and followed during execution
  - ◆ Aka conditional routing, decision
- Each path is characterized by a guard
  - ◆ Represent a condition that, when true, enable the execution of the corresponding path

Exclusive choice

[Quick order]   [else]

Express delivery   Normal Delivery
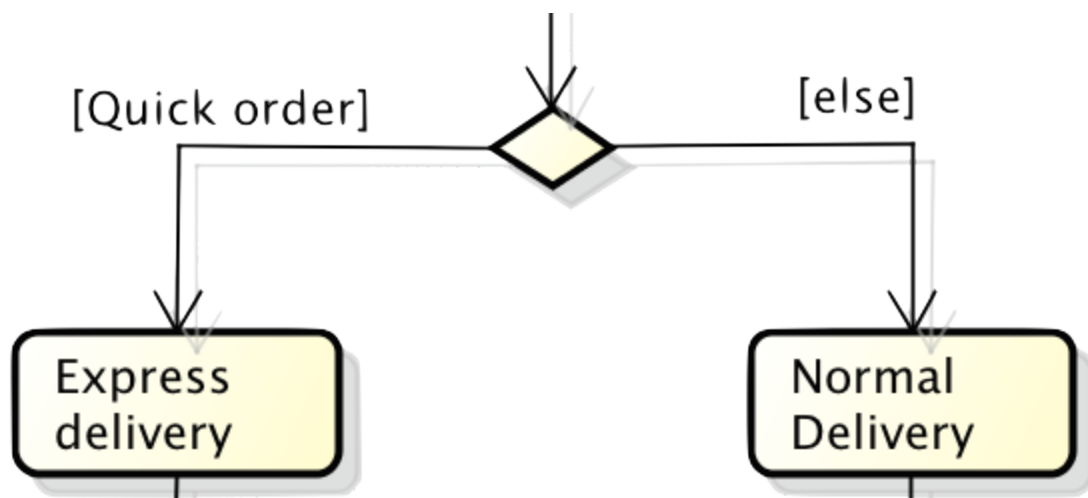
Exclusive choice – Semantics

- The token follows exactly one of the outgoing arcs

[Quick order]   [else]

Express delivery   Normal Delivery
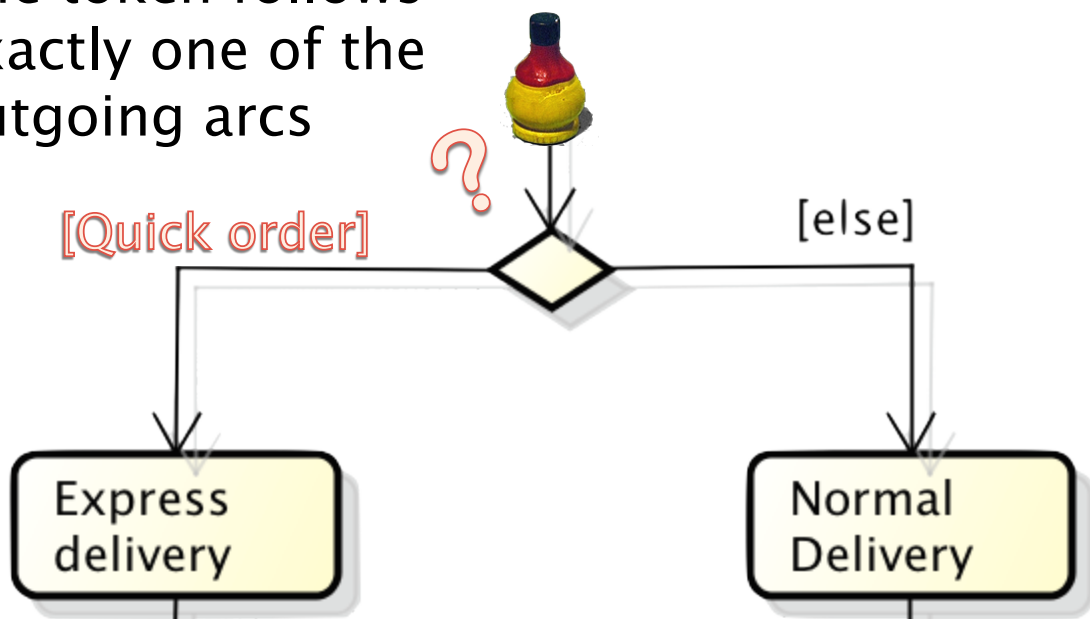
Merge

- The convergence of two or more threads into a single one
  - Any incoming thread activates the outgoing path
  - Aka join
- No synchronization is performed

Exclusive choice

[Quick order]   [else]

Express
delivery

Normal
Delivery

Merge- Semantics

[Quick order]   ?   [else]

Express delivery

Normal Delivery
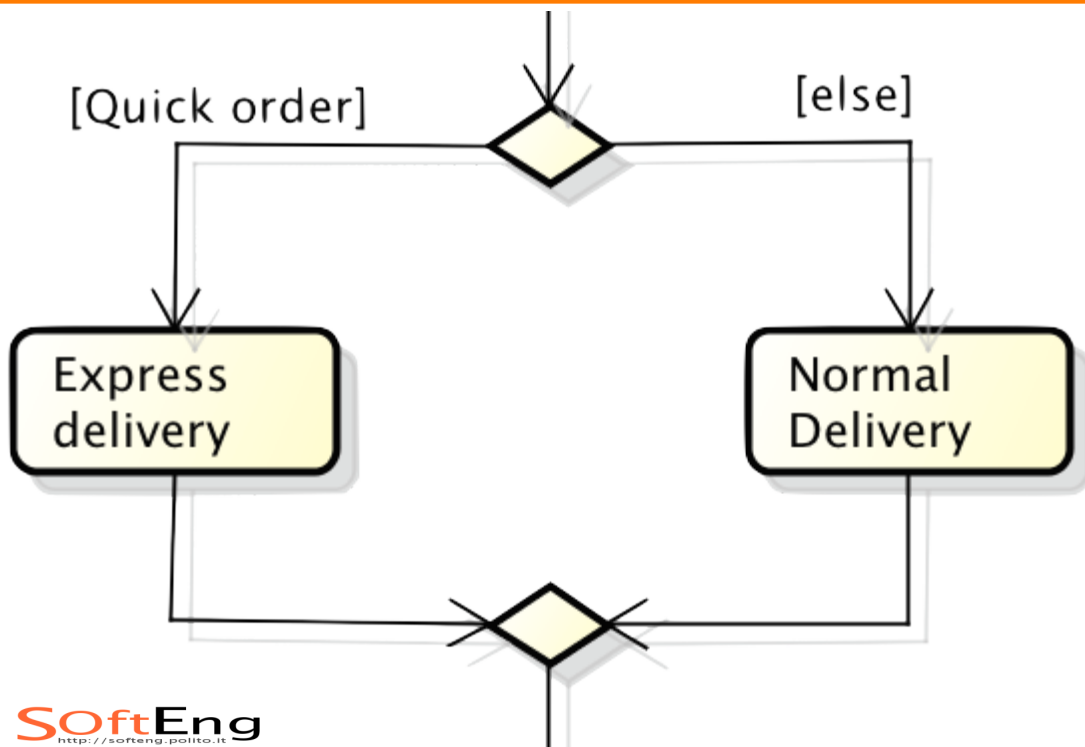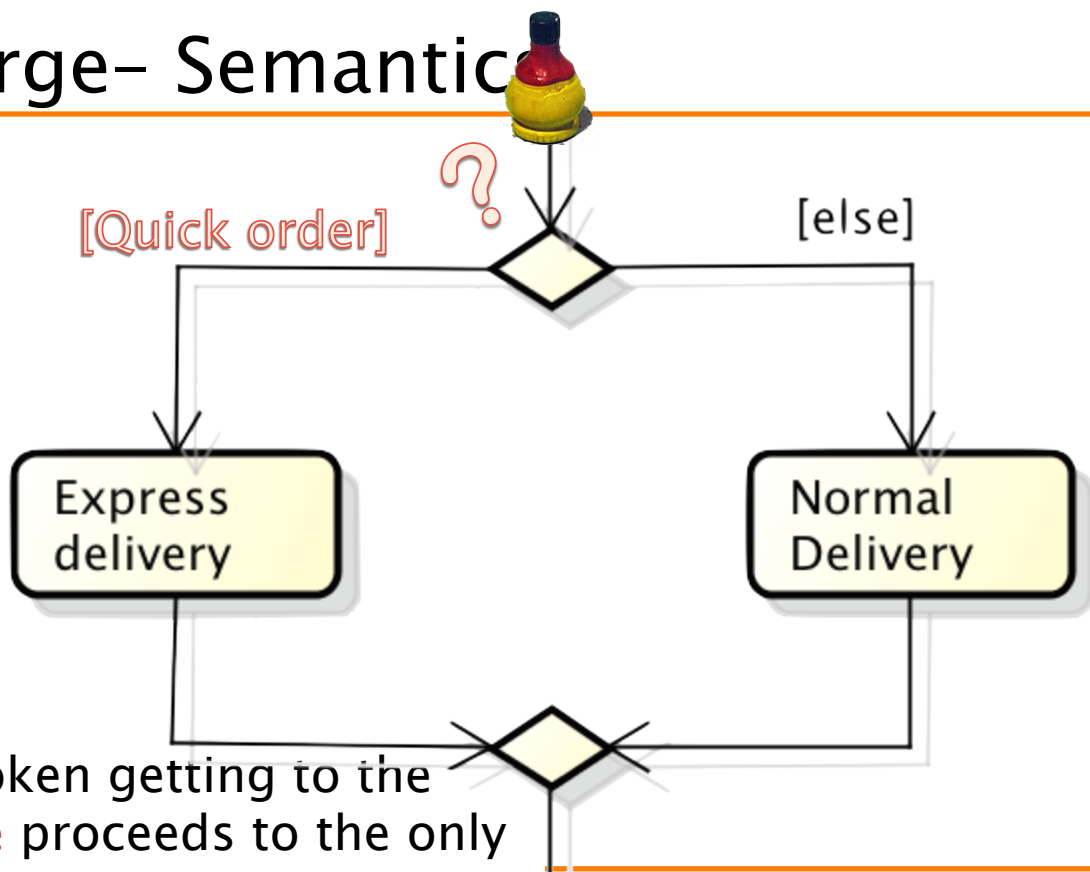
The token getting to the merge proceeds to the only outgoing arc

Multiple choice

- When several paths are available it is possible to chose one or more of them
  - If no path is chosen, we have an abnormal stop to the flow

Select delivery option

[wrap option]   [card option]

Gift wrap

Enclose message card

Example

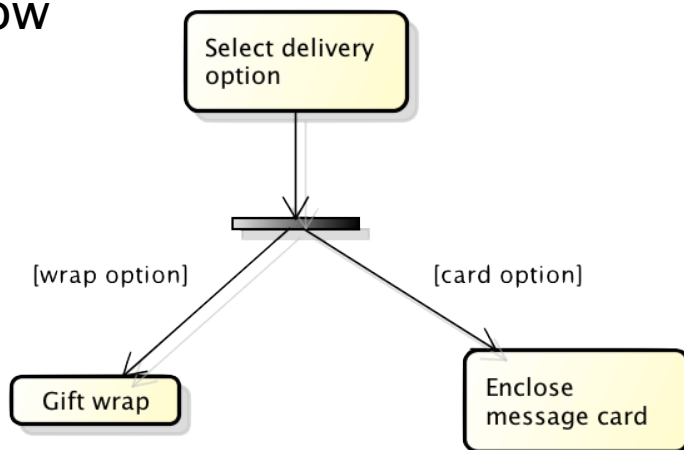**act** Process order

Receive Order

Fulfill Order

Send account information

[Quick order]   [else]

Express delivery

Normal Delivery

Receive Payment

Close Order
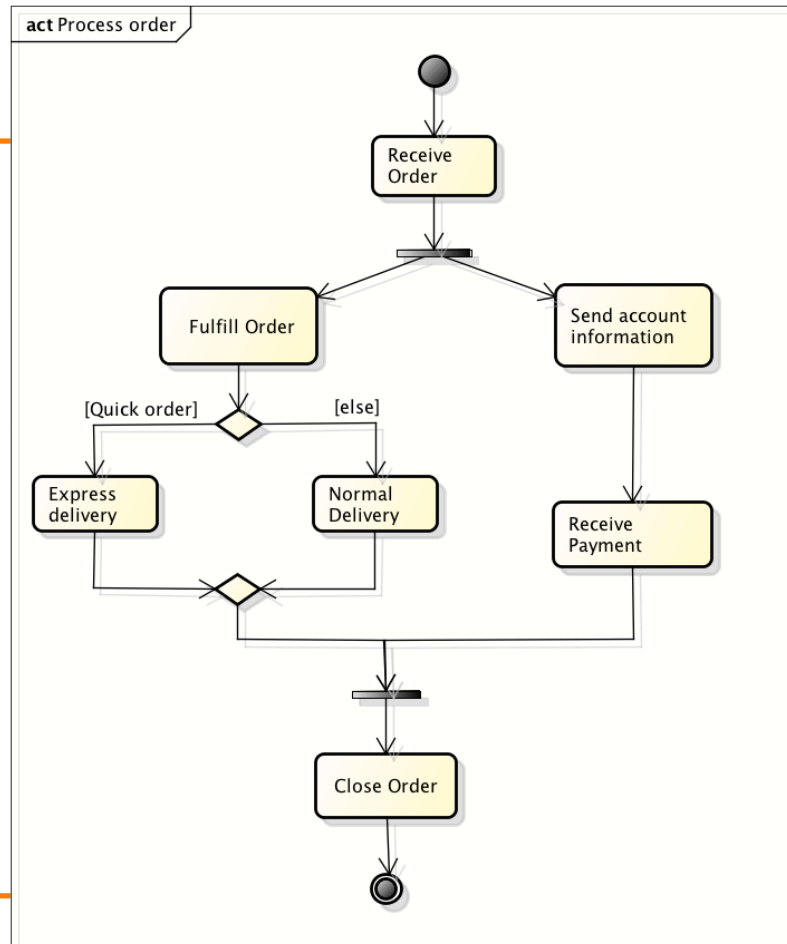
Structured processes

- Each action has exactly one input flow and one output flow

- Fork and Join must be coupled

- Decision and Merge must be coupled

Prescriptive vs. Descriptive

- Initial goal: understand the currently in place procedure
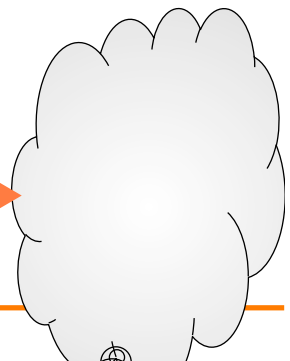 - ◆ Descriptive
- Next goal: provide guidance for defining IS-supported procedures
  - ◆ Prescriptive
- Advice: avoid unnecessary constraints

SOftEng
http://softeng.polito.it

Additional features

EVENTS, OBJECTS, SWIMLANES

SOftEng
http://softeng.polito.it
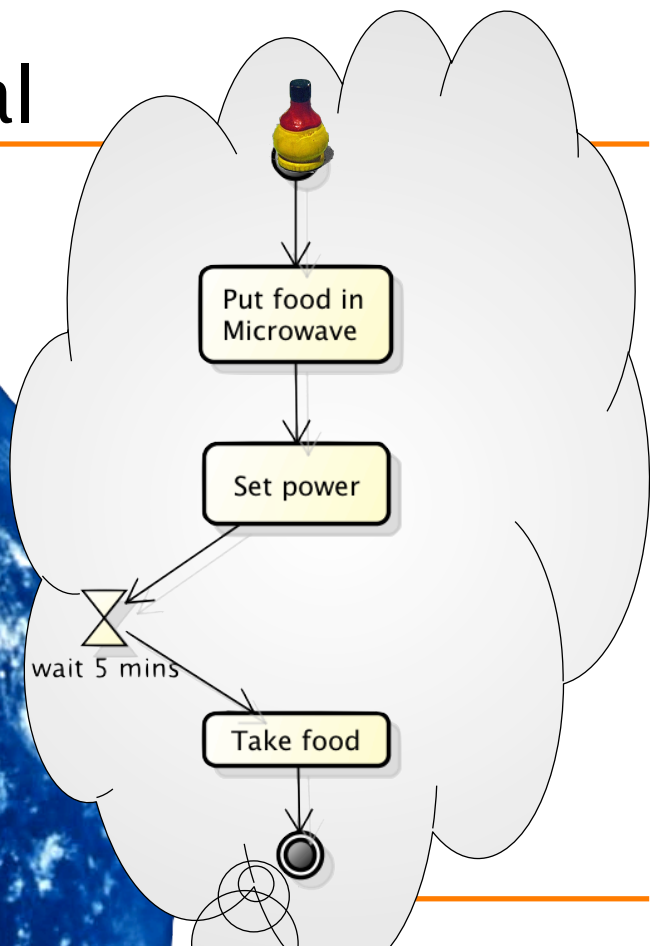
Signals and Events
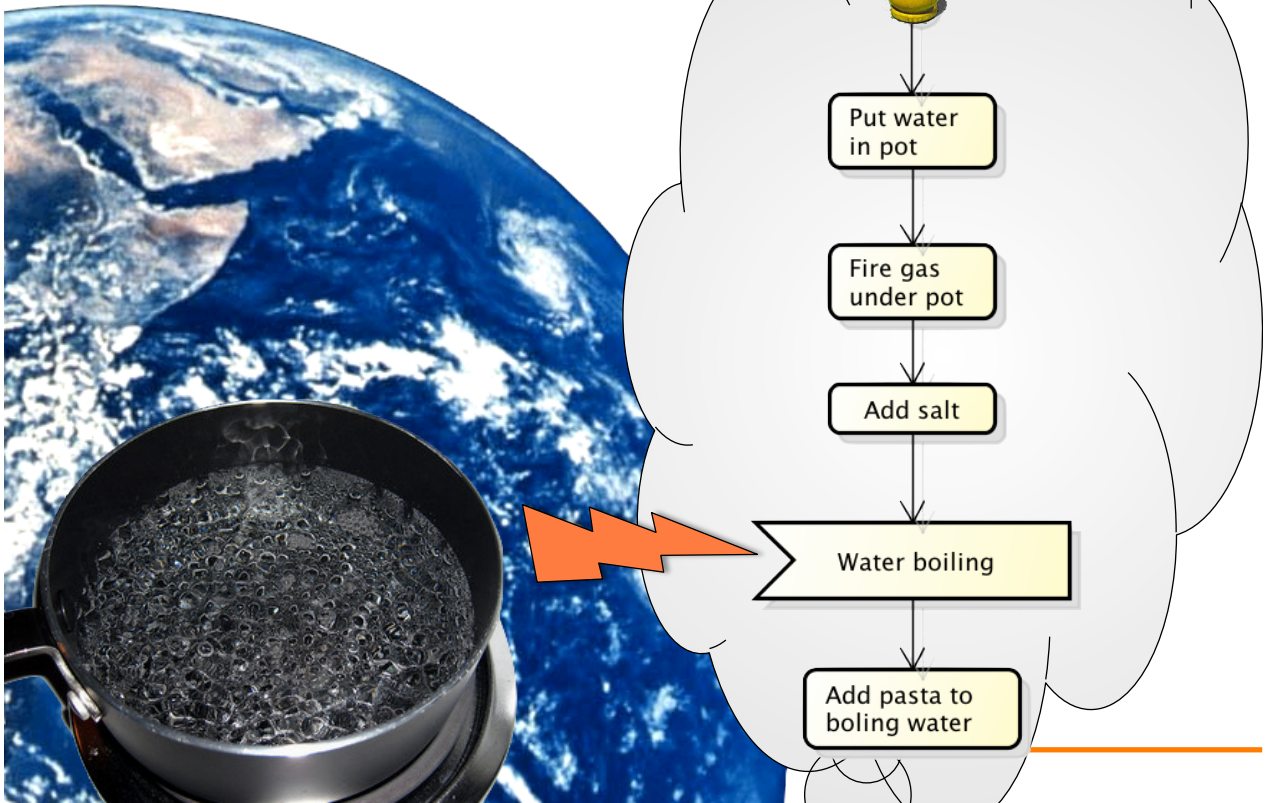
- Using an event that origins outside the process as a guard to proceed with the execution of a process
  - Temporal signal
  - Signal acceptance
  - Signal sending

Temporal signal

Signal acceptance

Put water in pot

Fire gas under pot

Add salt

Water boiling

Add pasta to boling water

Signal sending

Get email address

Write email

Click send button

Email sent

Close mailer
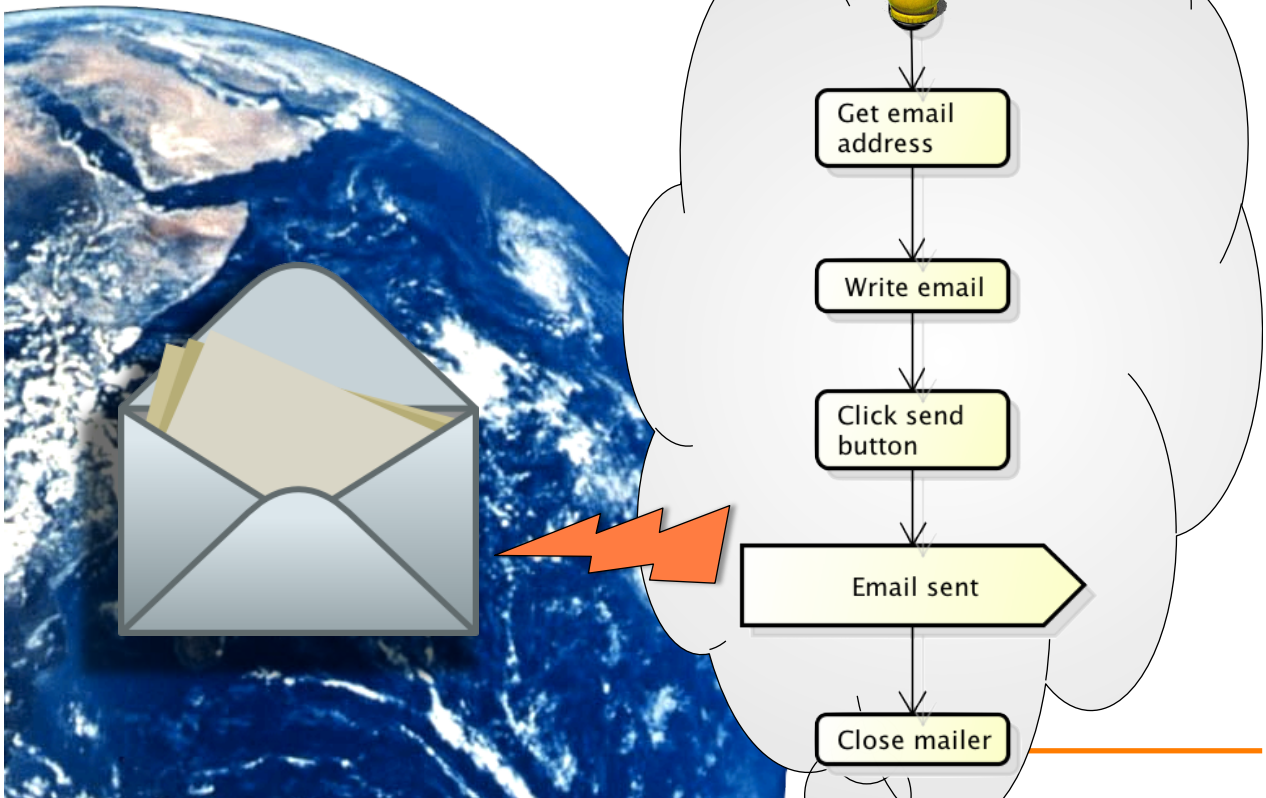
Signals – Example

Object nodes

- Indicate that an object node will be available at a specific point in the activity
  - ◆ Produced by an action
  - ◆ Consumed by an action
- The object is an instance of a class defined in the conceptual model
  - ◆ Or possibly a base type

Object nodes

Grade = 30

Assess exam

Grade : Integer

Record grade
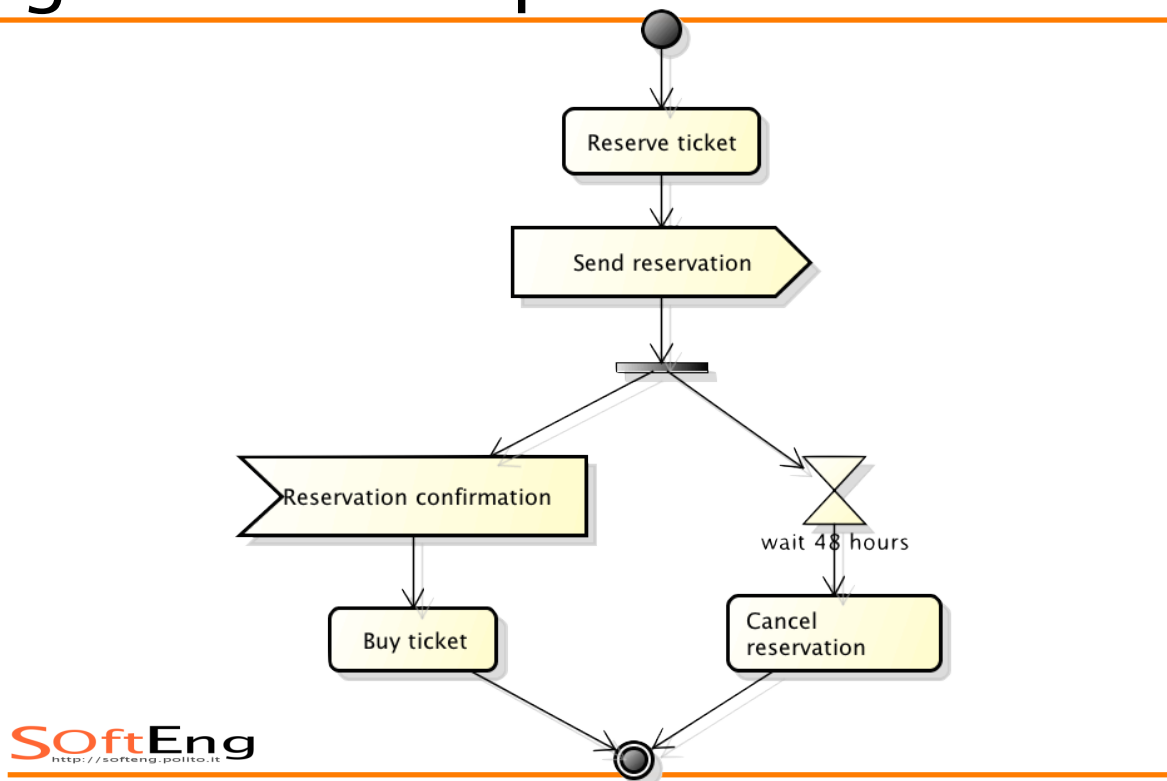
Arcs

Receive Order → Execute Payment

Receive Order → (A)   (A) → Execute Payment

Receive Order → theOrder → Execute Payment

Receive Order ▫—— theOrder ——▫ Execute Payment
theOrder
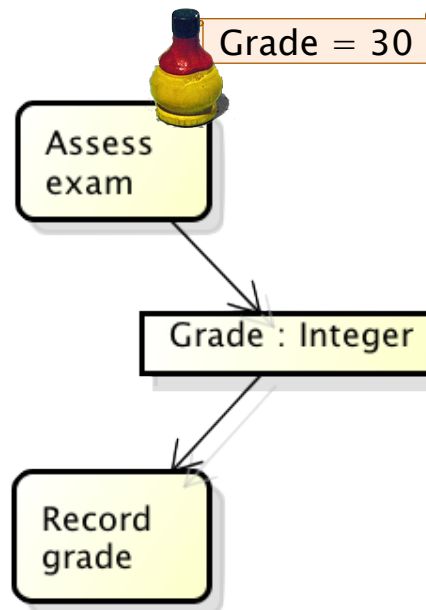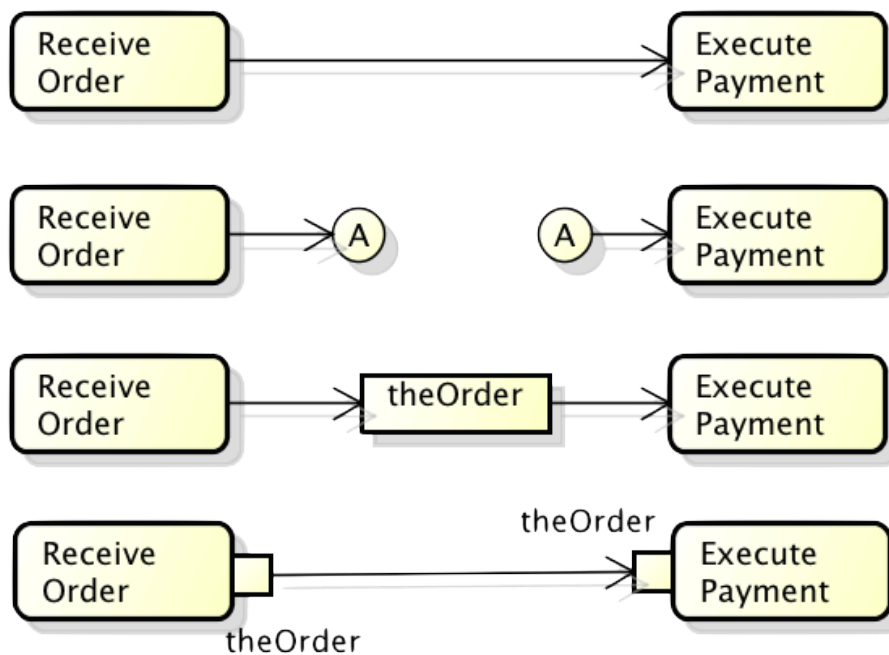
Swimlanes

- Actions can be responsibility of different actors or roles
- A swimlane groups together all the activities of a specific actor
  - Assigning responsibilities is not always required
  - Typically it represents a refinement step

Swimlanes – Example

Swimlanes

SOftEng
http://softeng.polito.it
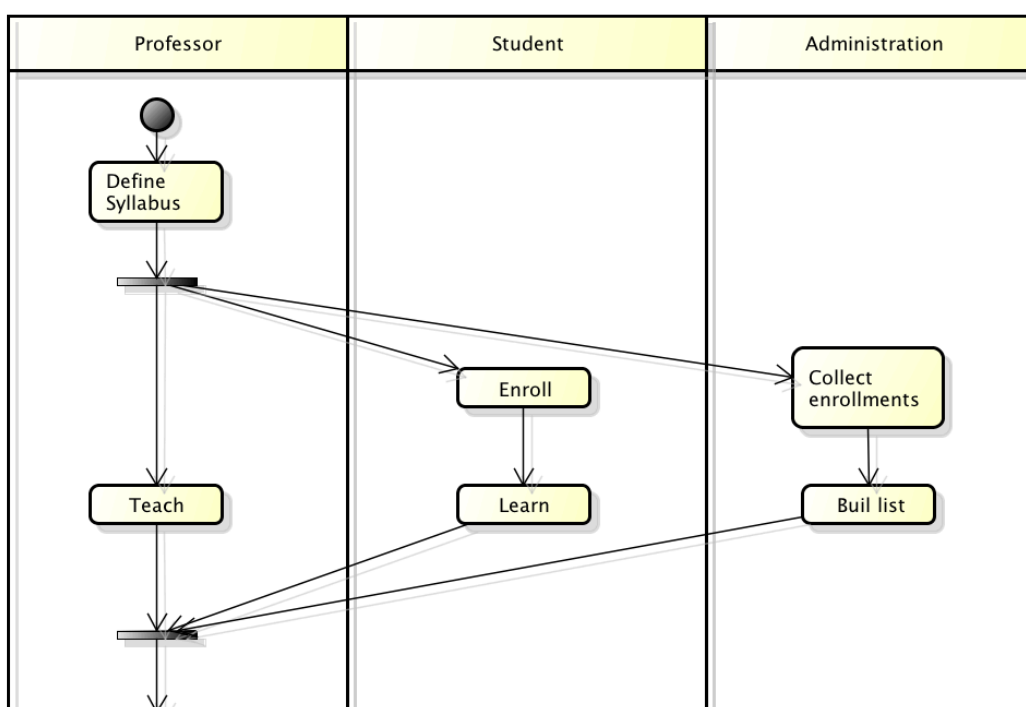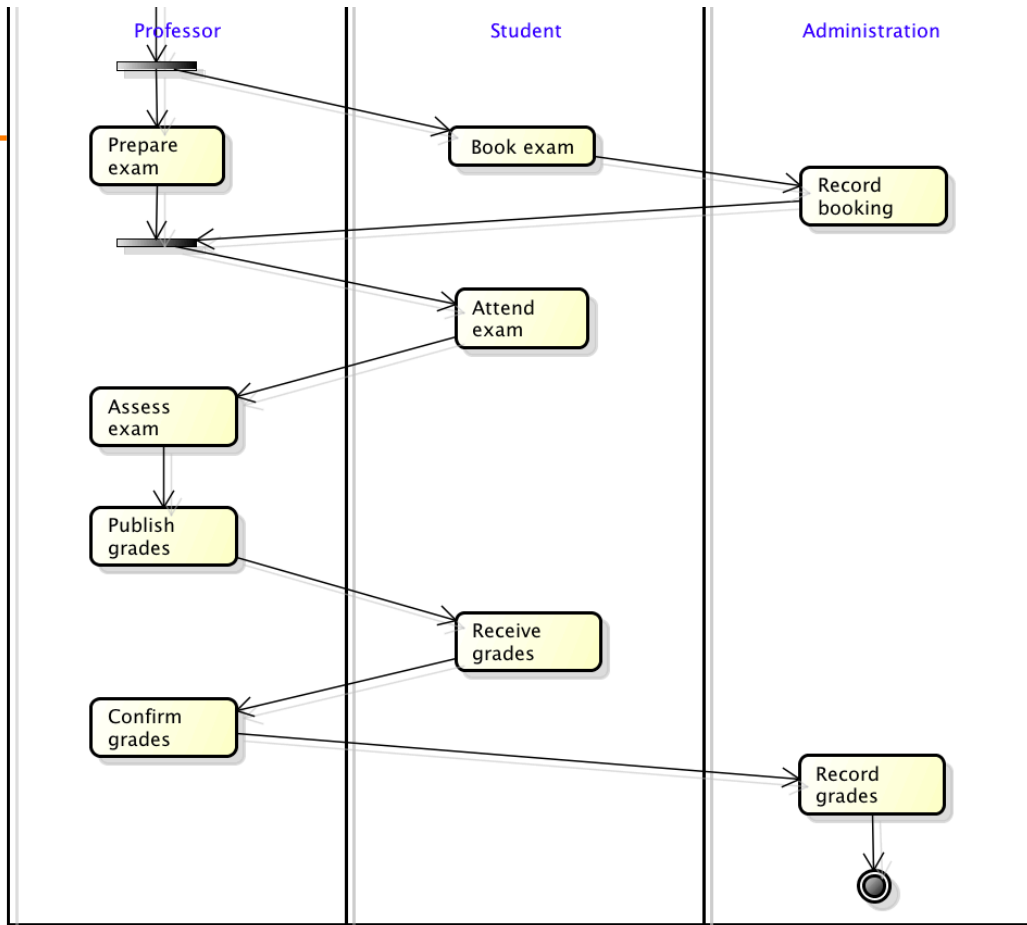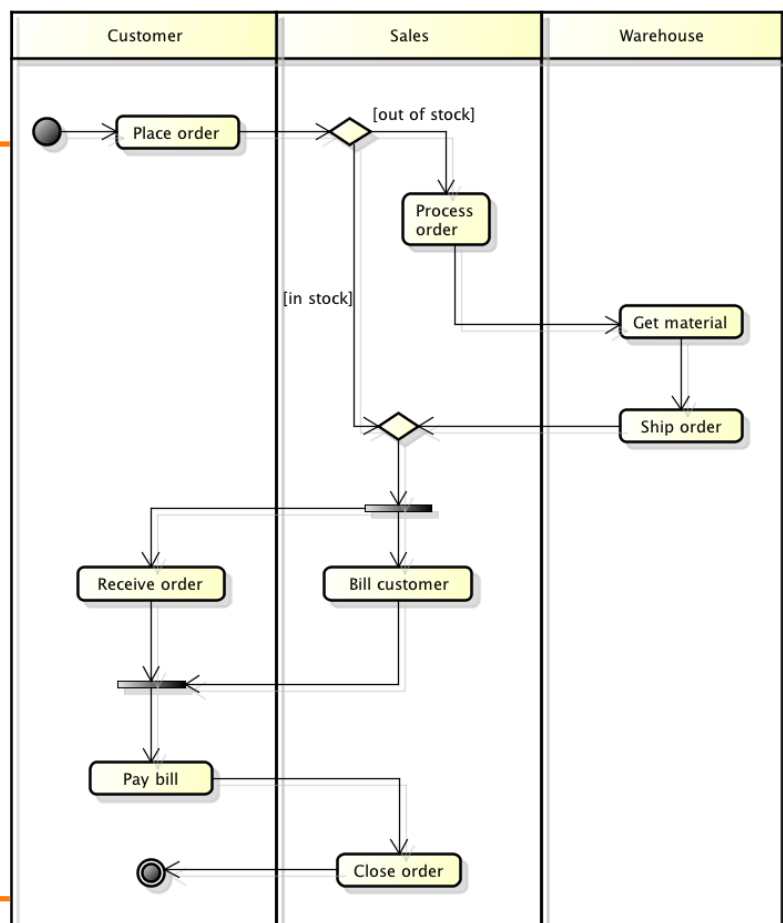
ADVANCED PATTERNS

Complex structures

- Complex activities
- Cycles / loops
- Arbitrary cycles
- Implicit termination
- Multiple choice

Complex action

- Represent a complex (sub–)process a single action
  - Call behavior
- The contents of the complex action can be represented in an additional diagram

Complex activity
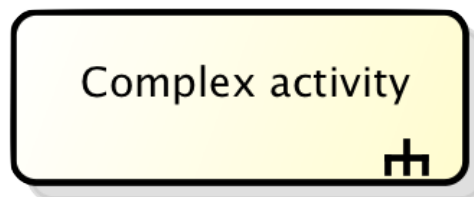
Structured Loop

- One or more activities are repeated until a specific condition become true
- Realized by means of decision and merge nodes
  - First a merge node
  - Then a condition

Loop – Repeat

```
do {
    read_item();
    pick_item();
} while( more_items );
```

Read item

Pick item from warehouse

[more items]

[no more items]

Loop – semantics

Read item

Pick item from warehouse

[more items]
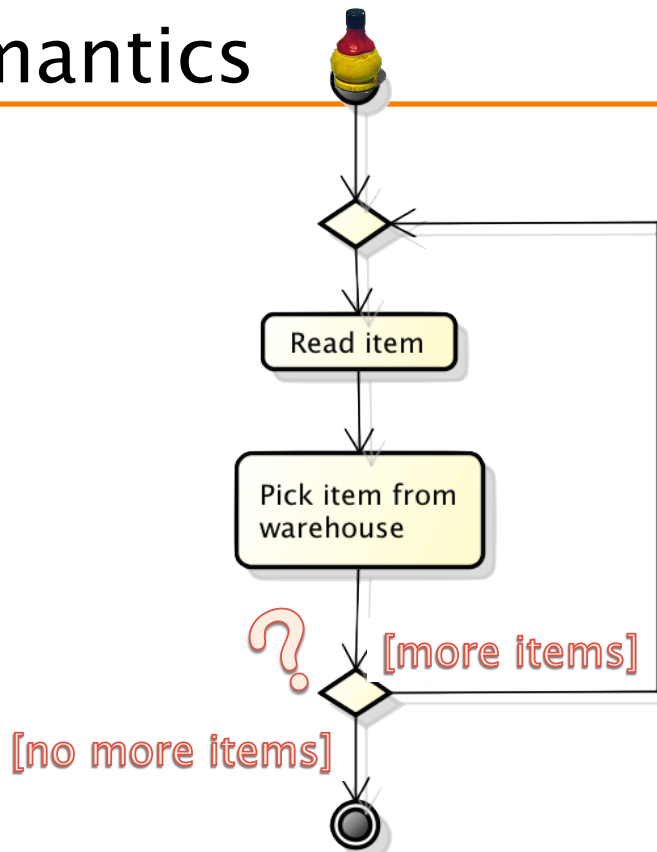
[no more items]

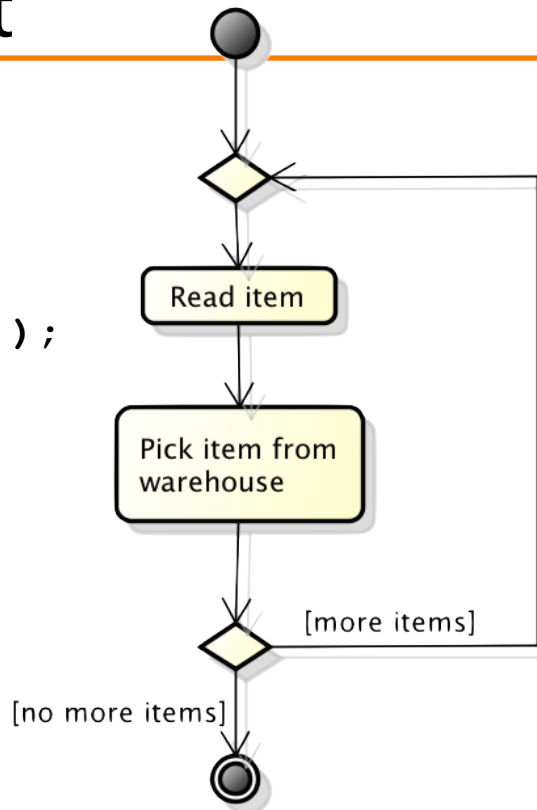# Loop – While

```
while( more_items ){
   read_item();
   pick_item();
}
```
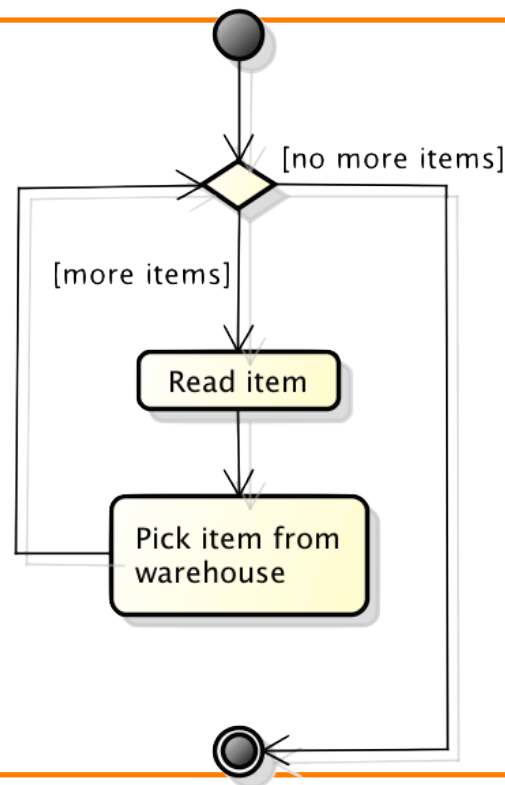
Arbitrary cycles

- Loop that is unstructured or not block structured.
- That is, the looping segment of the process may allow more than one entry or exit point.
- Important for the visualization of valid, but complex, looping situations in a single diagram

Arbitrary cycles
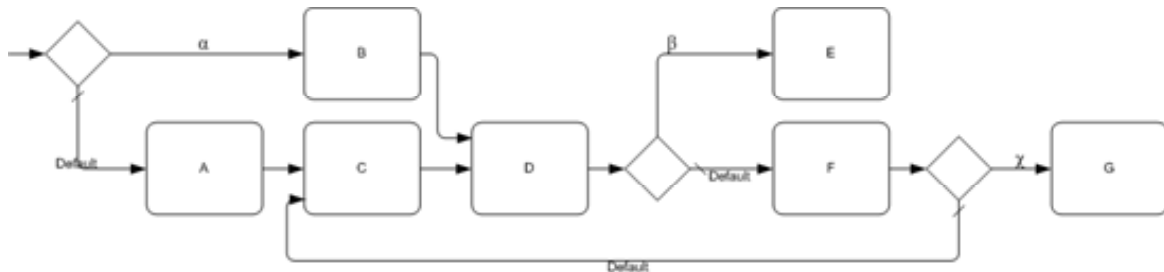
Implicit termination

- A specific path of a process can be concluded without other parallel paths be required to end as well.

- The normal case require the whole process to end when any end node is reached.

Implicit termination – semantics

Only one path is terminated

A

B   C

D

Explicit termination – semantics

A

B   C

The process is terminated, i.e. ALL path are terminated

D
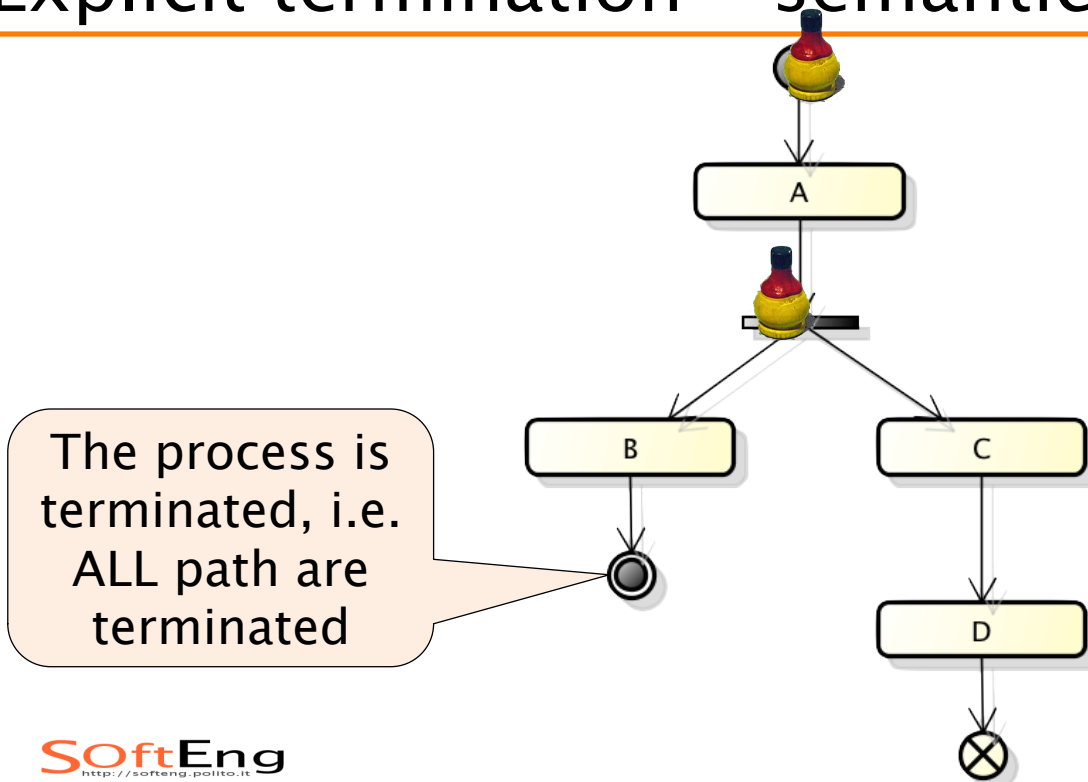
Free Tools

- Argo UML
- Ashtah community
- Star UML (win)
  - ◆ Graphical editors
  - ◆ Some support to translate to java
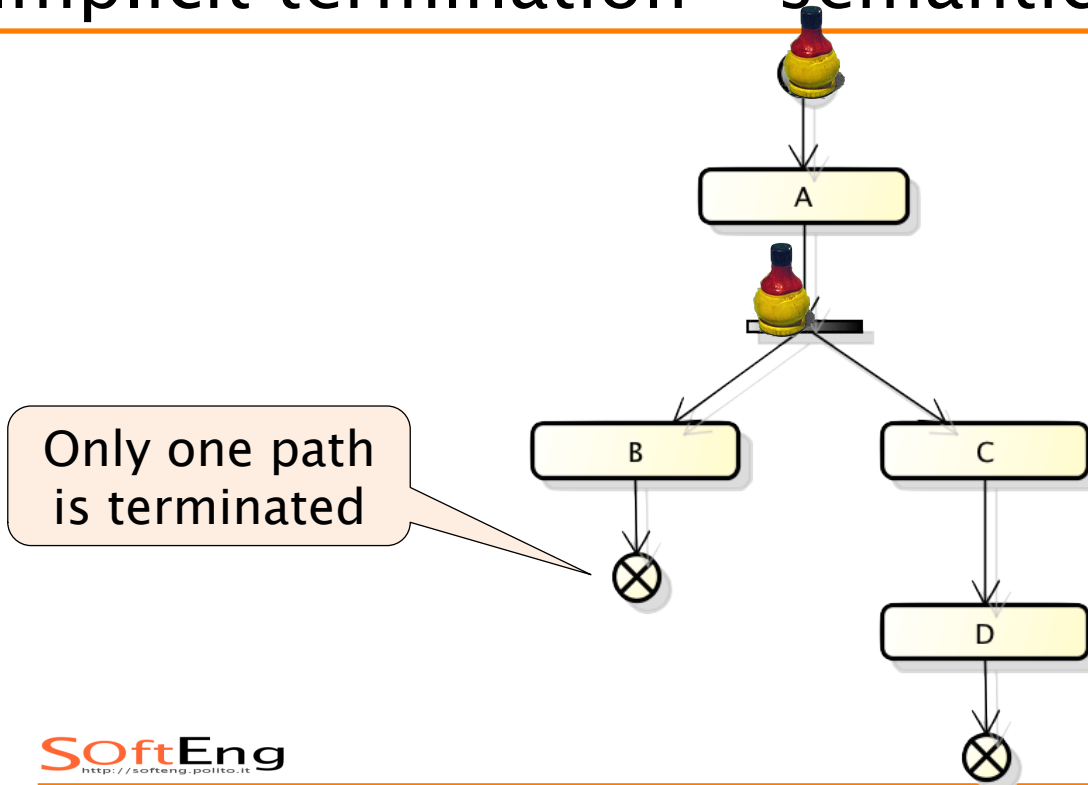 - ◆ No support to execute activity diagrams

SOftEng
http://softeng.polito.it

References

- OMG UML web site
  - ◆ http://www.uml.org
- M. Fowler, UML Distilled, Addison-Wesley
- N. Russell et al.
  WORKFLOW CONTROL-FLOW PATTERNS
  A Revised View
- N.Russel et al.
  On the Suitability of UML 2.0 Activity
  Diagrams for Business Process Modelling
- Workflow Patterns web site
  - ◆ http://www.workflowpatterns.com

SOftEng
http://softeng.polito.it

IDEF

IDEF

- Integrated Computer-aided Manufacturing Definition
- Approach of choice in the 1990s (have been around for over 25 years)
- Only one compliant with Federal Information Processing Standards (FIPS)
  - FIPS Publication 183

IDEF

- IDEF refers to a group of methods, each of which fulfills a specific purpose
  - IDEFØ, for example, is used to model an organization's functions
  - IDEF1x is used for DB modeling

IDEFØ

- "Box and arrow" graphics
  - function as a box
  - interfaces to or from the function as arrows entering or leaving the box
- Context diagram (main)
- Constraint diagrams (sub)
- Decomposition

IDEFØ – Example
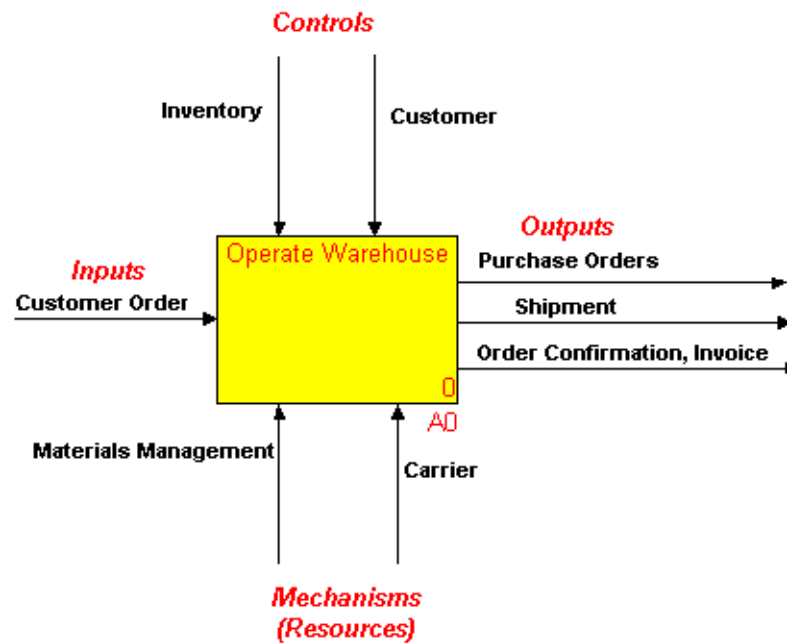
IDEFØ – Decomposition

DFD

DFD

- **Data Flow Diagram**
  - ◆ Yourdon and Coad
  - ◆ Gane and Sarson

DFD – Decomposition

- Initially a context diagram is drawn, which is a simple representation of the *entire system* under investigation
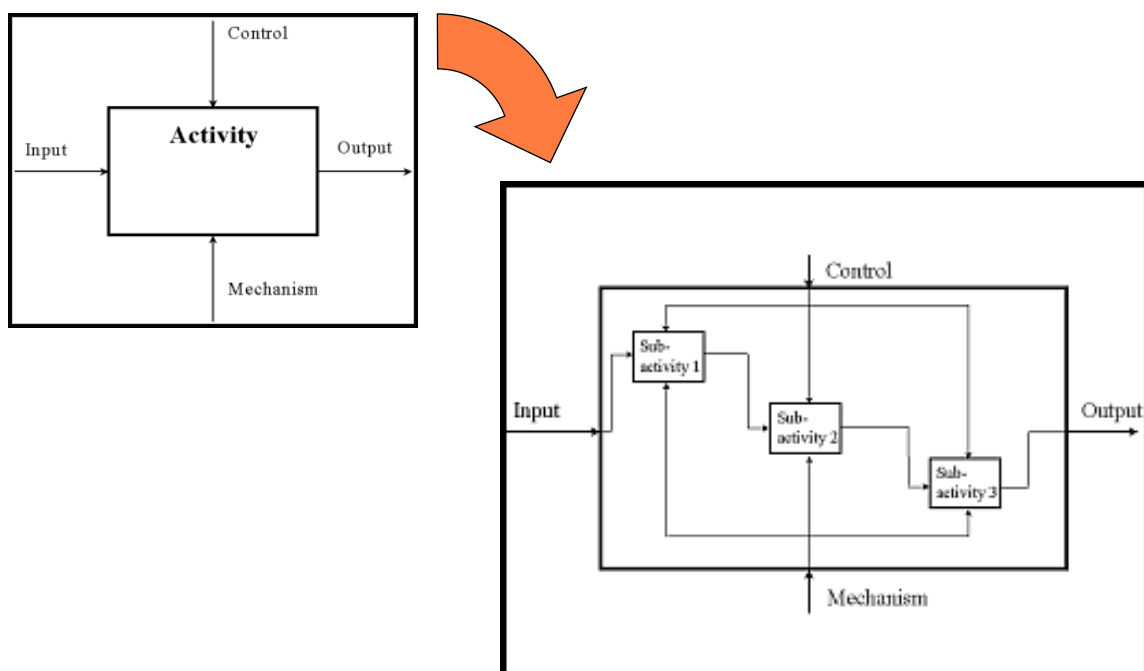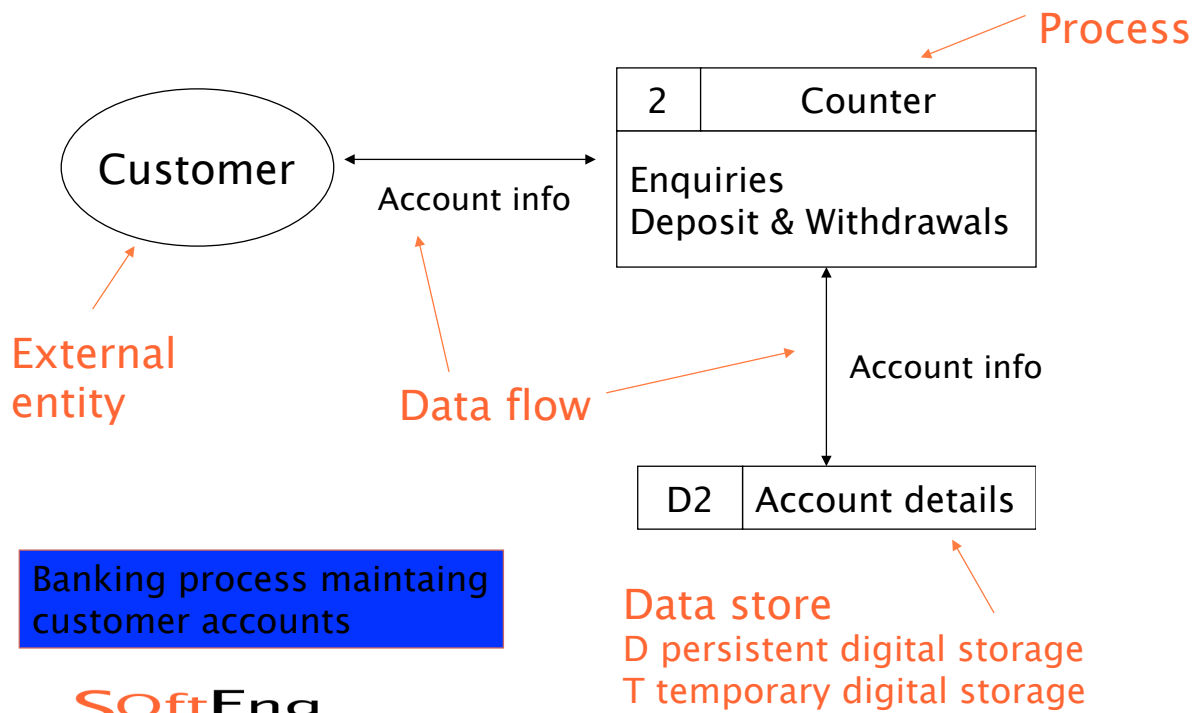- This is followed by a level 1 diagram, which identifies *major business processes* at a high level
- These processes can then be analyzed further with level 2 diagrams
- And so on…
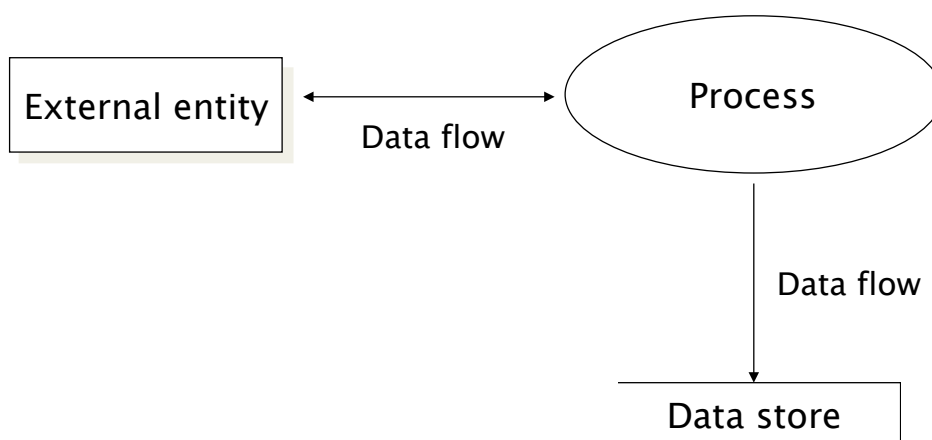
SOftEng
http://softeng.polito.it

DFD – Objects

- Process
  - A process is a unit of work that operates on the data
- Data flow
  - A data flow is a named flow of data through a system of processes
- Data store
  - A data store is a logical repository of data
- External entity
  - An external agent is a source or destination of data

SOftEng
http://softeng.polito.it

DFD – Example

Process

2 | Counter

Customer

Account info

Enquiries
Deposit & Withdrawals

External entity

Data flow

Account info

D2 | Account details

Banking process maintaing customer accounts

Data store
D persistent digital storage
T temporary digital storage

SOftEng
http://softeng.polito.it

DFD – Example II

External entity

Data flow

Process

Data flow

Data store

SOftEng
http://softeng.polito.it

DFD – Rules

- **Data flows are allowed between**
  - ◆ different external entities
  - ◆ processes and external entities
  - ◆ processes and data stores
- **Data flows are not allowed between**
  - ◆ external entities and data stores
  - ◆ one data store and another

73

License (1)

74

License (2)

- **4. Restrictions.** The license granted in Section 3 above is expressly made subject to and limited by the following restrictions:

    a. You may distribute, publicly display, publicly perform, or publicly digitally perform the Work only under the terms of this License, and You must include a copy of, or the Uniform Resource Identifier for, this License with every copy or phonorecord of the Work You distribute, publicly display, publicly perform, or publicly digitally perform. You may not offer or impose any terms on the Work that alter or restrict the terms of this License or the recipients' exercise of the rights granted hereunder. You may not sublicense the Work. You must keep intact all notices that refer to this License and to the disclaimer of warranties. You may not distribute, publicly display, publicly perform, or publicly digitally perform the Work with any technological measures that control access or use of the Work in a manner inconsistent with the terms of this License Agreement. The above applies to the Work as incorporated in a Collective Work, but this does not require the Collective Work apart from the Work itself to be made subject to the terms of this License. If You create a Collective Work, upon notice from any Licensor You must, to the extent practicable, remove from the Collective Work any credit as required by clause 4(c), as requested.

    b. You may not exercise any of the rights granted to You in Section 3 above in any manner that is primarily intended for or directed toward commercial advantage or private monetary compensation. The exchange of the Work for other copyrighted works by means of digital file-sharing or otherwise shall not be considered to be intended for or directed toward commercial advantage or private monetary compensation, provided there is no payment of any monetary compensation in connection with the exchange of copyrighted works.

    c. If you distribute, publicly display, publicly perform, or publicly digitally perform the Work, You must keep intact all copyright notices for the Work and provide, reasonable to the medium or means You are utilizing: (i) the name of the Original Author (or pseudonym, if applicable) if supplied, and/or (ii) if the Original Author and/or Licensor designate another party or parties (e.g. a sponsor institute, publishing entity, journal) for attribution in Licensor's copyright notice, terms of service or by other reasonable means, the name of such party or parties; the title of the Work if supplied; and to the extent reasonably practicable, the Uniform Resource Identifier, if any, that Licensor specifies to be associated with the Work, unless such URI does not refer to the copyright notice or licensing information for the Work. Such credit may be implemented in any reasonable manner; provided, however, that in the case of a Collective Work, at a minimum such credit will appear where any other comparable authorship credit appears and in a manner at least as prominent as such other comparable authorship credit.

    d. For the avoidance of doubt, where the Work is a musical composition:

        i. Performance Royalties Under Blanket Licenses. Licensor reserves the exclusive right to collect, whether individually or via a performance rights society (e.g. ASCAP, BMI, SESAC), royalties for the public performance or public digital performance (e.g. webcast) of the Work if that performance is primarily intended for or directed toward commercial advantage or private monetary compensation.

        ii. Mechanical Rights and Statutory Royalties. Licensor reserves the exclusive right to collect, whether individually or via a music rights agency or designated agent (e.g. Harry Fox Agency), royalties for any phonorecord You create from the Work ("cover version") and distribute, subject to the compulsory license created by 17 USC Section 115 of the US Copyright Act (or the equivalent in other jurisdictions), if Your distribution of such cover version is primarily intended for or directed toward commercial advantage or private monetary compensation.

        - **Webcasting Rights and Statutory Royalties.** For the avoidance of doubt, where the Work is a sound recording, Licensor reserves the exclusive right to collect, whether individually or via a performance-rights society (e.g. SoundExchange), royalties for the public digital performance (e.g. webcast) of the Work, subject to the compulsory license created by 17 USC Section 114 of the US Copyright Act (or the equivalent in other jurisdictions), if Your public digital performance is primarily intended for or directed toward commercial advantage or private monetary compensation.

License (3)

- **5. Representations, Warranties and Disclaimer**
- UNLESS OTHERWISE MUTUALLY AGREED BY THE PARTIES IN WRITING, LICENSOR OFFERS THE WORK AS-IS AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE WORK, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTIBILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, OR THE ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OF ABSENCE OF ERRORS, WHETHER OR NOT DISCOVERABLE. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES, SO SUCH EXCLUSION MAY NOT APPLY TO YOU.
- **6. Limitation on Liability.** EXCEPT TO THE EXTENT REQUIRED BY APPLICABLE LAW, IN NO EVENT WILL LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES ARISING OUT OF THIS LICENSE OR THE USE OF THE WORK, EVEN IF LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.
- **7. Termination**

    a. This License and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this License. Individuals or entities who have received Collective Works from You under this License, however, will not have their licenses terminated provided such individuals or entities remain in full compliance with those licenses. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this License.

    b. Subject to the above terms and conditions, the license granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different license terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this License (or any other license that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated as stated above.

8. Miscellaneous

    a. Each time You distribute or publicly digitally perform the Work or a Collective Work, the Licensor offers to the recipient a license to the Work on the same terms and conditions as the license granted to You under this License.

    b. If any provision of this License is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this License, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.

    c. No term or provision of this License shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.

    d. This License constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This License may not be modified without the mutual written agreement of the Licensor and You.