Understanding Source Package Organization Using the Hybrid Model

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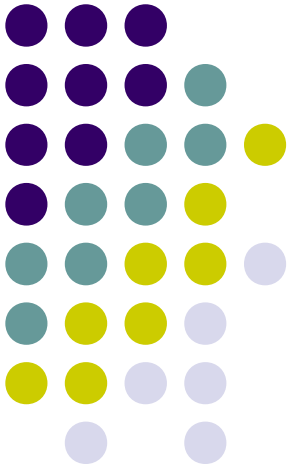

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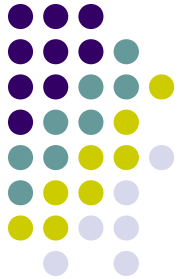
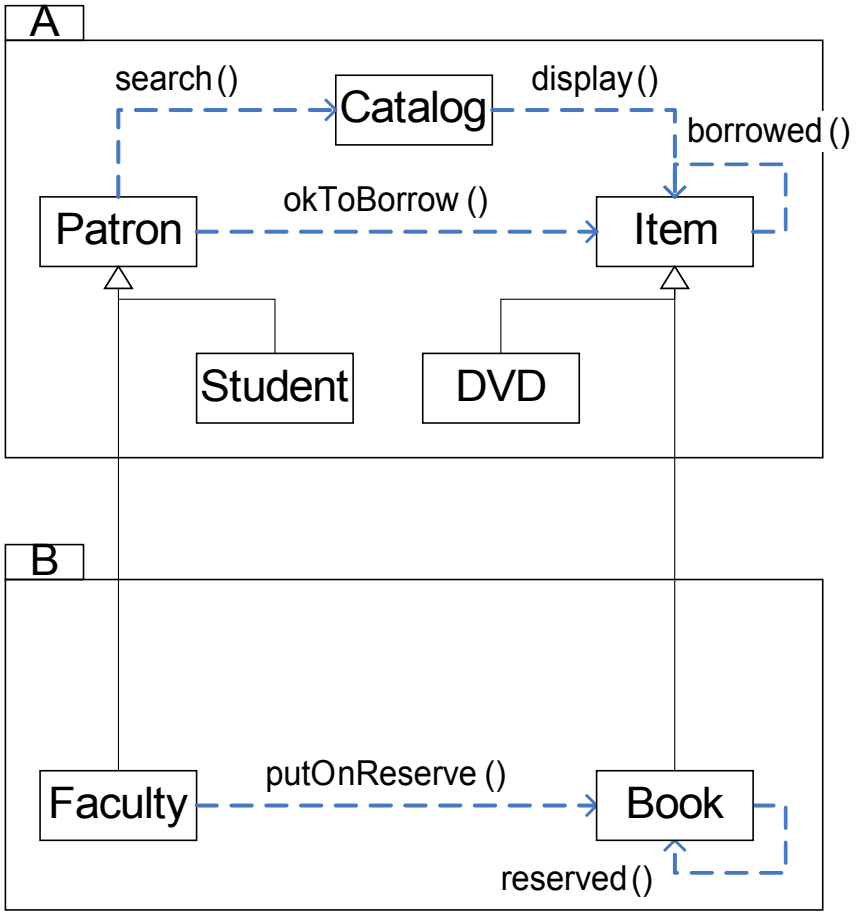
Introduction



- Objects are
  - the basic units of abstraction in OOD.
  - defined by classes.
  - too fine-grained to model large systems.
- Packages are
  - groups of classes.
  - coarse-grained logical design units.
- Understanding package organization is key to understanding high-level design.

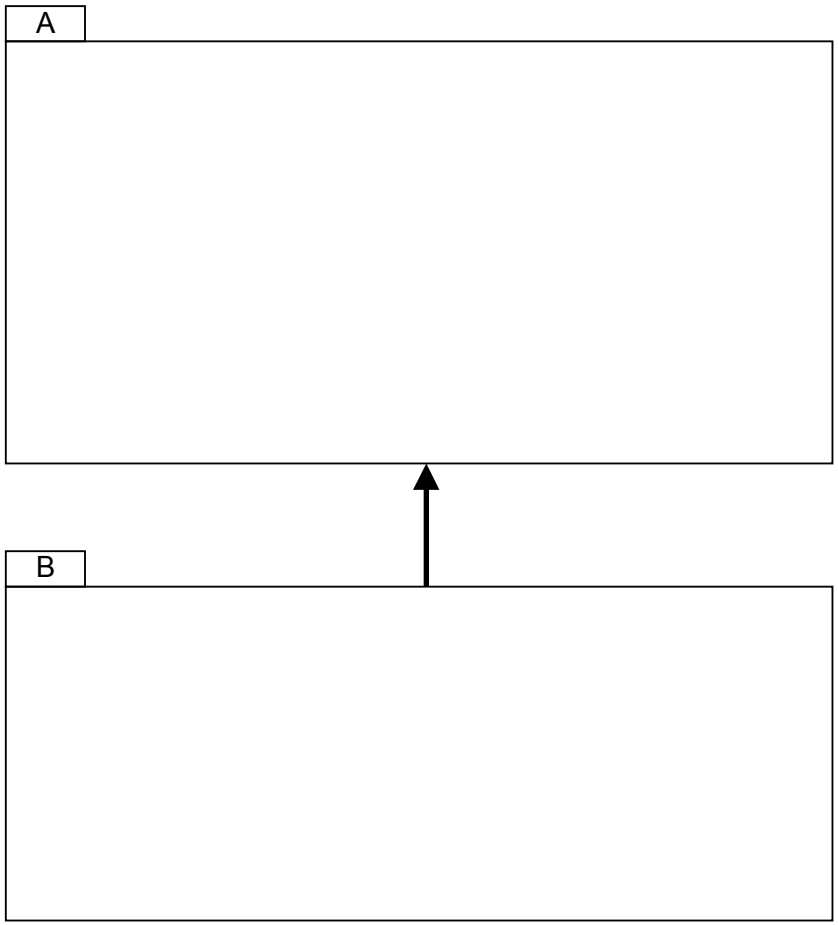
Package Diagram

- A Package Diagram
  - Captures structural dependencies.
  - Contains little semantic information.

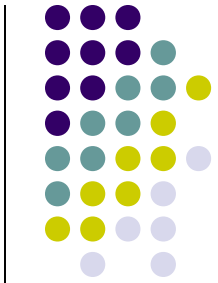


Package Diagram

- How is the functionality implemented in package *A* used by package *B*?
- Why the system's classes are divided into this set of packages?
- Is package *B* a design abstraction or just a contain?
- Is package *B* a part of a bigger abstraction?

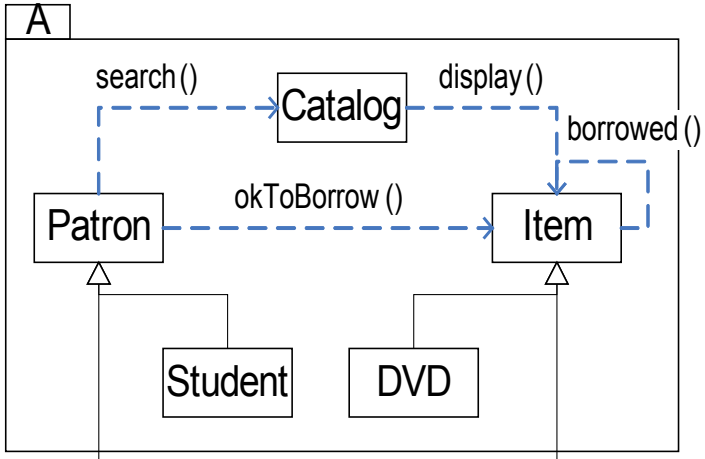


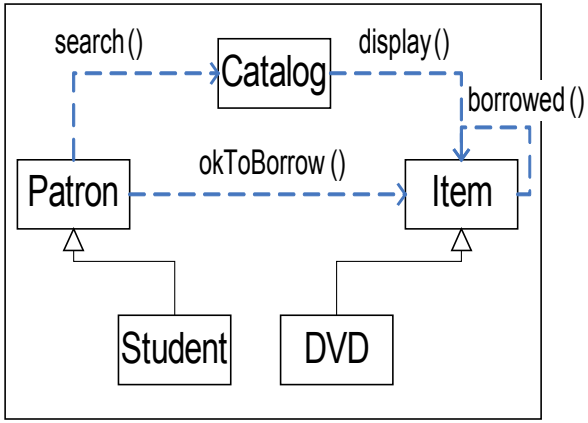
The Hybrid Model

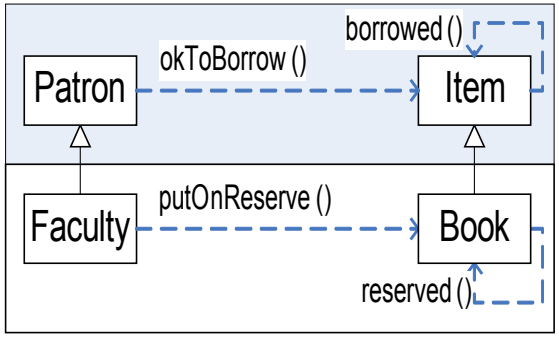


- A Hybrid Model enriches a package diagram with semantic information.
  - A package represents the objects that can be instantiated from concrete classes it contains.
  - Ports of a package capture the interface through which objects interact with its environment.

Library Management System(1)

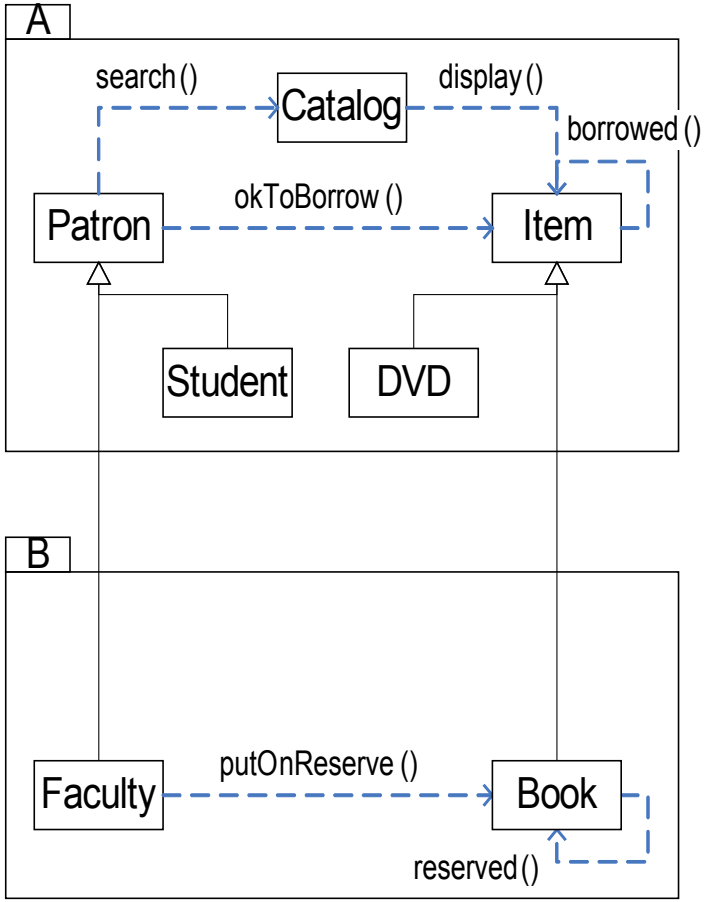




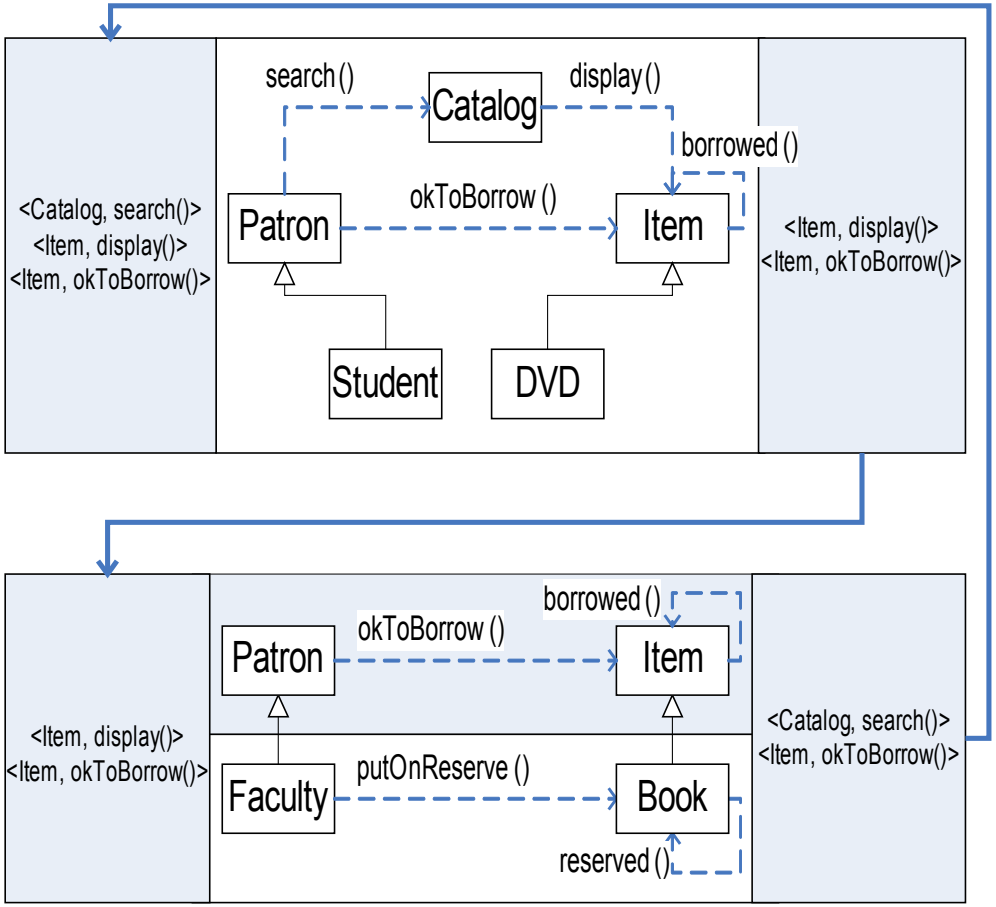


UML Package Diagram

Library Management System(2)



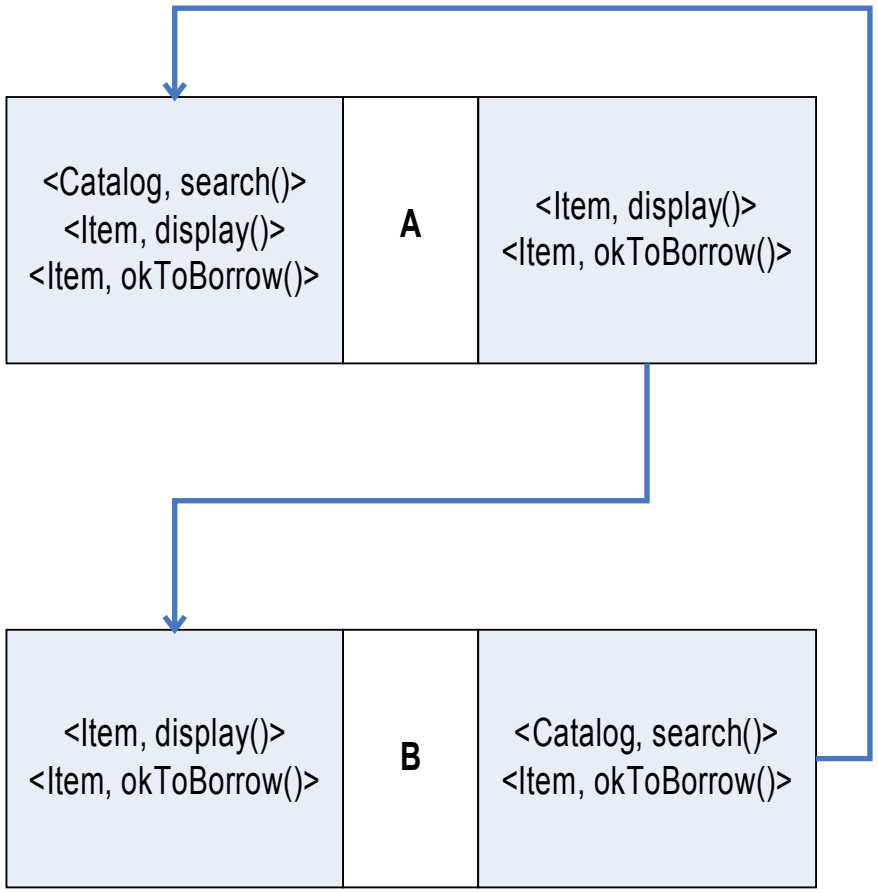
UML Package Diagram



Hybrid Model

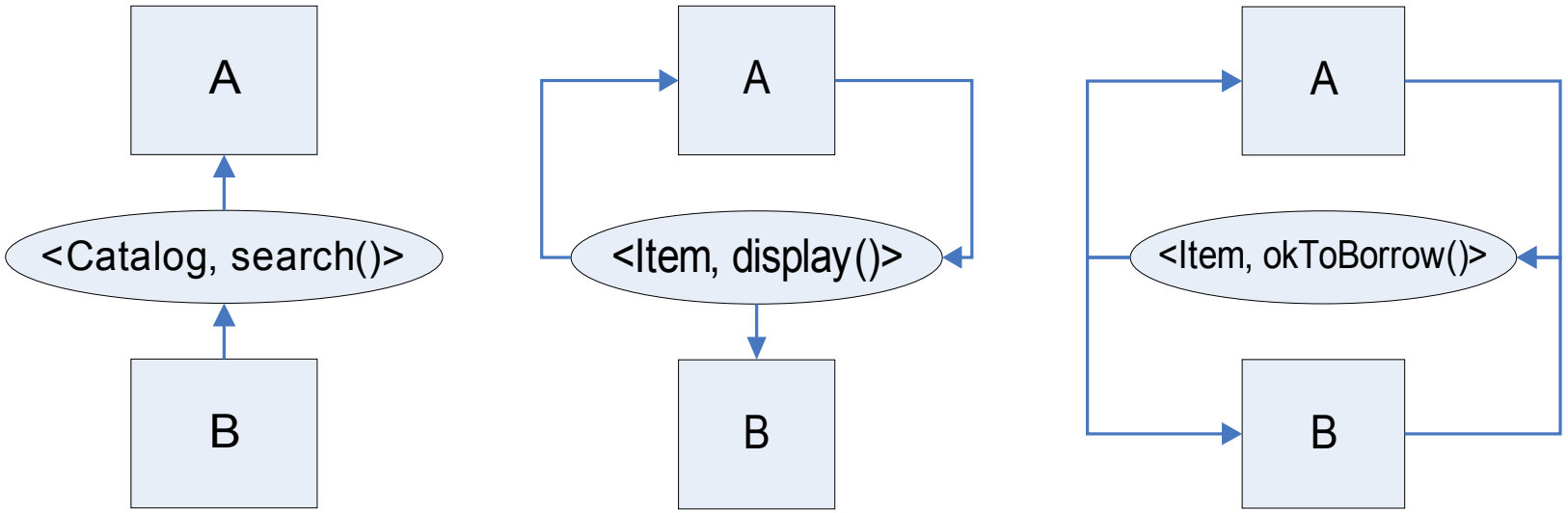
Ports

- An ***inport*** is the interface through which a package provides resources to others.
- An ***outport*** is the interface through which a package requires resources from others.

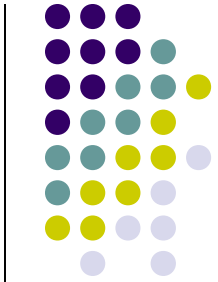


Connectors

- A connector specifies the client-server relationship between two packages.



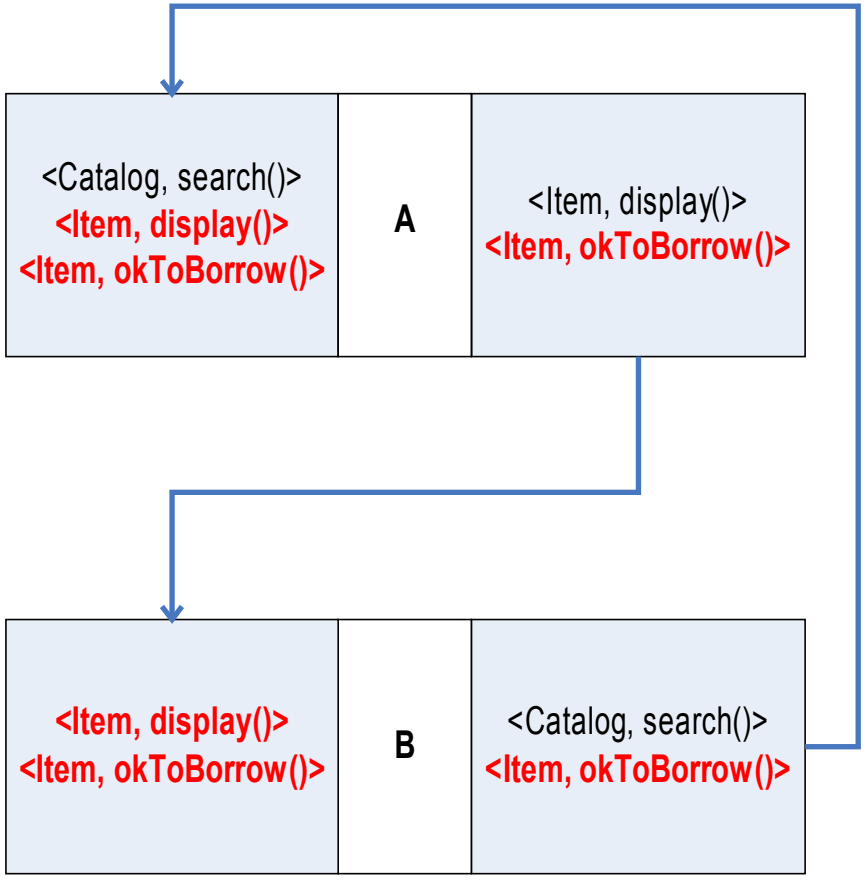
Analyzing Package Design Using the Hybrid Model



- We examine package relations from two perspectives:
  - Resources associated with a port
    - Similarity in ports
  - Resources associated with a connector
    - Collaboration patterns

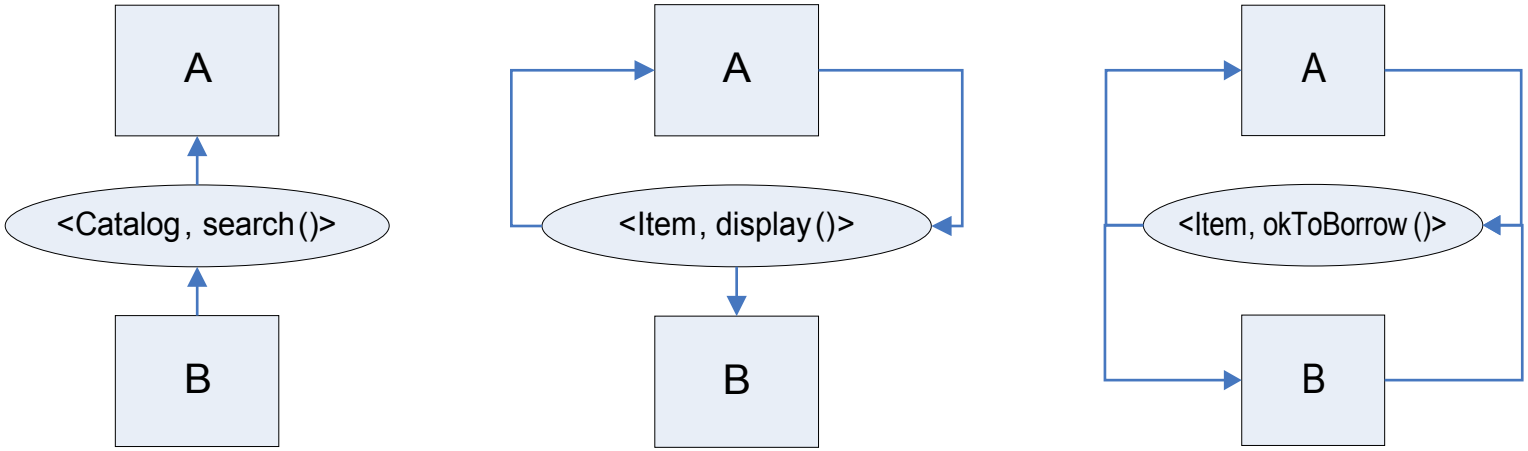
Similarity in Ports

- High similarity in inports
  - Two packages contain implementations of the same set of concepts.
  - E.g. 9 sub-packages in *org.opencms.db*
- High Similarity in outports
  - Two packages may have similar behaviors.
  - E.g. 3 sub-packages in *org.opencms.xml*



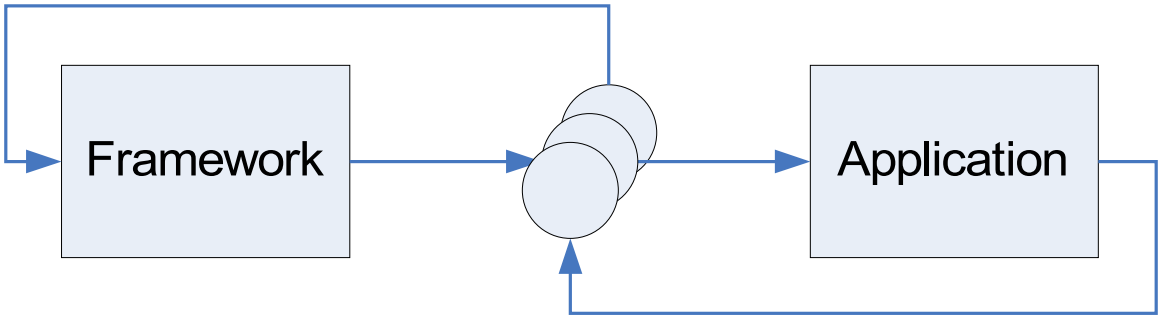
Collaboration Patterns

- How is a resource shared among packages?
  - 1→1 : One consumer one provider
  - m→1 : Many consumers one provider
  - 1→n : One consumer many providers
  - m→n : Many consumers many providers

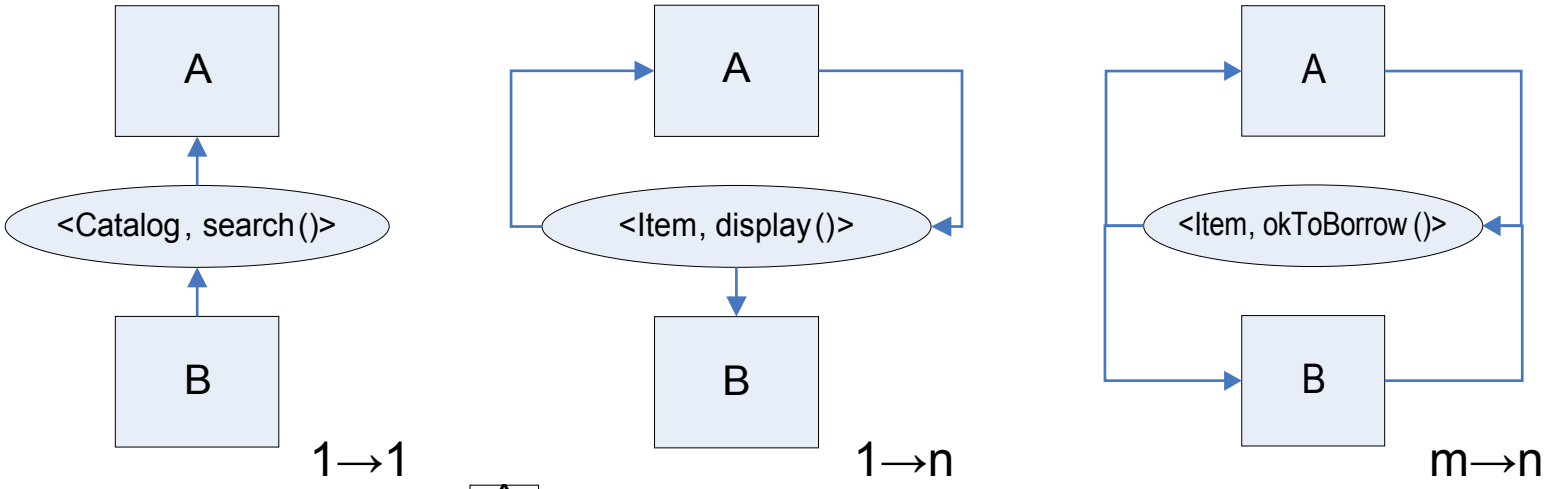


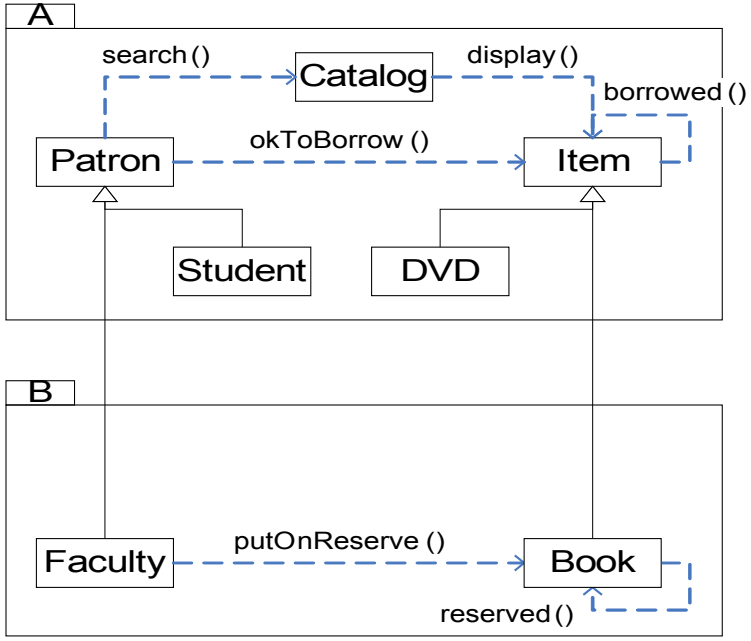
Package Collaboration

- Check the composition of the set of resources shared between two packages.



Library Management System



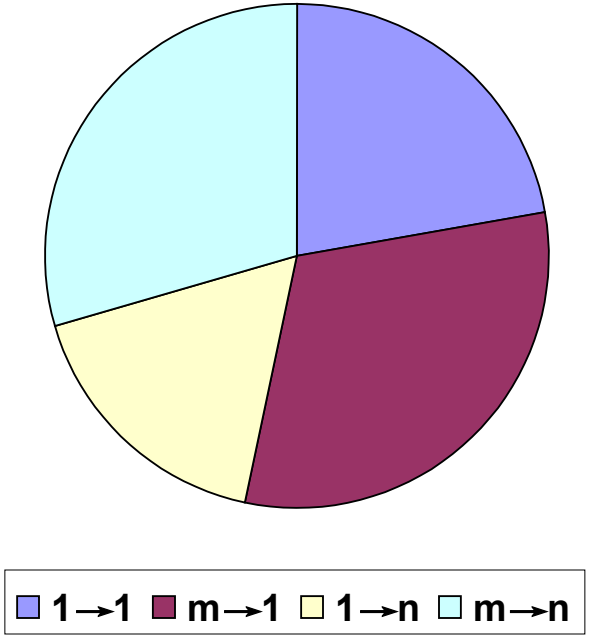


Case Study

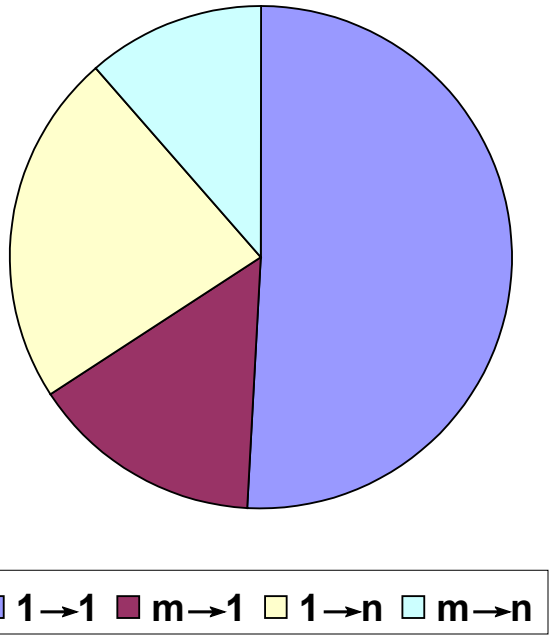
- Subject System: JHotDraw
  - Version 6.0 beta 1
    - 71,000 LOC, 17 packages, 396 classes
  - Version 7.1
    - 91,000 LOC, 32 packages, 561 classes
- Goal:
  - Did the package partition criteria change as the architecture changed ?

Shared Resources

- JHotDraw 6.0b1
  - # top-level pkg. = 8
  - # shared res. = 648
  - Avg. inport size = 157
  - Avg. outport size = 181



- JHotDraw 7.1
  - # top-level pkg. = 10
  - # shared res. = 838
  - Avg. inport size = 107
  - Avg. outport size = 107



Shared Resources in V6.0

	1→1	m→1	1→n	m→n
#res	*144*	*201*	*112*	***191***
applet	*3*		*7*	*8*
application	*3*	*12*	*22*	*16*
contrib	*34*	*2*	*74*	*151*
figures	*30*	*9*	*57*	*105*
framework	*11*	*17*		
samples			*71*	*125*
standard	*32*	*93*	*61*	*139*
util	*31*	*68*	*35*	*36*
total	*144*	*201*	*327*	***580***

res associated with inports

	1→1	m→1	1→n	m→n
#res	*144*	*201*	*112*	***191***
applet		*40*	*4*	*9*
application	*3*	*73*	*12*	*29*
contrib	*41*	*163*	*10*	*164*
figures	*18*	*107*	*21*	*88*
framework				
samples	*64*	*191*	*5*	*106*
standard	*15*	*29*	*35*	*131*
util	*3*	*23*	*25*	*42*
total	*144*	*626*	*112*	***569***

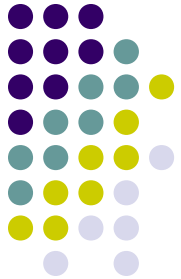
res associated with outports

Shared Resources in V7.1

	1→1	m→1	1→n	m→n
# res	*403*	*119*	*182*	*90*
samples	*32*		*182*	*90*
app	*13*	*6*	*15*	*4*
draw	*255*		*163*	*86*
beans				*1*
gui	*31*	*6*		
undo	*10*	*1*		
xml	*13*	*27*	*4*	*1*
geom	*27*	*63*		
io	*16*	*3*		
util	*6*	*13*		

	1→1	m→1	1→n	m→n
# res	*403*	*119*	*182*	*90*
samples	*298*	*115*	*15*	*89*
app	*58*	*11*	*13*	*4*
draw	*42*	*116*	*146*	*86*
beans				*1*
gui	*5*	*1*	*2*	
undo		*4*		
xml		*2*	*6*	*2*
geom				
io				
util				
Total	*403*	*240*	*182*	*182*

Discussion



- Compared to JHotDraw 6.0, JHotDraw 7.1
  - Has more packages.
  - Shares more resources among packages.
  - Has more 1→1 and 1→n collaboration, but fewer m→1 and m→n collaborations.
  - Exhibits a layered structure.
  - Forms a clear framework-application pattern.

- Reducing coupling, especially inheritance coupling, is the main concern in version 7.0.

Conclusion & Future Work

- Package Diagrams lack of necessary semantic information to understanding package design.
- Hybrid Models are helpful in interpreting package partition criteria.

- Future Work
  - Identify collaboration patterns in hierarchical package organization.
  - Automate the process of analyzing package relations.