SE 2AA4, CS 2ME3 (Introduction to Software Development)

Winter 2018

12 Object Oriented Design (Ghezzi Ch. 4)

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12 Object Oriented Design (Ghezzi Ch. 4)

- Administrative details
- OOD
- Inheritance
- Polymorphism
- Dynamic binding
- Introduction to UML

Administrative Details

- Assignment 1
  - Part 2: January 31, 2018
- Questions?

Reviewing Changes

- Use GitLab to review changes between commits
- Review before committing: `git difftool`
- To better deal with changes, use a "hard wrap" at an 80 column width, even for LaTeX documents (why?)

Set Idiom (H&S)

Routine name	**In**	**Out**	**Exceptions**
set_add	T		Member, Full
set_del	T		NotMember
set_member	T	boolean	
set_size		integer	

Sequence Idiom (H&S)

Routine name	**In**	**Out**	**Exceptions**
seq_init			
seq_add	integer, T		PosOutOfRange, Full
seq_del	integer		PosOutOfRange
seq_setval	integer, T		PosOutOfRange
seq_getval	integer	T	PosOutOfRange
seq_size		integer	
seq_start			
seq_next		T	AtEnd
seq_end		boolean	
seq_append	T		Full

When would you use seq_next in the interface, and exclude seq_getval?

Tuple Idiom Version 1 (H&S)

Routine name	**In**	**Out**	**Exceptions**
tp_init			
tp_set_f_1	T_1		
tp_get_f_1		T_1	
...	...	...	...
tp_set_f_N	T_N		
tp_get_f_N		T_N	

What is a potential problem with this idiom, especially if there are many fields to the tuple?

Tuple Idiom Version 2 (H&S)

Routine name	**In**	**Out**	**Exceptions**
tp_init			
tp_set	T_1, T_2, ..., T_N		
tp_get		T	

Object Oriented Design

- One kind of module, ADT, called class
- A class exports operations (procedures) to manipulate instance objects (often called methods)
- Instance objects accessible via references
- Can have multiple instances of the class (class can be thought of as roughly corresponding to the notion of a type)

Inheritance

- Another relation between modules (in addition to USES and IS_COMPONENT_OF)
- ADTs may be organized in a hierarchy
- Class B may specialize class A
  - B inherits from A
  - Conversely, A generalizes B
- A is a superclass of B
- B is a subclass of A

In Python, what class do all classes inherit?

What method inherited from object did we recently override?

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Template Module Employee

Routine name	**In**	**Out**	**Except**
New Employee	string, string, moneyT	Employee	
first_Name		string	
last_Name		string	
where		siteT	
salary		moneyT	
fire			
assign	siteT		

Inheritance Examples

Template Module Administrative_Staff **inherits** Employee

Routine name	In	Out	Exception
do_this	folderT		

Template Module Technical_Staff **inherits** Employee

Routine name	In	Out	Exception
get_skill		skillT	
def_skill	skillT		

Inheritance Continued

- A way of building software incrementally
- Useful for long lived applications because new features can be added without breaking the old applications
- A subclass defines a subtype
- A subtype is substitutable for the parent type
- Polymorphism - a variable referring to type A can refer to an object of type B if B is a subclass of A
- Dynamic binding - the method invoked through a reference depends on the type of the object associated with the reference at runtime
- All instances of the sub-class are instances of the super-class, so the type of the sub-class is a subtype
- All instances of Administrative_Staff and Technical_Staff are instances of Employee

Inheritance Continued

emp1, emp2: Employee
emp3: Technical_Staff

What assignments are allowed? That is, where would polymorphism allow us to switch references to the RHS with what appears on the LHS?

emp1 = Administrative_Staff()
emp2 = Technical_Staff()
emp3 = emp1
emp3 = (Technical_Staff) emp1

Inheritance Continued

emp1, emp2: Employee
emp3: Technical_Staff

What assignments are allowed? That is, where would polymorphism allow us to switch references to the RHS with what appears on the LHS?

emp1 = Administrative_Staff() $\surd$
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emp1, emp2: Employee
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What assignments are allowed? That is, where would polymorphism allow us to switch references to the RHS with what appears on the LHS?

emp1 = Administrative_Staff() $\surd$
emp2 = Technical_Staff() $\surd$
emp3 = emp1 $\times$
emp3 = (Technical_Staff) emp1

Inheritance Continued

emp1, emp2: Employee
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What assignments are allowed? That is, where would polymorphism allow us to switch references to the RHS with what appears on the LHS?

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emp3 = emp1 $\times$
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Inheritance Continued

emp1, emp2: Employee
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What assignments are allowed? That is, where would polymorphism allow us to switch references to the RHS with what appears on the LHS?

emp1 = Administrative_Staff() $\surd$
emp2 = Technical_Staff() $\surd$
emp3 = emp1 $\times$
emp3 = (Technical_Staff) emp1 $\surd$

Polymorphism: type of RHS must be a subtype of the LHS

Dynamic Binding

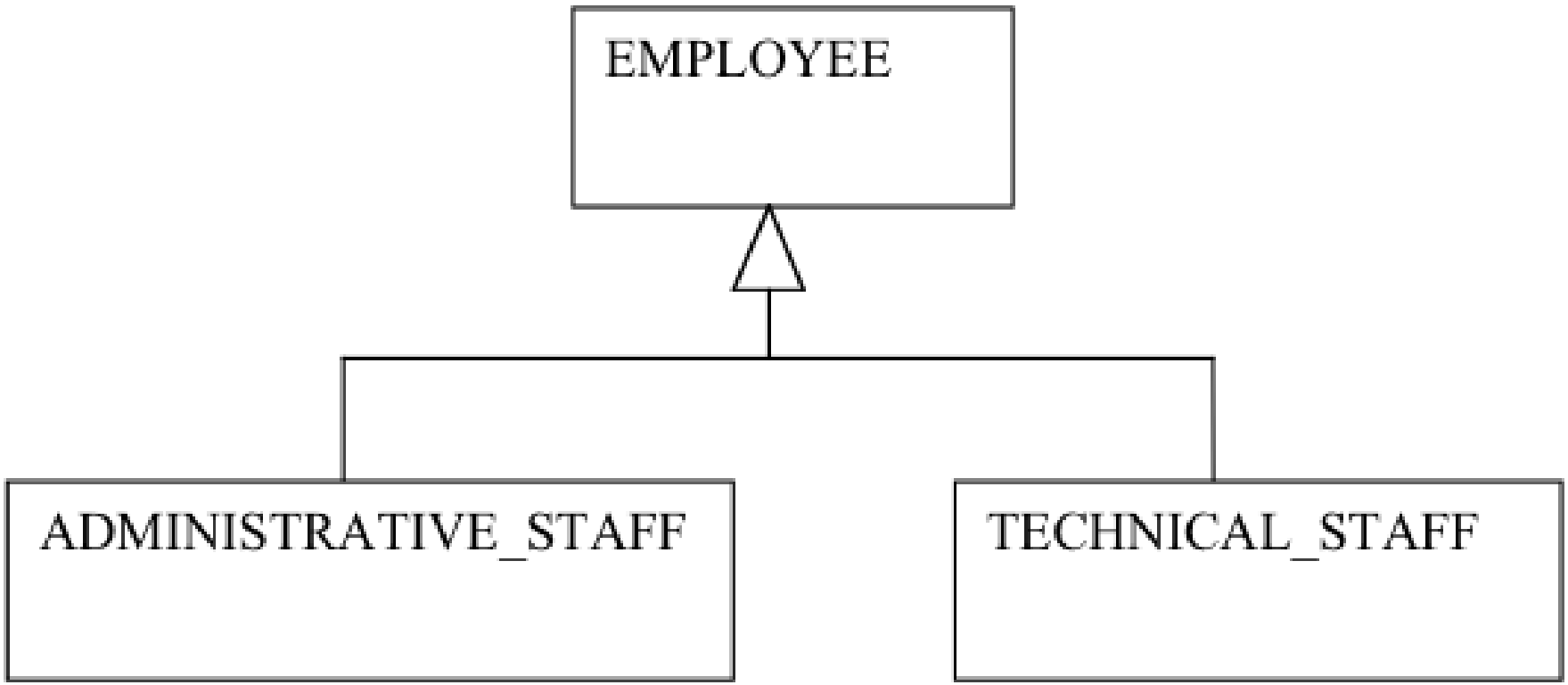
- Many languages, like C, use static type checking
- OO languages use dynamic type checking as the default
- There is a difference between a type and a class once we know this
  - Types are known at compile time
  - The class of an object may be known only at run time

How can Inheritance be Represented?

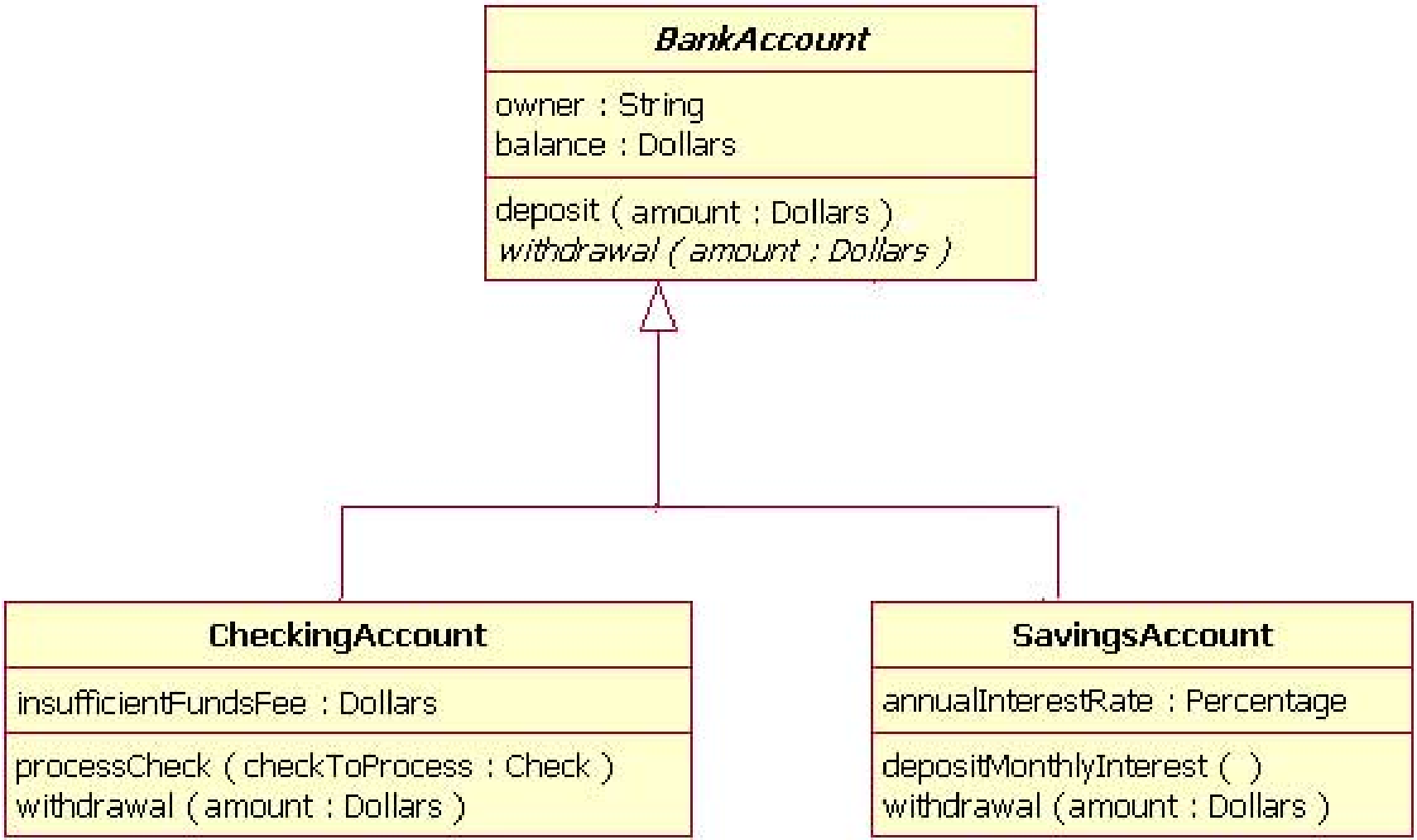
- We start introducing the UML notation
- UML (Unified Modelling Language) is a widely adopted standard notation for representing OO designs
- We introduce the UML class diagram
- Classes are described by boxes

Any guesses on what Parnas said UML stood for?

UML Representation of Inheritance



Bank Account Example



Class Diagram Versus MIS

- What information do the MIS and Class Diagram have in common?
- What information does the MIS add?
- What information does the Class Diagram add?

Class diagrams are closer to code since syntax of methods closer to actual syntax

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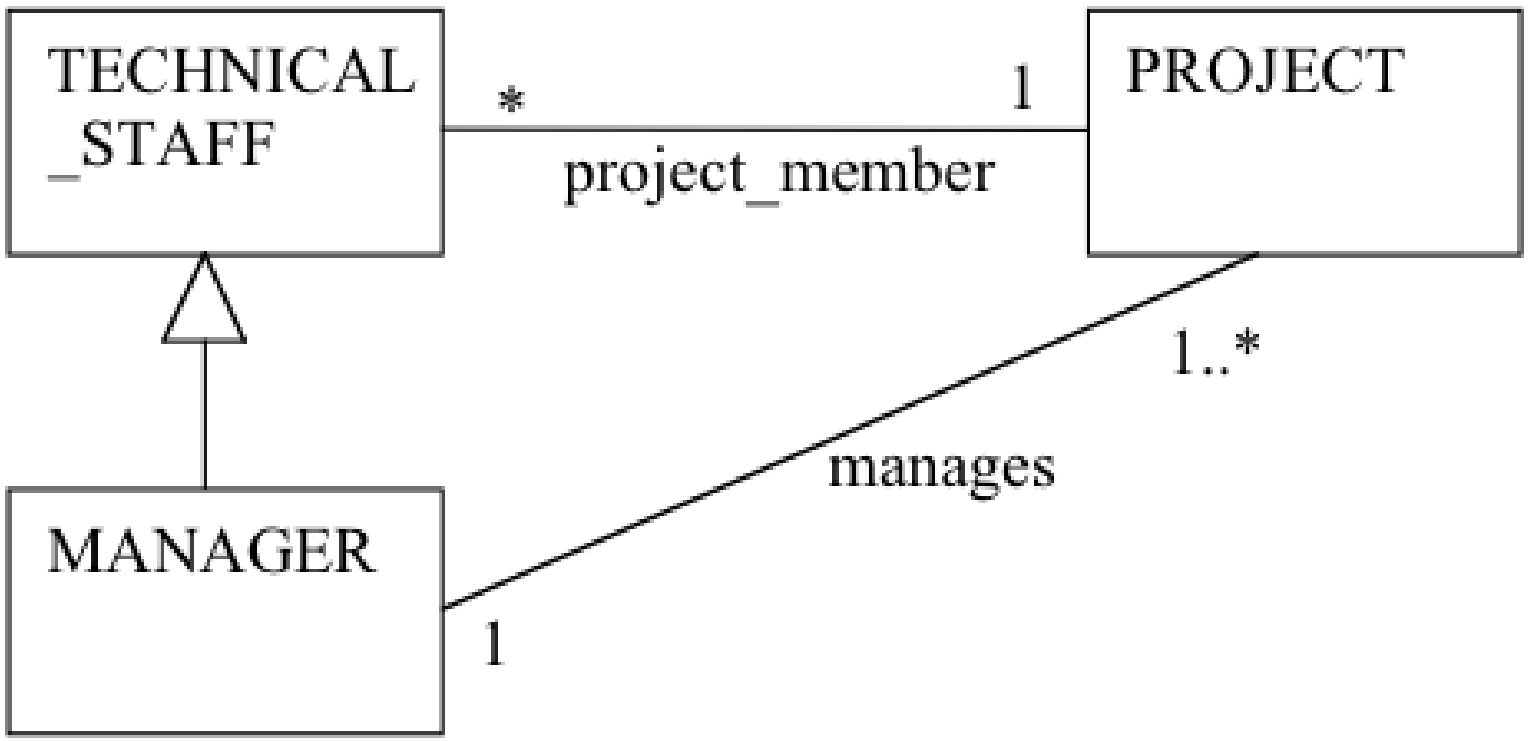
Showing Exceptions in UML Class Diagrams

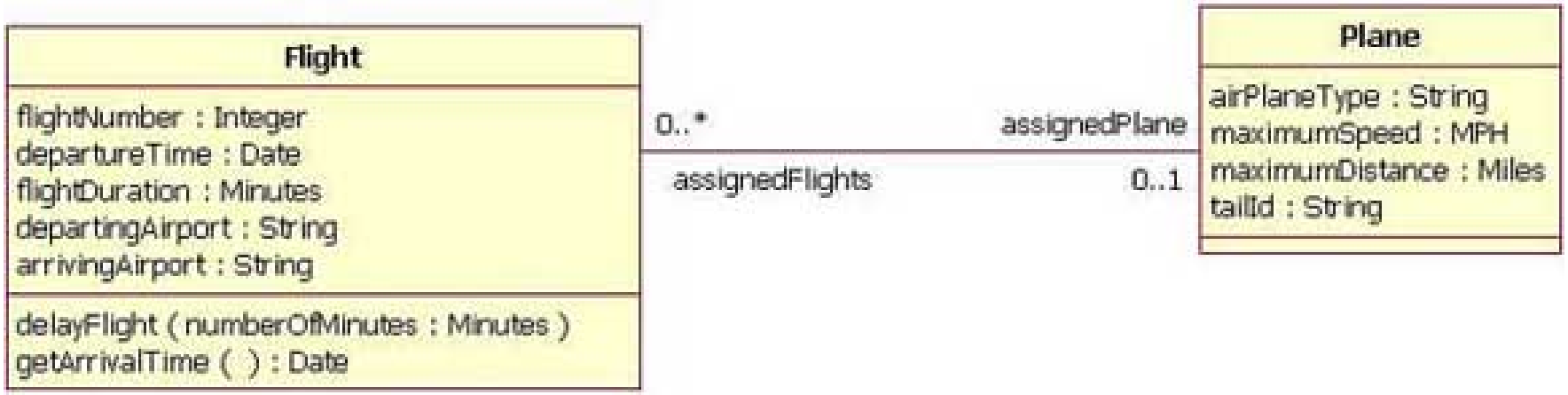
- Usually exceptions are not shown
- If they are, it is in brackets after the method name
- + findAllInstances(): Vector
  {exceptions=NetworkFailure, DatabaseError}

UML Associations

- Associations are relations that the implementation is required to support
- Can have multiplicity constraints



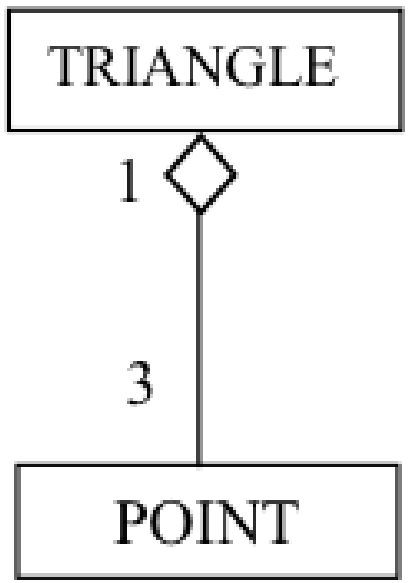
Flight Example



From IBM

UML Aggregation

- Defines a PART_OF relation
- Differs from IS_COMPONENT_OF
- TRIANGLE has its own methods
- TRIANGLE implicitly uses POINT to define its data attributes



UML Packages

IS_COMPONENT_OF is represented via the package notation