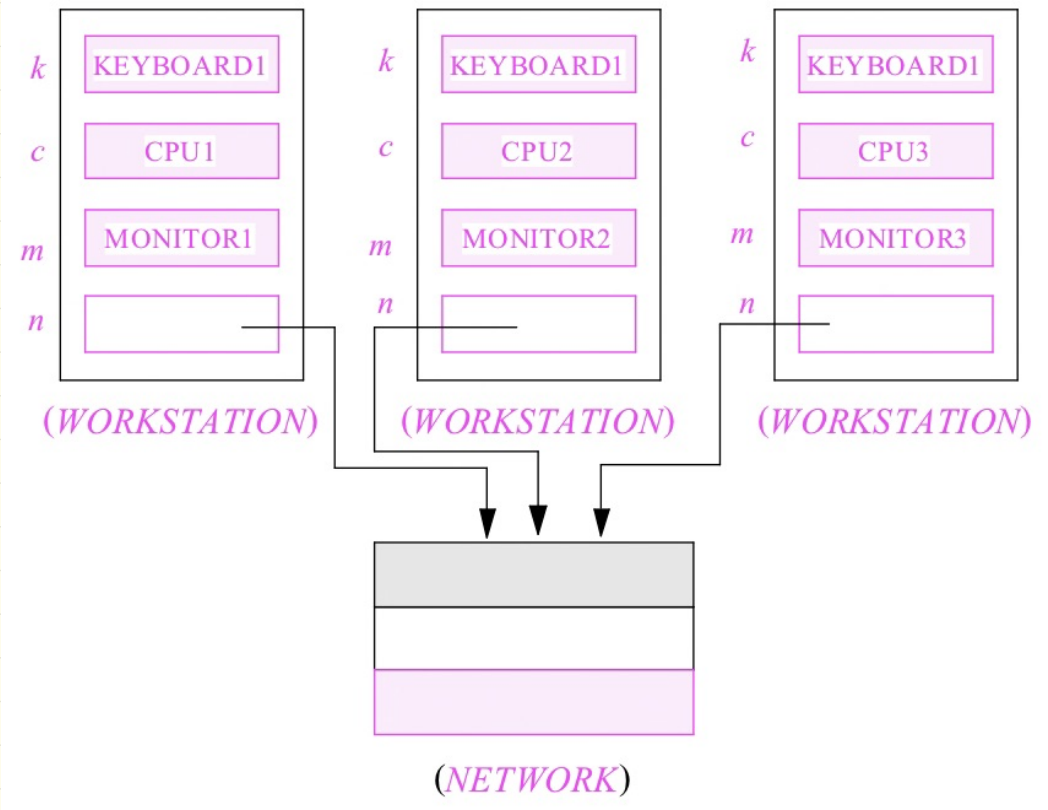
Lecture 5

Part 1

Expanded Types for Compositions

Modelling: Aggregation vs. Composition



Expanded Type for Composition

```
class KEYBOARD ... end class CPU ... end
class MONITOR ... end class NETWORK ... end
class WORKSTATION
  k: expanded KEYBOARD
  c: expanded CPU
  m: expanded MONITOR
  n: NETWORK
end
```

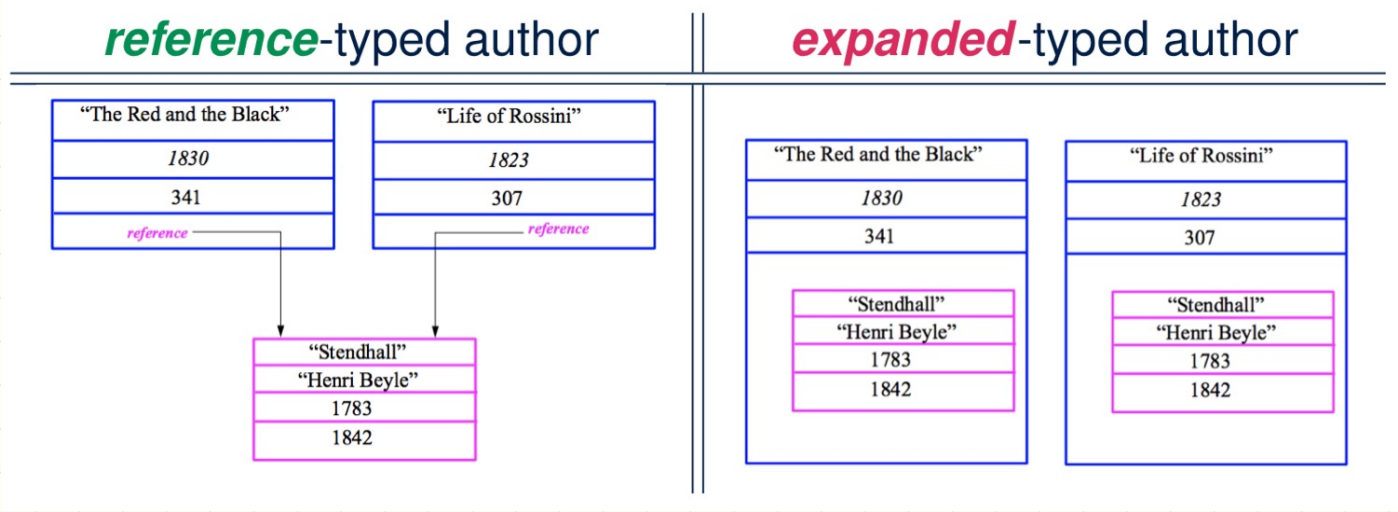
```
expanded class KEYBOARD ... end
expanded class CPU ... end
expanded class MONITOR ... end
class NETWORK ... end
class WORKSTATION
  k: KEYBOARD
  c: CPU
  m: MONITOR
  n: NETWORK
end
```

Use of Expanded Type

```
expanded class
  B
feature
  change_i (ni: INTEGER)
    do
      i := ni
    end
feature
  i: INTEGER
end
```

```
1  test_expanded
2   local
3     eb1, eb2: B
4   do
5     check eb1.i = 0 and eb2.i = 0 end
6     check eb1 = eb2 end
7     eb2.change_i (15)
8     check eb1.i = 0 and eb2.i = 15 end
9     check eb1 /= eb2 end
10    eb1 := eb2
11    check eb1.i = 15 and eb2.i = 15 end
12    eb1.change_i (10)
13    check eb1.i = 10 and eb2.i = 15 end
14    check eb1 /= eb2 end
15  end
```

Reference Type or Expanded Type



Lecture 5

Part 2

Sharing via Inheritance

Shared Data via Inheritance

Cohesion

Single Choice Principle

Descendant:

```
class DEPOSIT inherit SHARED_DATA
      -- 'maximum_balance' relevant
end

class WITHDRAW inherit SHARED_DATA
      -- 'minimum_balance' relevant
end

class INT_TRANSFER inherit SHARED_DATA
      -- 'exchange_rate' relevant
end

class ACCOUNT inherit SHARED_DATA
feature
      -- 'interest_rate' relevant
      deposits: DEPOSIT_LIST
      withdraws: WITHDRAW_LIST
end
```

Ancestor:

```
class
  SHARED_DATA
feature
  interest_rate: REAL
  exchange_rate: REAL
  minimum_balance: INTEGER
  maximum_balance: INTEGER
  ...
end
```

Problems?

Shared Data via Inheritance

Cohesion

Single Choice Principle

```
class
  SHARED_DATA
feature
  interest_rate: REAL
  exchange_rate: REAL
  minimum_balance: INTEGER
  maximum_balance: INTEGER
  ...
end
```

	DEPOSIT
ir	0.11
er	2.34
min	1000
max	1000000

	DEPOSIT
ir	0.11
er	2.34
min	1000
max	1000000

	WITHDRAW
ir	0.11
er	2.34
min	1000
max	1000000

	WITHDRAW
ir	0.11
er	2.34
min	1000
max	1000000

	TRANSFER
ir	0.11
er	2.34
min	1000
max	1000000

	TRANSFER
ir	0.11
er	2.34
min	1000
max	1000000

d1, d2: **DEPOSIT**
w1, w2: **WITHDRAW**
t1, t2: **INTERNATIONAL_TRANSFER**
...
d1.set_max_balance
w2.set_min_balance
t2.set_exchange_rate

Lecture 5

Part 3

Once Routines

Once Routine (1)

```
class A
create make
feature -- Constructor
  make do end
feature -- Query
  new_once_array (s: STRING): ARRAY[STRING]
      -- A once query that returns an array.
    once
      create {ARRAY[STRING]} Result.make_empty
      Result.force (s, Result.count + 1)
    end
  new_array (s: STRING): ARRAY[STRING]
      -- An ordinary query that returns an array.
    do
      create {ARRAY[STRING]} Result.make_empty
      Result.force (s, Result.count + 1)
    end
end
```

```
test_query: BOOLEAN
  local
    a: A
    arr1, arr2: ARRAY[STRING]
  do
    create a.make

    arr1 := a.new_array ("Alan")
    Result := arr1.count = 1 and arr1[1] ~ "Alan"
    check Result end

    arr2 := a.new_array ("Mark")
    Result := arr2.count = 1 and arr2[1] ~ "Mark"
    check Result end

    Result := not (arr1 = arr2)
    check Result end
  end
```

Once Routine (2)

```
class A
create make
feature -- Constructor
  make do end
feature -- Query
  new_once_array (s: STRING): ARRAY[STRING]
      -- A once query that returns an array.
    once
      create {ARRAY[STRING]} Result.make_empty
      Result.force (s, Result.count + 1)
    end
  new_array (s: STRING): ARRAY[STRING]
      -- An ordinary query that returns an array.
    do
      create {ARRAY[STRING]} Result.make_empty
      Result.force (s, Result.count + 1)
    end
end
```

```
test_once_query: BOOLEAN
  local
    a: A
    arr1, arr2: ARRAY[STRING]
  do
    create a.make

    arr1 := a.new_once_array ("Alan")
    Result := arr1.count = 1 and arr1[1] ~ "Alan"
    check Result end

    arr2 := a.new_once_array ("Mark")
    Result := arr2.count = 1 and arr2[1] ~ "Alan"
    check Result end

    Result := arr1 = arr2
    check Result end
end
```

Approximating Once Routines in Java (1)

```
class BankData {
  BankData() { }
  double interestRate;
  void setIR(double r);
  ...
}
```

```
class Account {
  BankData data;
  Account() {
    data = BankDataAccess.getData();
  }
}
```

```
class BankDataAccess {
  static boolean initOnce;
  static BankData data;
  static BankData getData() {
    if(!initOnce) {
      data = new BankData();
      initOnce = true;
    }
    return data;
  }
}
```

Problem?

Approximating Once Routines in Java (2)

We may encode Eiffel once routines in Java:

```
class BankData {
  private BankData() { }
  double interestRate;
  void setIR(double r);
  static boolean initOnce;
  static BankData data;
  static BankData getData() {
    if(!initOnce) {
      data = new BankData();
      initOnce = true;
    }
    return data;
  }
}
```

Problem?

Lecture 5

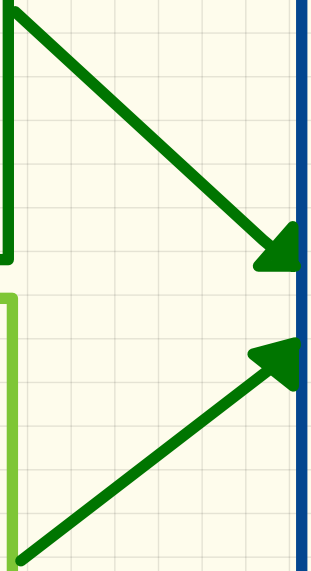
Part 4

Export Status

Export Status Case 1

```
class CLIENT_1
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```

```
class CLIENT_2
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```

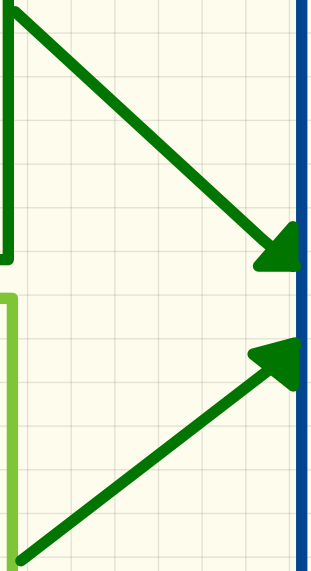


```
class SUPPLIER

create
      make

feature
   make (init_i: INTEGER)
      do
         i := init_i
      end

feature
   i: INTEGER
end
```

Export Status Case 2

```
class CLIENT_1
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```

```
class CLIENT_2
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```

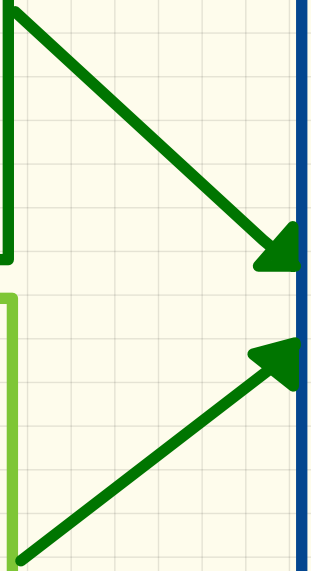


```
class SUPPLIER

create
      make

feature
   make (init_i: INTEGER)
      do
         i := init_i
      end

feature
   i: INTEGER
end
```

Export Status Case 3

```
class CLIENT_1
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```

```
class CLIENT_2
  ...
  test: BOOLEAN
    local
      s, old_s: SUPPLIER
    do
      create s.make (5)
      old_s := s
      create s.make (5)
      print (old_s = s)
      old_s := s
      s.make (7)
      print (old_s = s)
    end
end
```



```
class SUPPLIER

create
      make

feature
   make (init_i: INTEGER)
      do
         i := init_i
      end

feature
   i: INTEGER
end
```

Lecture 5

Part 5

Singleton Pattern

Singleton Design Pattern: Code (1)

Supplier:

```
class DATA
create {DATA_ACCESS} make
feature {DATA_ACCESS}
  make do v := 10 end
feature -- Data Attributes
  v: INTEGER
  change_v (nv: INTEGER)
    do v := nv end
end
```

```
expanded class
  DATA_ACCESS
feature
  data: DATA
      -- The one and only access
    once create Result.make end
invariant data = data
```

Client:

```
test: BOOLEAN
  local
    access: DATA_ACCESS
    d1, d2: DATA
  do
    d1 := access.data
    d2 := access.data
    Result := d1 = d2
      and d1.v = 10 and d2.v = 10
    check Result end
    d1.change_v (15)
    Result := d1 = d2
      and d1.v = 15 and d2.v = 15
  end
end
```

Writing **create** *d1.make* in `test` feature does not compile. Why?

Singleton Design Pattern: Code (2.1)

Supplier:

```
class BANK_DATA
create {BANK_DATA_ACCESS} make
feature {BANK_DATA_ACCESS}
  make do ... end
feature -- Data Attributes
  interest_rate: REAL
  set_interest_rate (r: REAL)
  ...
end
```

```
expanded class
  BANK_DATA_ACCESS
feature
  data: BANK_DATA
      -- The one and only access
    once create Result.make end
invariant data = data
```

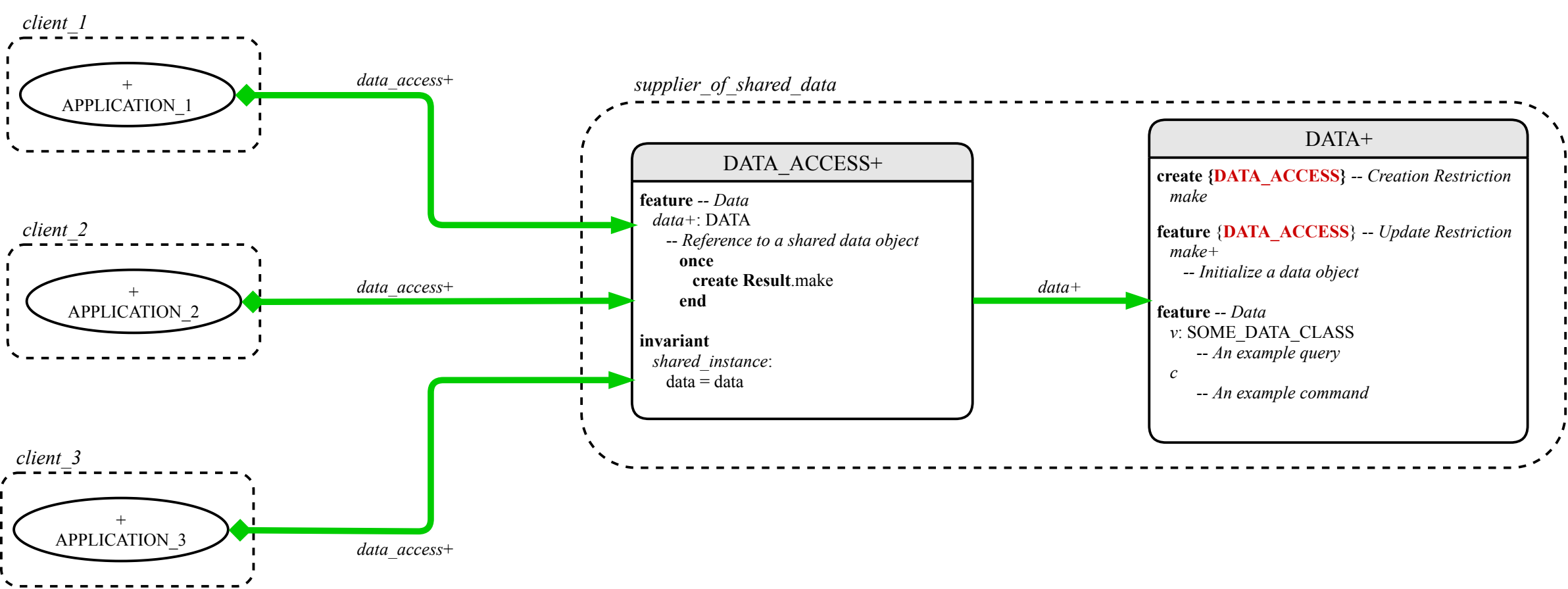
Client:

```
class
  ACCOUNT
feature
  data: BANK_DATA
  make (...)
      -- Init. access to bank data.
    local
      data_access: BANK_DATA_ACCESS
    do
      data := data_access.data
      ...
    end
end
```

Writing **create** *data.make* in client's `make` feature does not compile. Why?

Singleton Design Pattern: Code (2.2)

```
test_bank_shared_data: BOOLEAN
    -- Test that a single data object is manipulated
  local acc1, acc2: ACCOUNT
  do
    comment("t1: test that a single data object is shared")
    create acc1.make ("Bill")
    create acc2.make ("Steve")
    Result := acc1.data = acc2.data
    check Result end
    Result := acc1.data ~ acc2.data
    check Result end
    acc1.data.set_interest_rate (3.11)
    Result :=
          acc1.data.interest_rate = acc2.data.interest_rate
      and acc1.data.interest_rate = 3.11
    check Result end
    acc2.data.set_interest_rate (2.98)
    Result :=
          acc1.data.interest_rate = acc2.data.interest_rate
      and acc1.data.interest_rate = 2.98
  end
```


client_1
+
APPLICATION_1
data_access+
client_2
+
APPLICATION_2
data_access+
client_3
+
APPLICATION_3
data_access+
supplier_of_shared_data
DATA_ACCESS+
feature -- Data
data+: DATA
-- Reference to a shared data object
once
create Result.make
end
invariant
shared_instance:
data = data
data+
DATA+
create {DATA_ACCESS} -- Creation Restriction
make
feature {DATA_ACCESS} -- Update Restriction
make+
-- Initialize a data object
feature -- Data
v: SOME_DATA_CLASS
-- An example query
c
-- An example command