UML Part VI

- Implementing UML relationships in code (C++)

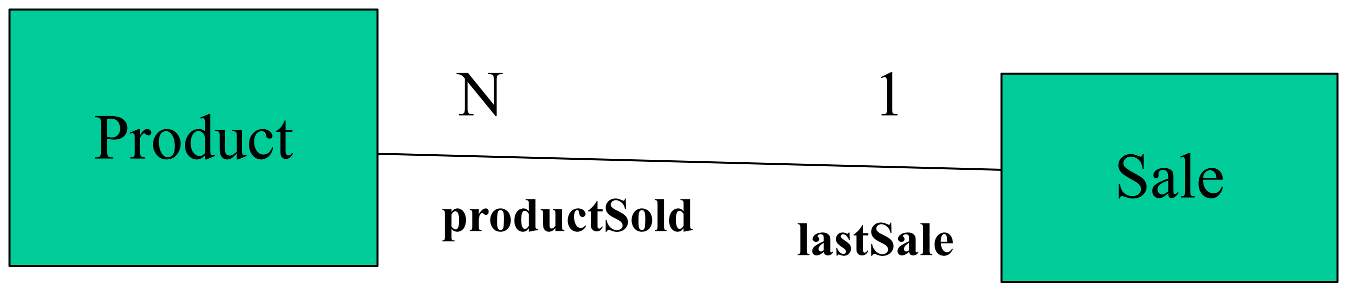
Relationships Among Classes

- Dependency
- Association
- Composition & Aggregation
- Generalization

Association

- Semantic dependency between classes without direction
- Cardinality
  - one to one
  - one to many
  - many to many

Association example

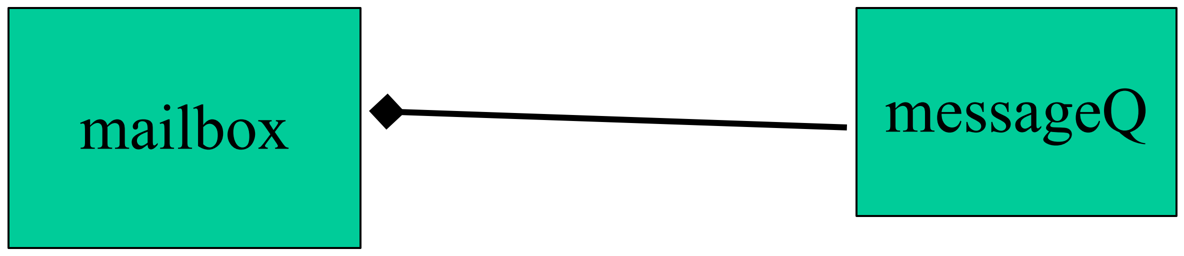


Association example

```
class Product {
public:
private:
  Sale *lastSale;
};

class Sale {
public:
private:
Product **productSold;
};
```

- Each instance of Product has a pointer to its last sale
- Each instance of Sale has a collection of pointers denoting the products sold

Composition example

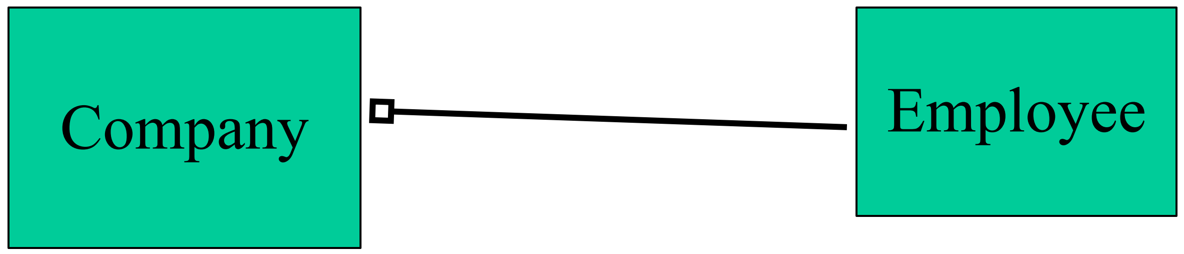


Composition

- A part of relationship (physical containment) when object is destroyed, so is attribute

```
class mailbox {
public:
  mailbox();
  ~mailbox();
  message getMessage(const InputReader&);

private:
  messageQ lst;
};
```

Aggregation example



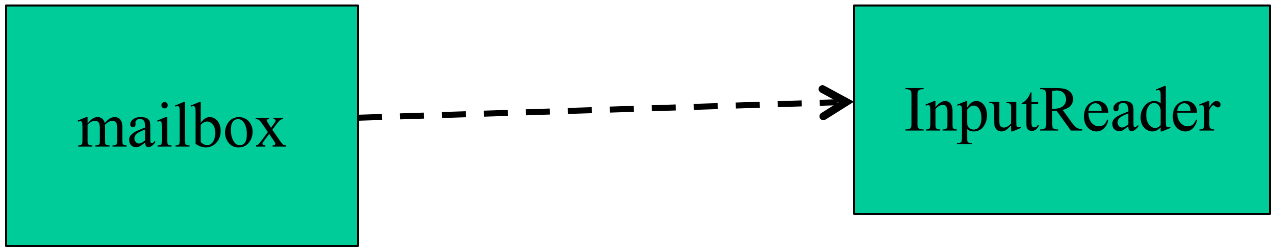
Aggregation

- A part of relationship - when container destroyed, attribute is not.

```
class company {
public:
  company();
  ~company();
  int numberOfEmployees() const;

private:
  employee *lst;
};
```

Dependency

- Peer to peer link
- Directional client/server relationship
- Refinement of association



Dependency

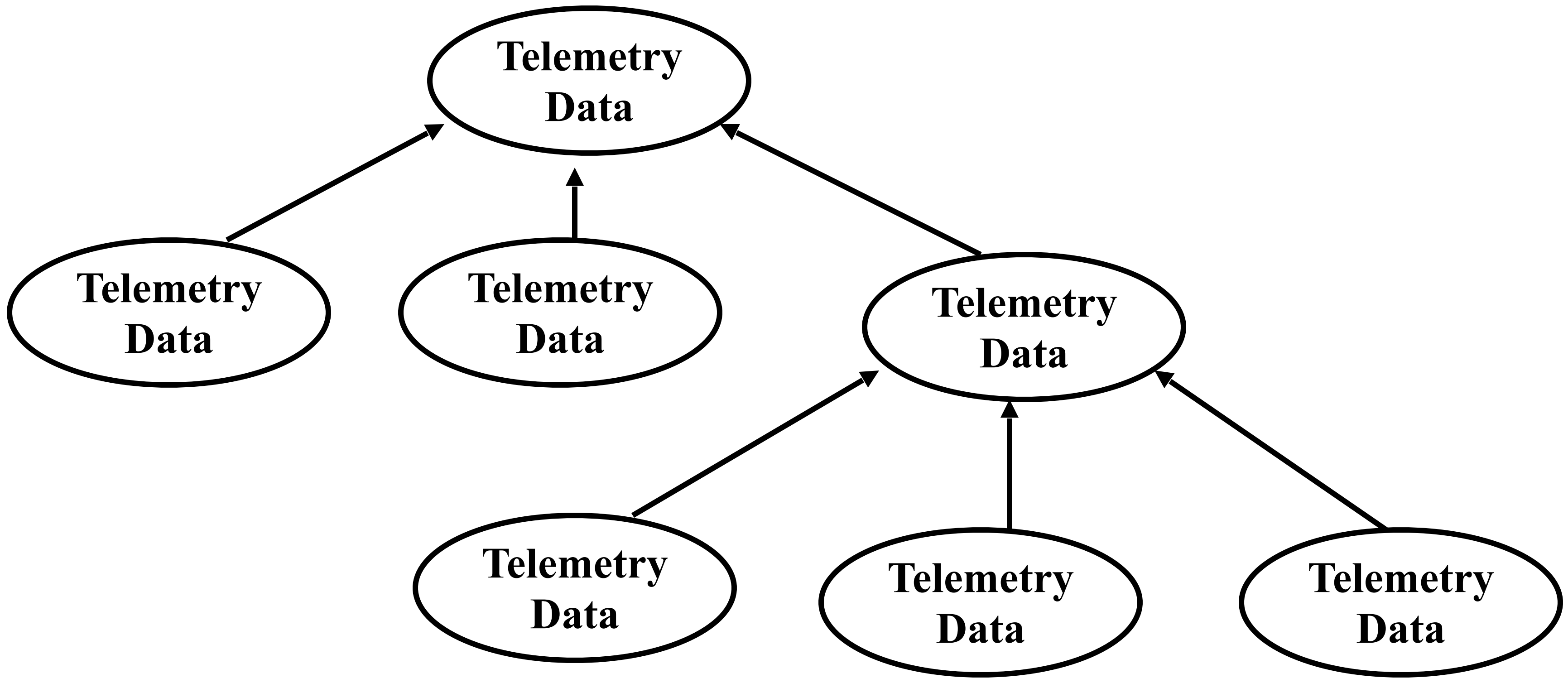
- A using relationship

```
class mailbox {
public:
  mailbox();
  ~mailbox();
  message getMessage(const InputReader&);

private:
  messageQ lst;
};
```

Generalization

- One class shares the structure/behavior of one (single inheritance) or more (multiple inheritance) classes
- Subclass typically augments or restricts the existing structure and behavior of the superclass

Single Inheritance



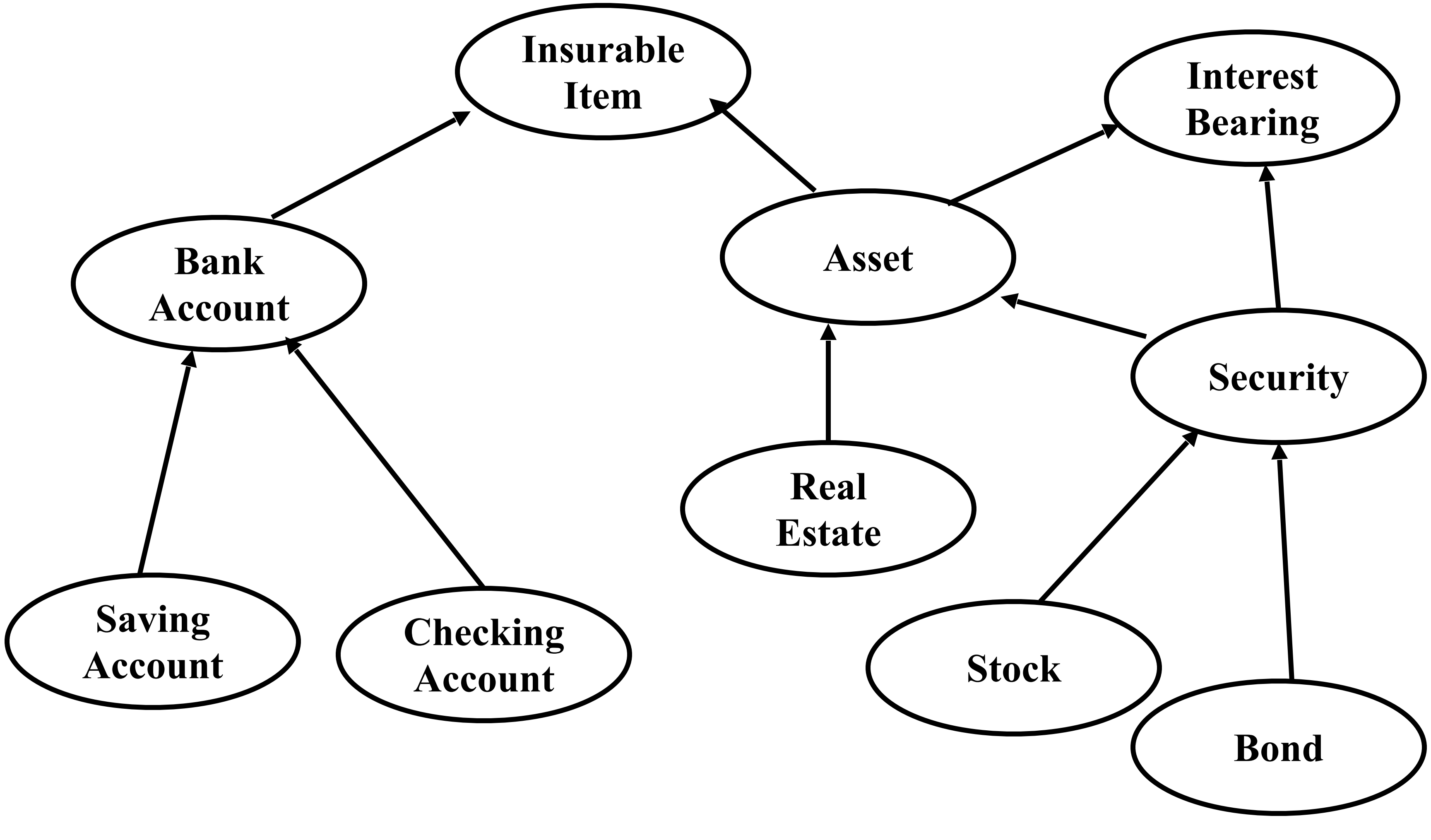
Single Inheritance

```
class TelemetryData {
public:
  TelemetryData();
  virtual ~TelemetryData();
  virtual void transmit();
  Time currentTime() const;
private:
  int id;
  Time timeStamp;
};

class ElectricalData : public TelemetryData {
public:
  ElectricalData(float v1, float v2,
                 float v1, float v2);
  virtual ElectricalData();
  virtual void transmit();
  float currentPower() const;
private:
float fuelCell1Voltage, fuelCell2Voltage;
float fuelCell1Amperes, fuelCell2Amperes;
};
```

Single Inheritance

```
void TelemetryData::transmit() {
// Transmit the id
// Transmit the timeStamp
}

void ElectricalData::transmit() {
// Transmit the voltages
// Transmit the amperes
}

void transmitFreshData(TelemetryData& d,
                       const Time& t){
  if (d.currentTime() >=t) d.transmit();
}

TelemetryData telemetry;
ElectricalData electrical(5.0, -5.0, 3.0, 7.0);

transmitFreshData(telemetry, Time(60));
transmitFreshData(electrical, Time(60));
```

Multiple Inheritance



Multiple Inheritance

```
class Asset;
class InsurableItem;
class InterestBearing;

class BankAccount : public Asset,
                    public InsurableItem,
                    public InterestBearing {};

class RealEstate  : public Asset,
                    public InsurableItem {};

class Security    : public Asset,
                    public InterestBearing {};

class SavingsAccount  : public BankAccount {};
class CheckingAccount : public BankAccount {};

class Stock : public Security {};
class Bond  : public Security {};
```