Value vs. Entity Objects, Information Hiding

**Readings:** Eckel, Vol. 1
Ch. 5 Hiding the Implementation

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### Entity vs. Value Objects

**Entity Object**
- computer embodiment of real-world entity
- each object has a distinct identity
- object with the same attribute values are **NOT** equal

**Value Object**
- simply represents a value of an ADT
- objects with the same attribute values are considered to be identical

#### Value ADT Examples
- mathematical types: rational numbers, polynomials, matrices, ...
- measurements: size, distance, weight, mass, energy, duration, ...
- other quantities: money
- other properties: colour, location, date, time, ...
- restricted value sets: names, addresses, postal codes, number ranges, ...

#### Entity ADT Examples
- physical objects: airplane, runway, taxiway, ...
- people: passenger, booking agent, ...
- records: customer information, boarding pass, flight schedule, ...
- transactions: reservations, cancellations, receipts, ...

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### Design of Entity ADTs

An operation on an entity object should reflect a real-world event:

- Copying an entity is not meaningful; program no longer reflects reality; operations on copies are uncoordinated and can be lost (when copies disappear)
  - prohibit copy constructor
  - prohibit assignment
  - prohibit type conversions
  - avoid equality
  - *clone* operation may be useful

- Computations on entities are not meaningful.
  - Think twice before overloading operators except *new* and *delete.*
  - *operator<>* is useful if overloaded to apply to entity's name or unique id.

- Entities referred by pointers/references (a consequence of the no-copy rule).

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### Design of Value-based ADTs

Equality is important in value types:
- equality and other comparison operators
- copy constructor
- assignment operator

Computations involving values may make sense.
- Consider overloading arithmetic operators.

Virtual functions and inheritance are uncommon.
Mutable Objects

Mutable Value-based ADTs (e.g., Date) are problematic when they can be referenced from two variables.

```cpp
Person myPerson ( "David O'Leary", new Date(1, "May", 1990) );
// name, DOB
cout << myPerson.DOB() << endl;

Date myDate = myPerson.DOB();
myDate.monthIs( myDate.month() + 1 );
cout << myPerson.DOB() << endl;
```

Entity Objects are mutable:
- their objects can change value via mutators, other functions

Value-based Objects are usually immutable:
- their objects cannot change value
- instead, variables of the ADT are assigned a different object

Implications:
- no mutators
- member functions cannot be overridden (non virtual)
- copy/assignment operations are deep copies
- all data members are private
- all data members are of primitive or immutable types, else
  - make a copy of any (mutable) attribute parameter value
  - make a copy of any output (mutable) attribute return value

Singleton Design Pattern

Ensures that exactly one object of our ADT exists.

```
class Egg {
    static Egg e; // singleton instance
    int i; // data member
    Egg(int ii) : i(ii) {} // private constructor

public:
    static Egg* instance() { return &e; }
    int val() const { return i; }
    Egg(const Egg&) = delete; // prevent copy
    Egg& operator= (const Egg&) = delete; // prevent assign
};

Egg Egg::e(42); // initialization of singleton
```

Exposed Implementation

```
class Rational {
public:
    Rational (int numer = 0, int denom = 1);
    int numerator() const;
    int denominator() const;
private:
    int numerator_;
    int denominator_;
};
```
PImpl Idiom

Encapsulate the data representation in a nested private structure (which can be in a separate file).

class Rational {
public:
    Rational (int numer = 0, int denom = 1);
    int numerator() const;
    int denominator() const;
private:
    struct Impl;
    Impl* rat_;  
public:
    ~Rational();
    Rational (const Rational&);
    Rational& operator= (const Rational&);
};