CMPT 373
Software Development Methods

Design Patterns: The Visitor

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Recall: Design Patterns

- Capture programming idioms
- Exploit polymorphism in well understood ways

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- Capture programming idioms
- Exploit polymorphism in well understood ways
- 3 primary categories:
  - Creational – provide flexibility in creating objects
  - Structural – compose classes to add new behavior
  - Behavioral – focus on communication between entities

Recall: Design Patterns

- Capture programming idioms
- Exploit polymorphism in well understood ways
- 3 primary categories:
  - Creational – provide flexibility in creating objects
  - Structural – compose classes to add new behavior
  - Behavioral – focus on communication between entities
- We have seen: prototype, decorator, command, …

A New Problem

- Different classes can perform the same action differently

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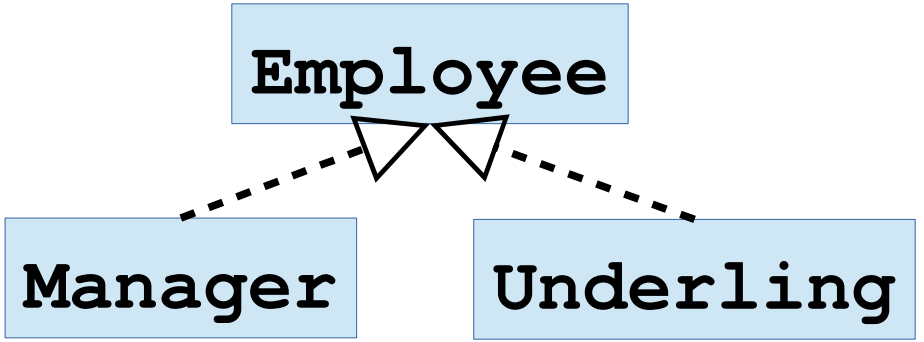

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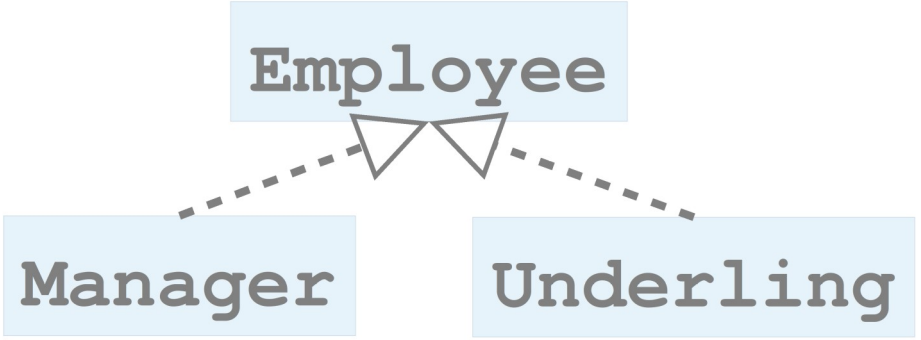
Manager manager;
manager.updatePay();

Underling underling;
underling.updatePay();
```



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Operations for Employees

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- Sometimes, you can't even know all of the actions in advance!

Why are these problems?

A New Problem

- Let us take a look at our **`Employee`** base class…

```
class Employee {
public:
  ...
  virtual void updatePay() = 0;
  virtual void performJob() = 0;
  virtual void serialize() = 0;
  virtual void displayAvatar() = 0;
  virtual void printPerformanceReview() = 0;
  virtual void findFavoriteOfficeMate() = 0;
  virtual void procrastinate() = 0;
};
```

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Solutions

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- We need to find a better way
  - What are the tools at our disposal?
    - Classes
    - Polymorphism
  - How can we use them to attack the problem?
    - Group related behaviors into classes
    - Invoke them when desired

Grouping Related Behavior

- How should we group related behaviors?

What does SRP dictate?

Grouping Related Behavior

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Grouping Related Behavior

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```
class EmployeeSerializer {
public:
  void serialize(Manager &manager);
  void serialize(Underling &underling);
};

class PerformanceReviewPrinter {
public:
  void printReview(Manager &manager);
  void printReview(Underling &underling);
};
```

How Do We Invoke It?

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```
EmployeeSerializer serializer;
std::vector<Employee*> employees;

for (auto *employee : employees) {
  serializer.serialize(*employee);
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Will this work? Why?

How Do We Invoke It?

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for (auto *employee :
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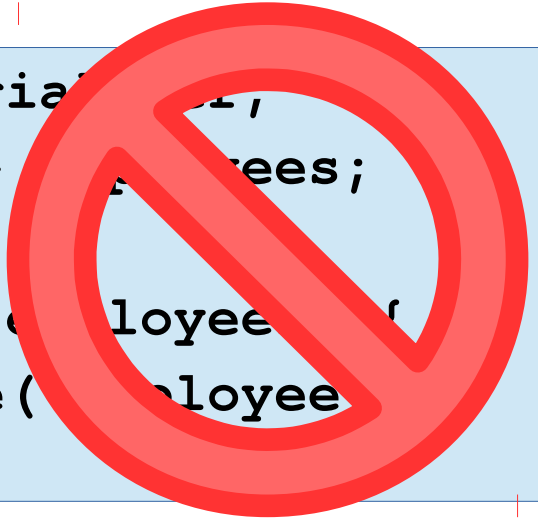
}
```



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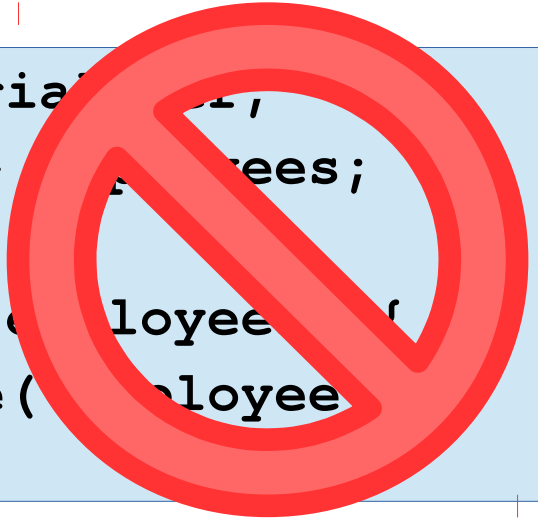

No!

What is the core problem?

How Do We Invoke It?

- Problem:
  - We want to call a method based on *multiple dynamic types*

```
serializer.serialize(*employee);
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EmployeeSerializer

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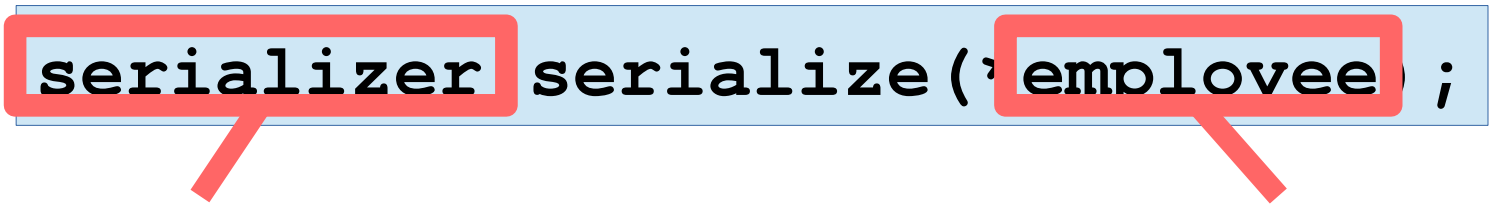

EmployeeSerializer **Manager/Underling**

How Do We Invoke It?

- Problem:
  - We want to call a method based on multiple dynamic types
  - *Multiple Dispatch* (or double dispatch in this case)

```
serializer.serialize(employee);
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EmployeeSerializer **Manager/Underling**

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  - We want to call a method based on multiple dynamic types
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EmployeeSerializer **Manager/Underling**

But we only know that **employee** is an **Employee***

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EmployeeSerializer **Manager/Underling**

But we only know that **employee** is an **Employee***

```
for (auto* employee : employees) {
  serializer.serialize(*employee);
```

How Do We Invoke It?

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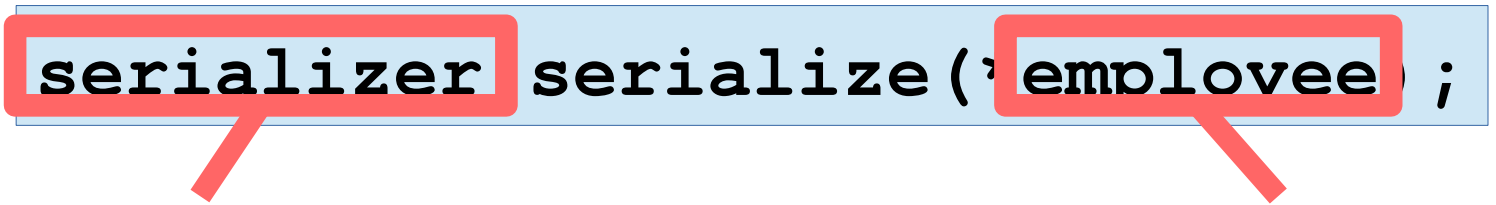

But we only know that `employee` is an `Employee*`

How can we resolve the issue?

How Do We Invoke It?

- Problem:
  - We want to call a method based on multiple dynamic types
  - *Multiple Dispatch* (or double dispatch in this case)

```
serializer.serialize(*employee);
```

- Solution:
  - The Visitor Pattern

The Visitor Pattern

Abstract away the added behaviors:

```
class EmployeeSerializer : public Visitor {
public:
  void visit(Manager &manager) override;
  void visit(Underling &underling) override;
};
```

The Visitor Pattern

Change the original classes:

```
class Employee {
public:
  virtual void accept(Visitor &v) = 0;
}
class Manager : public Employee {
  ...
  void accept(Visitor &v) override {
    v.visit(*this);
  }
};
```

The Visitor Pattern

Change the original classes:

```
class Employee {
public:
   virtual void accept(Visitor &v) = 0;
}
class Manager : public Employee {
   ...
   void accept(Visitor &v) override {
     v.visit(*this);
   }
};
```

The dynamic type of **`Employee`** is known!

Calls **`visit(Manager &manager)`** here.

The Visitor Pattern

Use the new behaviors through their classes:

```
EmployeeSerializer serializer;
PerformanceReviewPrinter reviewer;
std::deque<Employee*> employees;

for (auto *employee : employees) {
  employee->accept(serializer);
  employee->accept(reviewer);
}
```

The Visitor Pattern

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EmployeeSerializer serializer;
PerformanceReviewPrinter reviewer;
std::deque<Employee*> employees;

for (auto *employee : employees) {
  employee->accept(serializer);
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}
```

What if we want a return value?

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- A behavioral pattern

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- A behavioral pattern
- Useful for adding new behaviors to a collection of related classes
  - *It also keeps those behaviors isolated!*
  - Useful for designing APIs open to extension

The Visitor Pattern

- A behavioral pattern
- Useful for adding new behaviors to a collection of related classes
- But what are the downsides?
  - Can we overcome them?