Object Creation

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ADAP C09

Agenda

1. Object creation patterns
2. Switch / case statement
3. Factory method
4. Abstract factory
5. Product trader
6. Prototype (cloning)
7. Object creation reviewed
8. Object creation model

1. Object Creation Patterns

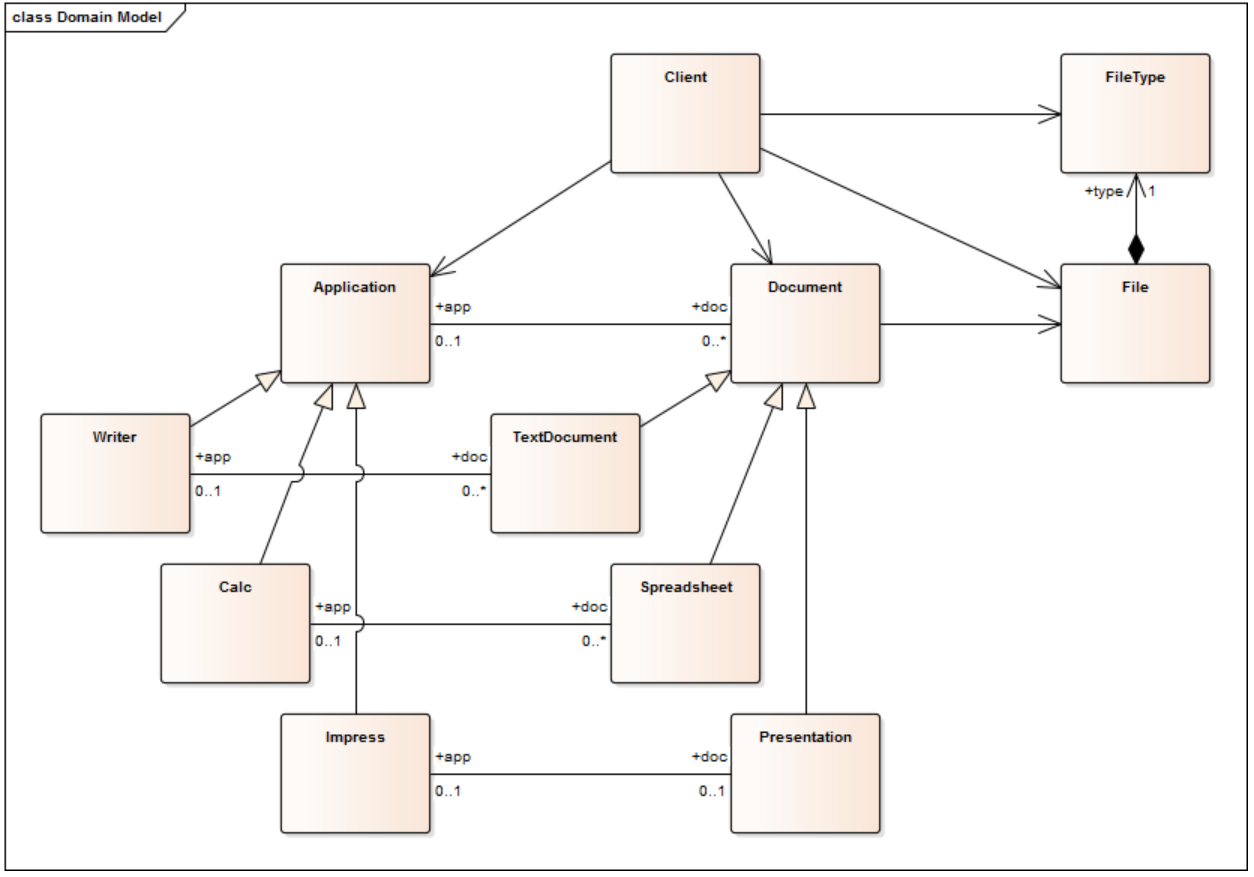
(Design) Patterns of Object Creation

1. Switch / Case
2. Factory Method
3. (Abstract) Factory
4. Product Trader
5. Prototype

Object Creation Example

- Create a document from its file type (extension)
- Create an application for the document

Application Document Model



Evaluation Criteria

Ease of

1. **Reading code**
2. **Understanding code**
3. **Changing code**
4. **Extending code**

2. Switch / Case Statement

Scenario 1: File-type → Document

- Client is run-time environment, e.g. desktop
- Wants to create document for given file

Switch / Case Applied

```
public class Client {

  public Document createDocument(File file) {
    String fileType = file.getFileType();
    Document result = null;

    if (fileType.equals("odt")) {
      result = new TextDocument();
    } else if (fileType.equals("ods")) {
      result = new Spreadsheet();
    } else if (fileType.equals("odp")) {
      result = new Presentation();
    }

    ...
    return result;
  }

  ...
}
```

Switch / Case Evaluated

- Advantages
  - Easy to read
  - Easy to understand
  - Easy to change
- Disadvantages
  - Hard to extend
- Additional notes
  - May require use of initialization method

3. Factory Method

Scenario 2: Application → Document

- Client is run-time environment, e.g. desktop
- Wants to create document for given application

Factory Method Applied

```
public abstract class Application {
  public abstract Document createDocument();
  ...
}
```

```
public class Writer extends Application {
  public Document createDocument() { return new TextDocument(); }
  ...
}
```

```
public class Calc extends Application {
  public Document createDocument() { return new Spreadsheet(); }
  ...
}
```

```
public class Impress extends Application {
  public Document createDocument() { return new Presentation(); }
  ...
}
```

Factory Method Evaluated

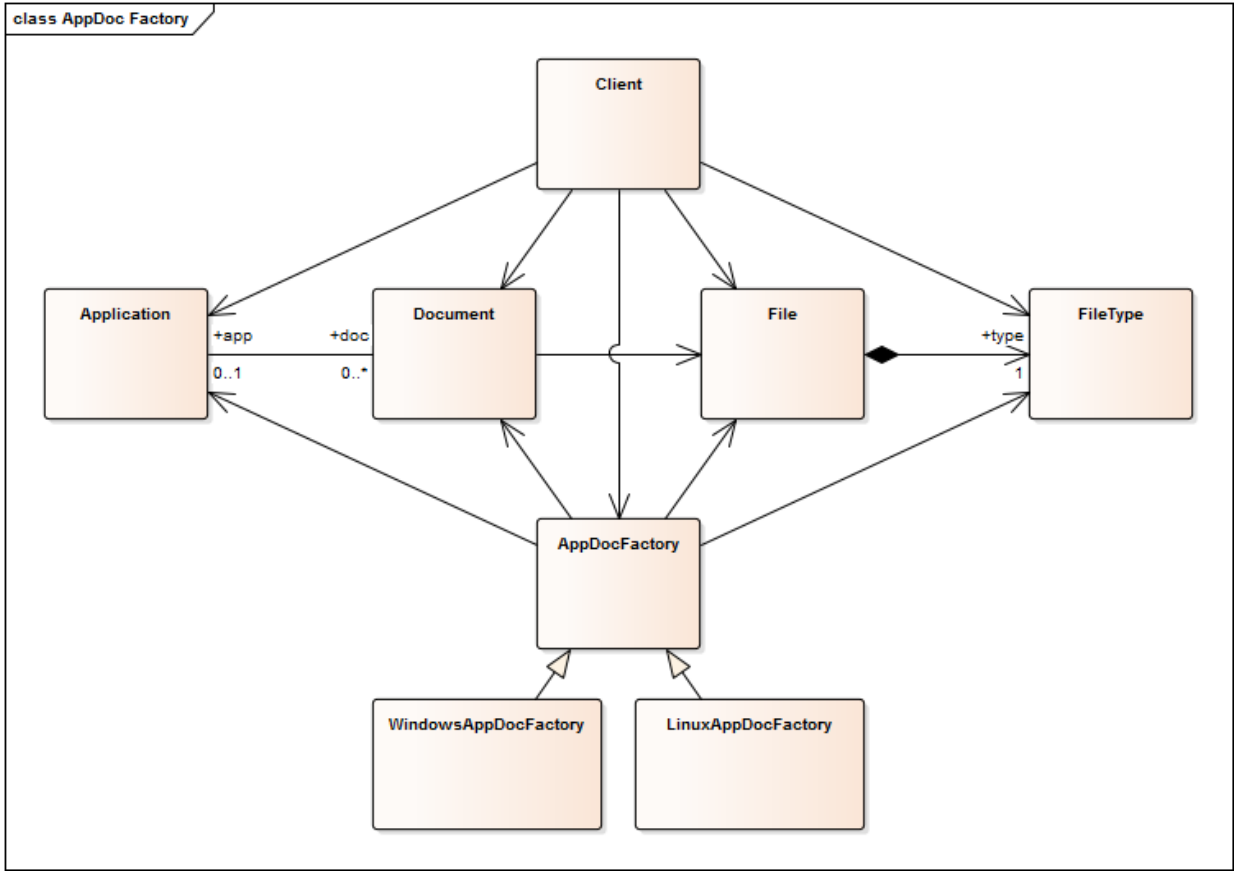
- Advantages
  - Easy to change
  - Easy to extend
- Disadvantages
  - Creation code is not centralized any longer

4. Abstract Factory

Scenario 3: File-type → Document (v2)

- Client is run-time environment, e.g. desktop
- Wants to create document for given file
- Wants to add new Document types in one place

Application Document Factory



Abstract Factory Applied

```
public interface AppDocFactory {
  public Application createFrom(Document doc);
  public Document createFrom(File file);
  ...
}
```

```
public class DefaultAppDocFactory implements AppDocFactory {
  ...

  public Document createFrom(File file) {
    String fileType = file.getFileType();
    if (fileType.equals("odt")) {
      result = new TextDocument();
    } else if ...

    return result;
  }
  ...
}
```

Abstract Factory Evaluated

- Advantages
  - Easy to read
  - Easy to change
  - Easier to extend (than v1)
- Disadvantages
  - Harder to understand
- Additional notes
  - Factories are versatile, advantages and disadvantages depend on further choices like
    - how to implement the creation methods

5. Product Trader

Scenario 4: Document → Application

- Client is run-time environment, e.g. desktop
- Wants to create application for given document
- Wants to add new Application types in one place

Product Trader Applied 1 / 2

```
public interface AppDocFactory {
  public void registerApplicationClass(Class dc, Class ac);
  public Application createFrom(Document doc);
  ...
}
```

```
public class DefaultAppDocFactory implements AppDocFactory {

  Map<Class, Class> appClasses = new HashMap<Class, Class>();
  static {
    appClasses.put(TextDocument.class, Writer.class);
    appClasses.put(Spreadsheet.class, Calc.class);
    appClasses.put(Presentation.class, Impress.class);
  }

  ...
}
```

Product Trader Applied 2 / 2

```
public class DefaultAppDocFactory implements AppDocFactory {

  Map<Class, Class> appClasses = new HashMap<Class, Class>();
  public void registerApplicationClass(Class dc, Class ac) {
    assert (dc != null) && (ac != null);
    appClasses.put(dc, ac);
  }

  public Application createFrom(Document doc) {
    Class appClass = appClasses.get(doc.getClass());
    assert appClass != null;
    return createInstance(appClass);
  }

  protected Application createInstance(Class ac) {
    ...
  }

  ...
}
```

Product Trader Evaluated

- Advantages
  - Easy to read
  - Easy to change
  - Easy to extend
- Disadvantages
  - Hard to understand
  - Hard to debug
- Additional notes
  - Product Trader delays everything until runtime
  - May be viewed as just a complex (abstract) factory

6. Prototype (Cloning)

Scenario 5: File-type → Document (v3)

- Client is run-time environment, e.g. desktop
- Wants to create document for given file type
- Wants to add new Document types in one place
- Wants to initialize complex but default document

Prototype Applied 1 / 2

```
public interface AppDocFactory {
  public void registerDocumentPrototype(FileType ft, Document doc);
  public Document createFrom(FileType ft);
  ...
}
```

Prototype Applied 2 / 2

```
public class DefaultAppDocFactory implements AppDocFactory {


  Map<String, Document> docProtos = new HashMap<String, Document>();
  public void registerDocumentPrototype(FileType ft, Document doc) {
    assert (ft != null) && (doc != null);
    docProtos.put(ft, doc);
  }

  public Document createFrom(FileType ft) {
    Document prototype = docProtos.get(ft);
    assert (prototype != null) && (prototype.isCloneable());
    return prototype.clone();
  }

  ...
}
```

Prototype Evaluated

- Advantages
  - Easy to read
  - Easy to change
  - Easy to extend
- Disadvantages
  - Hard to understand

7. Object Creation Reviewed

Problems with Using Design Patterns

- Many design patterns address multiple issues at once, e.g.
  - Factory method: Creation method and subclassing for configuration
  - Abstract factory: Factory object and subclassing for configuration
  - Prototype: Creation configuration and complex object structures

Design Process for Object Creation

- Use your experience
- Use a pattern language
- Choose from design space
  - Delegation (of object creation)
  - Selection (of concrete class)
  - Configuration (of class mapping)
  - Instantiation (of concrete class)
  - Initialization (of new object)
  - Building (of object structure)

8. Object Creation Model

Design Space for Object Creation

1. **Delegation** of object creation
2. **Selection** of concrete class
3. **Configuration** of class mapping
4. **Instantiation** of concrete class
5. **Initialization** of new object
6. **Building** of object structure

Details of Design Space for Object Creation

- **Delegation** (Who gets to create the object?)
  - on-the-spot, this-object, separate-object
- **Selection** (How is the concrete class selected?)
  - on-the-spot, by-switch-case, by-subclassing, by-colocating, by-mapping
- **Configuration** (How is a class mapping configured?)
  - in-code, by-annotation, by-configuration-file
- **Instantiation** (How is the concrete class instantiated?)
  - in-code, by-class-object, by-prototype, by-function-object
- **Initialization** (How is the new object initialized?)
  - default, by-cloning, by-fixed-signature, by-key-value-pairs, in-second-step
- **Building** (How is the object structure built?)
  - default, by-cloning, by-building

1. Delegation of Object Creation

- **`On-the-spot`**
  - Definition: Hard-code in client code
  - Use: If product class is unlikely to change, ever
- By delegating to **`this-object`**
  - Definition: Delegate to separate (creation) method
  - Use: If this class has multiple places that need this type of new object
- By delegating to a **`separate-object`**
  - Definition: Delegate to a separate (factory) object
  - Use: If many places in the system need to create new objects of this type

2. Selection of Concrete Class

- **`On-the-spot`**
  - Definition: Hard-code in place (whether this method, this class or factory)
  - Use: If there is no need for varying the concrete class, ever
- **`By-switch-case`** statement
  - Definition: Hard-code in place using switch/case statement
  - Use: If there are multiple options, none of which changes, ever
- **`By-subclassing`**
  - Definition: Select concrete class by delegating to subclass
  - Use: If you need a family and dual hierarchies need to be satisfied
- **`By-colocating`**
  - Definition: Select concrete class as part of a family selection
  - Use: If your concrete class is part of a family of co-dependent classes
- **`By-mapping`**
  - Definition: Look-up concrete class as part of some spec → class mapping
  - Use: If your concrete class needs to be configurable at runtime

3. Configuration of Class Mapping

- **`In-code`**
  - Definition: Hard-code mapping in configuration method
  - Use: If you need a mapping, but it is unlikely to change, ever
- **`By-annotation`**
  - Definition: Use annotations to (incrementally) configure mapping
  - Use: If your mapping is small and does not need to be centralized
- **`By-configuration-file`**
  - Definition: Read mapping from configuration file
  - Use: If you need to manage large and changing mappings

4. Instantiation of Concrete Class

- **`In-code`**
  - Definition: Call constructor (new) directly
  - Use: If there is no need for configuration
- **`By-class-object`**
  - Definition: Represent each concrete class using its class object
  - Use: If you don’t need specialized initialization
- **`By-prototype`**
  - Definition: Represent each concrete class using a prototype (object)
  - Use: If you don’t need specialized initialization and don’t have class objects
- **`By-function-object`**
  - Definition: Represent each concrete class using a function object
  - Use: If you need specialized initialization or don’t have class objects

5. Initialization of New Object

- **`Default`**
  - Definition: Provide a fixed (default) field assignment in constructor
  - Use: If there is no need for client-specific initialization (or it can be done later)
- **`By-cloning`**
  - Definition: Provide a fixed field assignment by cloning a prototype
  - Use: If there is no need for a client-specific initialization
- **`By-fixed-signature`**
  - Definition: Provide a field assignment using a fixed method signature
  - Use: If you can channel everything though a fixed method signature
- **`By-key-value-pair`** list
  - Definition: Provide a field assignment using a variable argument list
  - Use: If considerable variation is possible and needed in object initialization
- **`In-second-step`**
  - Definition: Push back object initialization to client until after creation finished
  - Use: If there is too much variation in the initialization arguments

6. Building of Object Structure

- **`Default`**
  - Definition: Let the new object create any dependent object structure
  - Use: If the client wants no say in creating any dependent objects
- **`By-cloning`**
  - Definition: Create the desired object structure by cloning a prototype
  - Use: If someone else needs to define the object structure for the client
- **`By-building`**
  - Definition: Create the desired object structure by building it piece-by-piece
  - Use: If the client needs to direct the building of a complex object structure

Design Patterns and Design Space

	Factory Method	Abstract Factory	Product Trader	Prototype	Builder
1. Delegation	• **this-object**	• **separate-object**	• **separate-object**	• **separate-object**	• **separate-object**
2. Selection	• **by-subclassing**	• all possible	• **by-mapping**	• **by-subclassing**	• all possible
3. Configuration	• N/A	• all possible	• all possible	• N/A	• all possible
4. Instantiation	• **in-code**	• **in-code**	• by-class-object • by-prototype • by-function-object	• **by-prototype**	• all possible
5. Initialization	• all possible	• all possible	• all possible	• all possible	• all possible
6. Building	• N/A	• default • by-cloning	• default • by-cloning	• **default** • **by-cloning**	• **by-building**

Green background indicates characteristic property
Orange background indicates unnecessary constraint
all possible = all options are valid options
N/A = not applicable

Review / Summary of Session

- Object creation patterns
  - Switch / case
  - Factory method
  - Abstract factory
  - Product trader
  - Prototype
  - Builder
- The design space

Thank you! Questions?

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