Creational Patterns

Software Modeling

Author: Eng. Carlos Andrés Sierra, M.Sc.
carlos.andres.sierra.v@gmail.com

Lecturer
Computer Engineer
School of Engineering
Universidad Distrital Francisco José de Caldas

2024-I

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Basic Concepts

- **Intent**: Separate the construction of a complex object from its representation so that the same construction process can create different representations.
- **Motivation**:
  - **Problem**: An application needs to create instances of a class, but the class is abstract and has many possible implementations.
  - **Solution**: Provide different object creation mechanisms, which allow the client to create the object without knowing the concrete implementation. This increase flexibility and reuse of code.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Basic Concepts

- **Intent**: Separate the construction of a complex object from its representation so that the same construction process can create different representations.
- **Motivation**:
  - **Problem**: An application needs to create instances of a class, but the class is abstract and has many possible implementations.
  - **Solution**: Provide different object creation mechanisms, which allow the client to create the object without knowing the actual implementation. This increase flexibility and reuse of code.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Basic Concepts

- **Intent**: Separate the construction of a complex object from its representation so that the same construction process can create different representations.
- **Motivation**:
  - **Problem**: An application needs to create instances of a class, but the class is abstract and has many possible implementations.
  - **Solution**: Provide different object creation mechanisms, which allow the client to create the object without knowing the actual implementation. This increase flexibility and reuse of code.

Basic Concepts

- **Intent**: Separate the construction of a complex object from its representation so that the same construction process can create different representations.
- **Motivation**:
  - **Problem**: An application needs to create instances of a class, but the class is abstract and has many possible implementations.
  - **Solution**: Provide different object creation mechanisms, which allow the client to create the object without knowing the actual implementation. This increase flexibility and reuse of code.

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Builder Concepts

- It is a pattern that lets **construct** a complex object **step by step**. The idea is to create **different representations** of an object using the **same construction code**.
- One typical **problem** is work with a **class** that has **many attributes** and it is difficult to create an instance of it. It gets **worse** when there are **many possible representations** of the object.
- Several **attributes** are **optional** and the client has to specify them in a specific order. So, this could be a problem for both objects management and code maintenance. Also, increase memory consumption.
- The **solution** is to encapsulate the object construction and **use** separate **methods** to add or **build** the object attributes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Builder Concepts

- It is a pattern that lets **construct** a complex object **step by step**. The idea is to create **different representations** of an object using the **same construction code**.
- One typical **problem** is work with a **class** that has **many attributes** and it is difficult to create an instance of it. It gets **worse** when there are **many possible representations** of the object.
- Several **attributes** are **optional** and the client has to specify them in a specific order. So, this could be a problem for both objects management and code maintenance. Also, increase memory consumption.
- The **solution** is to encapsulate the object construction and **use** separate **methods** to add or **build** the object attributes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Builder Concepts

- It is a pattern that lets **construct** a complex object **step by step**. The idea is to create **different representations** of an object using the **same construction code**.
- One typical **problem** is work with a **class** that has **many attributes** and it is difficult to create an instance of it. It gets **worse** when there are **many possible representations** of the object.
- Several **attributes** are **optional** and the client has to specify them in a specific order. So, this could be a problem for both objects management and code maintenance. Also, increase memory consumption.
- The **solution** is to encapsulate the object construction and **use** separate **methods** to add or **build** the object attributes.

Builder Concepts

- It is a pattern that lets **construct** a complex object **step by step**. The idea is to create **different representations** of an object using the **same construction code**.
- One typical **problem** is work with a **class** that has **many attributes** and it is difficult to create an instance of it. It gets **worse** when there are **many possible representations** of the object.
- Several **attributes** are **optional** and the client has to specify them in a specific order. So, this could be a problem for both objects management and code maintenance. Also, increase memory consumption.
- The **solution** is to encapsulate the object construction and **use** separate **methods** to add or **build** the object attributes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Builder Classes Structure

Lets the director orchestrate the building process.

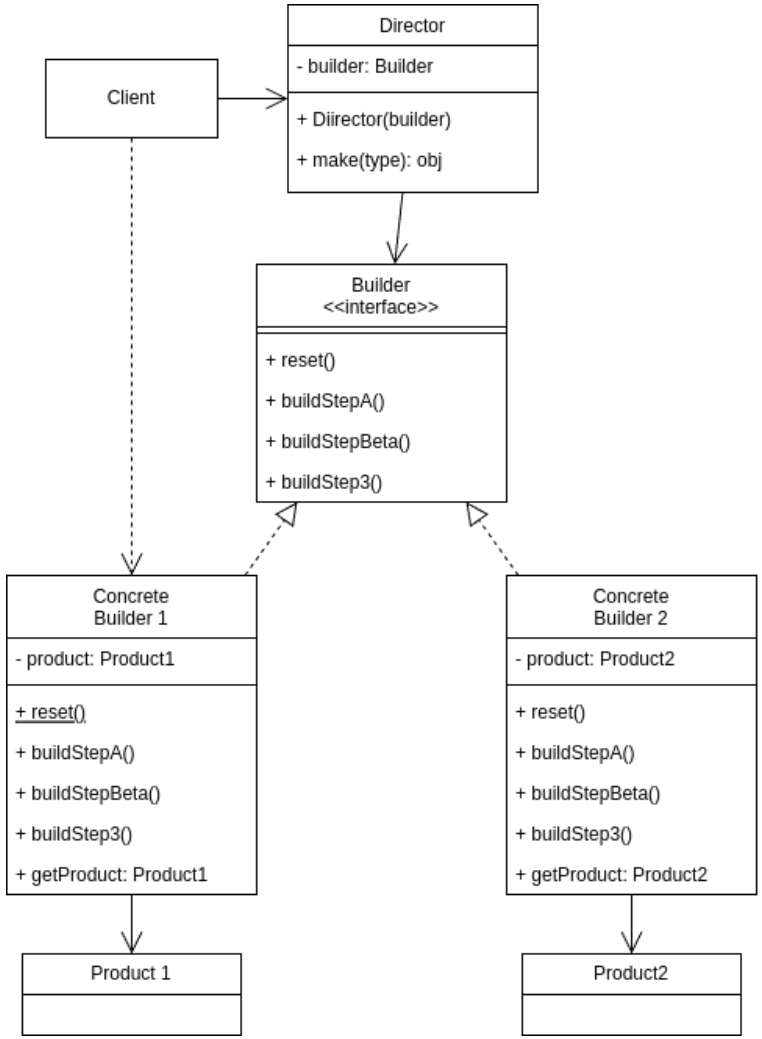


Figure: Builder Class Diagram

Builder Example: Computers

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Factory Concepts

- It is pattern based on a **superclass** and the subclasses could alter the type of objects to be created.
- One of the most **common** design pattern used, is simple, powerful and flexible. It is used with many other design patterns.
- It lets make **simple** a complex code. If you have **groups** of **objects** that are created in a similar way, the factory method is the best choice.
- The **client** just needs to **interact** with the **factory** and the factory will create the object. The **client** does **not** need to **know** the actual implementation of the object (or the subclasses).

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Factory Concepts

- It is pattern based on a **superclass** and the subclasses could alter the type of objects to be created.
- One of the most **common** design pattern used, is simple, powerful and flexible. It is used with many other design patterns.
- It lets make **simple** a complex code. If you have **groups** of **objects** that are created in a similar way, the factory method is the best choice.
- The **client** just needs to **interact** with the **factory** and the factory will create the object. The **client** does **not** need to **know** the actual implementation of the object (or the subclasses).

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Factory Concepts

- It is pattern based on a **superclass** and the subclasses could alter the type of objects to be created.
- One of the most **common** design pattern used, is simple, powerful and flexible. It is used with many other design patterns.
- It lets make **simple** a complex code. If you have **groups** of **objects** that are created in a similar way, the factory method is the best choice.
- The **client** just needs to **interact** with the **factory** and the factory will create the object. The **client** does **not** need to **know** the actual implementation of the object (or the subclasses).

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Factory Concepts

- It is pattern based on a **superclass** and the subclasses could alter the type of objects to be created.
- One of the most **common** design pattern used, is simple, powerful and flexible. It is used with many other design patterns.
- It lets make **simple** a complex code. If you have **groups** of **objects** that are created in a similar way, the factory method is the best choice.
- The **client** just needs to **interact** with the **factory** and the factory will create the object. The **client** does **not** need to **know** the actual implementation of the object (or the subclasses).

Factory Classes Structure

It is like to watch *Charlie and the Chocolate Factory*.

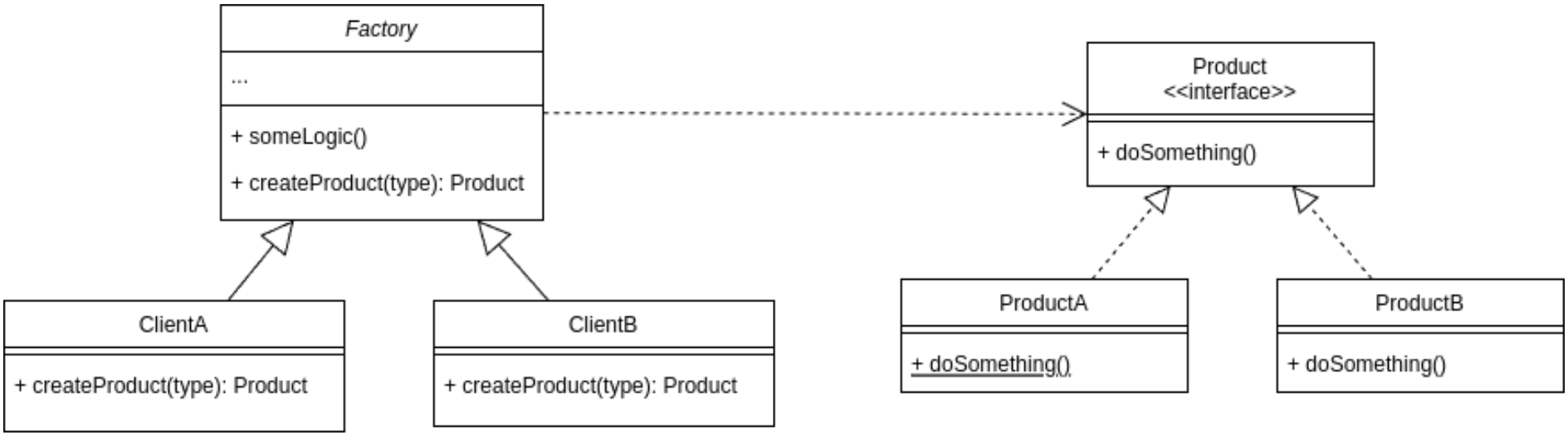


Figure: Factory Class Diagram

Factory Example: On-line Store

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Abstract Factory Concepts

- This is a **pattern** that lets you **produce families** of related objects without specifying their concrete classes.
- It is a **super factory** that creates other factories. It is used when you have a **super class** that can create **subclasses** and the **subclasses** can create **objects**.
- Also this pattern allows to keep the **client** code **decoupled** from the **actual objects** in the system. Keep old code when you need to add new representations.
- It is used when you have **many objects** that can be **grouped** in **families**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Abstract Factory Concepts

- This is a **pattern** that lets you **produce families** of related objects without specifying their concrete classes.
- It is a **super factory** that creates other factories. It is used when you have a **super class** that can create **subclasses** and the **subclasses** can create **objects**.
- Also this pattern allows to keep the **client** code **decoupled** from the **actual objects** in the system. Keep old code when you need to add new representations.
- It is used when you have **many objects** that can be **grouped** in **families**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Abstract Factory Concepts

- This is a **pattern** that lets you **produce families** of related objects without specifying their concrete classes.
- It is a **super factory** that creates other factories. It is used when you have a **super class** that can create **subclasses** and the **subclasses** can create **objects**.
- Also this pattern allows to keep the **client** code **decoupled** from the **actual objects** in the system. Keep old code when you need to add new representations.
- It is used when you have **many objects** that can be **grouped** in **families**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Abstract Factory Concepts

- This is a **pattern** that lets you **produce families** of related objects without specifying their concrete classes.
- It is a **super factory** that creates other factories. It is used when you have a **super class** that can create **subclasses** and the **subclasses** can create **objects**.
- Also this pattern allows to keep the **client** code **decoupled** from the **actual objects** in the system. Keep old code when you need to add new representations.
- It is used when you have **many objects** that can be **grouped** in **families**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Abstract Factory Classes Structure

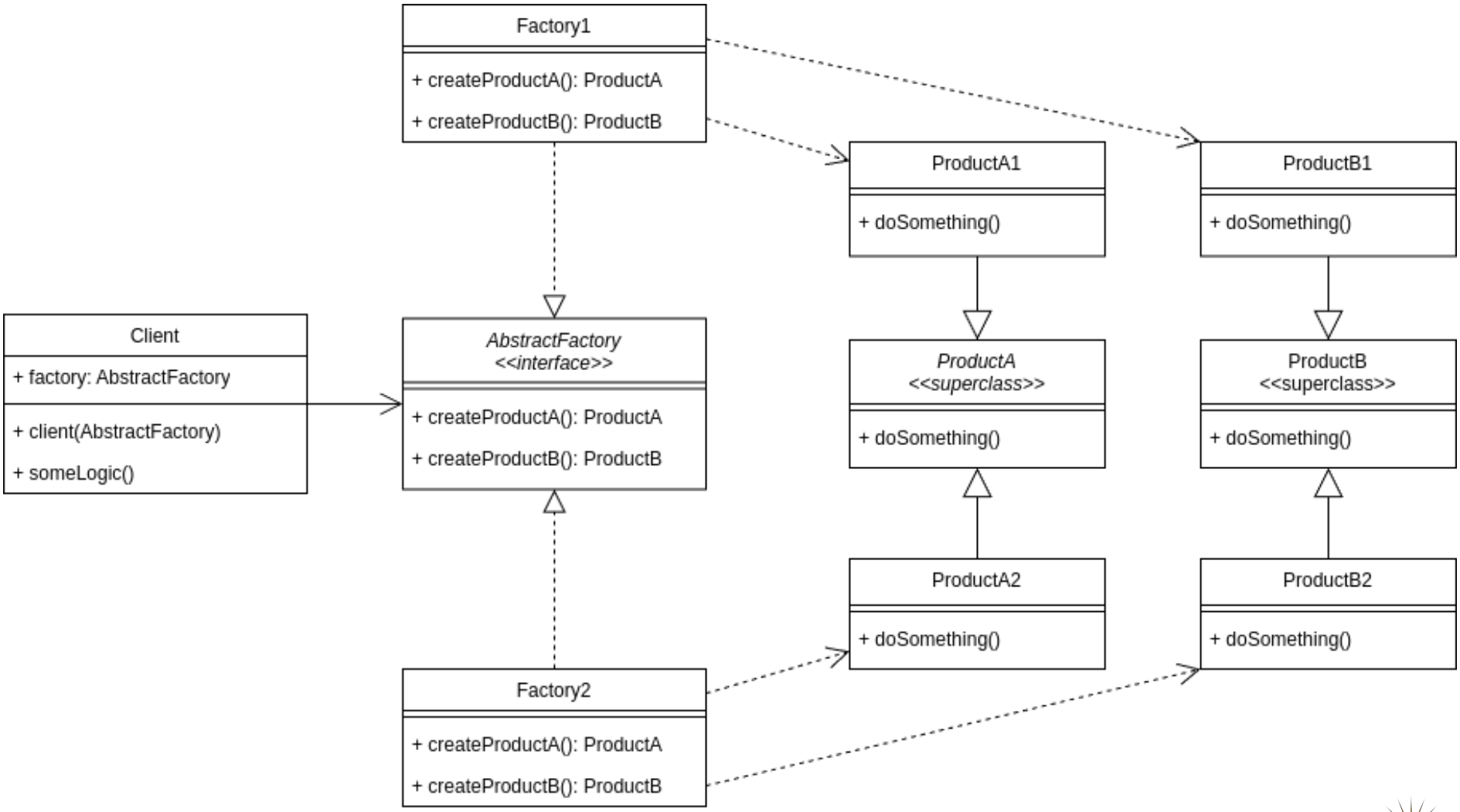


Figure: Abstract Factory Class Diagram

Abstract Factory Example: Furniture Shop

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Singleton Concepts

- In an attemp to **reduce memory** consumption, this pattern ensure that a **class** has only **one instance** and provide a global point of access to it.
- It is used when you need to **control** the **number of instances** of a class, so just one class instance is allowed across all the application. Also it allows to apply the concept of **lazy creation**.
- It is pretty simple: just create a class with a **method** that **creates** a new **instance** of the class **if** one does **not exist**. If an instance already exists, it returns a reference to that object.
- It violates the *Single Responsability principle* and the *Open/Closed principle*. Also, internal instance and get method are *static*.
- **Not** a very **good idea** if you are using a **multi-trending** application, could be issues trying to access a shared single object.

Singleton Concepts

- In an attemp to **reduce memory** consumption, this pattern ensure that a **class** has only **one instance** and provide a global point of access to it.
- It is used when you need to **control** the **number of instances** of a class, so just one class instance is allowed across all the application. Also it allows to apply the concept of **lazy creation**.
- It is pretty simple: just create a class with a **method** that **creates** a new **instance** of the class **if** one does **not exist**. If an instance already exists, it returns a reference to that object.
- It violates the *Single Responsability principle* and the *Open/Closed principle*. Also, internal instance and get method are *static*.
- **Not** a very **good idea** if you are using a **multi-trending** application, could be issues trying to access a shared single object.

Singleton Concepts

- In an attemp to **reduce memory** consumption, this pattern ensure that a **class** has only **one instance** and provide a global point of access to it.
- It is used when you need to **control** the **number of instances** of a class, so just one class instance is allowed across all the application. Also it allows to apply the concept of **lazy creation**.
- It is pretty simple: just create a class with a **method** that **creates** a new **instance** of the class **if** one does **not exist**. If an instance already exists, it returns a reference to that object.
- It violates the *Single Responsability principle* and the *Open/Closed principle*. Also, internal instance and get method are *static*.
- **Not** a very **good idea** if you are using a **multi-trending** application, could be issues trying to access a shared single object.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Singleton Concepts

- In an attemp to **reduce memory** consumption, this pattern ensure that a **class** has only **one instance** and provide a global point of access to it.
- It is used when you need to **control** the **number of instances** of a class, so just one class instance is allowed across all the application. Also it allows to apply the concept of **lazy creation**.
- It is pretty simple: just create a class with a **method** that **creates** a new **instance** of the class **if** one does **not exist**. If an instance already exists, it returns a reference to that object.
- It violates the *Single Responsability principle* and the *Open/Closed principle*. Also, internal instance and get method are *static*.
- **Not** a very **good idea** if you are using a **multi-trending** application, could be issues trying to access a shared single object.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Singleton Concepts

- In an attemp to **reduce memory** consumption, this pattern ensure that a **class** has only **one instance** and provide a global point of access to it.
- It is used when you need to **control** the **number of instances** of a class, so just one class instance is allowed across all the application. Also it allows to apply the concept of **lazy creation**.
- It is pretty simple: just create a class with a **method** that **creates** a new **instance** of the class **if** one does **not exist**. If an instance already exists, it returns a reference to that object.
- It violates the *Single Responsability principle* and the *Open/Closed principle*. Also, internal instance and get method are *static*.
- **Not** a very **good idea** if you are using a **multi-trending** application, could be issues trying to access a shared single object.

Singleton Classes Structure

Think in a circle room with several doors but just one doorman.

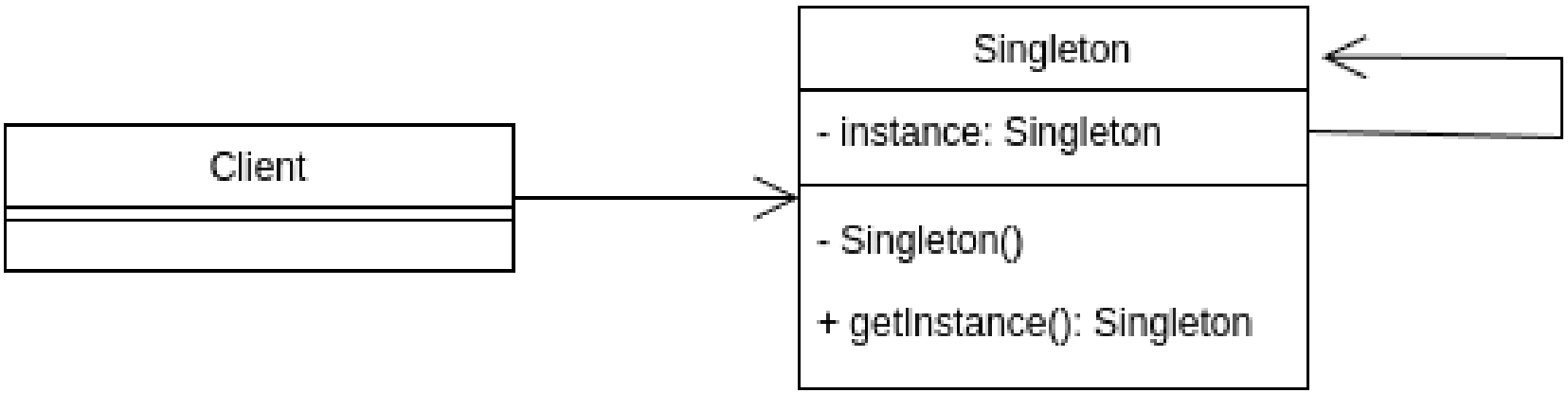


Figure: Singleton Class Diagram

Singleton Example: Game Style Preferences

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Prototype Concepts

- It is based on **copy** of an **existing object**. It is used when the type of objects to create is determined by a prototypical instance, which is **cloned** to produce new objects.
- Remember, **clone** is not just copy an object, it is **create** a new **object** with the **same attributes** and **values** of the original object.
- It solves the problem of copy the private attributes of an object. So, you could create a **copy including the hide logic**.
- This pattern **delegates** the **cloning** process to the **actual objects** that are being cloned. This is a good idea because the object knows how to create a copy of itself using an internal method.
- It exists the concept of **prototype registry**, just to make quick access and save of frecuently-used ptototypes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Prototype Concepts

- It is based on **copy** of an **existing object**. It is used when the type of objects to create is determined by a prototypical instance, which is **cloned** to produce new objects.
- Remember, **clone** is not just copy an object, it is **create** a new **object** with the **same attributes** and **values** of the original object.
- It solves the problem of copy the private attributes of an object. So, you could create a **copy including the hide logic**.
- This pattern **delegates** the **cloning** process to the **actual objects** that are being cloned. This is a good idea because the object knows how to create a copy of itself using an internal method.
- It exists the concept of **prototype registry**, just to make quick access and save of frecuently-used ptototypes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Prototype Concepts

- It is based on **copy** of an **existing object**. It is used when the type of objects to create is determined by a prototypical instance, which is **cloned** to produce new objects.
- Remember, **clone** is not just copy an object, it is **create** a new **object** with the **same attributes** and **values** of the original object.
- It solves the problem of copy the private attributes of an object. So, you could create a **copy including the hide logic**.
- This pattern **delegates** the **cloning** process to the **actual objects** that are being cloned. This is a good idea because the object knows how to create a copy of itself using an internal method.
- It exists the concept of **prototype registry**, just to make quick access and save of frecuently-used ptototypes.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Prototype Concepts

- It is based on **copy** of an **existing object**. It is used when the type of objects to create is determined by a prototypical instance, which is **cloned** to produce new objects.
- Remember, **clone** is not just copy an object, it is **create** a new **object** with the **same attributes** and **values** of the original object.
- It solves the problem of copy the private attributes of an object. So, you could create a **copy including the hide logic**.
- This pattern **delegates** the **cloning** process to the **actual objects** that are being cloned. This is a good idea because the object knows how to create a copy of itself using an internal method.
- It exists the concept of **prototype registry**, just to make quick access and save of frecuently-used ptototypes.

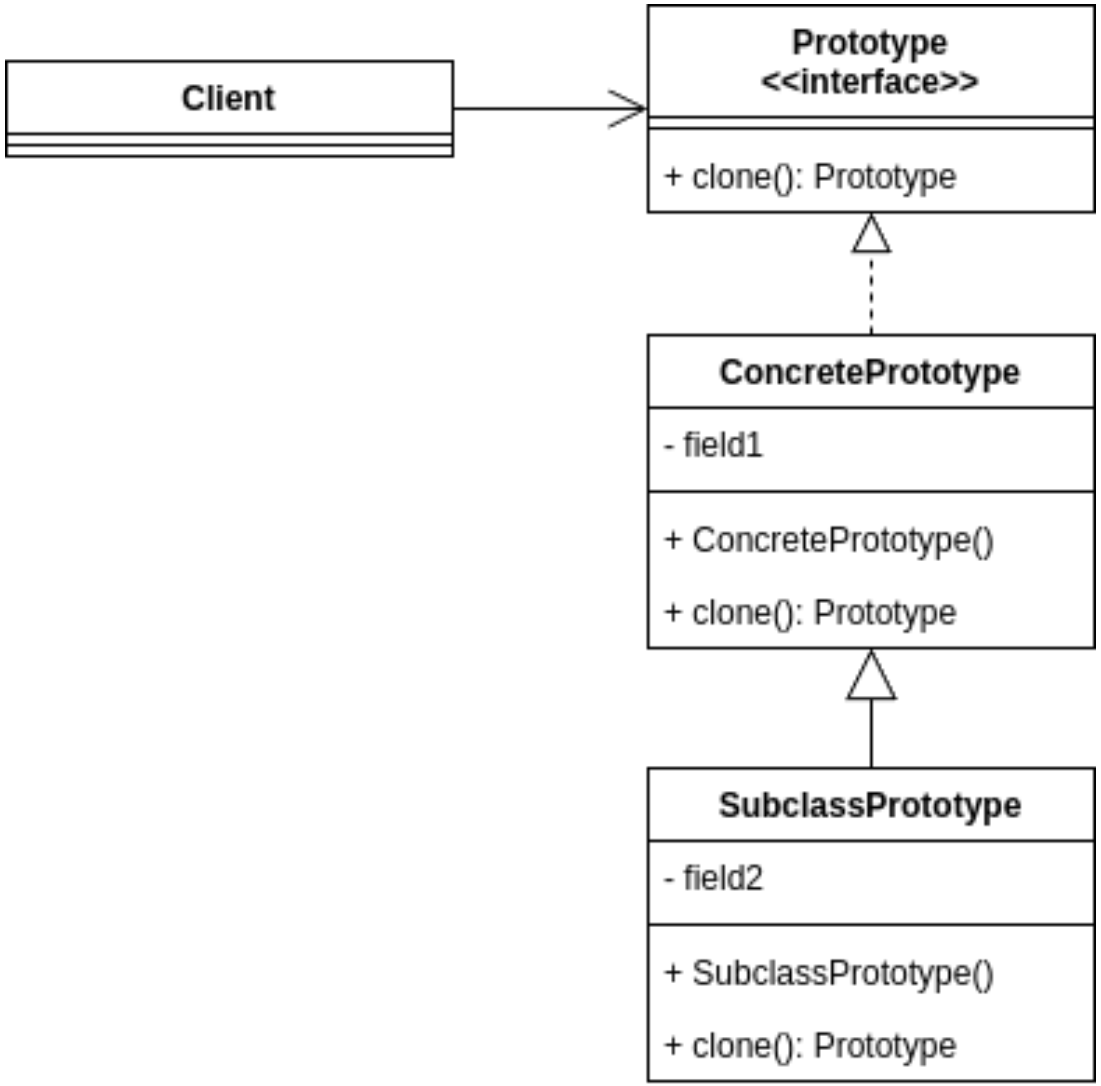
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Prototype Concepts

- It is based on **copy** of an **existing object**. It is used when the type of objects to create is determined by a prototypical instance, which is **cloned** to produce new objects.
- Remember, **clone** is not just copy an object, it is **create** a new **object** with the **same attributes** and **values** of the original object.
- It solves the problem of copy the private attributes of an object. So, you could create a **copy including the hide logic**.
- This pattern **delegates** the **cloning** process to the **actual objects** that are being cloned. This is a good idea because the object knows how to create a copy of itself using an internal method.
- It exists the concept of **prototype registry**, just to make quick access and save of frecuently-used ptototypes.

Prototype Classes Structure

You know all my secrets, so you could create a clone of me.



Prototype Example: Cellular Differenciation

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Conclusions

- There are a few ways to create objects inside an application in a pretty eficient way. You just need to think about it and choose the best one for your application.
- You could combine these patterns to create a more complex and flexible application. However, you need to be careful with the complexity of the application.
- The **Builder** pattern is used to create a complex object step by step.
  The **Factory** pattern is used to create objects in a simple way.
  The **Abstract Factory** pattern is used to create families of objects.
  The **Singleton** pattern is used to create just one instance of a class.
  The **Prototype** pattern is used to create a new object by copying an existing object.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Conclusions

- There are a few ways to create objects inside an application in a pretty eficient way. You just need to think about it and choose the best one for your application.
- You could combine these patterns to create a more complex and flexible application. However, you need to be careful with the complexity of the application.
- The **Builder** pattern is used to create a complex object step by step.
  The **Factory** pattern is used to create objects in a simple way.
  The **Abstract Factory** pattern is used to create families of objects.
  The **Singleton** pattern is used to create just one instance of a class.
  The **Prototype** pattern is used to create a new object by copying an existing object.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Conclusions

- There are a few ways to create objects inside an application in a pretty eficient way. You just need to think about it and choose the best one for your application.
- You could combine these patterns to create a more complex and flexible application. However, you need to be careful with the complexity of the application.
- The **Builder** pattern is used to create a complex object step by step.
  The **Factory** pattern is used to create objects in a simple way.
  The **Abstract Factory** pattern is used to create families of objects.
  The **Singleton** pattern is used to create just one instance of a class.
  The **Prototype** pattern is used to create a new object by copying an existing object.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Thanks!

Questions?

Repo: *github.com/engandres/ud-public/software-modeling*