# Creational Design Pattern

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# Outline

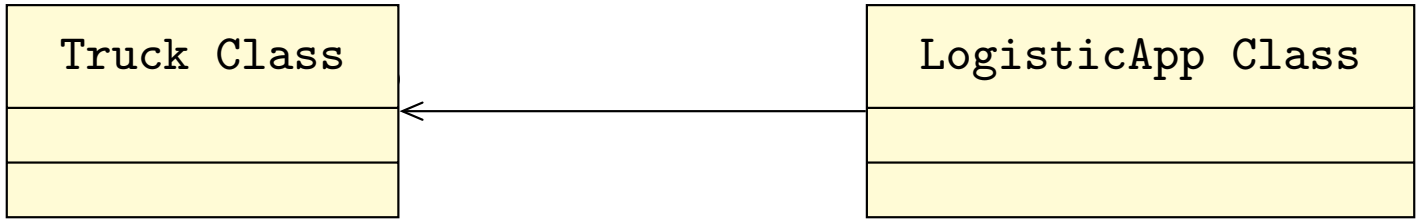
# Creational Pattern Overview

**Construction process of an object.**

- **Singleton**: Ensure only one instance.
- **Factory Method**: Create instance without depending on its concrete type.
- **Object pool**: Reuse existing instances.
- **Abstract factory**: Create instances from a specific family.
- **Prototype**: Clone existing objects from a prototype.
- **Builder**: Construct a complex object step by step.

# Logistic App


# Logistic App




- Your app can only handle transportation by trucks.
- The bulk of your code lives inside the Truck class.

You have more request from oversea regions, how to incorporate sea transportation with current app?

- At present, your code is tightly coupled with Truck class.
- Adding new Ship class resulting in change all code base.
- Logistic app depends on transportation object.

# Using "new" operator

```
1  #include <iostream>
2
3  using namespace std;
4
5  class Box {
6  private:
7    double length;
8    double breadth;
9    double height;
10 };
11
12 int main(void) {
13   Box *pBox = new Box();
14   delete pBox;
15   return 0;
16 }
```

- Need name of class
- Tightly coupled with the name
- Add new class, modify the existing code
- Compiler does not know which instance created at compile time or an instance has to be created at runtime?

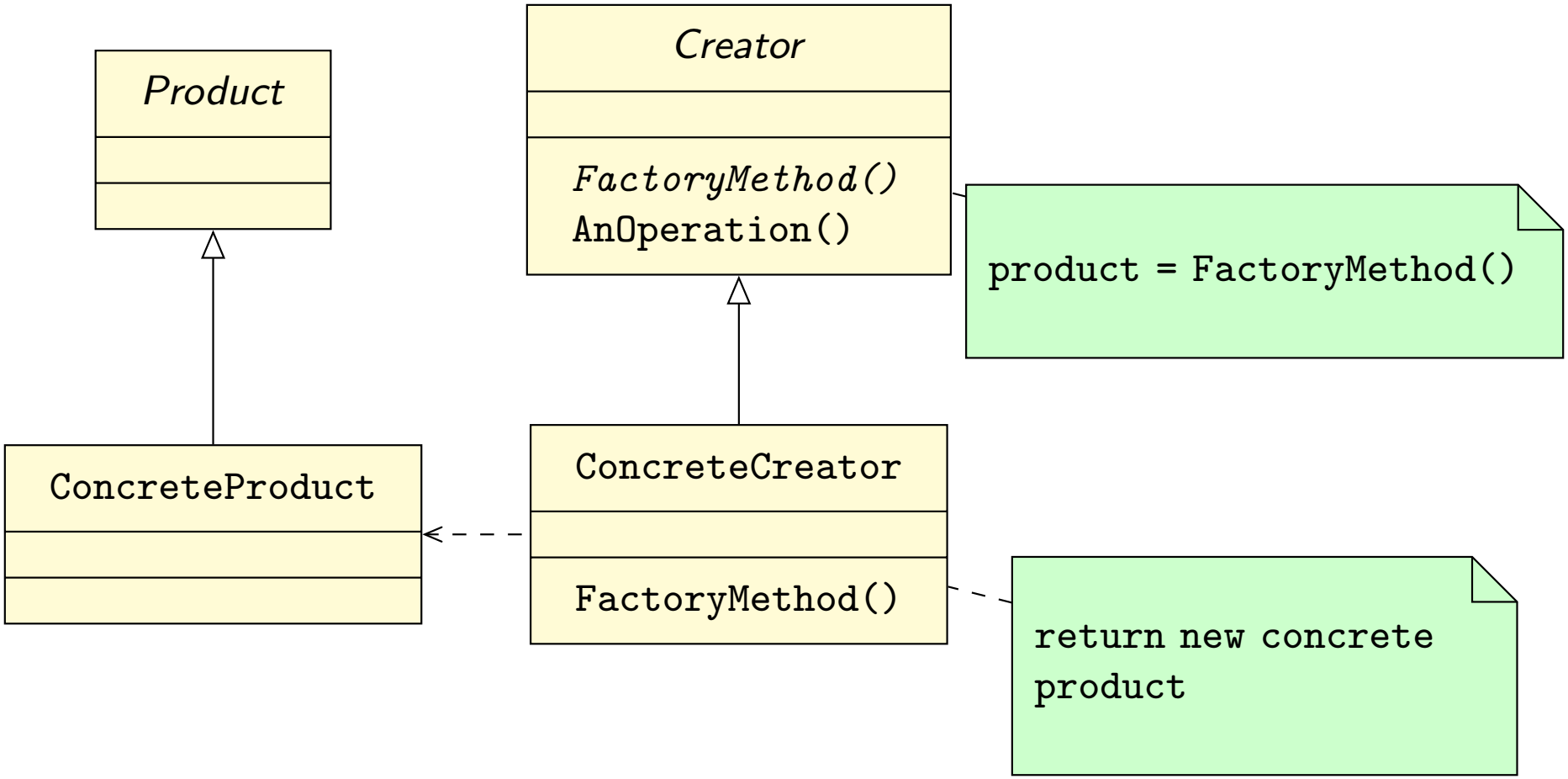
# The Intent of Factory Method Design Pattern

**Define an interface for creating an object, but let subclasses which class to instantitate. Factory method lets class defer instantiation to subclasses.**

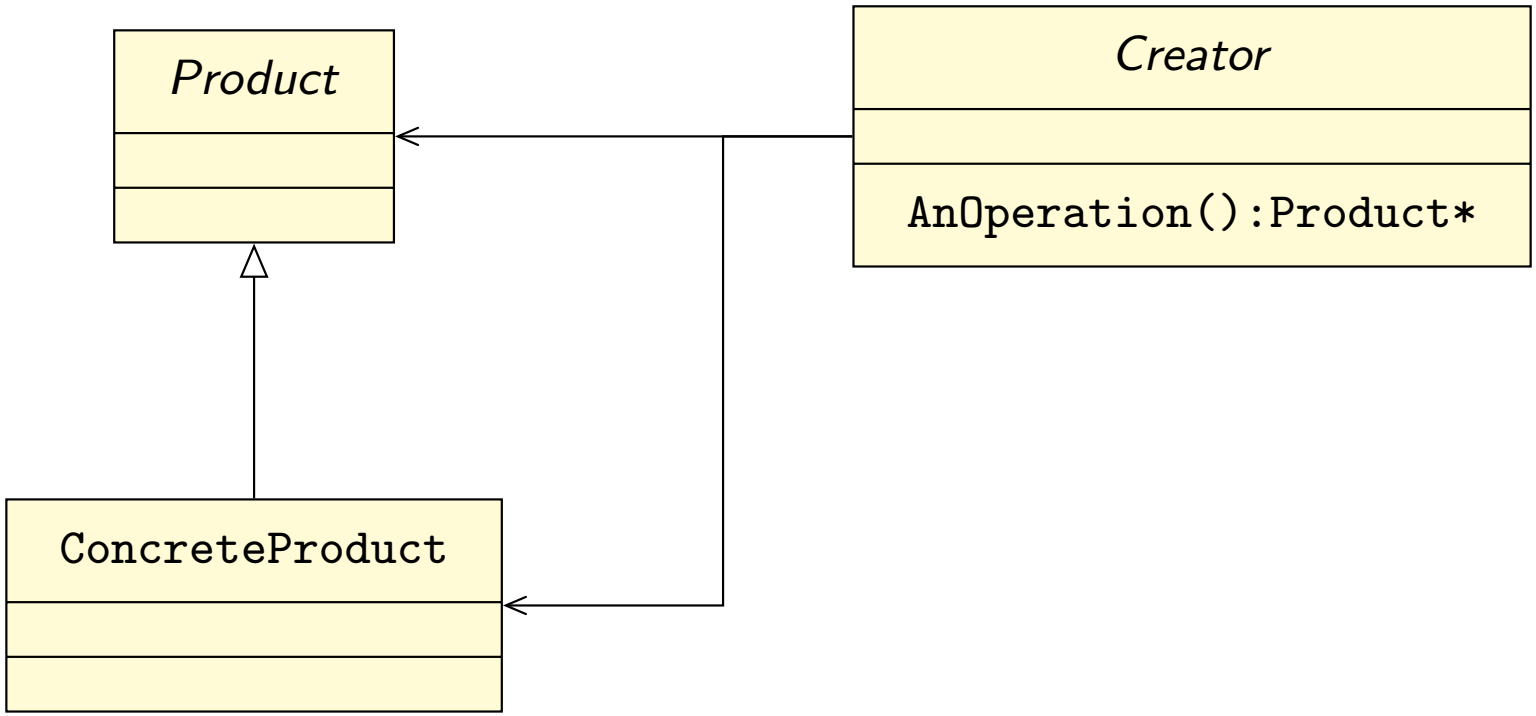
# How to Implement of Factory Method Design Pattern?

- Different ways to implement
- An overridable method is provide that returns an instance of a class
- This method can be overridden to return instance of a subclass
- Behave likes **constructor**
- However, the constructor always returns the same instance
- The factory method can returns any sub-type
- The factory method also called **virtual constructor**
- C++ language does not allow virtual constructor

# Structure of Factory Method Design Pattern

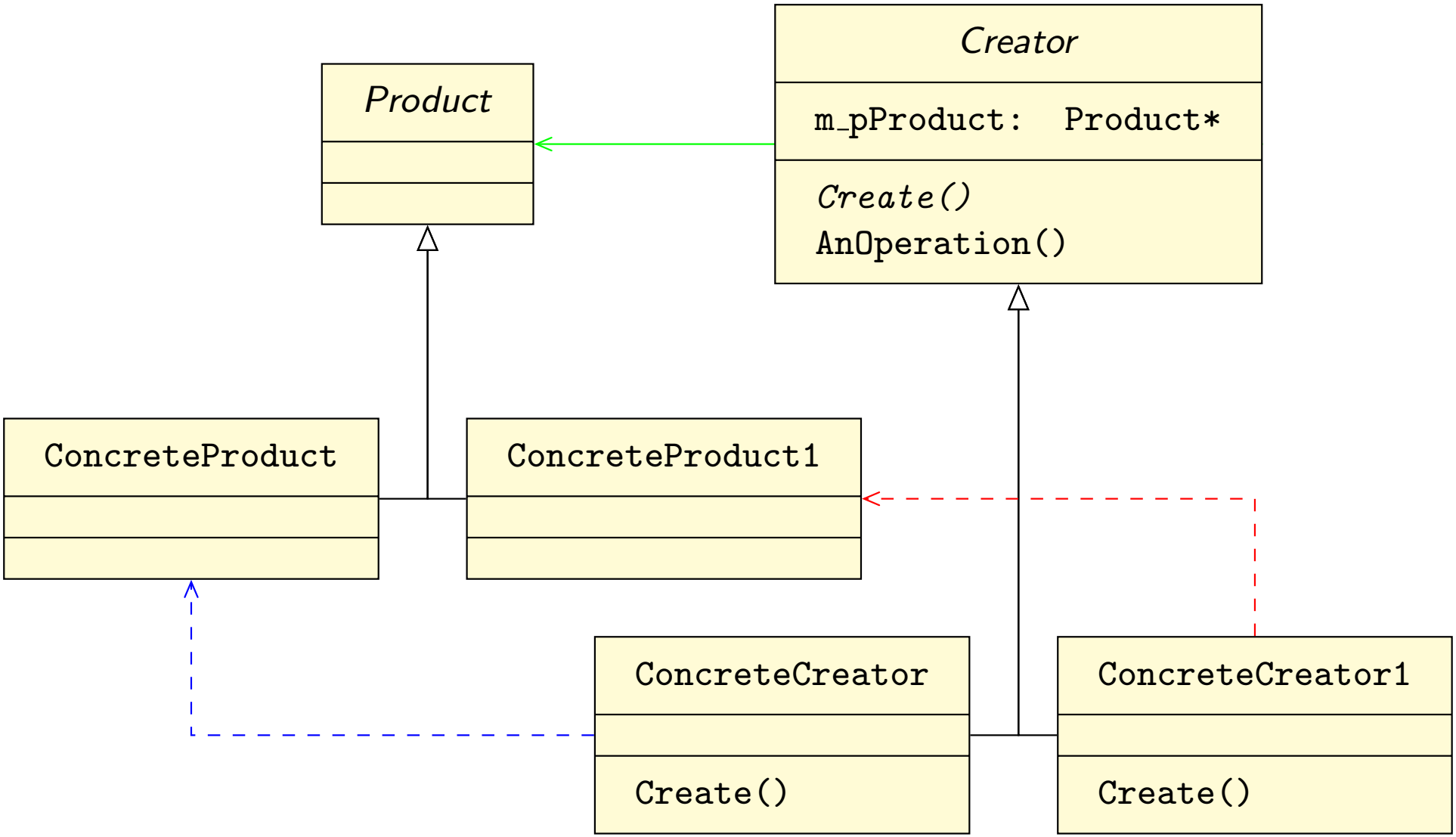


# Modify existing code problem




- Operation() method returns ConcreteProduct object
- Add more ConcreteProduct class, modify AnOperation() method
- End up with if else condition.
- Always return the same class (using new operator)

# Class Diagram Explaining



# Create a ConcreteProduct object

main.cpp

```
#include "Creator.h"
#include "ConcreteCreator.h"
#include "ConcreteCreator1.h"
int main() {
  ConcreteCreator1 ct;
  ct.AnOperation();
}
```

- Create() Method (or factory method) is overridden in derived classes.
- The dependency on ConcreteProduct is no longer required
- AnOperation method calls Create() method.
- With the main function, which Create() method will invoke?
- No need to modify the AnOperation()
- Create() method behaves like virtual constructor

# Real World Example: Application Framework?

We want to create an framework!

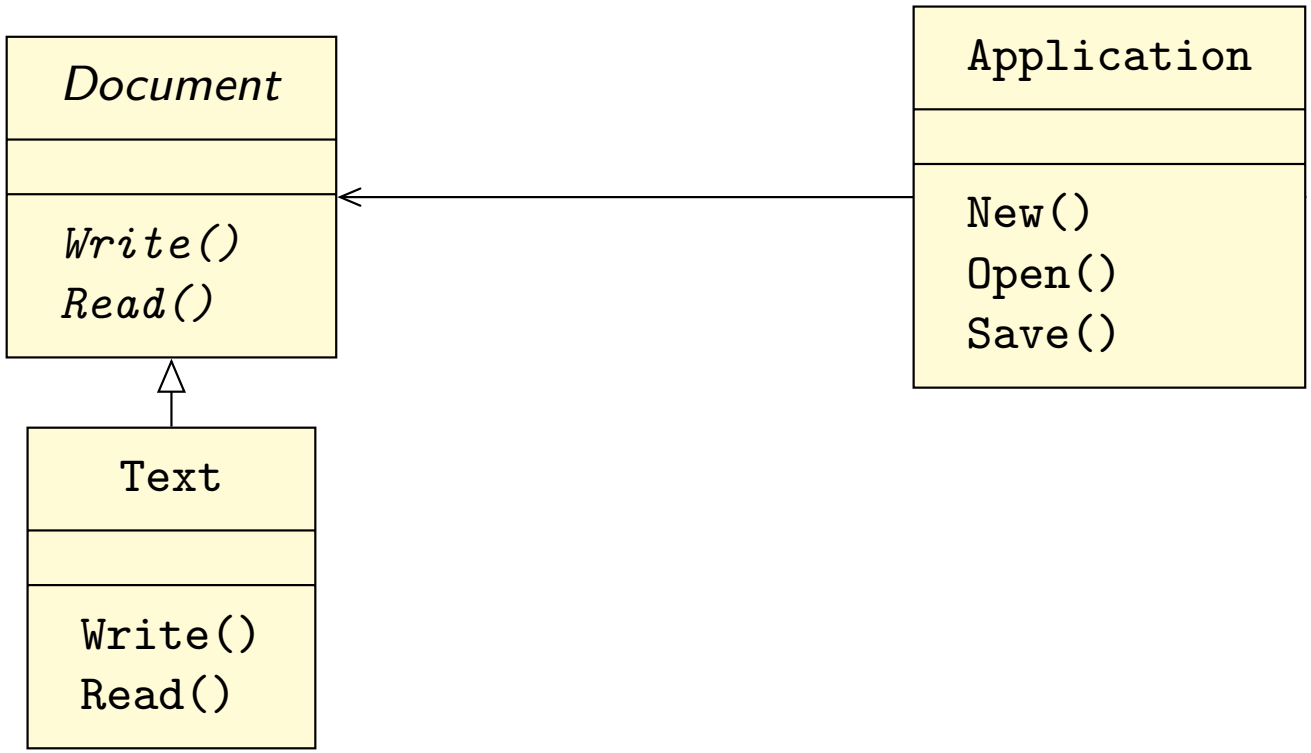
- The programmer can create an Application based on App framework.
- Framework provides managing different kinds of documents.
- Framework provides infrastructure of application.
- By using app framework, programmer can create an application which can display different kinds of data (Text or Graphics).
- To manage the data, the framework provides support through which is easy to maintain data.
- We add Application class for managing data and display them.
- We need add an Document class that Application manages

# Real World Example: Application Framework?

- Application class uses the features of Document class (display them).
- However, Application does not know what kind of data is.
- Document class need to be abstract in our framework.
- **Document class has methods Read(), Write() which are overridden in derived classes.**
- **Application class uses the features of Document class.**

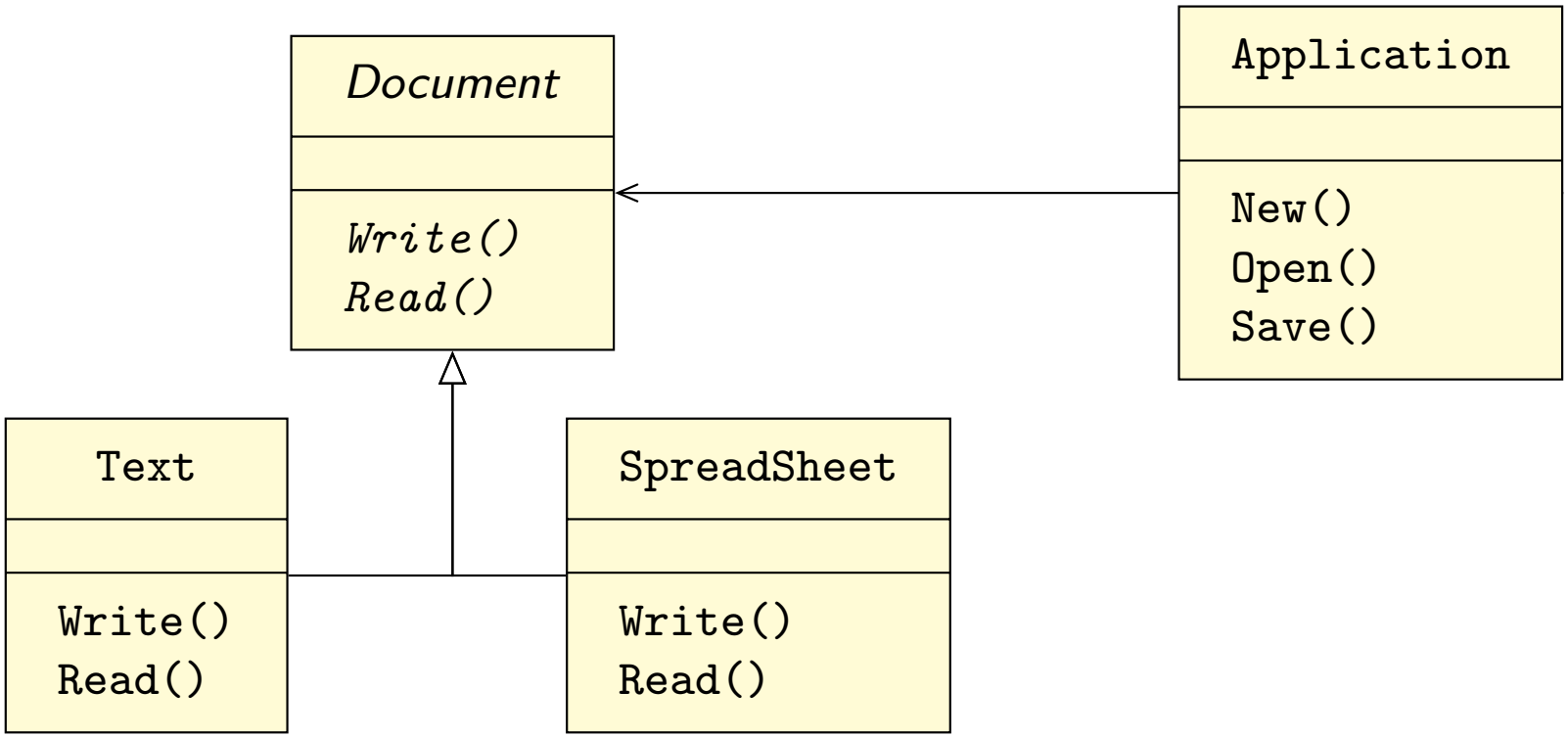
# Using Framework for managing data

- Programmer want to use the framework for managing the Text data.
- Create a class Text which is derived class of Document class.
- Application can use Text through Document class.

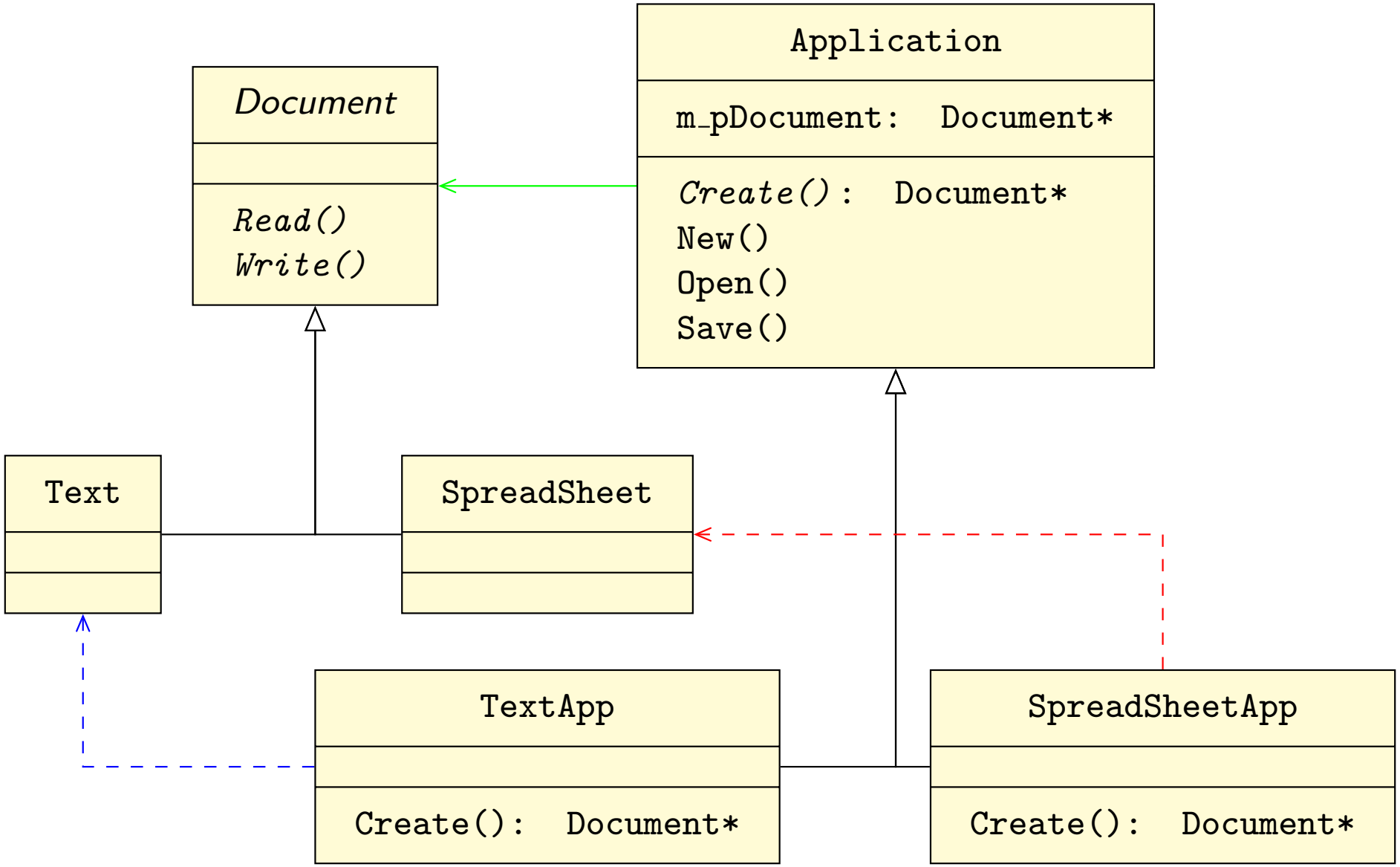


# Adding SpreadSheet class

- New(), Open(), Save() are tight coupled with Text class.
- Adding new Document class, change the Application class.
- The framework does not allow modifying.



# App framework with factory method



# The Intent of Factory Method Design Pattern

**Define an interface for creating an object, but let subclasses which class to instantitate. Factory method lets class defer instantiation to subclasses.**

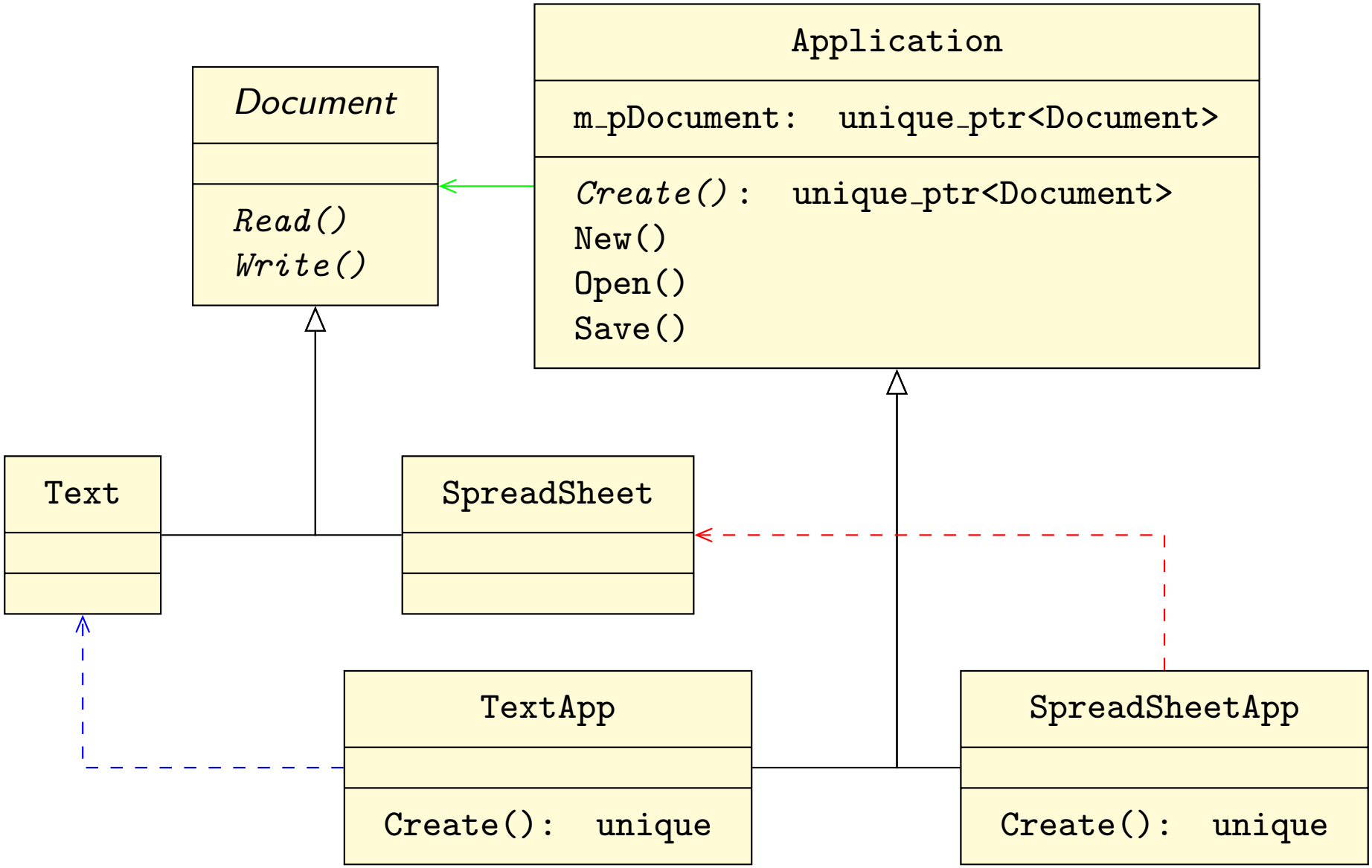
- Application class is an interface.
- Create() method is factory method.
- The subclasses (TextApp and SpreadSheetApp) instantiate objects.

# Resource Management

```
#include "TextApplication.h"
#include "TextDocument.h"
Document* TextApplication::Create()
        {
   return new TextDocument{};
}
```

- How to free the instance?
- Using smart pointers

# Using smart pointer

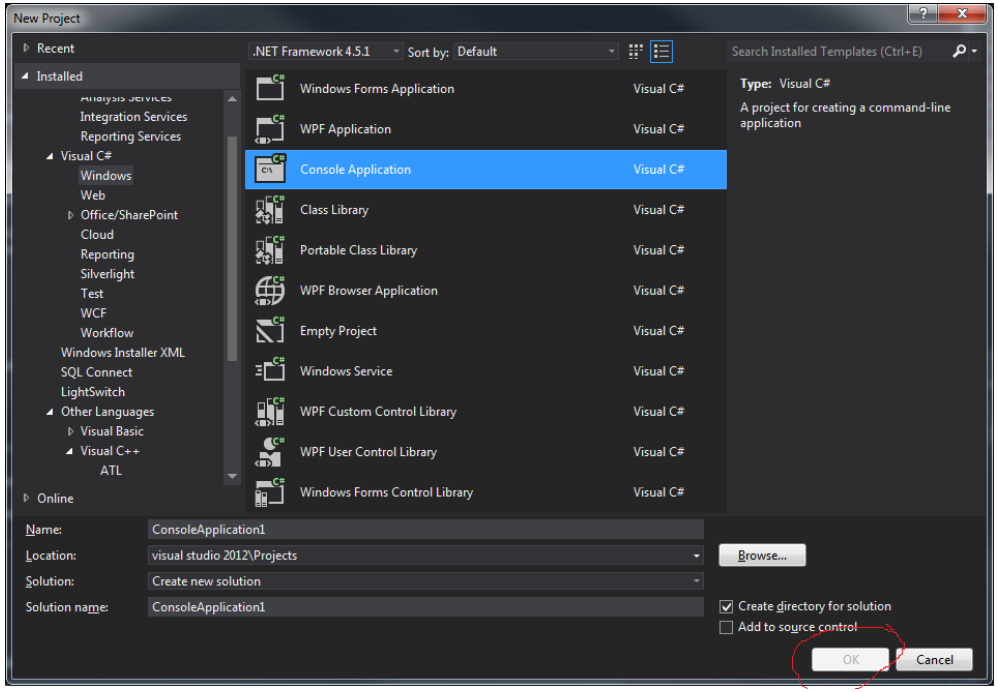


# Add new Document, add more Application?

How to create multiple instances without creating corresponding application class?

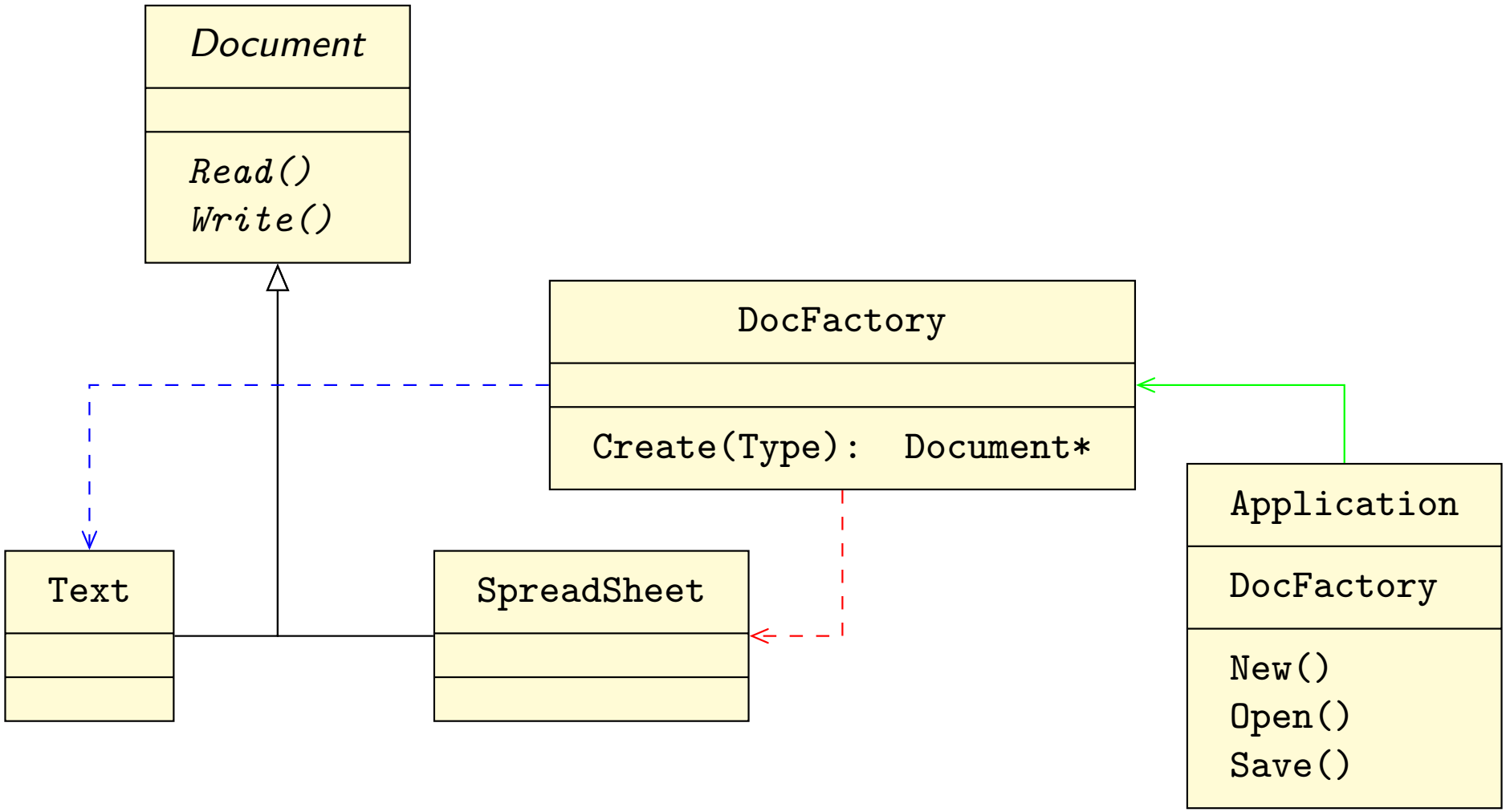
**Using Parameterized Factory**

# What if you want to read different kinds of document?




- Like dialog shows options which clients can chose.
- You need to know how many applications before implementations.
- Input Type through user interface.

# Classes structure: Parameterized Factory



# Pros and Cons

## Pros

- Instances can be created at runtime
- Promote loose coupling
- Construction becomes simple due to abstraction
- Construction becomes encapsulated
- May not return new instance every time (return a cache instance), useful for object pool

## Cons

- Every new product class may require a corresponding factory class.

# Where to use?

- A class does not know which instance it needs at runtime.
- A class does not want to depend on concrete classes that it uses.
- You want to encapsulate the creation process.