1. Sources:

* <https://refactoring.guru/pl/design-patterns/>

1. General notes

* Gamma categorization of design patterns:
  + Creational patterns
    - Deal with the creation (construction) of objects
    - Explicit (constructor) vs implicit (DI, reflection etc.)
    - Wholesale (singe statement) vs piecewise (step by step)
  + Structural patterns
    - Concerned with the structure (e.g., class members)
    - Many patterns are wrappers that mimic the underlying class interface
    - Stress the importance of good API design
  + Behavioral patterns
    - They are all different, no central theme

1. SOLID

* Single responsibility principle
  + Class should have only 1 reason to change
  + Different tasks handle different independent tasks, problems
  + Example is having a journal with title and add\_entry() method. Bad idea is to add new functionality to this class for saving journal to file. In case we have a lot of classes operating on strings, it would lead us to copying this functionality to other classes. It is better to create separate class for new concern (interfacing with files).
* Open – close principle
  + Classes should be open for extensions (by inheriting for example) but closed for modifications
  + It is better to not come back to same class as it is already tested and also client maybe would have to recompile client program to use new library
* Liskov substitution principle
  + You should be able to substitute a base type with a inherit class
  + If we have class square and rectangle, it’s better to make those 2 classes inherit from shape instead of square inherit from rectangle (square only 1 member, rectangle 2)
* Interface segregation
  + Don’t put to much into 1 interface, split into separate interfaces
  + Example with IMachine witch were able to print(), scan() and fax(). Every class inheriting from this interface has to implement all of these function even if it is only printer
* Dependency inversion principle
  + High level modules should not depend on low level ones, use abstractions

1. Builder (Creational)

* Instead of creating a component in user code, you create specialized class/structure to create (build) this component (encapsulate this component) and work with whis component
* If you want to force user to not use component, you can make ctrors private and add friend class builder into component
* You can either give builder a constructor and initialize components members in it, or you can return builder via static function (components member)
* Use it to avoid million parameters in constructor

Diagram

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1. Factory (Creational)

* Used when creation logic is too complicated and/or constructors would be not descriptive (constructors has the same name as component, you cannot overload them with same args with diffrent names, can turn into ‘std::optional hell’)
* Object creation (non-piecewise, unlike Builder) can be outsourced to:
  + Separate function (Factory method)
  + Separate class (Factory)
  + Hierarchy of factories (Abstract Factory)

Diagram

Description automatically generated

1. Prototype (Creational)

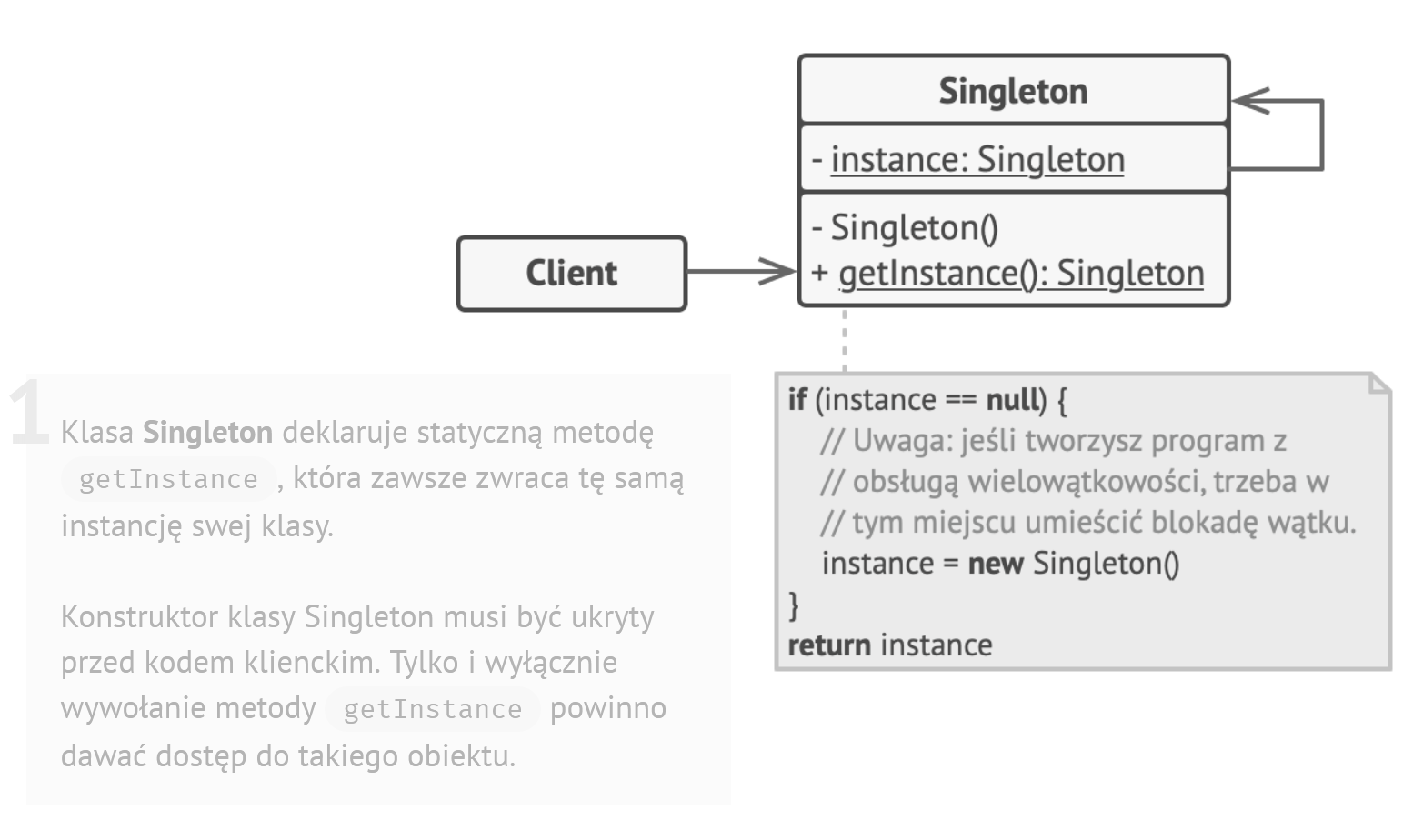
* Interface needs to implement prototype in means partially create object and store it somewhere to copy
* User has to copy prototype (already created object – then he can customize fields of this object in his favour, but for all other fields will be already filled with some values)
* To make copy possible, interface has to implement copy constructor or implement serialization methods
* Is better then just copying obj because by copying obj user cannot copy private members, also the object that you are copying to, don’t have to be the same type (it is enough that it inherits from common interface)

Diagram

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1. Singleton (Creational)

* Only one component in the system (e.g. database or object factory)
* E.g. when constructor is very expensive
* Can be implemented with hiding ctrs (copy as well) in private part. Then providing member of class Singleton\* singleton and static method if (singleton == nullptr) -> singleton = make\_unique<Singleton>() and return singleton beside if. This way every caller of this static method will get same instance of Singleton (first will allocate memory for it).
* Monolit design pattern is type of Singleton where we have static data member (is one and common for all class instances)



1. Adapter (Structural)

* Allows objects with incompatible interface to collaborate.
* Example: You created stock market monitoring app which displays charts and diagrams in XML. Then you decide to improve app by integrating 3rd-party library. But the library works only with JSON format.
* Adapter is a special object that converts the interface of one object that another can understand it.
* The adapter gets an interface, compatible with one of the existing objects.
* Using this interface, the existing object can safely call the adapter’s methods.
* Upon receiving a call, the adapter passes the request to the second object, but in a format and order that the second object expects.
* Sometimes it’s even possible to create a two-way adapter that can convert the calls in both directions.
* 2 implementations, object adapter (composition) and class adapter (inheritance)

Text

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Diagram

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1. Bridge (structural)

* Can be implemented with pImpl idiom. We can have few implementations and unique\_ptr to type of base class to those implementations. Then we can change the implementations of our interface dynamically.
* It is used to not create million classes for every implementation (app for windows, app for linux etc.)

Diagram

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1. Composite (structural)

* Is used when core model of app can be represented as tree
* Example is app where you have products (one base class) and boxes (another base class). In one order, you can have 1 product, 2 boxes, In one of this boxes we can have another 3 boxes and etc. so if you want to count the price of whole order you need to call get\_price, for every box, and every box inside will do the same recursively. Using a loop would be a bad idea, because you would have to know what kind od Products and box you work with (derived classes).

Diagram

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1. Decorator (structural)

* Use aggregation instead of inheritance to expand functionality of some component
* Usually, decorator wraps the component that you want to expand, but also inherit from it, so in constructor it can take no only this component but also other decorator obj (dynamic polymorphism).

Diagram, text

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1. Façade (structural)

* A facade is a class that provides a simple interface to a complex subsystem which contains lots of moving parts. A facade might provide limited functionality in comparison to working with the subsystem directly. However, it includes only those features that clients really care about.
* Having a facade is handy when you need to integrate your app with a sophisticated library that has dozens of features, but you just need a tiny bit of its functionality.

Diagram

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1. Flyweight (structural)

* Simple purpose: minimizing memory usage.
* Flyweight class contains object state that can be shared between multiple objects (intrinsic) and takes unique state via methods (extrinsic)
* You might be trading RAM over CPU cycles when some of the context data needs to be recalculated each time somebody calls a flyweight method.

Diagram

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1. Proxy (structural)

* The Proxy pattern suggests that you create a new proxy class with the same interface as an original service object. Then you update your app so that it passes the proxy object to all of the original object’s clients. Upon receiving a request from a client, the proxy creates a real service object and delegates all the work to it.
* If you need to execute something either before or after the primary logic of the class, the proxy lets you do this without changing that class.

Diagram

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