Composite

A nice and common design pattern

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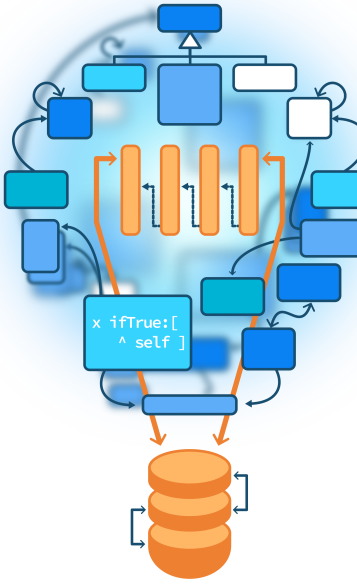


Outline

- Motivating examples
- Presentation of the Composite design pattern
- Discussions on Composite

File entry examples

```
Pharo.image
```

```
MOOC_Files/
  Pharo.image
  Pharo.changes
```

```
MOOC_Files/
  src/
  doc/
  images/
    Pharo.image
    Pharo.changes
```

A file entry is:

- a file
- or a folder with entries as children

Documents

A document is composed of:

- a title
- a table of contents
- chapters

A chapter is composed of:

- sections

A section is composed of:

- paragraphs
- figures
- lists
- sub-sections

Diagram

- A diagram is composed of elements
- An element is:
  - a circle
  - a segment
  - a text
  - a group of elements (i.e, diagram)

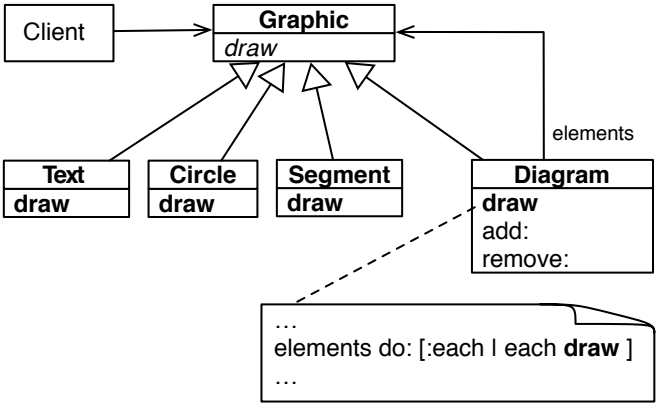
Now the question!

- How do we draw diagram elements?
- How do we draw a diagram?

Can we draw *diagram elements* (circle, ...) and *diagrams* (composed of elements) without explicitly checking?

Composite motivation

Elements and diagrams should offer the same API!



Composite: Intent

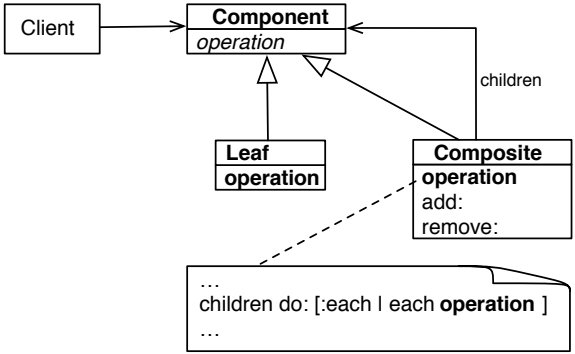
- Compose objects into tree structures to represent **part-whole** hierarchies
- Let clients treat **individual** objects and **compositions** of objects **uniformly**

Client's code:

```
aGraphic draw
```

aGraphic being a Text, Circle, ... or even Diagram (group of Graphics)

Essence of the Composite design pattern

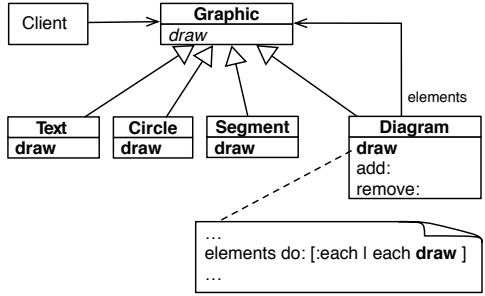


Essence of the Composite desing pattern

What is key:

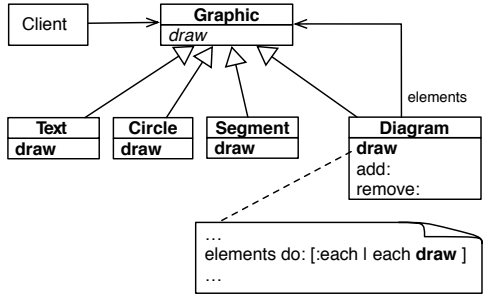
- Leaves offer the **same** API as the composite
- Each leave do something **different** but with the **same** API (polymorphism)
- The composite element offers the same API and some functionality to manage children
- Leaves and the composite are **substitutable**
  - Clients do not have to check

Composite participants: Client



Client manipulates objects in the composition through the **Component** interface (here Graphic)

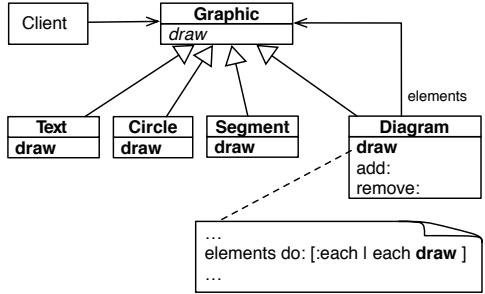
Composite participants: Component



Component (here Graphic)

- declares the interface for objects in the composition
- **may** implement a default behavior for common interface
- **may** declare an interface for accessing and managing its child components
  - see Lecture on “Polymorphic objects”

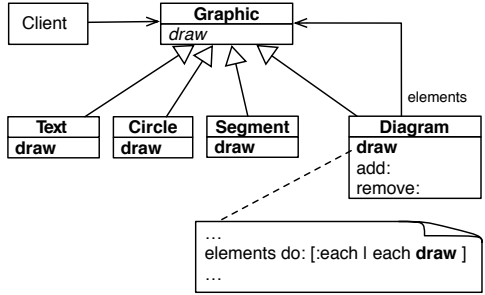
Composite participants: Leaf



Leaf (here Circle, Segment, Text, ...)

- represents leaf objects in the composition
- usually has no children
- defines behavior for primitive objects in the composition using a **polymorphic** API

Composite participants: Composite



Composite (here Diagram)

- defines behavior for components with children via a **polymorphic** API (here draw)
- stores child components
- implements child-related operations (add,remove,...)

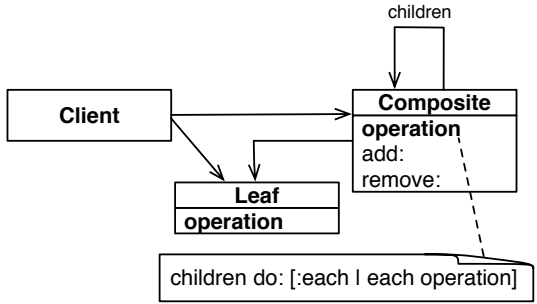
Important!

A Design Pattern:

- is a name and an intent
- can have multiple implementations (pros/cons)

Composite in dynamically-typed languages

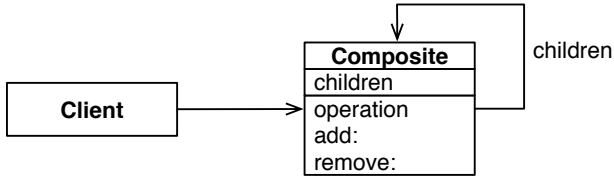
- Polymorphism results from compatible API and not compile-time types checking (see Lecture on Polymorphic objects)
- So, composite and leaves do **not** have to inherit from a common ancestor
  - more difficult to recognize the composite but it works



Composite: extreme implementation

Extreme Composite implementation:

- a single class
- the components (leaves) are composite with no children
- the gain of such an implementation is unclear



Frequently Asked Questions

Can Composite contain any type of child?

- Yes if they implement the common API
- Wrappers or adapters can help with third-party objects

Can we limit the depth of a composite object (number of children)?

- Yes

Can we have different Composites within the same system?

- Yes and each Composite can have a different constraints, behavior, ...

About Composite behavior

Variations on Composite behavior:

- **Simple forward** sends the message to all the children and merges the results without performing any other behavior
- **Selective forward** conditionally forwards the message to some children
- **Extended forward** adds an extra behavior and delegates to leaves
- **Overriding** does not delegate to leaves

Composite and other design patterns

Composite and Visitors

- Visitors walk on structured recursive objects e.g. composites
- see Lectures on Visitor

Composite and Factories

- Factories can create composite elements

Conclusion

- Composite is about composing objects into tree structures to represent part-whole hierarchies
- Composite provides a uniform API to clients for leaves and composite
- Composite is extensible (easy to add new leaves)
- Basis for complex treatments expressed as Visitors
  - see Lectures on Visitor

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A course by
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