Douglas C. Schmidt

Other Considerations of the Composite Pattern

Consequences

+ *Uniformity*

- Treat components the same regardless of complexity & behavior

```
Expression_Tree expr_tree = ...;
Visitor visitor = ...;

for (auto iter =
       expr_tree.begin(order);
     iter != expr_tree.end(order);
     ++iter)
  (*iter).accept(visitor);
```

No syntactic distinction between leaf nodes or composite nodes (iterator variant)

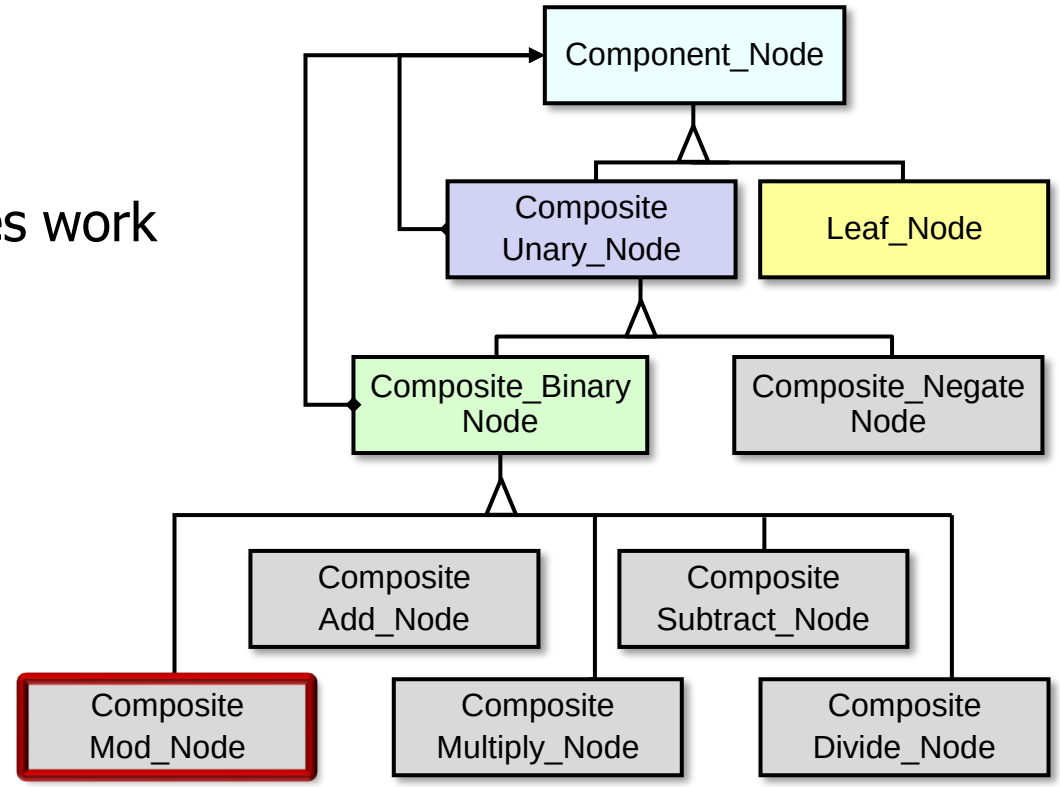
Eliminate type tags & switch statements when combined with other patterns.

Consequences

+ *Uniformity*

+ *Extensibility*

  - New component subclasses work wherever existing ones do



Consequences

+ *Uniformity*
+ *Extensibility*
+ *Parsimony*
  - Classes & interfaces only include fields & methods that they need


```
class Component_Node {

  virtual int item() const {
    throw Invalid_Function_Call
        ("method not implemented");
    return 0;
  }

  virtual Component_Node *right(){
     return nullptr;
  }

  virtual Component_Node *left() const {
     return nullptr;
  }
  ...
}
```

Consequences

+ *Uniformity*
+ *Extensibility*
+ *Parsimony*
  - Classes & interfaces only include fields & methods that they need

```
class Component_Node {
```

Only default "no-op" methods

```
  virtual int item() const {
    throw Invalid_Function_Call
        ("method not implemented");
    return 0;
  }

  virtual Component_Node *right(){
     return nullptr;
  }

  virtual Component_Node *left() const {
     return nullptr;
  }
  ...
}
```

Consequences

+ *Uniformity*
+ *Extensibility*
+ *Parsimony*
  - Classes & interfaces only include fields & methods that they need

```
class Leaf_Node : public Component_Node {
    ...

    int mItem;

    int item() { return mItem; }
}

class Composite_Unary_Node
      : public Component_Node {
    ...
    Component_Node *mRight;

    Component_Node *right()
    { return mRight; }
}
```

Stores the Leaf Node's value

Consequences

+ *Uniformity*
+ *Extensibility*
+ *Parsimony*
  - Classes & interfaces only include fields & methods that they need

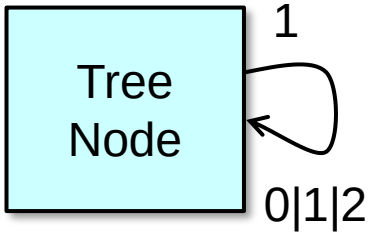
```
class Leaf_Node : public Component_Node {
    ...

    int mItem;

    int item() { return mItem; }
}

class Composite_Unary_Node
      : public Component_Node {
    ...
    Component_Node *mRight;

    Component_Node *right()
    { return mRight; }
}
```

Reference to the right child.

Consequences

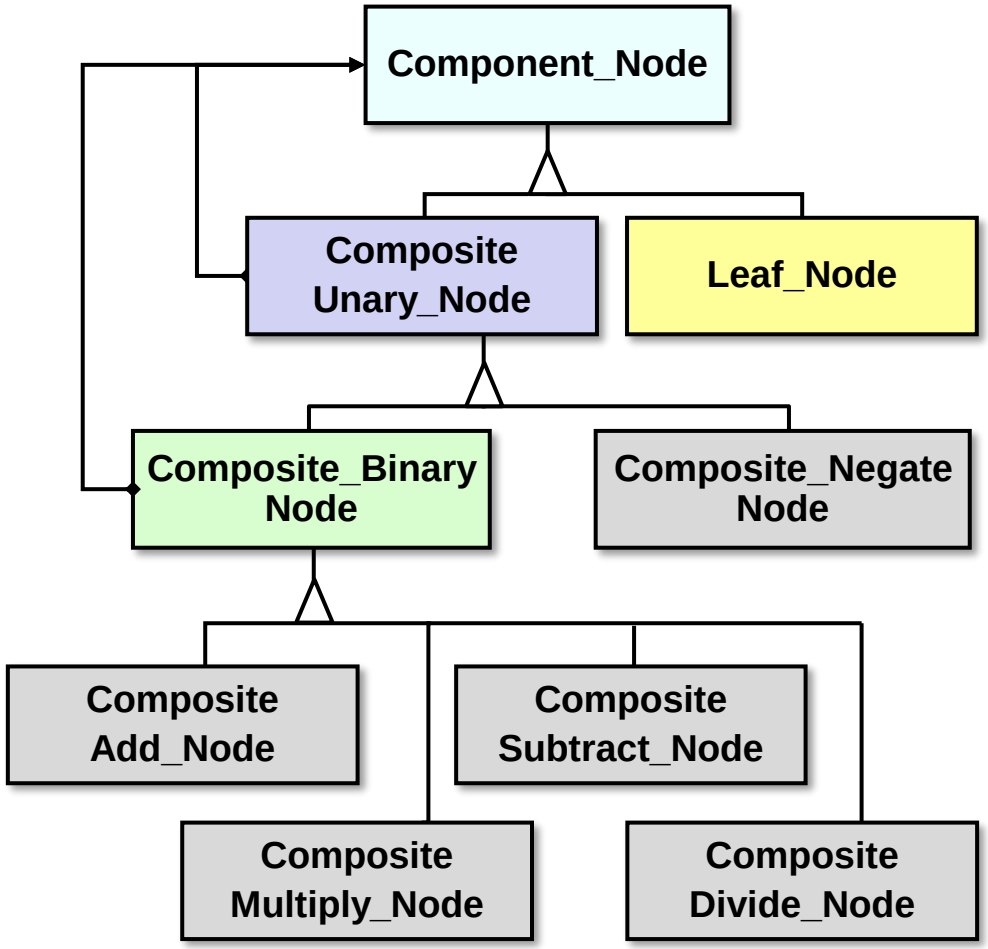
– *Perceived complexity*

- May need what seems like a prohibitively large number of classes and/or objects



vs.

Algorithmic Decomposition

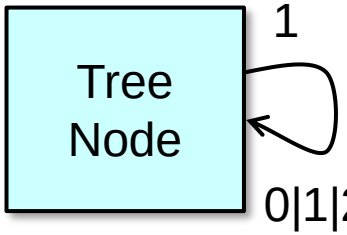


Pattern- & OO-Decomposition

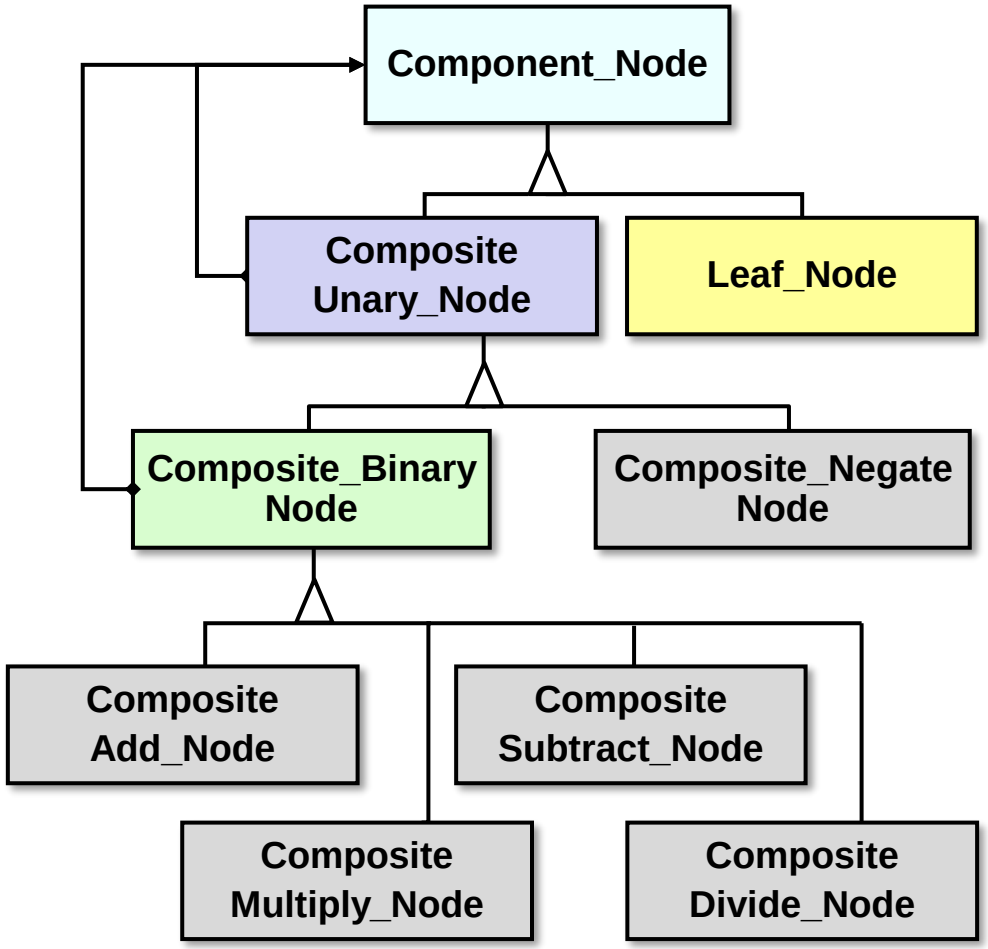
Consequences

– *Perceived complexity*

- May need what seems like a prohibitively large number of classes and/or objects

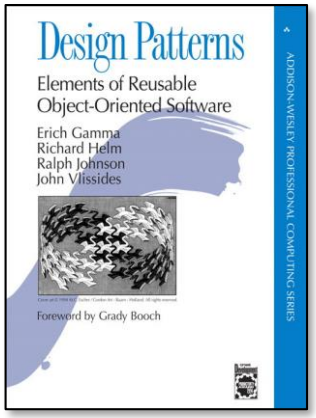


vs.



Algorithmic Decomposition

Pattern- & OO-Decomposition



Knowledge of patterns is essential to alleviate perceived complexity.

Consequences

– *Awkward designs*

- May yield "bloated" interfaces for composites & leaves

`item()` is unused in composite nodes.

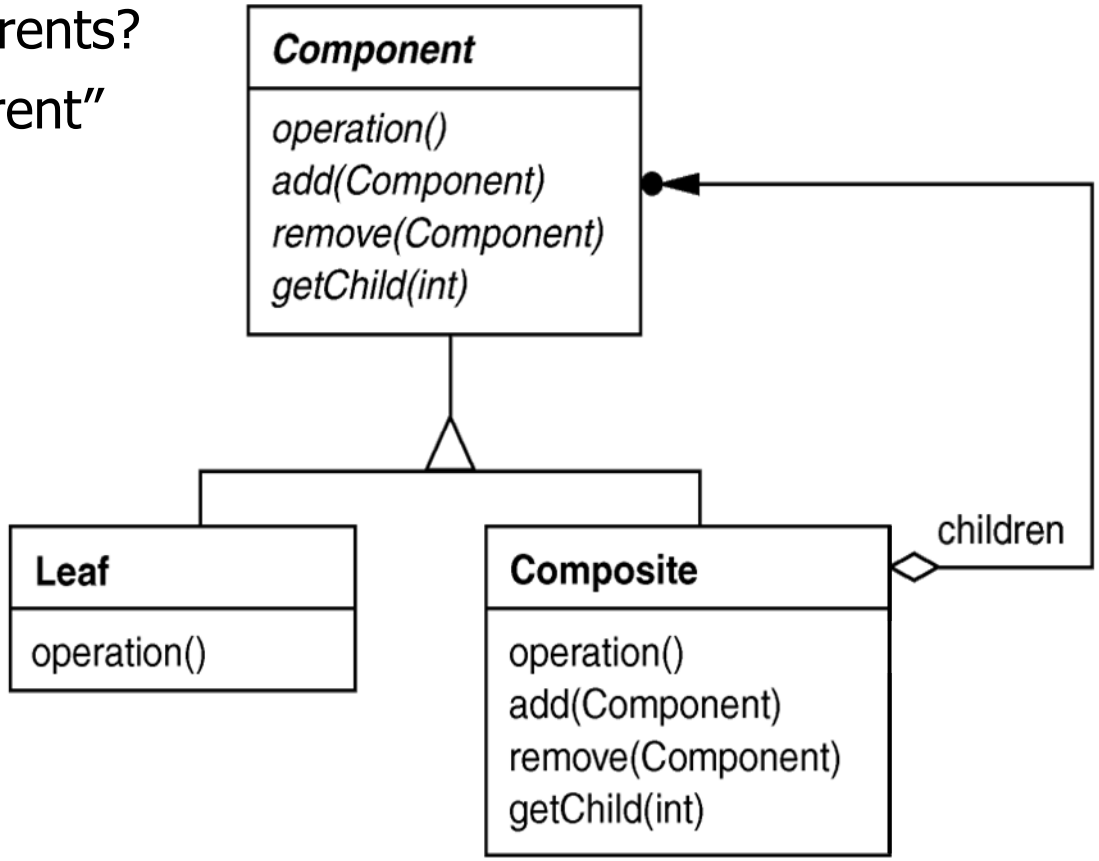
`left()` & `right()` are unused in leaf nodes.

```
int            item()
Component_Node *left()
Component_Node *right()
void           accept(Visitor &visitor)
```

See en.wikipedia.org/wiki/Interface_bloat

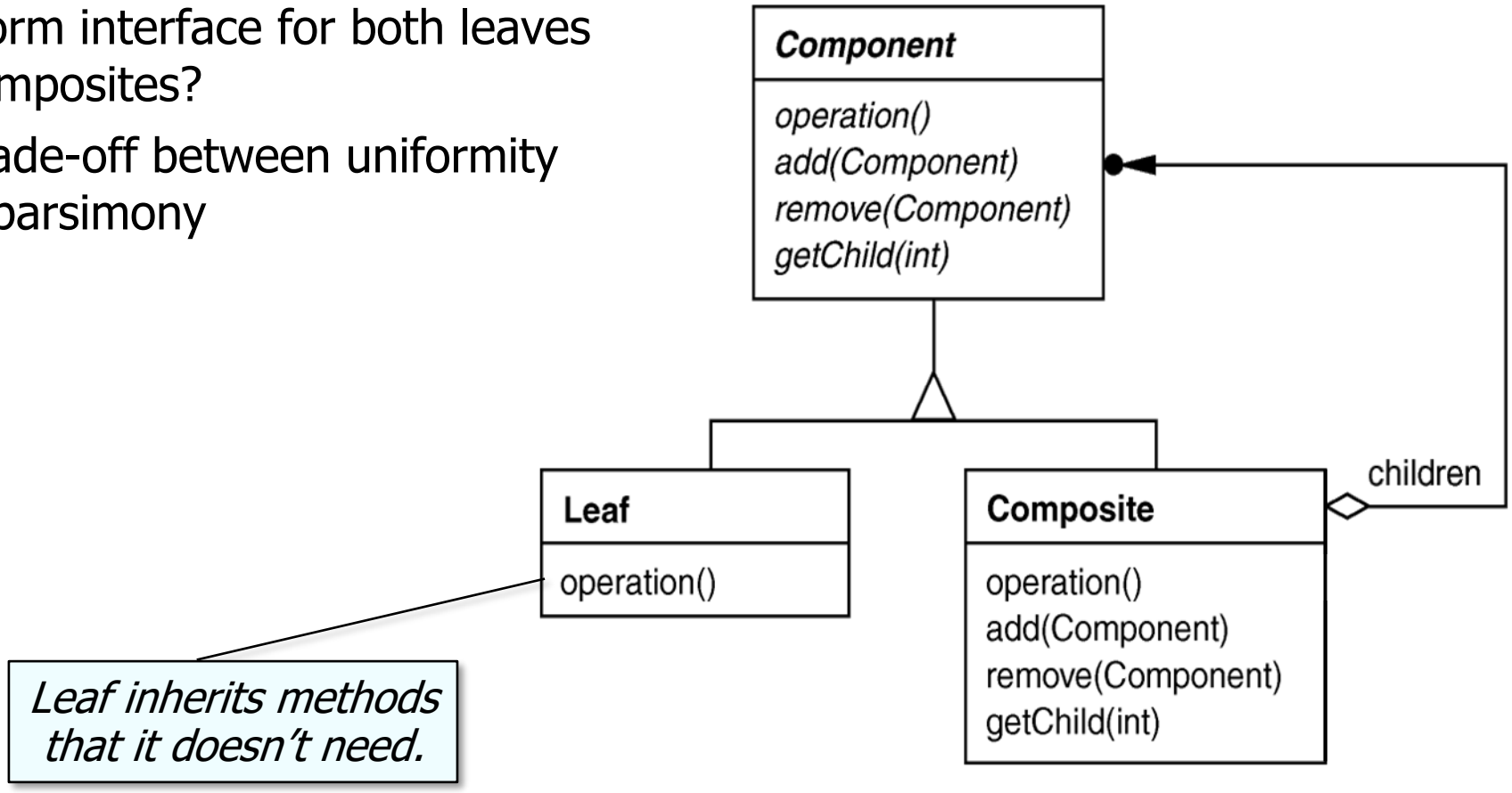
Implementation considerations

- Do components know their parents?
  - e.g., is there an explicit "parent" pointer/reference?



Implementation considerations

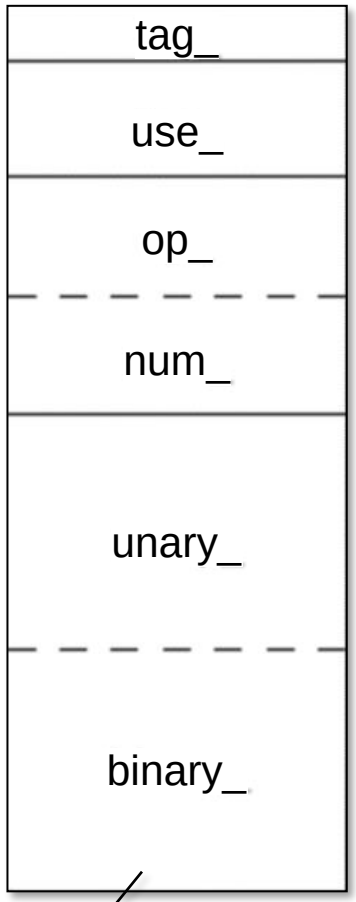
- Uniform interface for both leaves & composites?
  - Trade-off between uniformity & parsimony



Implementation considerations

- Don't allocate child storage in component super class.

```
typedef struct Tree_Node {
  enum { NUM, UNARY, BINARY } tag_;
  short use_;
  union {
    char op_[3]; int num_;
  } o_;
  union {
    struct Tree_Node *unary_;
    struct { struct Tree_Node *l_,
             *r_;} binary_;
  } c_;
} Tree_Node;
```

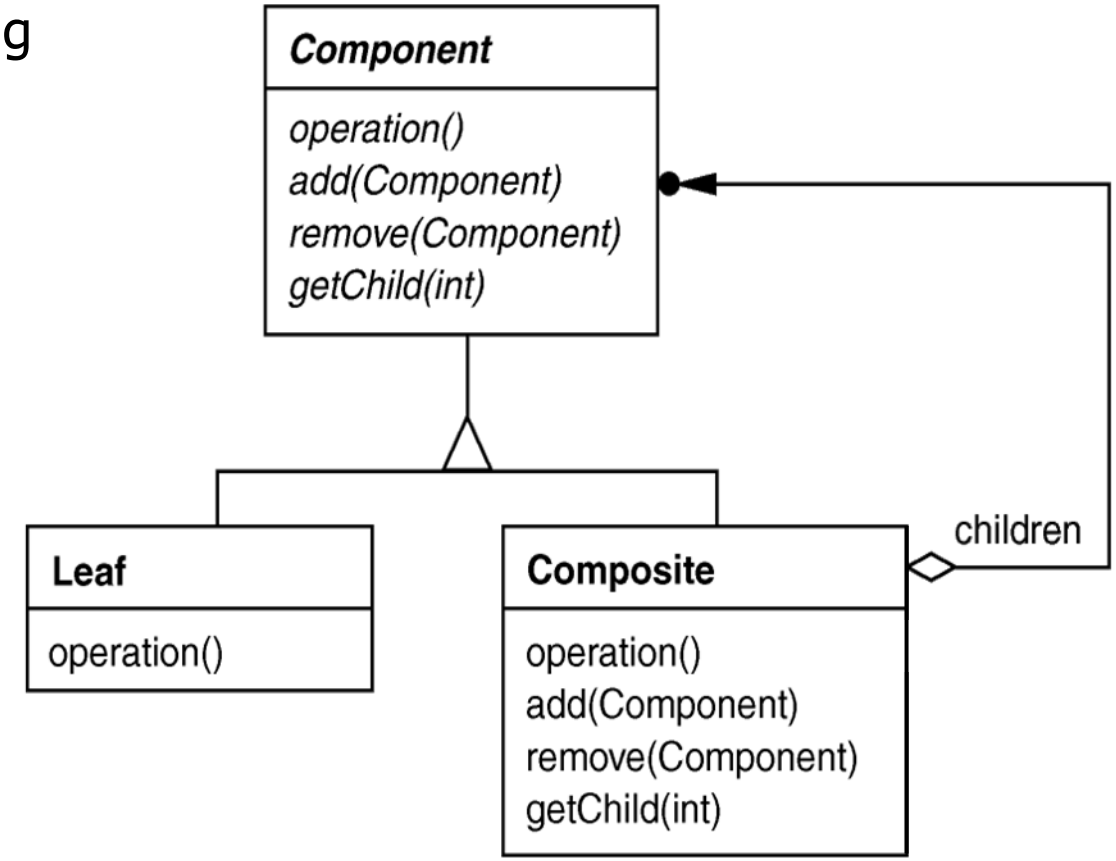


Memory Layout

This was a big problem with the algorithmic decomposition.

Implementation considerations

- Who is responsible for deleting children?
  - e.g., the parent or the child itself?

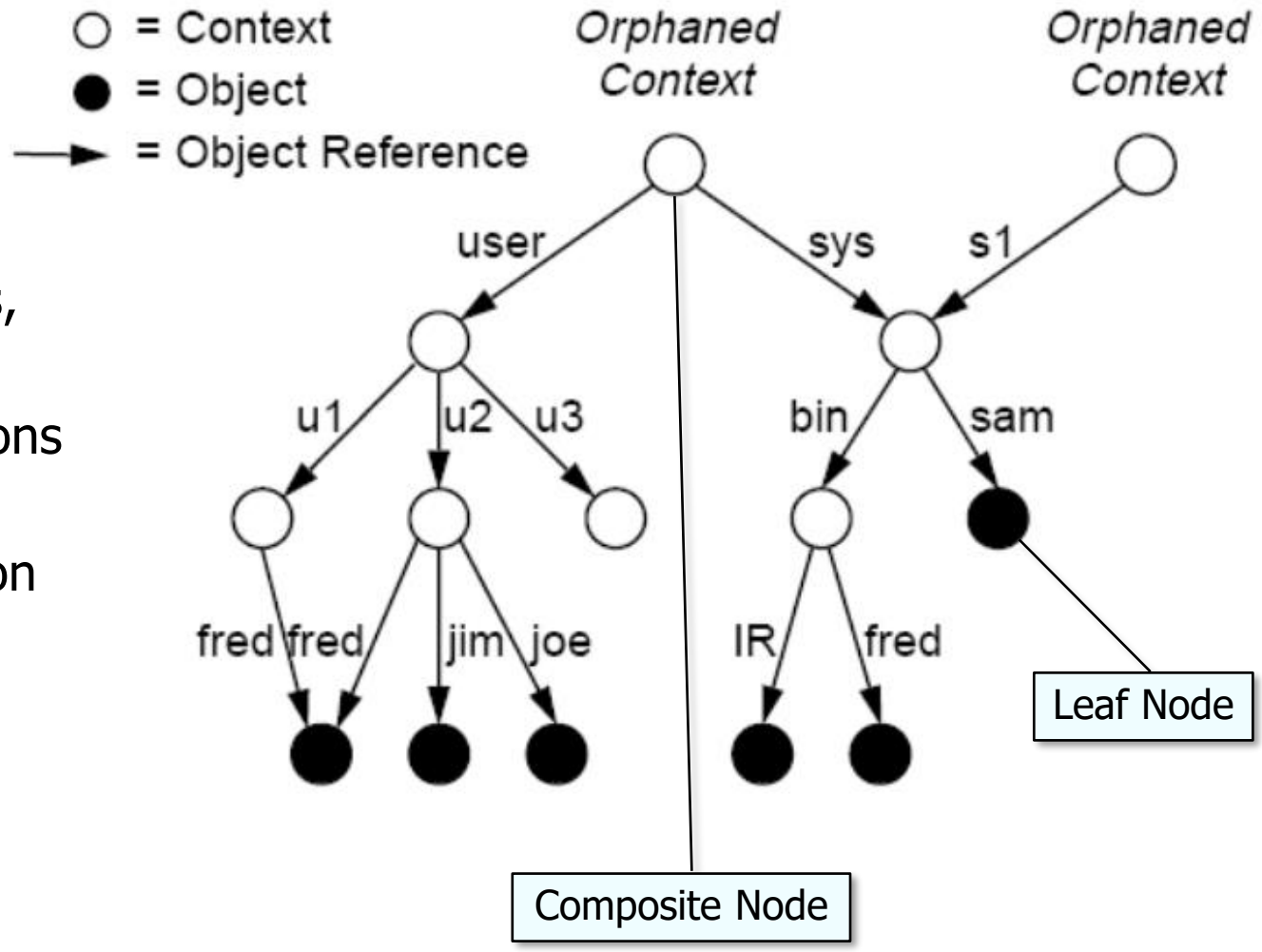


See rmdir vs. /bin/rm -rf at www.linfo.org/rmdir.html

Composite GoF Object Structural

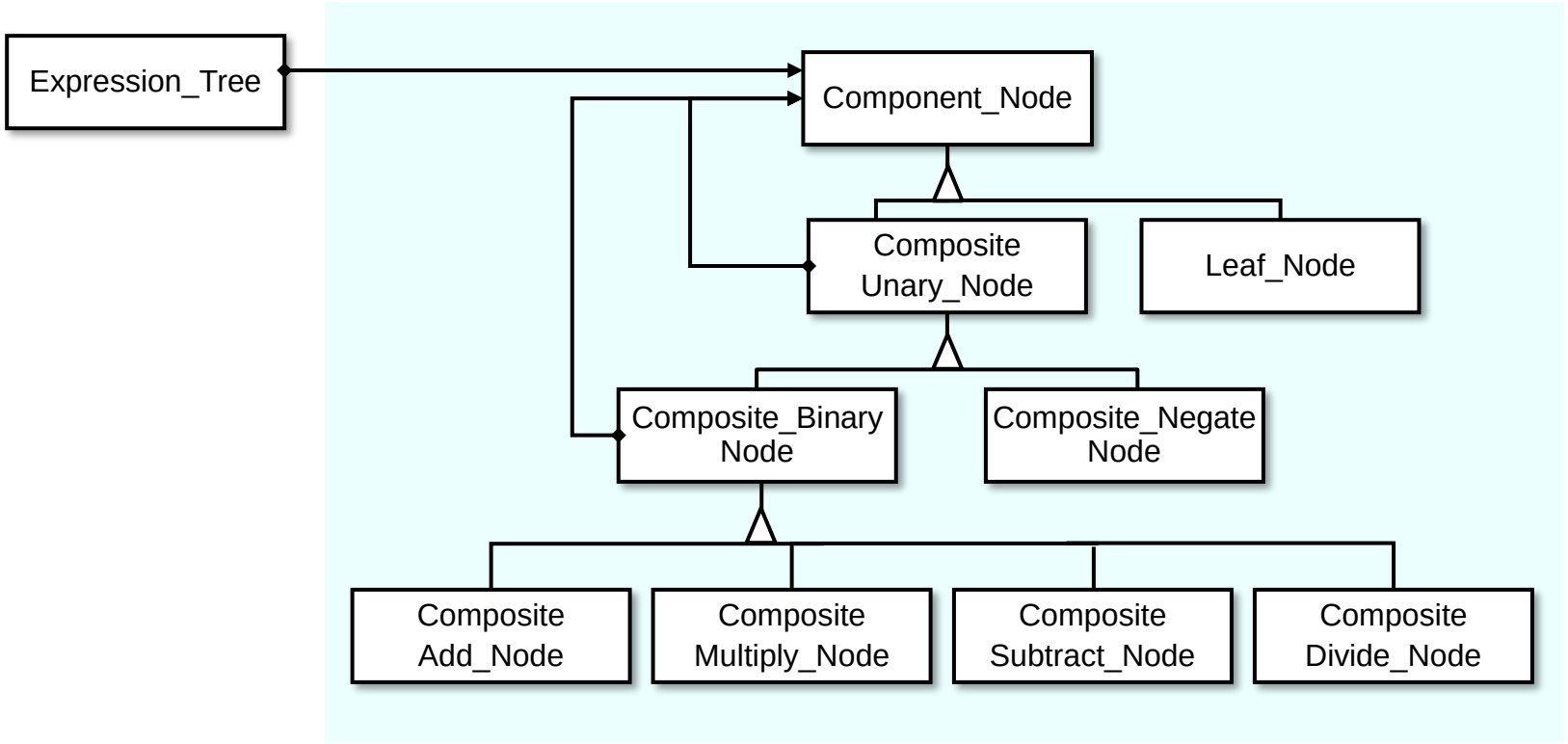
Known uses

- ET++ Vobjects
- InterViews Glyphs, Styles
- Unidraw Components, Macro_Commands
- Internal representations of MIME types
- Directory structures on UNIX & Windows
- java.awt.Container #add(Component)
- Naming Contexts in CORBA



Summary of the Composite Pattern

- The expression tree processing app uses the *Composite* pattern to enhance the uniformity & extensibility of its key internal data structure.



Composite

Adding new types of nodes (& new operations on nodes) is greatly simplified.