GOOL: A Generic Object-Oriented Language

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Observations

OO languages:

- Structurally similar

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OO languages:

- Structurally similar
- Mainly *shallow* syntaxtic differences
- Like Romance languages
- We tend to say similar things in all of them

The Goal

One language to express them all.

- Is it possible?
- Capture the meaning of OO programs
- DSL for domain of OO programs
- Currently targets Java, Python, C#, C++

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- **idiomatic**: For readability, understandability
- **documented**: For readability, understandability
- **patterns**: More efficient coding
- **expressivity**: Works for real examples
- **common**: Reduce code duplication

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Approach

Start from real OO programs

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Start from real OO programs

What we can say vs. want to say vs. need to say

Readability Features

Example: Blocks

- Semantically meaningless
- Reflect how people write programs

```
# Initialize dimensions
h = input('What is the height? ')
w = input('What is the width? ')
d = input('What is the depth? ')

# Calculate volume and surface area
v = h * w * d
sa = 2 * (h * w + w * d + h * d)
```

Some ingredients

- Variables distinct from values (viz use/mention)

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- Smart constructors for common idioms

GOOL Language

Types	`bool`, `int`, `float`, `char`, `string`, `infile` (read mode), `outfile` (write mode), `listType`, `obj`
Variables	`var`, `extVar`, `classVar`, `objVar`, `$->` (infix operator for `objVar`), `self`, [`listVar`]
Values	`valueOf` (value from variable), `litTrue`, `litFalse`, `litInt`, `litFloat`, `litChar`, `litString`, `?!`, `?&&`, `?<`, `?<=`, `?>`, `?>=`, `?==`, `?!=`, `#~`, `#/^`, `#—`, `#+`, `#-`, `#*`, `#/`, `#^`, `inlineIf`, `funcApp`, `extFuncApp`, `newObj`, `objMethodCall`, [`selfFuncApp`, `objMethodCallNoParams`]
Statements	`varDec`, `varDecDef`, `assign`, `&=`, `&+=`, `&-=`, `&++`, `&~-`, `break`, `continue`, `returnState`, `throw`, `free`, `comment`, `ifCond`, `ifNoElse`, `switch`, `for`, `forRange`, `forEach`, `while`, `tryCatch`, `block`, `body` [`bodyStatements` (single-block body), `oneLiner` (single-statement body)]
List API	`listAccess`, `at` (same as `listAccess`), `listSet`, `listAppend`, `listIndexExists`, `indexOf`, `listSlice`
Scope	`public`, `private`
Binding	`static_`, `dynamic_`
Functions	`function`, `method`, `param`, `pointerParam`, `mainFunction`, `docFunc`, [`pubMethod`, `privMethod`]
State Variables	`stateVar`, `constVar`, [`privMVar`, `pubMVar` (dynamic), `pubGVar` (static)]
Classes	`buildClass`, `docClass`, [`pubClass`, `privClass`]
Packages	`buildModule`, `fileDoc`, `docMod`, `prog`, `package`, `doxConfig`, `makefile`

Encoding

Tagless with type families – 2 Layers of abstraction

1. Over target language
2. Over language-specific representational data structures

```
class (TypeSym repr) => VariableSym repr where
  type Variable repr
  var  ::  Label -> repr (Type repr)
    -> repr (Variable repr)
```

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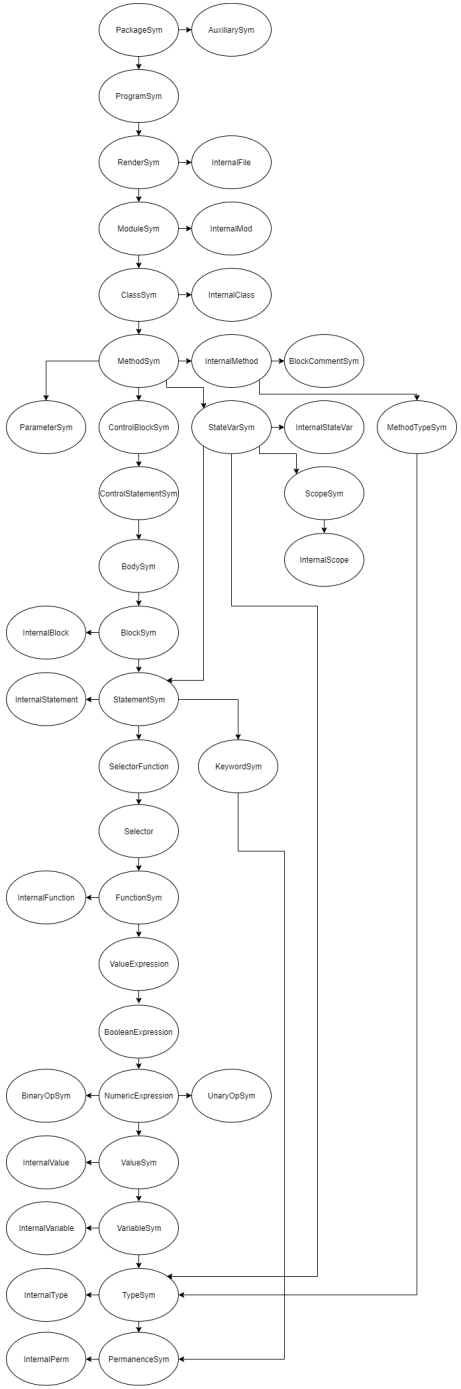
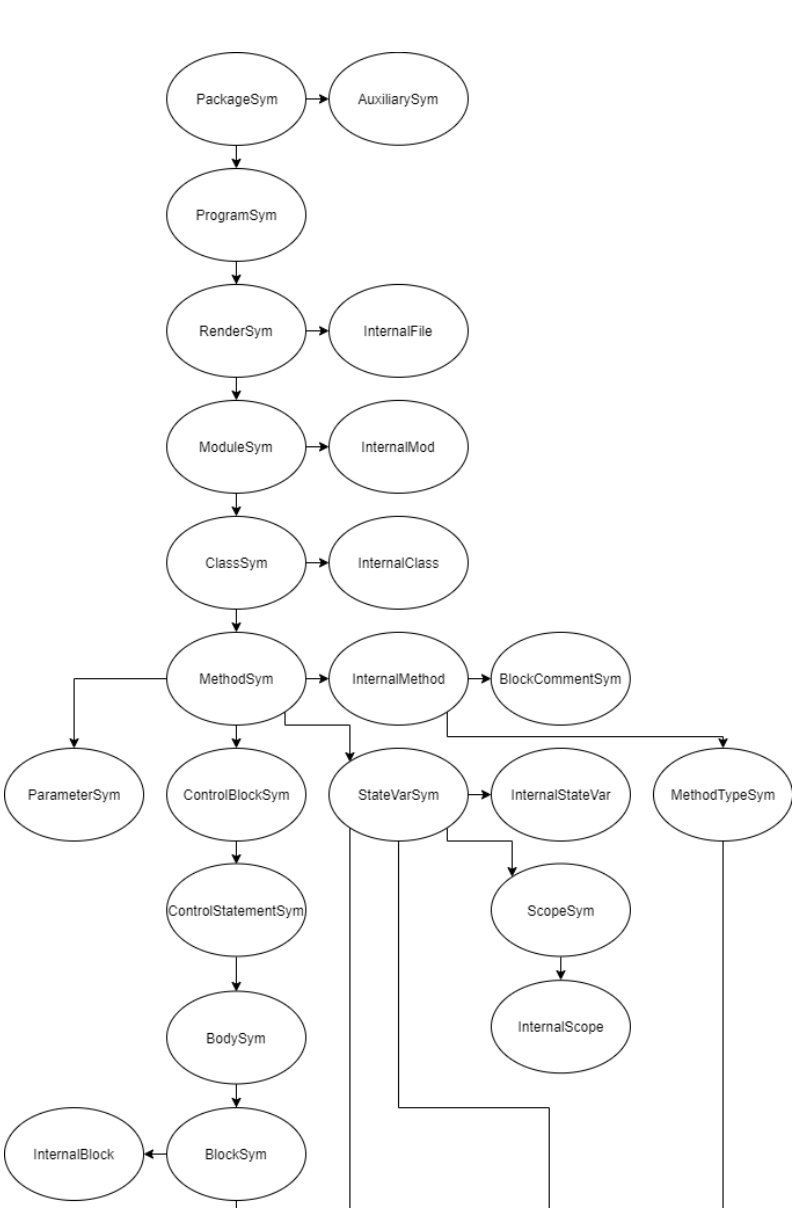
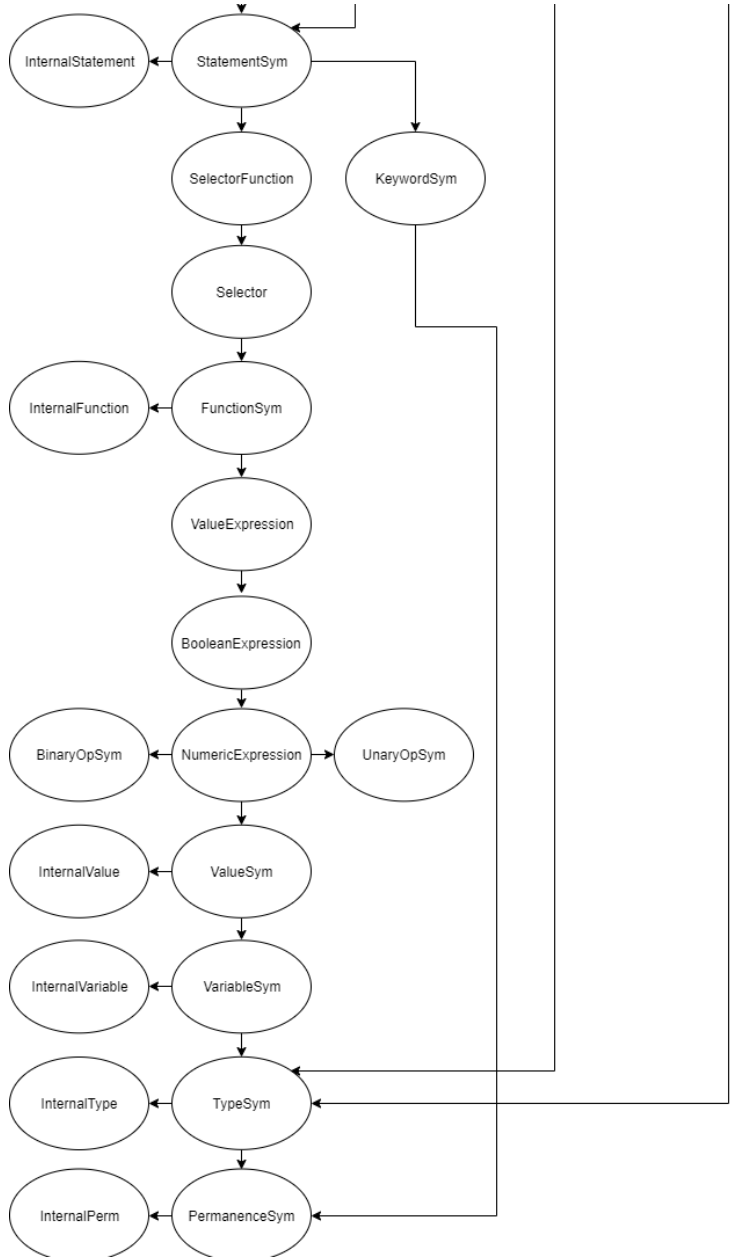
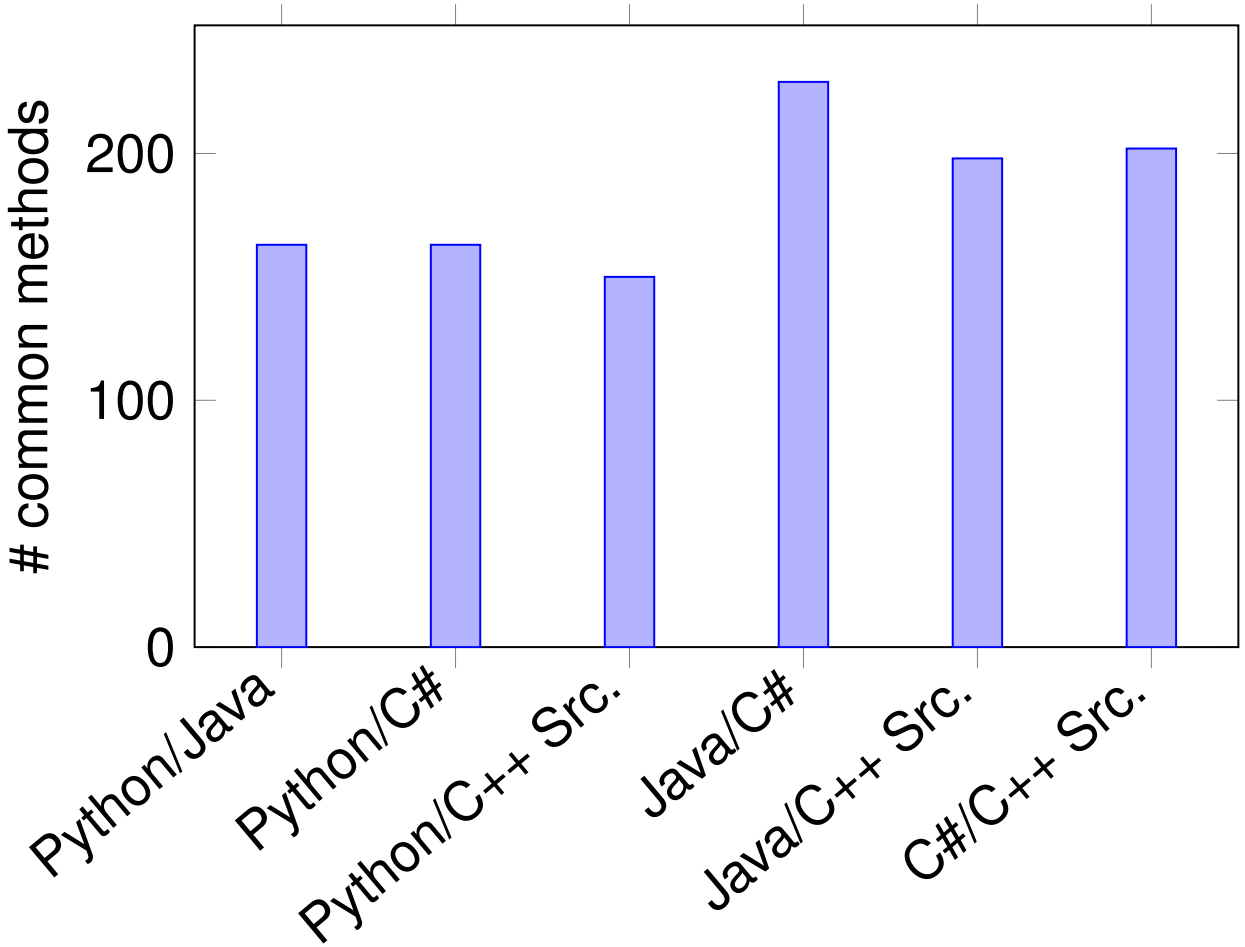






Statistics

- 43 classes, 328 methods
- 300 functions that abstract over commonalities
- 40% more common methods between Java and C# than Java and Python



Things we need/want to say

- Command line arguments
- Lists
- I/O
- Procedures with Input/Output/Both parameters
- Getters and setters
- Design patterns

Example: List Slicing

GOOL: *hideous, we know*

```
listSlice sliced (valueOf old) (Just $ litInt 1)
  (Just $ litInt 3) Nothing
```

Python:

```
sliced = old [1:3:]
```

Example: List Slicing

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Java:

```
ArrayList<Double> temp = new ArrayList<Double>(0);
for (int i_temp = 1; i_temp < 3; i_temp++) {
    temp.add(old.get(i_temp));
}
sliced = temp;
```

Example: List Slicing

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```

C#:

```
List<double> temp = new List<double>(0);
for (int i_temp = 1; i_temp < 3; i_temp++) {
    temp.Add(old[i_temp]);
}
sliced = temp;
```

Example: List Slicing

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C++:

```
vector<double> temp(0);
for (int i_temp = 1; i_temp < 3; i_temp++) {
    temp.push_back(old.at(i_temp));
}
sliced = temp;
```

Example: Setters

GOOL:

```
setMethod "FooClass" foo
```

Python:

```
def setFoo(self, foo):
    self.foo = foo
```

Example: Setters

GOOL:

```
setMethod "FooClass" foo
```

Java:

```
public void setFoo(int foo)  throws Exception {
    this.foo = foo;
}
```

Example: Setters

GOOL:

setMethod ”FooClass” foo

C#:

```
public void setFoo(int foo) {
    this.foo = foo;
}
```

Example: Setters

GOOL:

setMethod ”FooClass” foo

C++:

```
void FooClass::setFoo(int foo) {
    this->foo = foo;
}
```

Currently working on

- More types
- Smarter generation - ex. import statements
- Interfacing with external libraries
- User-decisions - ex. which type to use for lists?
- More patterns

Language of Design

Drasil project - http://github.com/JacquesCarette/Drasil

- Generate scientific software
- Design language lets users guide design
- GOOL is the backend

Complete Example

Projectile program

Design 1

- Documented
- Bundled inputs

Design 2

- Logging
- More modular

Conclusion

We currently use GOOL to generate some examples of scientific software (glass breakage, projectile simulation)

Together new:

- Idiomatic code generation
- Human-readable, documented code generation
- Coding patterns are language idioms

With respect to “The Goal” — It is possible