Do We Really Need to Extend Syntax for Advanced Modularity?

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Advanced modularity

- Objectives
  - Code reuse
    - Avoid code clones (duplicated code)
  - Composability
    - Build software by combining modules as is
      (without modifications)
  - Grouping related code
    - for spatial locality per concern
  - Information hiding
    - Give higher-level abstraction

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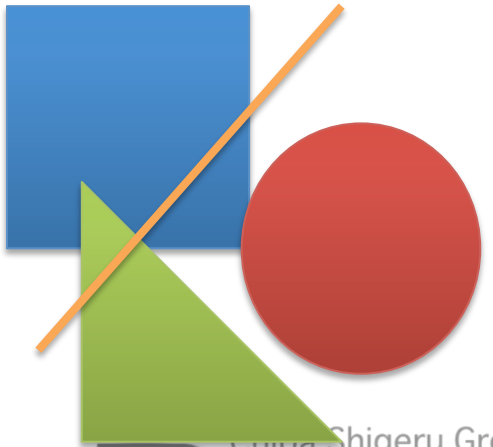
Observer pattern in Java

```
class Line extends Shape {
   int angle, len;

   void setPos(int nx, int ny) {
      x = nx; y = ny;
      DisplayUpdate.after(this);
   }

   void setLength(int nlen) {
      len = nlen;
      DisplayUpdate.after(this);
   }

   int getLength() { return len; }
   /* (snip) */
}
```

```
class Rectangle {
   void setWidth(int nw) {
      width = nw;
      DisplayUpdate.after(this);
}}
```

```
class DisplayUpdate {
   static void after(Shape s) {
      s.display().repaint();
}}
```

Crosscutting concern



Modularization in AspectJ

- The display-update concern is in an aspect.
  - Good composability *i.e.* easily removable

```
class Line extends Shape {
  int angle, len;
  void setPos(int nx, int ny) {
    x = nx; y = ny;
  }
  // (snip)
}
```

```
aspect DisplayUpdate {
  pointcut change(Shape s):
    execution(void Shape+.set*(..)) && this(s);

  after(Shape s): change(s) {
    s.display().repaint(s);
}}
```

define when the advice is invoked

Limitation of AspectJ: grouping related code

- A code snippet belongs to multiple concerns.

Original

```
class Line extends Shape {
   void setPos(int nx, int ny) {
      x = nx; y = ny;
      DisplayUpdate.after(this);
   }

   void setLength(int nlen) {
      len = nlen;
      DisplayUpdate.after(this);
   }
   // (snip)
}
```

Class + aspect

```
class Line extends Shape {
   void setPos(int nx, int ny) {
      x = nx; y = ny;
   }

   void setLength(int nlen) {
      len = nlen;
   }
   // (snip)
}
```

Cannot see the entire Line concern!!

```
aspect DisplayUpdate {
   // (snip)
   after(Shape s): change(s) {
      s.display().repaint(s);
}}
```

Another Limitation of AspectJ: Code reuse

- Cannot avoid code duplication

DisplayUpdate

```
void around(Line line, int x, int y):
     execution(void Shape+.setPos(int, int)) && this(line) && args(x, y) {
   if (line.x != x || line.y != y) {
      proceed(line, x, y);
      line.display().repaint(line);
}}

void around(Line line, int len):
     execution(void Line.setLength(int)) && this(line) && args(len) {
   if (line.len != len) {
      proceed(line, len);
      line.display.repaint(line);
}}
// (snip)
```

only if a filed value is changed

Meta-helical contextual predicate dispatch

Proposal

- An extension to contextual predicate dispatch [Chiba, et al, OOPSLA'10]

```
void around anySetter(Line line, Method setter, Object[] args):
   execution(void Shape+.setPoint(int,int)
        || void Shape+.setPoint.setLength(int))
   && this(line) => $setter($args)

boolean around posSetter(int x, int y): within anySetter
                  execution(void Shape+.setPos(int,int)) && args(x, y)
{ line.x != x || line.y != y } => $conditionExpr

boolean around lenSetter(int len): within anySetter
                     execution(void Shape+.setLength(int)) && args(len)
{ line.len != len } => $conditionExpr

void setter(args) within anySetter && (posSetter || lenSetter) {
   super.setter(args);
   if (conditionExpr)
       line.display().repaint(line);
}
```

End of Skit

Developing a complex language.

This is our typical research, but is this a right approach?

(The last slide is fake)

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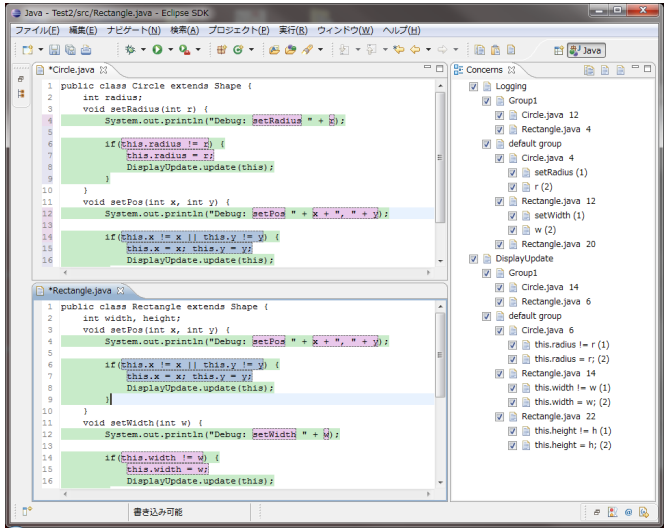
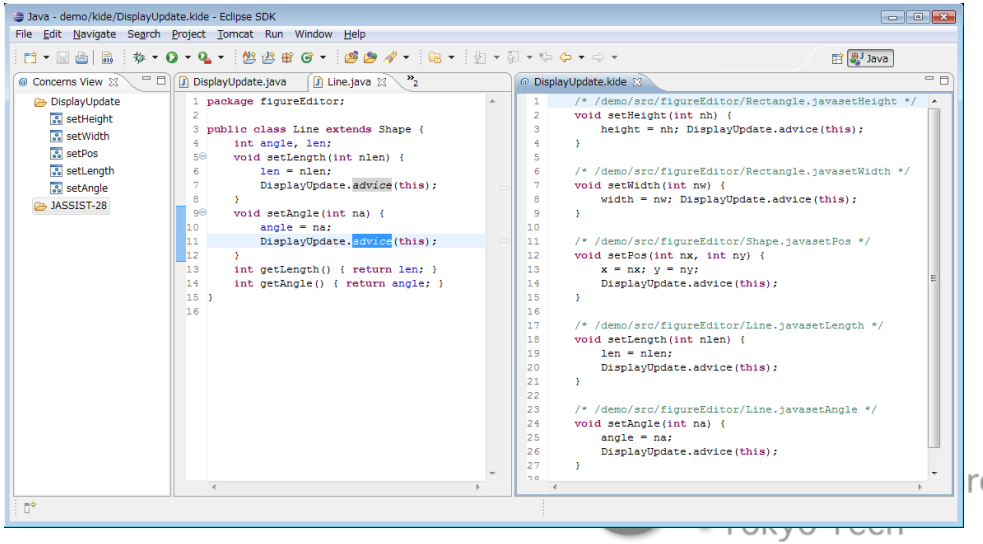
Programs expressed in dynamic text

Our vision

- Dynamic text
  - changes its appearance while editing and browsing
    - like web page written in HTML + JavaScript
  - Traditional languages uses only static text.
- Two preliminary systems for implementing this idea.





Programs expressed in dynamic text

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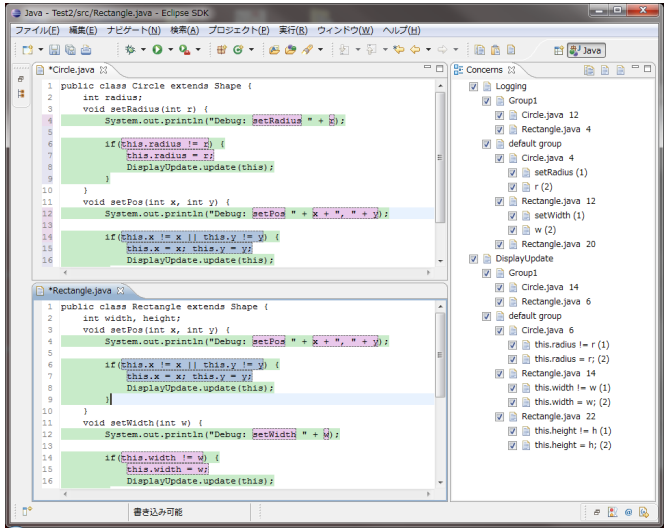
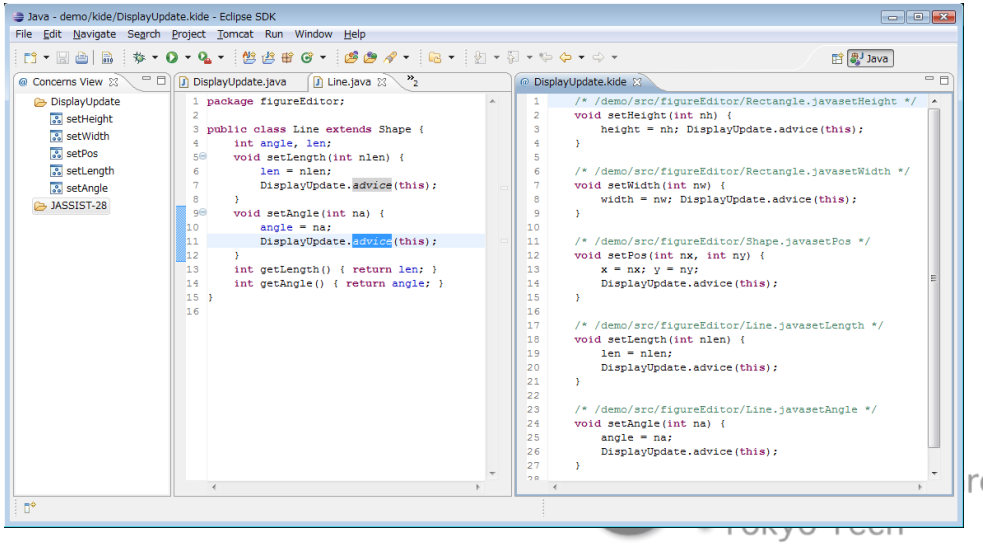
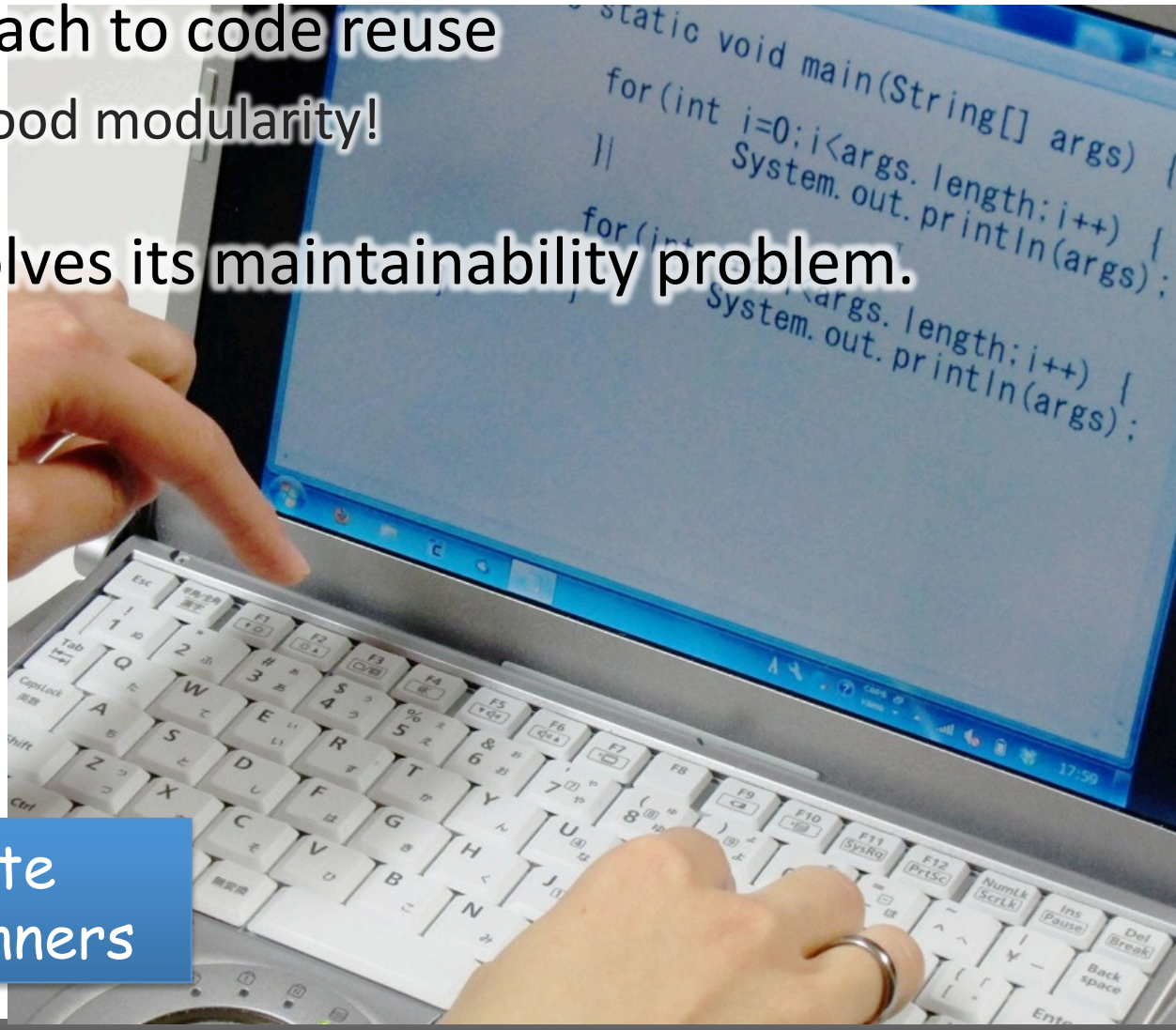




Copy & paste

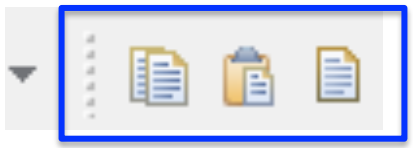
- The easiest approach to code reuse
  - actually provides good modularity!
- Dynamic text resolves its maintainability problem.



We love copy & paste
when we were beginners

Synchronous copy & paste

- Synchronizes code clones



- Automatically updates synchronized clones when one of them is updated

*Line.java

```
5      void setPos(int nx, int ny) {
6          x = nx; y = ny;
7          this.display().repaint(this);
8      }
9
10     void setLength(int nlen) {
11         len = nlen;
12         this.display().repaint(this);
13     }
14 }
```

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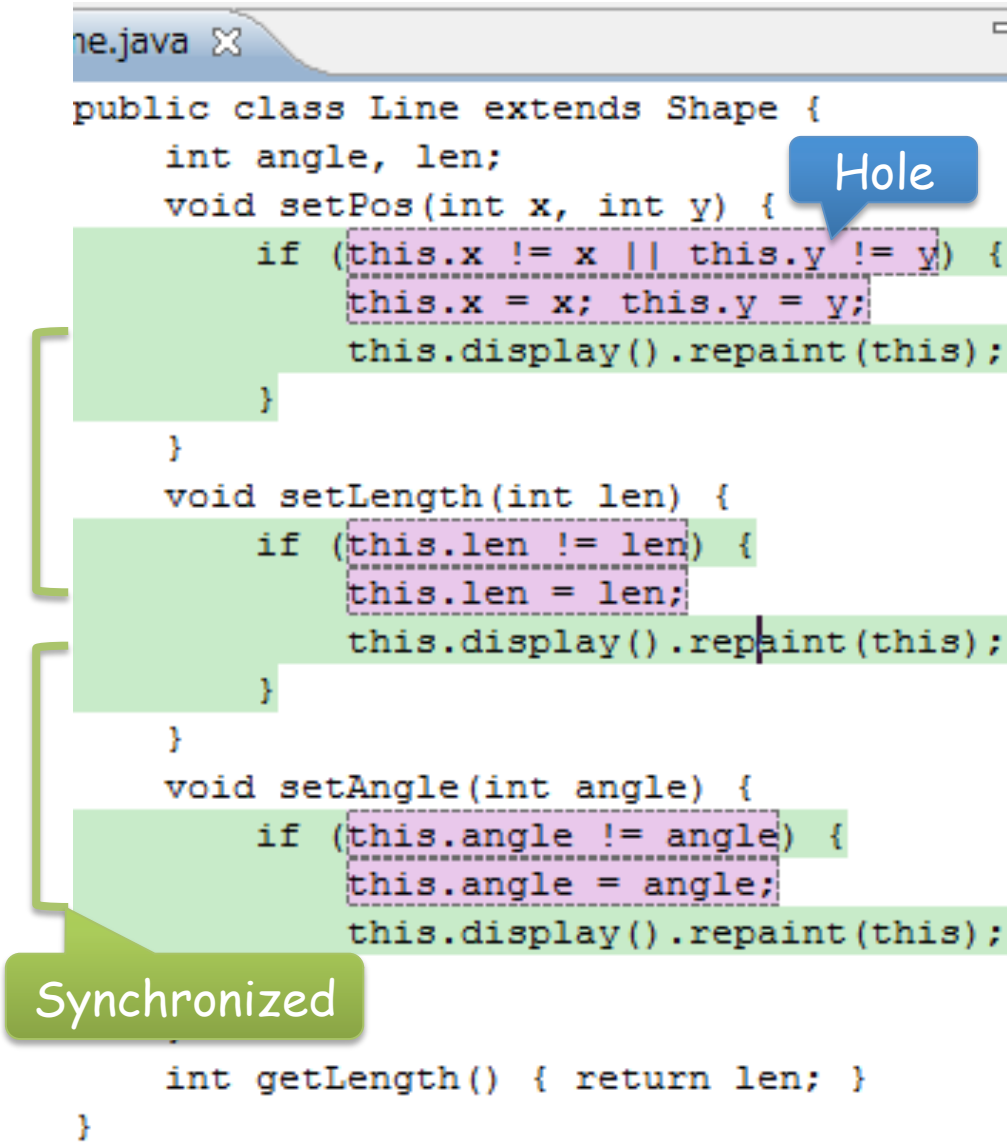
Holes

- The text in the holes is not synchronized
  - Can synchronize somewhat different code clones



It's like a procedure or an advice!

- Synchronized clones look like a procedure
  - Holes are parameters
- Better reusability
  - resolves the problem of AspectJ

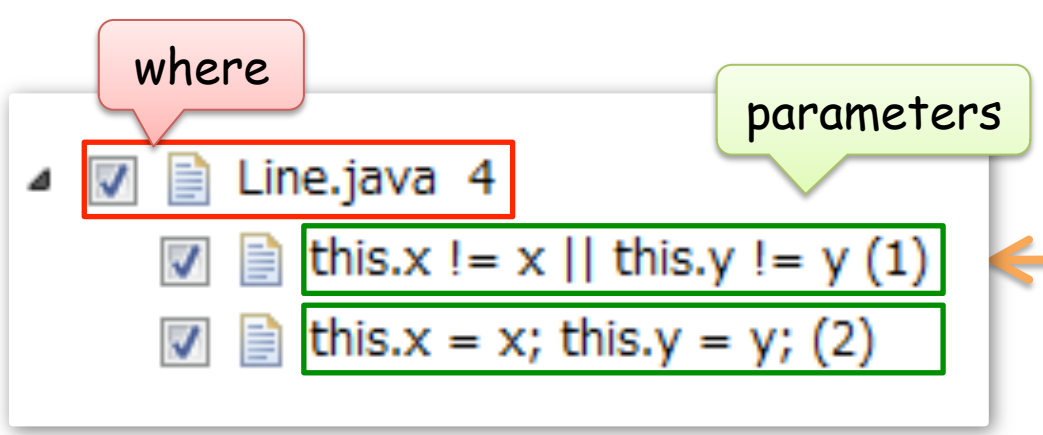
```
ne.java
public class Line extends Shape {
    int angle, len;
    void setPos(int x, int y) {
        if (this.x != x || this.y != y) {
            this.x = x; this.y = y;
            this.display().repaint(this);
        }
    }
    void setLength(int len) {
        if (this.len != len) {
            this.len = len;
            this.display().repaint(this);
        }
    }
    void setAngle(int angle) {
        if (this.angle != angle) {
            this.angle = angle;
            this.display().repaint(this);
        }
    }
    int getLength() { return len; }
}
```

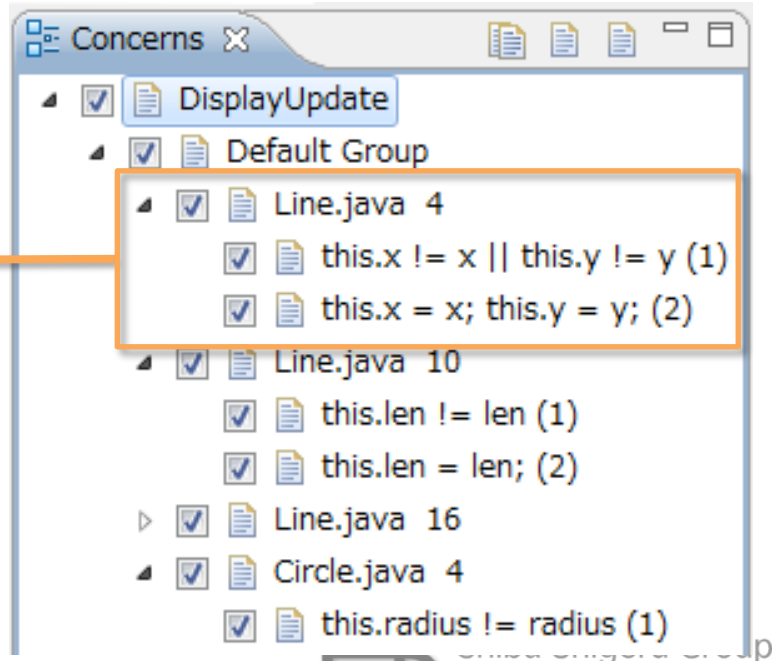
call

```
void updateDisplay(cond, do) {
  if (cond) {
    do;
    this.display().repaint(this);
}}
```

Concerns view

- Shows a group of code synchronized with each other.
  - provides the same information that AspectJ pointcuts do.
  - actual parameters are displayed





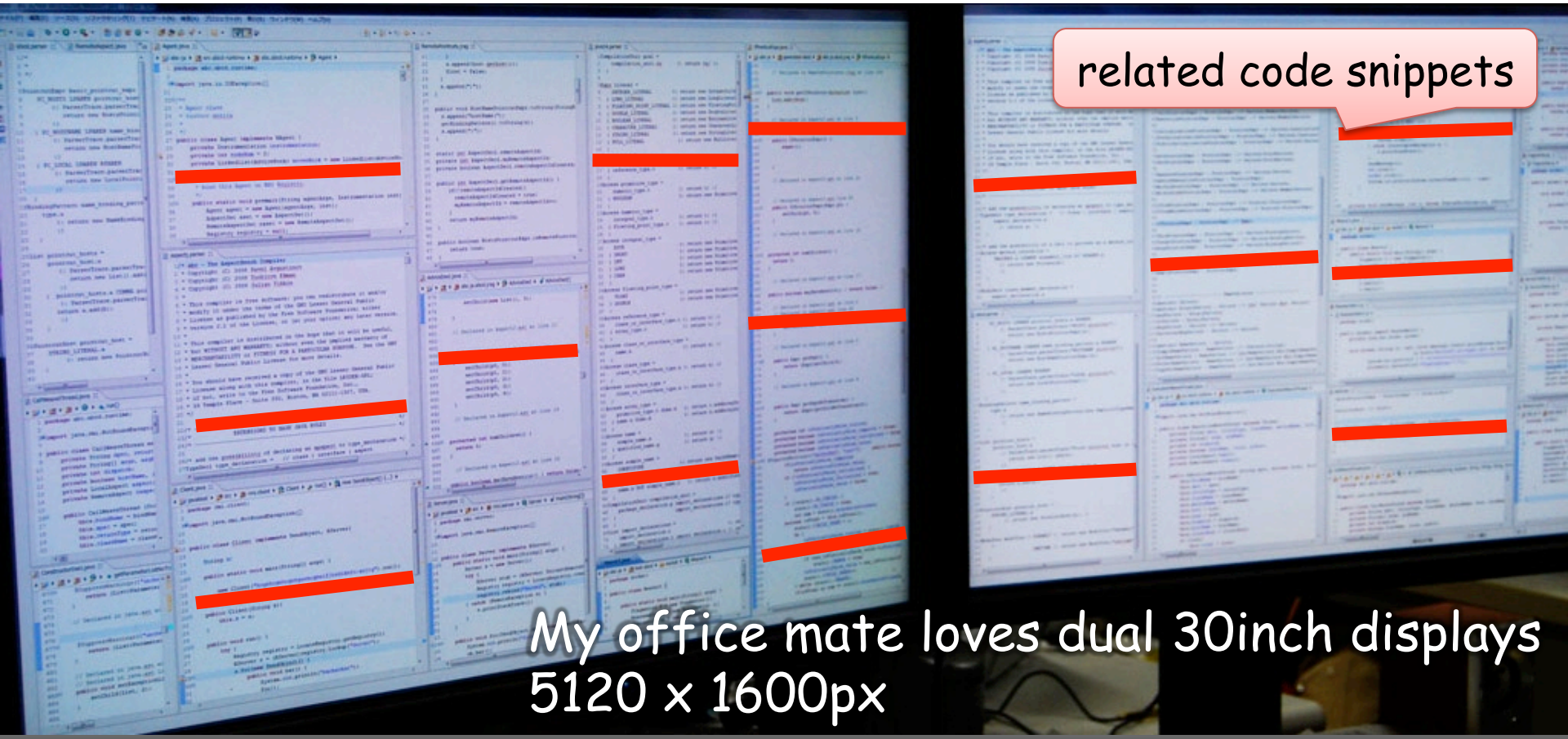

```
execution(void Shape+.setPos(int, int)) &&
   this(line) && args(x, y)
```

Browsing related code at a glance

- Developers have to open each file

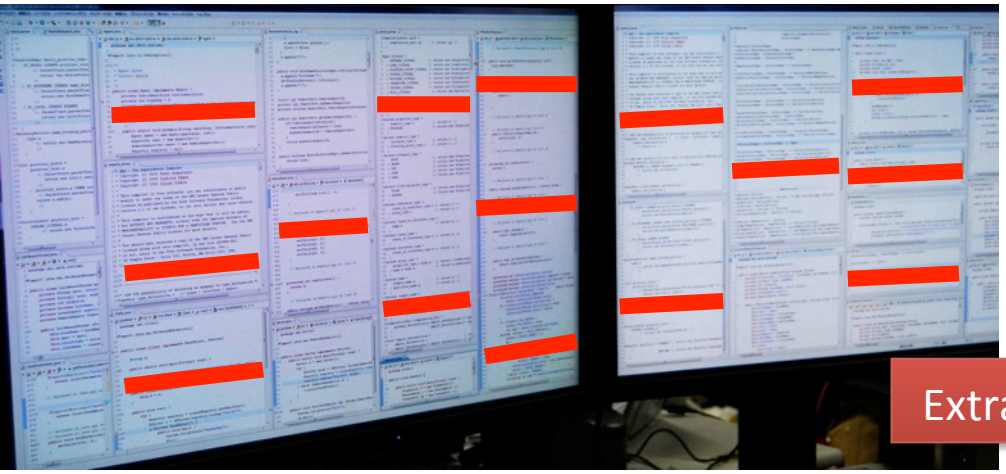
Browsing related code at a glance

- Developers have to open each file



Grouping related code with Kide

- A virtual source file
  - collects related snippets from many source files



Physical source files

Extract

DisplayUpdate.kide

```
/* src/Line.java */
void setPos(int nx, int ny) {
   x = nx; y = ny;
   DisplayUpdate.advice(this);
}

/* src/Line.java */
void setLength(int nlen) {
   len = nlen;
   DisplayUpdate.advice(this);
}

/* src/Rectangle.java */
void setWidth(int nlen) {
   len = nlen;
   DisplayUpdate.advice(this);
}
```

A virtual source file

A virtual source file

- Developers can edit as a normal source file

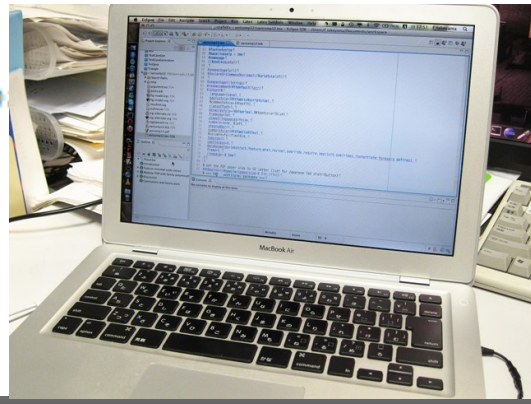
@ DisplayUpdate.kide

A comment indicating physical source file

```
1   /* /demo/src/figureEditor/Rectangle.javasetHeight */
2   void setHeight(int nh) {
3       height = nh; DisplayUpdate.advice(this);
4   }
5
6   /* /demo/src/figureEditor/Rectangle.javasetWidth */
7   void setWidth(int nw) {
8       width = nw; DisplayUpdate.advice(this);
9   }
10
11  /* /demo/src/figureEditor/Shape.javasetPo
12  void setPos(int nx, int ny) {
13      x = nx; y = ny;
14      DisplayUpdate.advice(this);
15  }
```

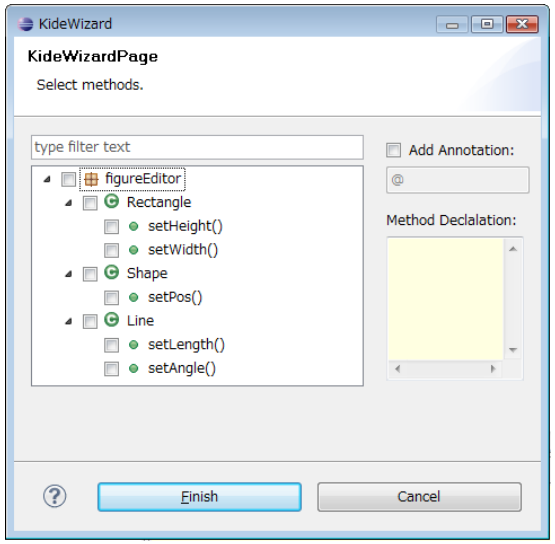
From Rectangle.java

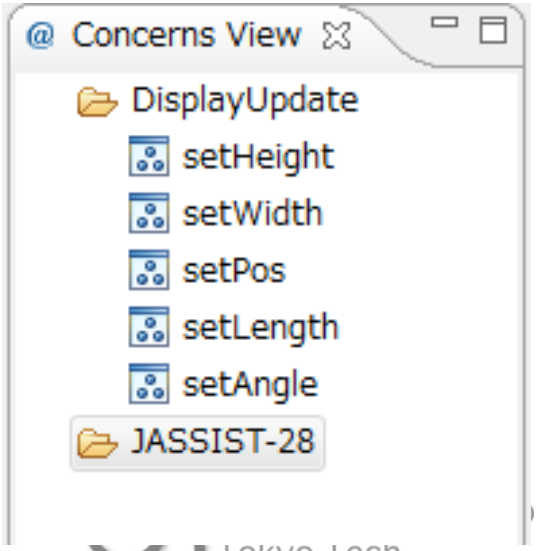
From Shape.java



Selecting code snippets for a virtual source

- by Wizard-like UI
  - no pointcut language
  - supports to select all methods calling a specific method
    - like AspectJ's call pointcut
- A virtual source files is saved as part of a project
  - listed in concerns view





Better grouping than AspectJ

- From the viewpoint of the Line concern
  - the same presentation as in pure Java

```
class Line extends Shape {
   void setPos(int nx, int ny) {
      x = nx; y = ny;
      DisplayUpdate.after(this);
   }

   void setLength(int nlen) {
      len = nlen;
      DisplayUpdate.after(this);
   }

   int getLength() {
      return len;
   }
   // (snip)
}
```

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Better grouping than AspectJ (cont.)

- From other viewpoints

```
class Rectangle extends Shape {
   void setWidth(int nw) {
      width = nw;
      DisplayUpdate.after(this)
   }
   // (snip)
}
```

A physical source file

Virtual source files

DisplayUpdate.kide

```
/* src/Line.java */
void setLength(int nlen) {
  len = nlen;
  DisplayUpdate.after(this);
}

/* src/Rectangle.java */
void setWidth(int nlen) {
  len = nlen;
  DisplayUpdate.after(this);
}
```

SetWidthHeight.kide

```
/* src/Circle.java */
void setWidth(int nw) {
  this.width = nw; /*(snip)*/
  DisplayUpdate.after(this);
}

/* src/Rectangle.java */
void setWidth(int nlen) {
  len = nlen;
  DisplayUpdate.after(this);
}
```

Crosscutting over documentation

- A virtual source can contain plain text from any text file
  - Literate programming
- Bug report
  - Kide helps to quote method declarations from source files

jassist#28.kide

```
at sun.reflect.DelegatingMethodAccessorImpl.in
at java.lang.reflect.Method.invoke(Method.java
at javassist.util.proxy.FactoryHelper.toClass(
... 46 more

The performance is also very bad in comparison

Solution:
The folloing are the methods I changed for fix
```

description about this bug

```
    /* /javassist/src/javassist/CtClass.java/a
    public void addConstructor(CtConstructor c
        throws CannotCompileException
    {
        checkModify();
        if (c.getDeclaringClass() != this)
            throw new CannotCompileException("

        getConstructorsCache();
        constructorsCache = (CtConstructor)CtM
        getClassFile2().addMethod(c.getMethodI
```

Related declarations of method

Related work: code clone

- Tools for managing code clones
  - Simultaneous editing [R. C. Miller, et al., USENIX 2002]
  - Linked Editing [M. Toomim, et al., VLHCC 2004]
    - supports parameters
  - CReN [D. Hou, et al., CASCON 2009]
- These tools do not provide the concerns view
  - Sync. copy & paste does since its focus is on modularity.

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Related work: aspect orientation

- Mylar [M. Kersten, et al., AOSD 2005]
  - monitors developers' action and detects a group of related code
    - Temporary concerns
  - does no change the expression of source code
- Fluid AOP [T. Hon, et al., OOPSLA 2006]
  - can show a program differently from the representation in the actual source file
  - requires AspectJ-like syntax
    - Sync. Copy & paste and Kide does not

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Related work: other systems

- CIDE [C. Kästner, et al., ICSE 2008]
  - Developers can mark a code snippet with a color of its feature
    - They can include/exclude all the code snippets related to a given feature
    - by a single action
    - without syntactic directive `#ifdef`
  - Its navigation panel is similar to our concerns view
  - It does not provide a virtual source file
- Code Bubbles [A. Bragon, et al. ICSE 2010]
  - A small editor dedicated for every method can be freely placed on the screen
    - can be used as an editor of a virtual source file
  - does not provide a wizard-based support tool

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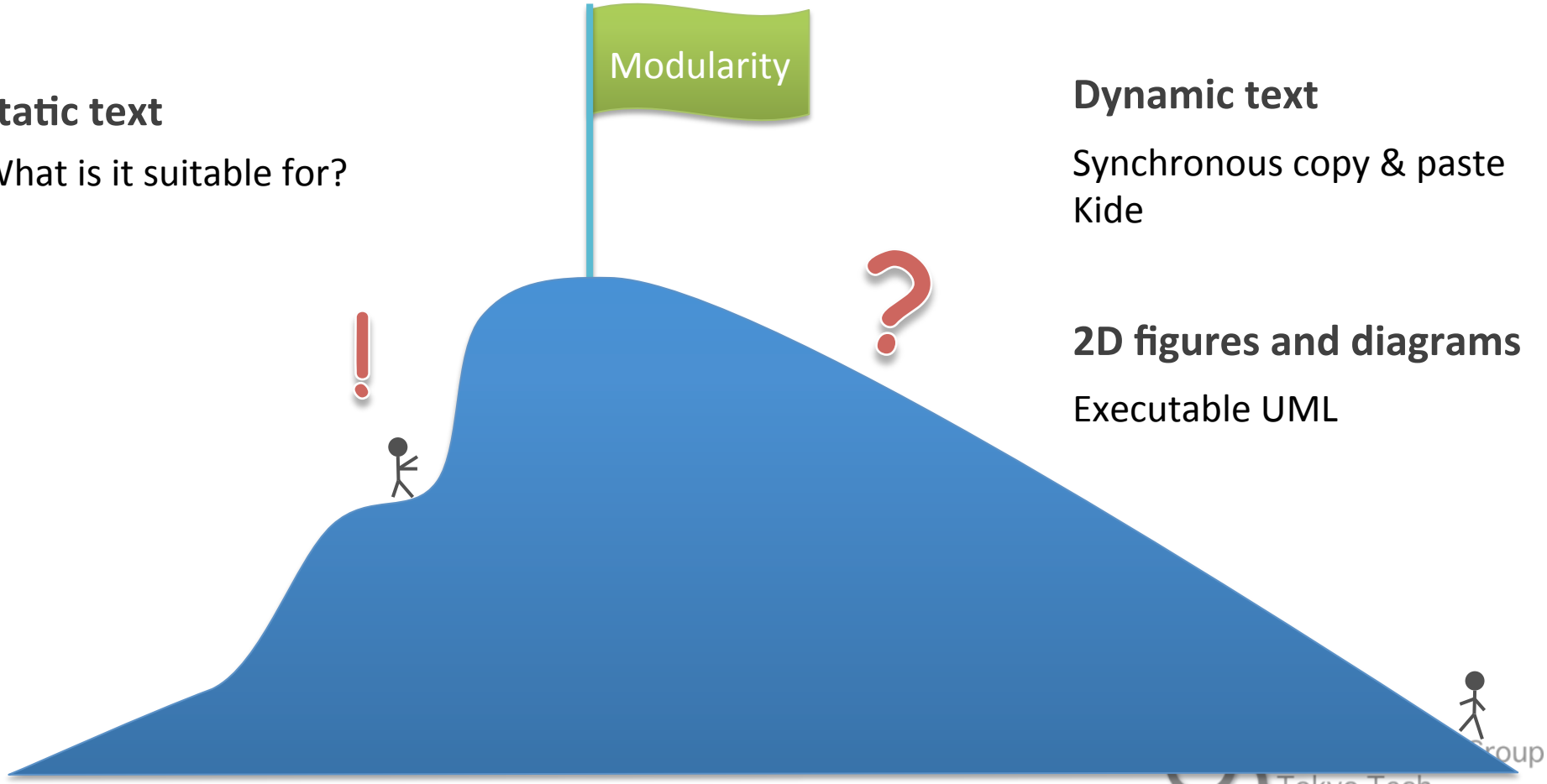
Approaches to modularity

- A language based on ...

static text

What is it suitable for?



Dynamic text

Synchronous copy & paste
Kide

2D figures and diagrams

Executable UML