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# A Unified Meta-Model for Concept-Based Reverse Engineering

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# Outline

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## Reverse Engineering

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## Concept-based Reverse Engineering

Ontologies, WordNet, Meta-Model

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## Experiences

Synonymy, Logical Duplication, Polysemy

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## Conclusion & Future Work

# Reverse Engineering

Reverse engineering is the process of analyzing a subject system to

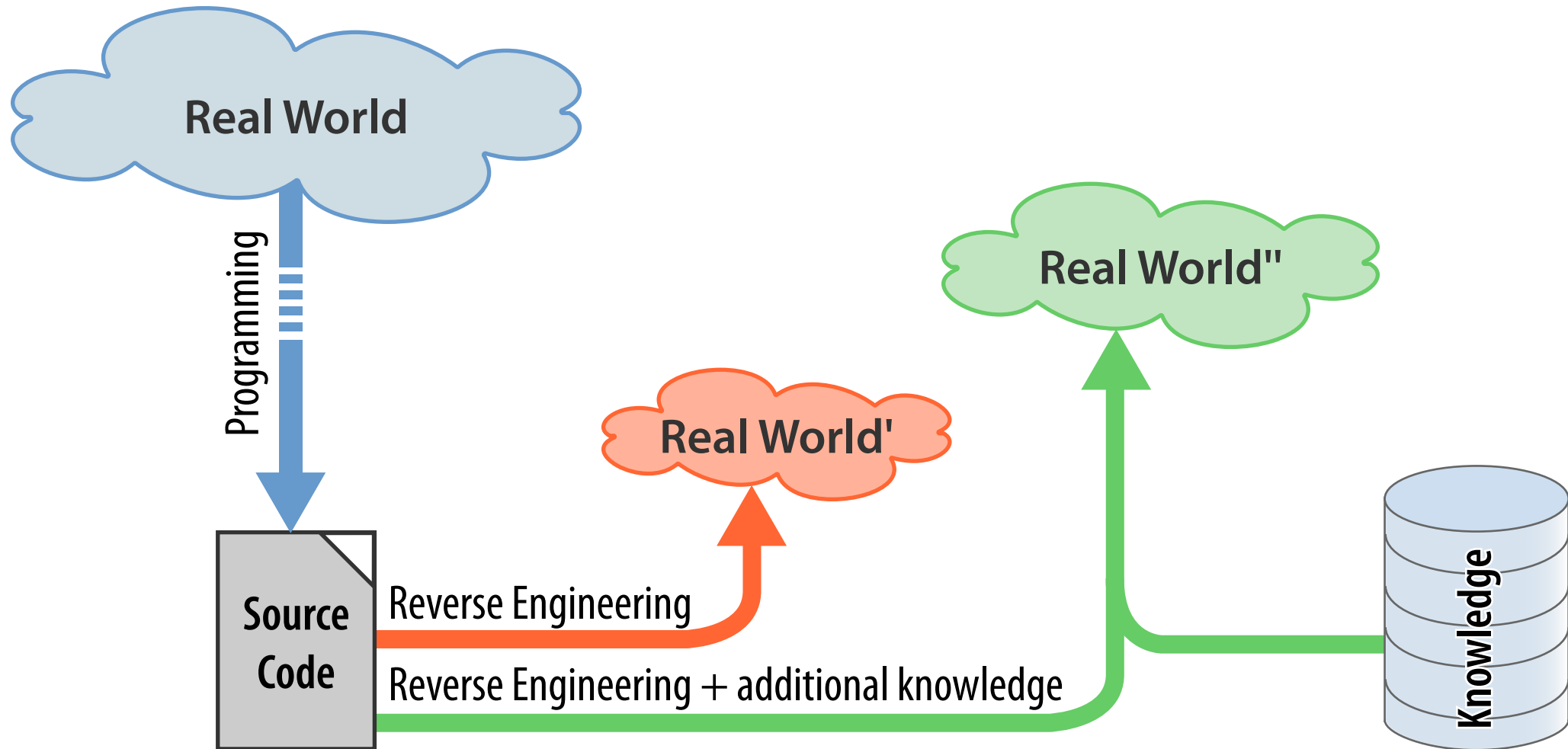
- identify the system's components and their interrelationships and
- create representations of the system in another form or at a higher level of abstraction.\*

## Pressing Issues

- Logical duplication
- Naming defects
- Documentation quality
- Impact analysis
- Dependency management
- Aspect mining

\* E.J. Chikofsky, J.H. Cross, *Reverse engineering and design recovery: A taxonomy*, 1990

# Information Loss

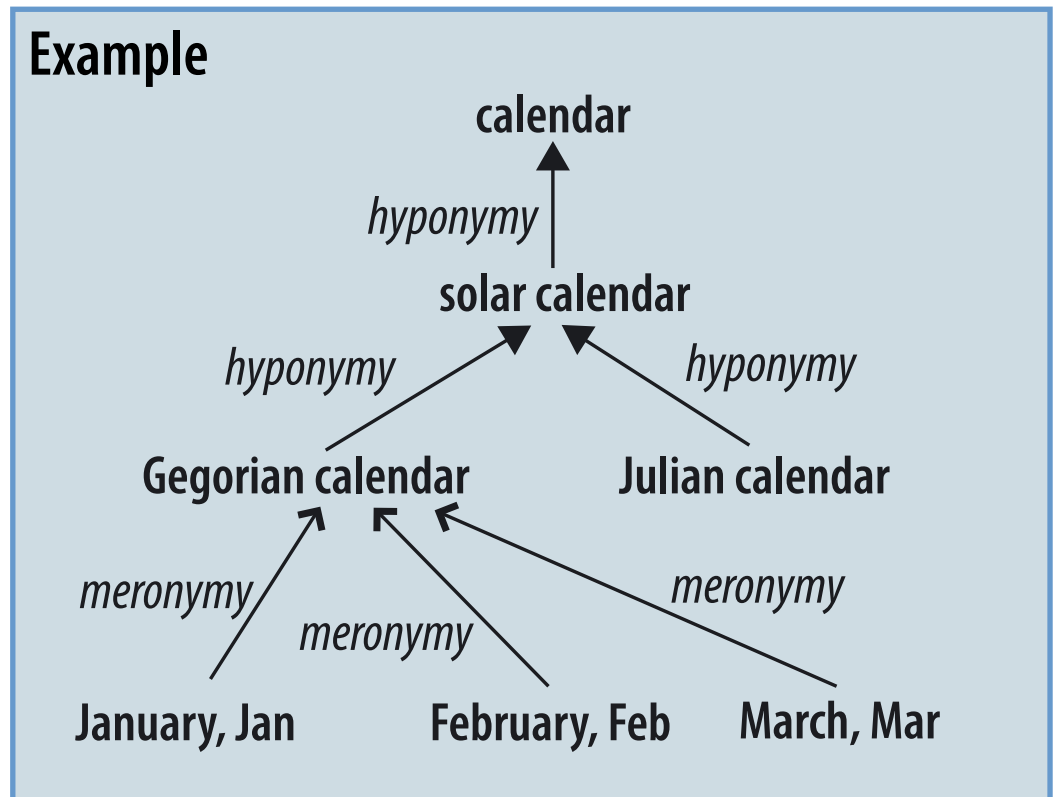


Unfortunately, source code does not contain much of the original design information, which must be reconstructed from only the barest of clues.\*

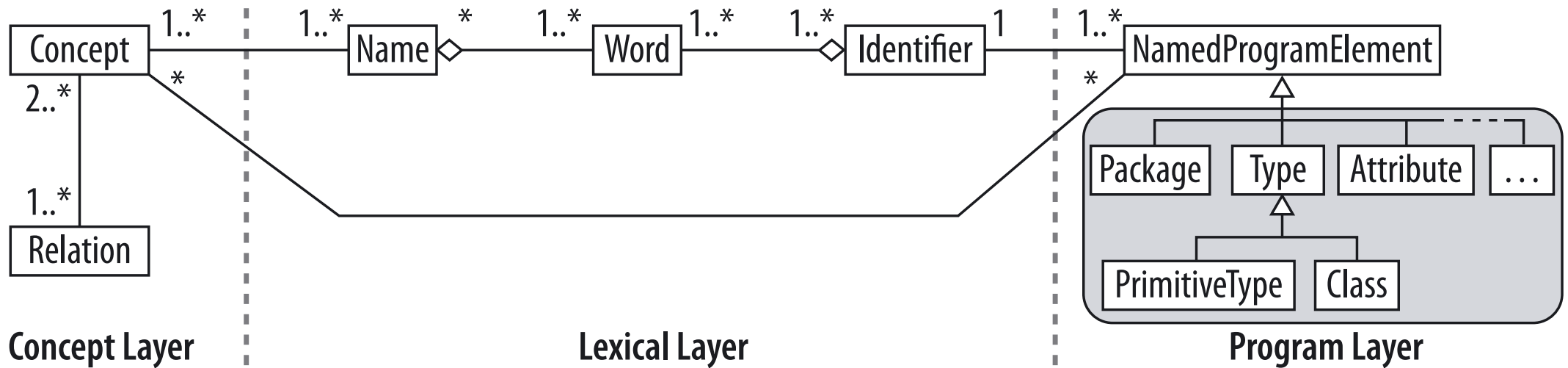
\* T.J. Biggerstaff, *Design Recovery for Maintenance and Reuse*, 1989

# WordNet Ontology

- Provides »Common Knowledge«
- Lexicalized concepts only
- ≈ 150.00 Words
- ≈ 115.00 Concepts
- Synonymy
- Polysemy
- Relations
  - Hypernymy/Hyponymy
  - Holonymy/Meronymy



# Meta-Model



- Concept layer
- Lexical layer
- Program layer
- Extends structural models
- Names are the »glue«
- Explicit mapping between concepts and program elements

# Instantiation

```
class Calendar {  
    ...  
}  
class GregorianCalendar  
    extends Calendar {  
    int JANUARY = 0;  
    int FEBRUARY = 1;  
    ...  
}
```

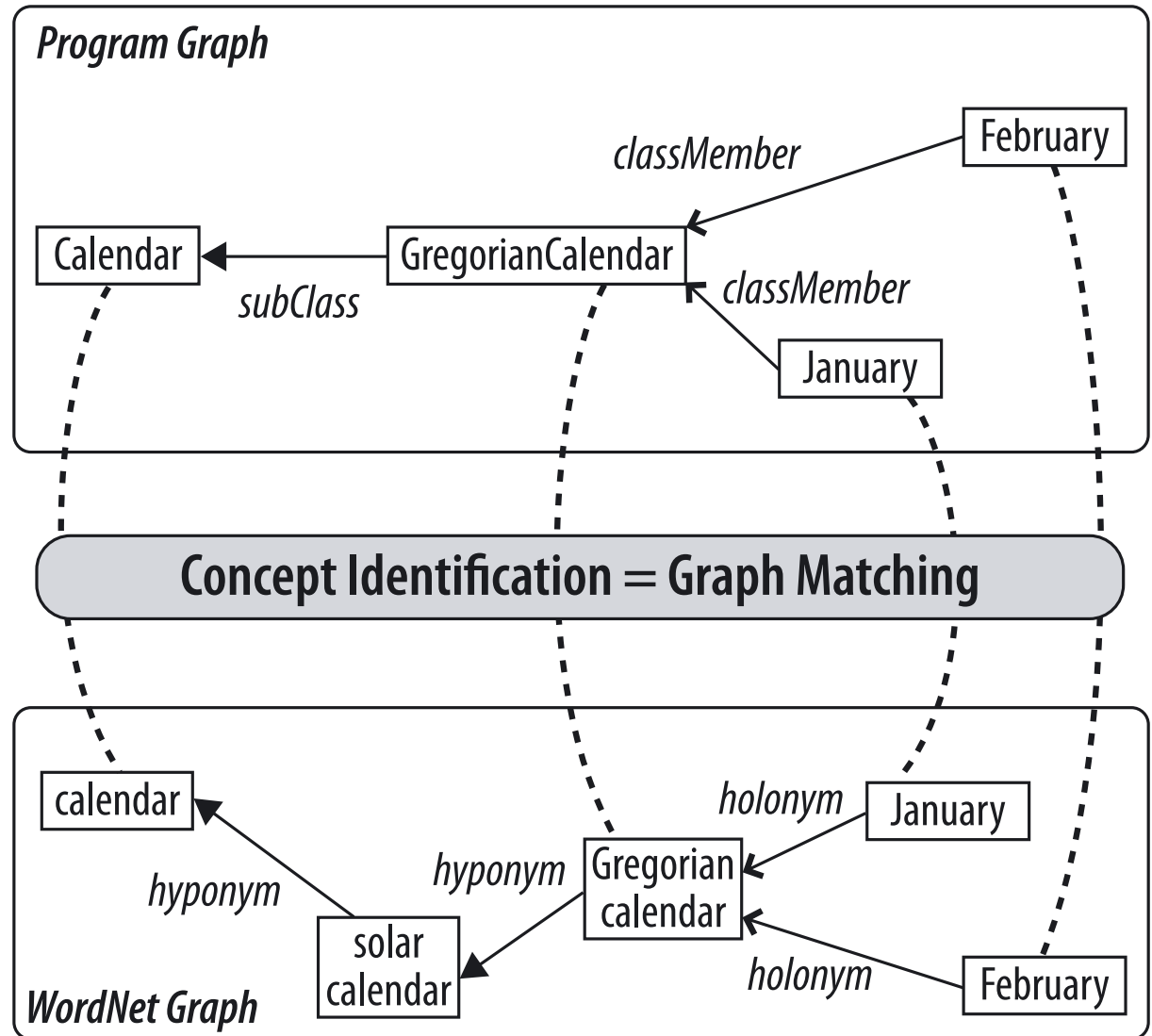
*Source Code*

□ □ □ □ →  
Program hierarchy  
between names  
represented  
as graphs

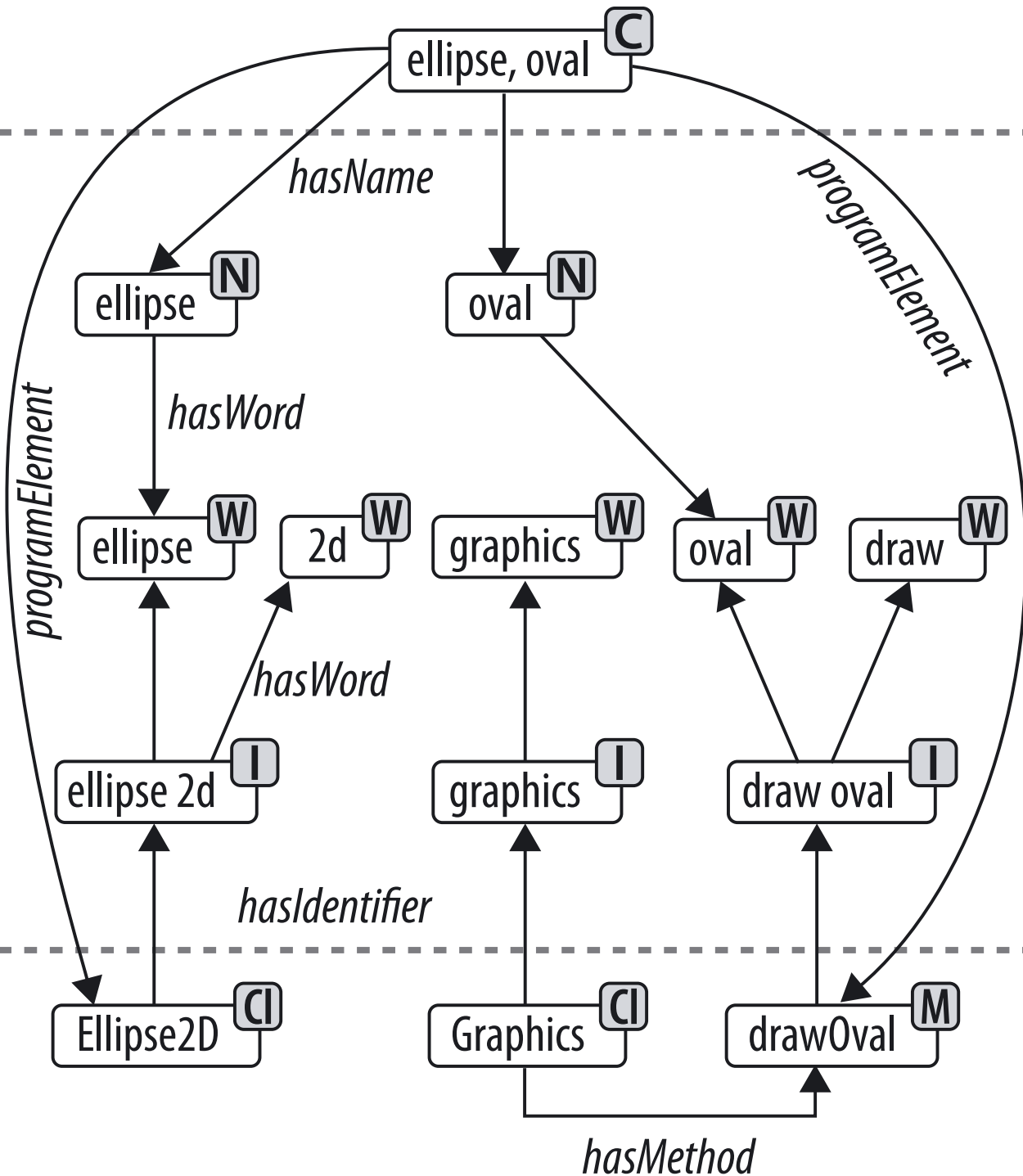


*Ontology*  
**WordNet 2.0**

□ □ □ □ →  
Ontology  
represented  
as Graph



# Example 1: Synonymy



**drawOval** **JavaDoc**

```
public abstract void drawOval( int x,
                               int y,
                               int width,
                               int height)
```

Draws the outline of an oval. ...

**Ellipse2D.Double** **JavaDoc**

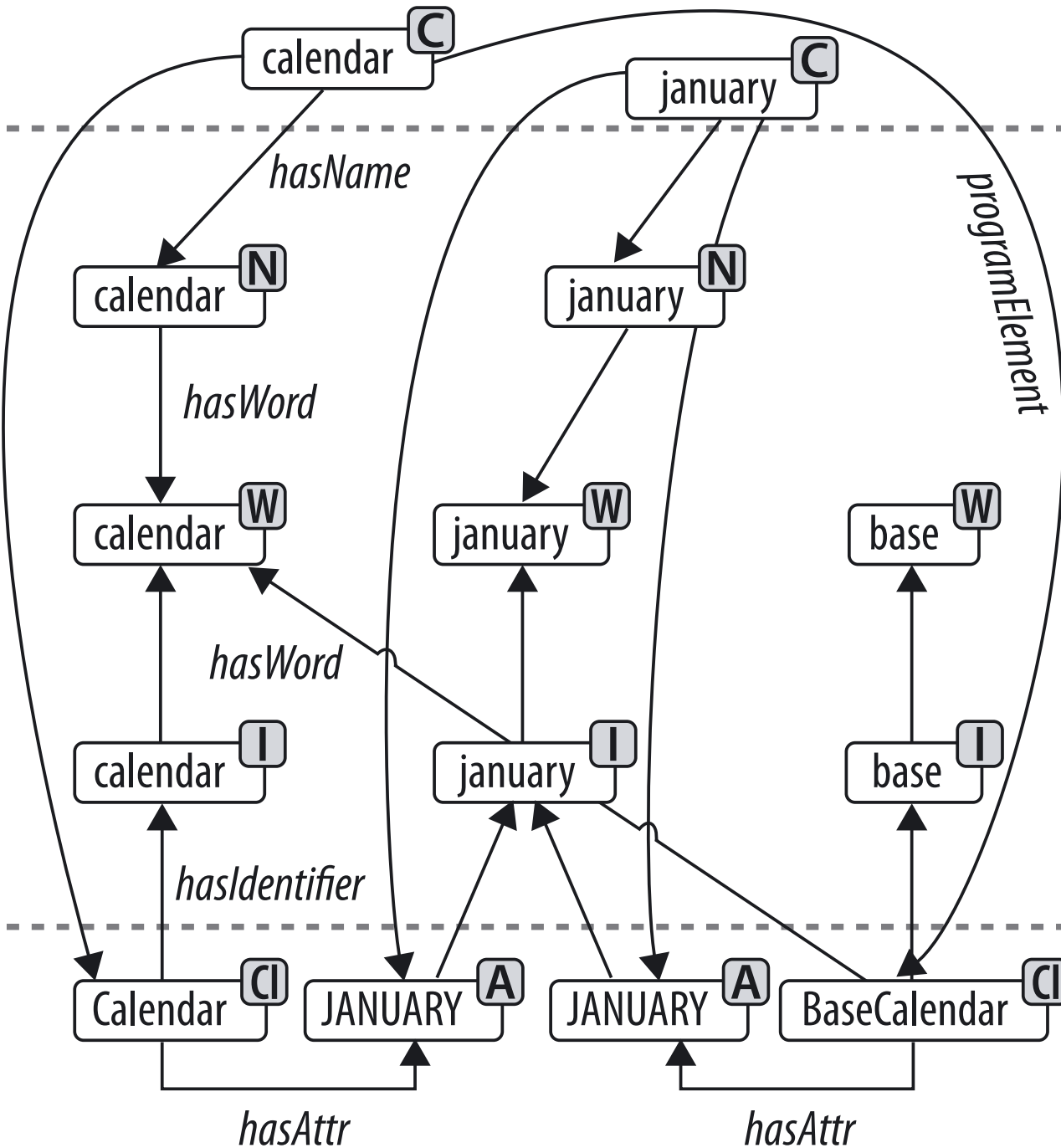
```
public Ellipse2D.Double(double x,
                        double y,
                        double w,
                        double h)
```

Constructs and initializes an Ellipse2D ...

- |                  |                     |
|------------------|---------------------|
| <b>C</b> Concept | <b>I</b> Identifier |
| <b>N</b> Name    | <b>Cl</b> Class     |
| <b>W</b> Word    | <b>A</b> Attribute  |
| <b>M</b> Method  |                     |



# Example 2: Logical Duplication



## java.util.Calendar

```
public final static int JANUARY = 0;
public final static int FEBRUARY = 1;
public final static int MARCH = 2;
...
```

## sun.util.calendar.BaseCalendar

```
public final static int JANUARY = 1;
public final static int FEBRUARY = 2;
public final static int MARCH = 3;
...
```

- |                  |                     |
|------------------|---------------------|
| <b>C</b> Concept | <b>I</b> Identifier |
| <b>N</b> Name    | <b>Cl</b> Class     |
| <b>W</b> Word    | <b>A</b> Attribute  |
| <b>M</b> Method  |                     |

# Example 3: Polysemy

java.awt.BorderLayout

```
/**
 * The north layout constraint (top of container).
 */
public static final String NORTH = "North";

...

/**
 * Constant to specify components location to be the
 * north portion of the border layout.
 * ...
 */
Component north;
```

# Conclusions & Future Work

## Conclusions

- Lost information needs to be recovered for effective reverse engineering.
- Additional information must be provided and...
- ...explicitly linked to the source code.
- Results are encouraging but need further research.
- Variation points need to be investigated.

## Future work

- Chained ontologies
- Hand-crafted ontologies
- Different types of relations