AMAP:
Automatically Mining Abbreviation Expansions in Programs to Enhance Software Maintenance Tools

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Abbreviations in Code

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Consider, for example, this Java code snippet.

Abbreviations with long forms nearby in the code are common, such as ‘l’ for ‘Locale’.

However, cases where the long form is no where near short form, such as UI, Attr, J, or VK -- these are the interesting and more difficult cases.

In fact, sometimes short forms occur more frequently than the long form!

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Abbreviations can occur more frequently than long form

In Java 2: `num` (5,226) more frequent than `number` (4,314)

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Concrete Example: Concern Location

But why do we care? Let me give you a concrete example for concern location. In this example we're looking for the "delete auction" concern in an auction sniping program.

Although there are many methods relevant to this concern, let me draw your attention to two. The first is 'delEntry', which contains the abbreviation 'del' for delete in the method name. A simple lexical search will return this method because it contains the word 'delete' both in the comments and other identifiers in the method. However, the other relevant method 'refilterAll' only refers to 'delEntry', and will be missed by a simple lexical search.

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 * This also tells the auction entry to unregister itself!
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public void refilterAll(boolean clearCurrent) {
  for(int i=_tSort.getRowCount()-1; i>=0; i--) {
    AuctionEntry ae = (AuctionEntry) _tSort.getValueAt(i, -1);
    if (clearCurrent) {
      delEntry(ae);
    } else {
      ae.setCategory(null);
      FilterManager.getInstance().refilterAuction(ae, false);
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Why do we care?

- Improve effectiveness of language-based software tools
  - Concern location
  - Documentation to source code traceability
  - Analysis of software artifacts, e.g., defect reports
  - Program Comprehension

Again, why do we care? If we had access to accurate automatic abbreviation expansion techniques, we could improve the effectiveness of natural language-based software tools---tools that use the lexical information in comments and identifiers.

The most obvious application is in program comprehension. When a developer comes across an unfamiliar abbreviation in code, the automatic expansion technique can present likely long forms, instead of the developer having to waste time looking through code for the expansion.

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Automatically expanding abbreviations can give tools access to words and associated meanings that were previously meaningless sequences of characters

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Automatic Abbreviation Expansion

- Given a code segment, identify character sequences that are short forms and determine long form

To identify character sequences, or tokens, in code boils down to splitting the identifiers. The hardest case is no boundary cases. If not properly split, abbreviations will be missed, such as in string length.

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    Component comp = super.prepareRenderer(renderer, row, column);
    if (comp instanceof JLabel) {
                if (convertColumnIndexToModel(column) == COLUMN_FILESIZE) {
        // Numbers are right-adjusted, regardless of component orientation
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        } else {
```

1. Split Identifiers:

To identify character sequences, or tokens, in code boils down to splitting the identifiers. The hardest case is no boundary cases. If not properly split, abbreviations will be missed, such as in string length.

Automatic Abbreviation Expansion

- Given a code segment, identify character sequences that are short forms and determine long form

```
final JTable detailsTable = new JTable(detailsTableModel) {
    // Handle Escape key events here
    protected boolean processKeyBinding(KeyStroke ks, KeyEvent e, int condi
    if (e.getKeyCode() == KeyEvent.VK_ESCAPE && getCellEditor() == null) {
        // We are not editing, forward to filechooser.
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     - e.g., `strlen`

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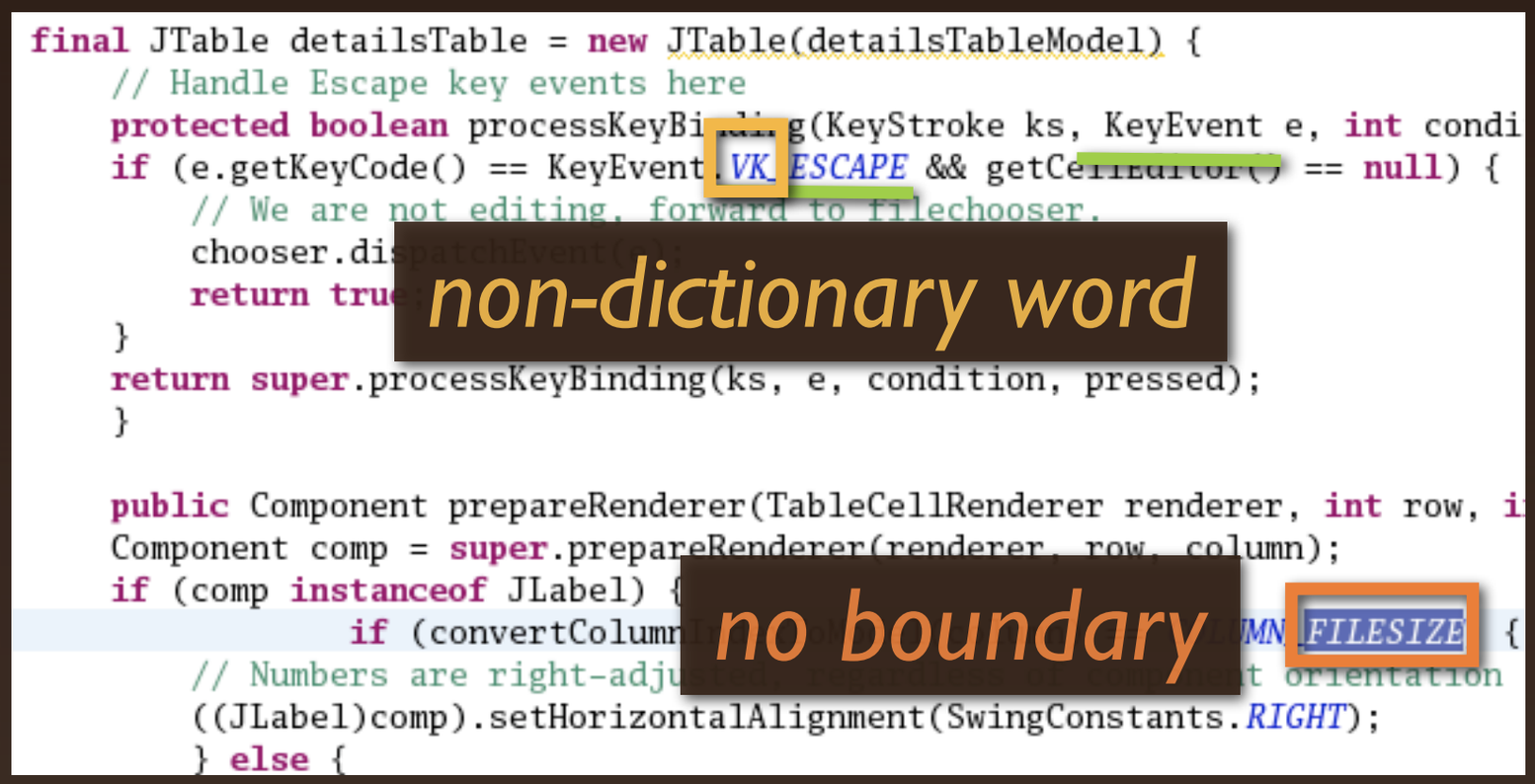

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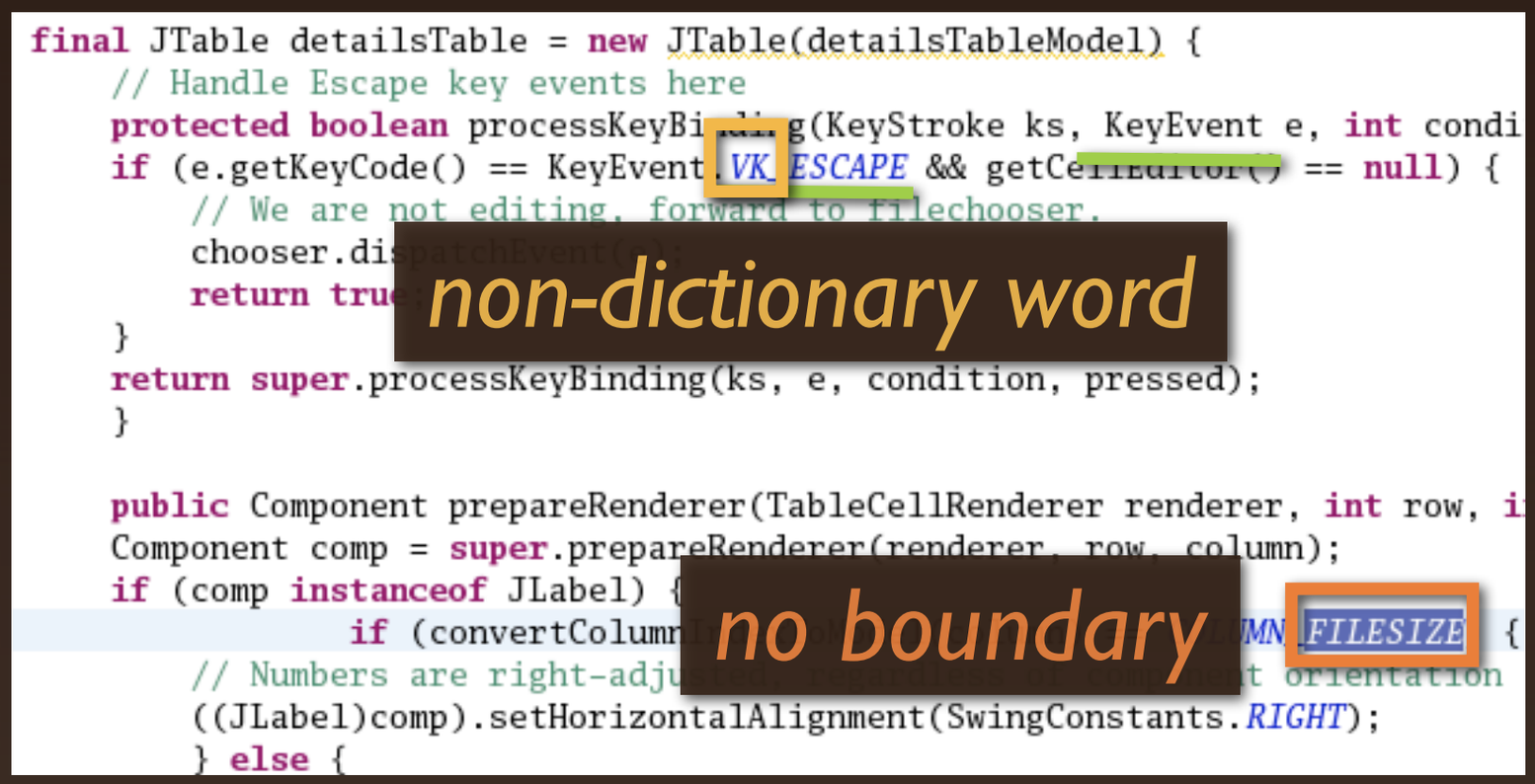

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Dictionary Approach

The simplest approach is a manually created dictionary of common short forms in code. However, this has a couple drawbacks.

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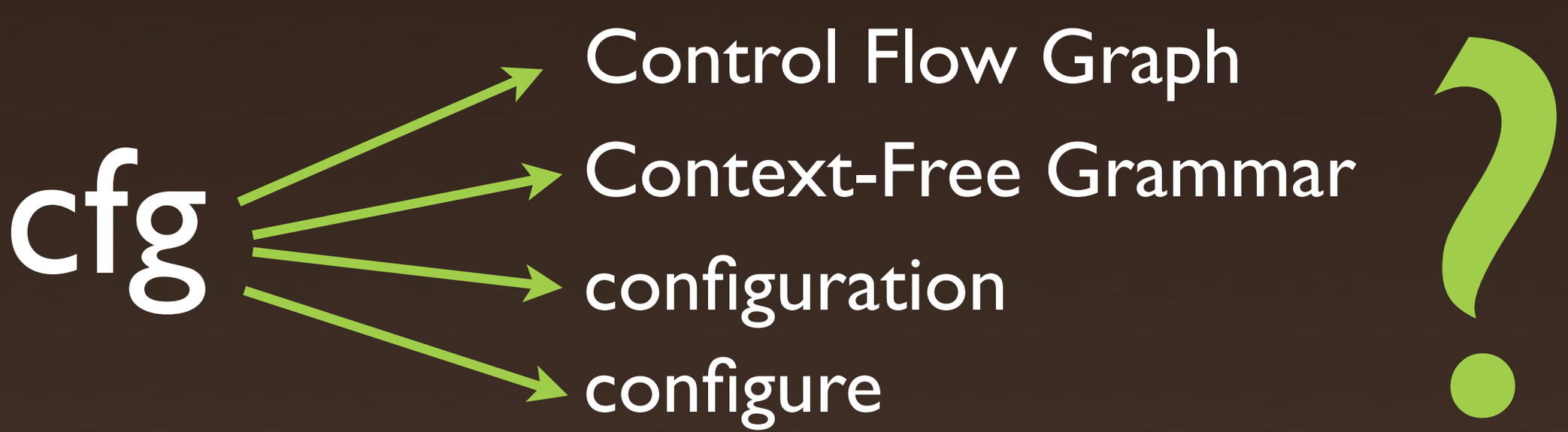

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```
public static IdentifiableFactory makeJavaSerializationComponentFactory() {
return new EncapsulationFactoryBase(
             ORBConstants.TAG_JAVA_SERIALIZATION_ID) {
    public Identifiable readContents(InputStream in) {
    byte version = in.read_octet();
    Identifiable cmp = new JavaSerializationComponent(version);
    return cmp;
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   that is either greater than the current key, or equal
   to it.  In the latter case, remove the key.  */
int cmp = +1;
while ((cmp = nextString.compareTo(key)) < 0) {
if (stringIterator.hasNext())
    nextString = (String) stringIterator.next();
else
    nextString = sentinelKey;
}
if (cmp == 0) {
keyIterator.remove();
continue keys;
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Need to use abbreviation context to correctly identify long form

Mining Abbreviation Expansions

In this approach we are doing text mining, as opposed to the more general data mining.

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Step 2: Search for potential long forms

Types of Non-Dictionary Words

We looked at hundreds of example abbreviations, and observed a number of types of dictionary words.

The difference between combination and no boundary is that in combination, one or more of the concatenated tokens is an abbreviation.

It should be noted that our technique handles both combination and no boundary cases, as well as misspellings that are instances of dropped letter.

Step 2: Search for potential long forms

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- Single-Word
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- Others
  - No boundary (saveas, filesize)
  - Misspelling (instanciation, zzzcatzzzdogzzz)

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Long Form Search Patterns

For each of these abbreviation types, we search for long forms in the code by using regular expressions. For the actual patterns, please see the paper.

Notice that dropped letter and combination can match many more meaningless sequences.

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Search Pattern Order

- Search by abbreviation type:

Now that we know these patterns, how do we determine what abbreviation type a given short form is?

We were pretty sure conservative acronym and prefix should go first, followed by greedier dropped letter and combination -- but in what order?

After looking at hundreds of examples, we determined the following order:
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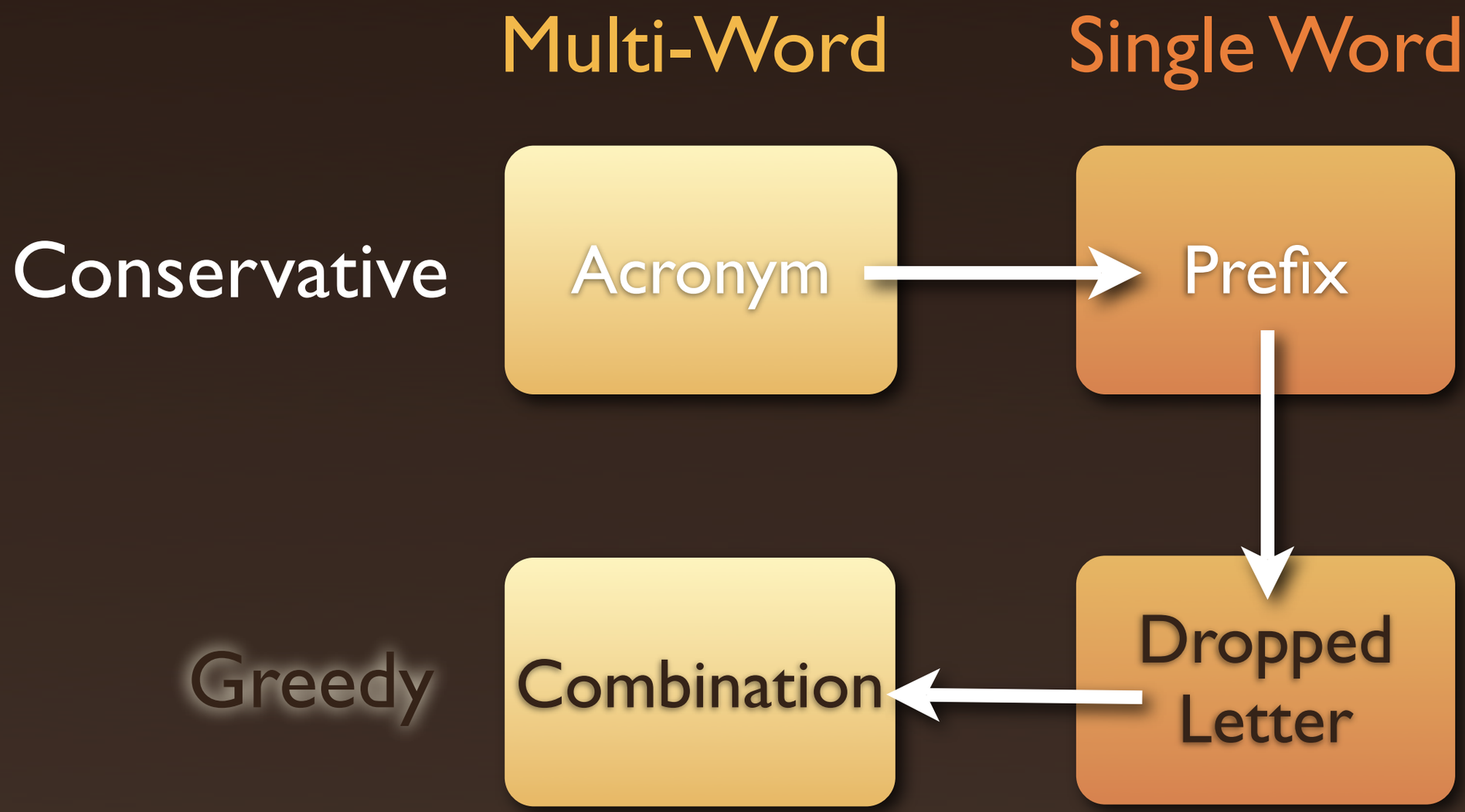

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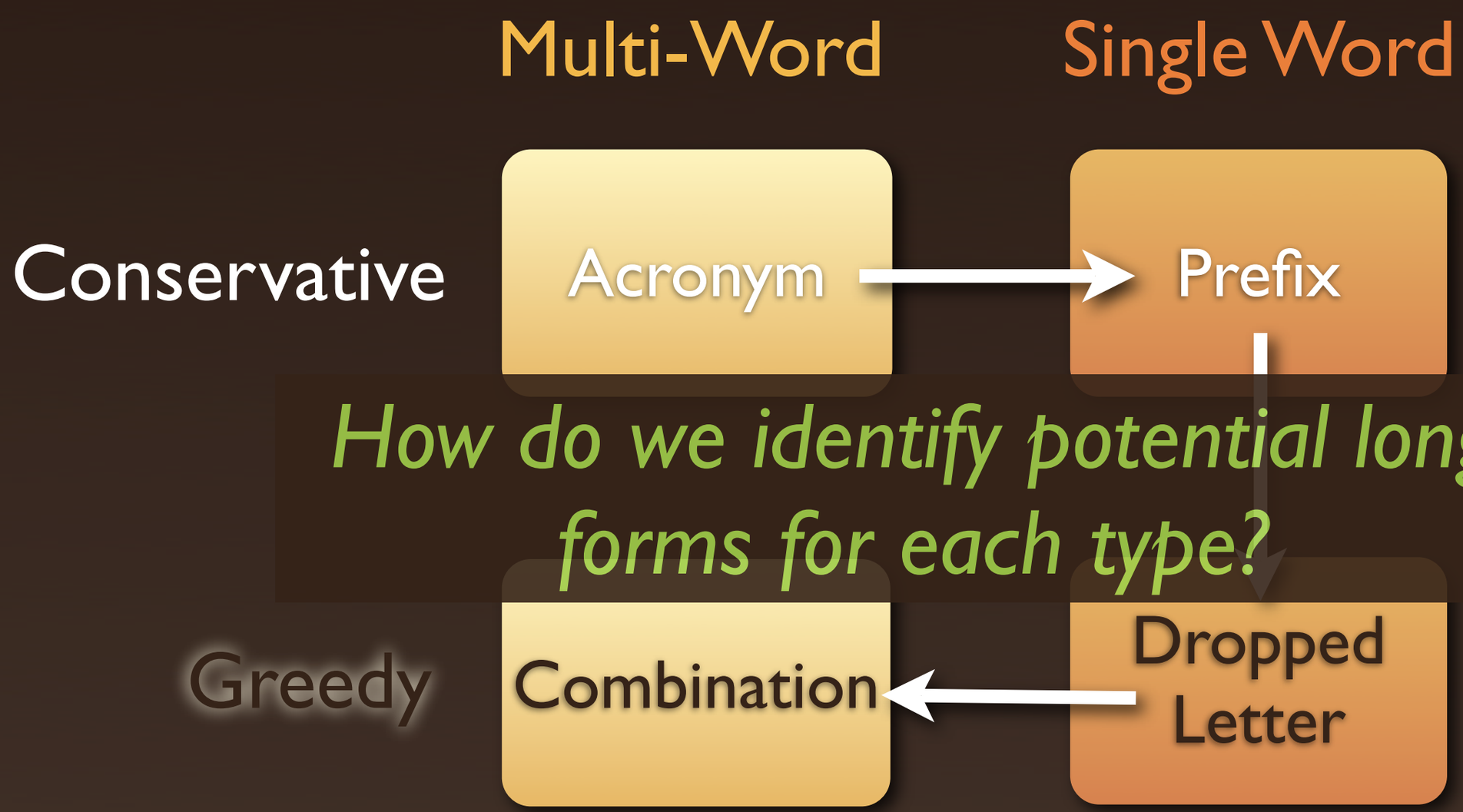

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Our Scoped Approach

Our approach is inspired by, but doesn't follow, static variable scoping. We start with locations in the code where we have high confidence in the long forms, and increase the scopes to less reliable locations in a best effort to find long forms.

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```
/**
 * Copies characters from this string into the destination character
 * array.
 *
 * @param      srcBegin   index of the first character in the string
 *                        to copy.
 * @param      srcEnd     index after the last character in the string
 *                        to copy.
 * @param      dst        the destination array.
 * @param      dstBegin   the start offset in the destination array.
 * @exception NullPointerException if <code>dst</code> is <code>null</code>
 */
public abstract void getChars(int srcBegin, int srcEnd, char dst[],
                              int dstBegin);
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 */
public abstract v
```

```
     * @param env Environment attributes.
     * @param mbs The MBeanServer for which the connector server provides
     * remote access.
     *
     */
    public static ClassLoader resolveServerClassLoader(Map env,
                                                       MBeanServer mbs)
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private void circulationPump(ControlFlowGraph cfg, InstructionContext start,
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    InstructionContextQueue icq = new InstructionContextQueue();
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```
Object source = event.getSource();
if (source instanceof Component) {
    Component comp = (Component)source;
    comp.dispatchEvent(event);
} else if (source instanceof MenuComponent) {
```


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```
public void setBarCodeImg(int type, String text, boolean showText, boolean checkSum){

    StringBuffer bcCall = new StringBuffer("it.businesslogic.ireport.barcode.BcImage.g
    //boolean isFormula = text.trim().startsWith("$");
    bcCall.append(type);
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3. Method Name (lf only)
4. Statements (sf & lf)

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2. Type Names of declared variables (name=sf)
3. Method Name (lf only)
4. Statements (sf & lf)

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final int nConstructors = constructors.size();
final int nArgs = _arguments.size();
final Vector argsType = typeCheckArgs(stable);
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Our approach is inspired by, but doesn't follow, static variable scoping. We start with locations in the code where we have high confidence in the long forms, and increase the scopes to less reliable locations in a best effort to find long forms.

Step 2: Search for potential long forms

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What if no long form found in any scope for any abbreviation type?

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What if no long form found?

In the second example, the long form ‘arguments’ didn’t appear anywhere in the class file.

Although after the Java MFE you could add in a hand-tuned list, the focus of this work was to see how well we could do with a purely automated approach.

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```
public boolean hasReferenceArgs() {
return _left.getType() instanceof ReferenceType ||
    _right.getType() instanceof ReferenceType;
}

public boolean hasNodeArgs() {
return _left.getType() instanceof NodeType ||
    _right.getType() instanceof NodeType;
}

public boolean hasNodeSetArgs() {
return _left.getType() instanceof NodeSetType ||
    _right.getType() instanceof NodeSetType;
}
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     - Option: hand-tuned common abbreviation list

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Experimental Evaluation:
Design

To evaluate our scoped approach, we compared our technique with 3 others.

Experimental Evaluation: Design

- Variable: Abbreviation expansion technique
  - Our scope approach (long form per method)
  - Program MFE (long form per program)
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    - Search ispell dictionary, rather than just those occurring in code
    - Search for dropped letter (incl. prefix) and acronym

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  - 250 randomly selected non-dictionary words from 5 large, open source Java programs (300-400K NCLOC)
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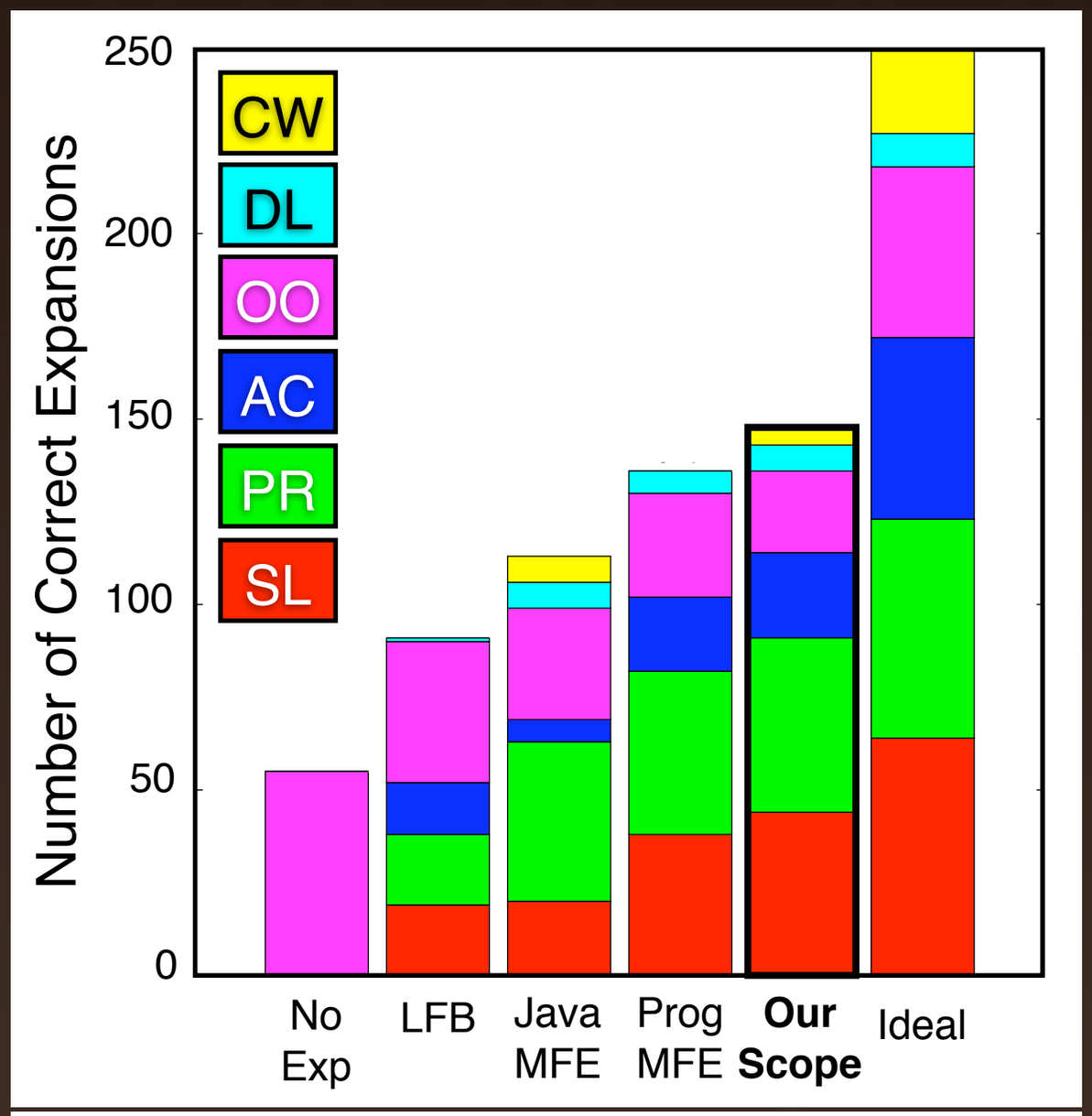
- Measure: accuracy (% correctly expanded short forms)

$$\text{accuracy} = \frac{\#\text{ correct expansions}}{250}$$

Experimental Evaluation: Results



Accuracy:	22%	***40%***	45%	54%	59%	
					63%	

- Histogram of number of correct expansions for each abbreviation expansion technique, broken down by type.
- For reference, included results of returning no expansion as well as the type breakdown for the ideal set (maximum possible number correct, 250)
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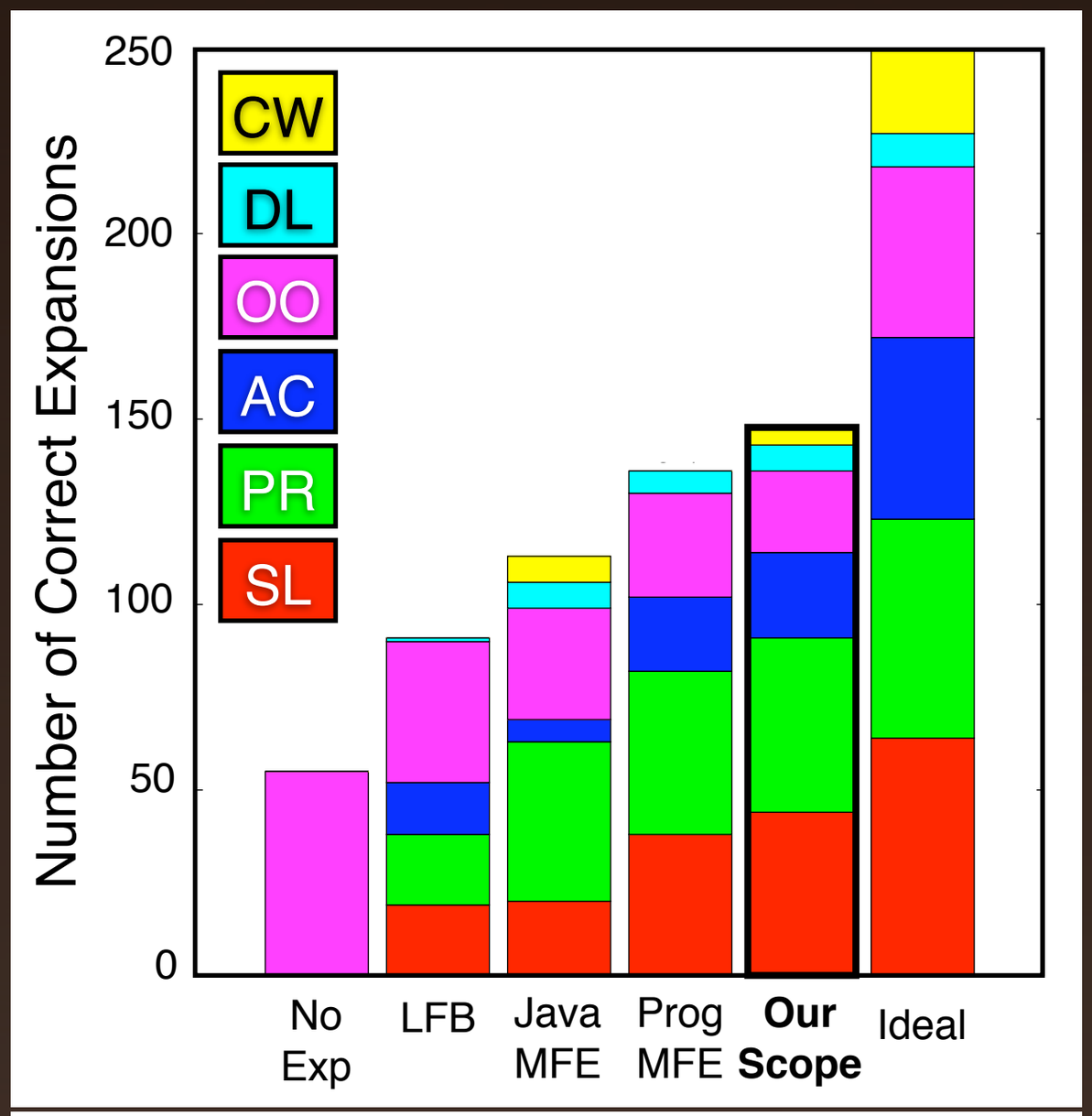

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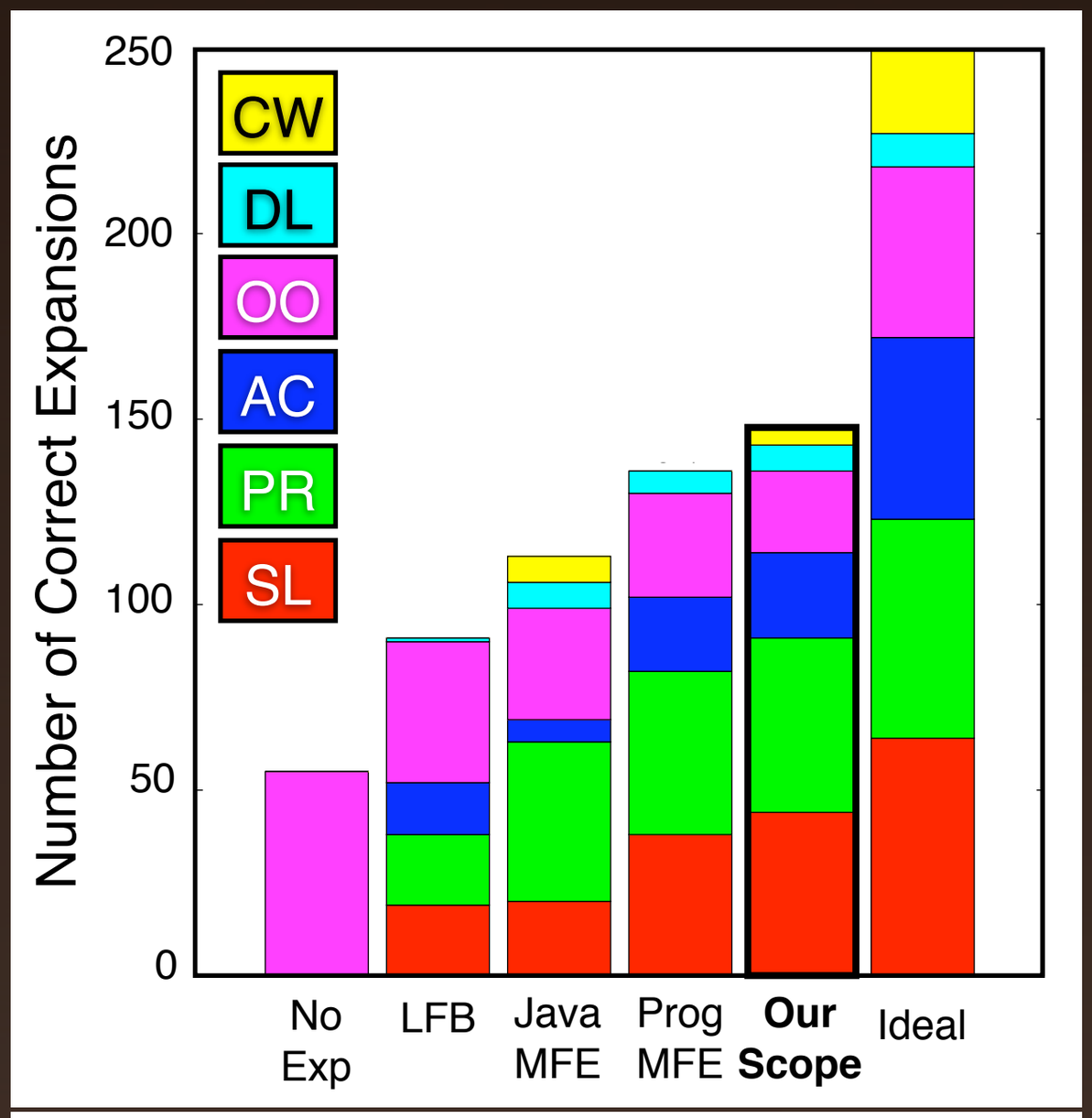

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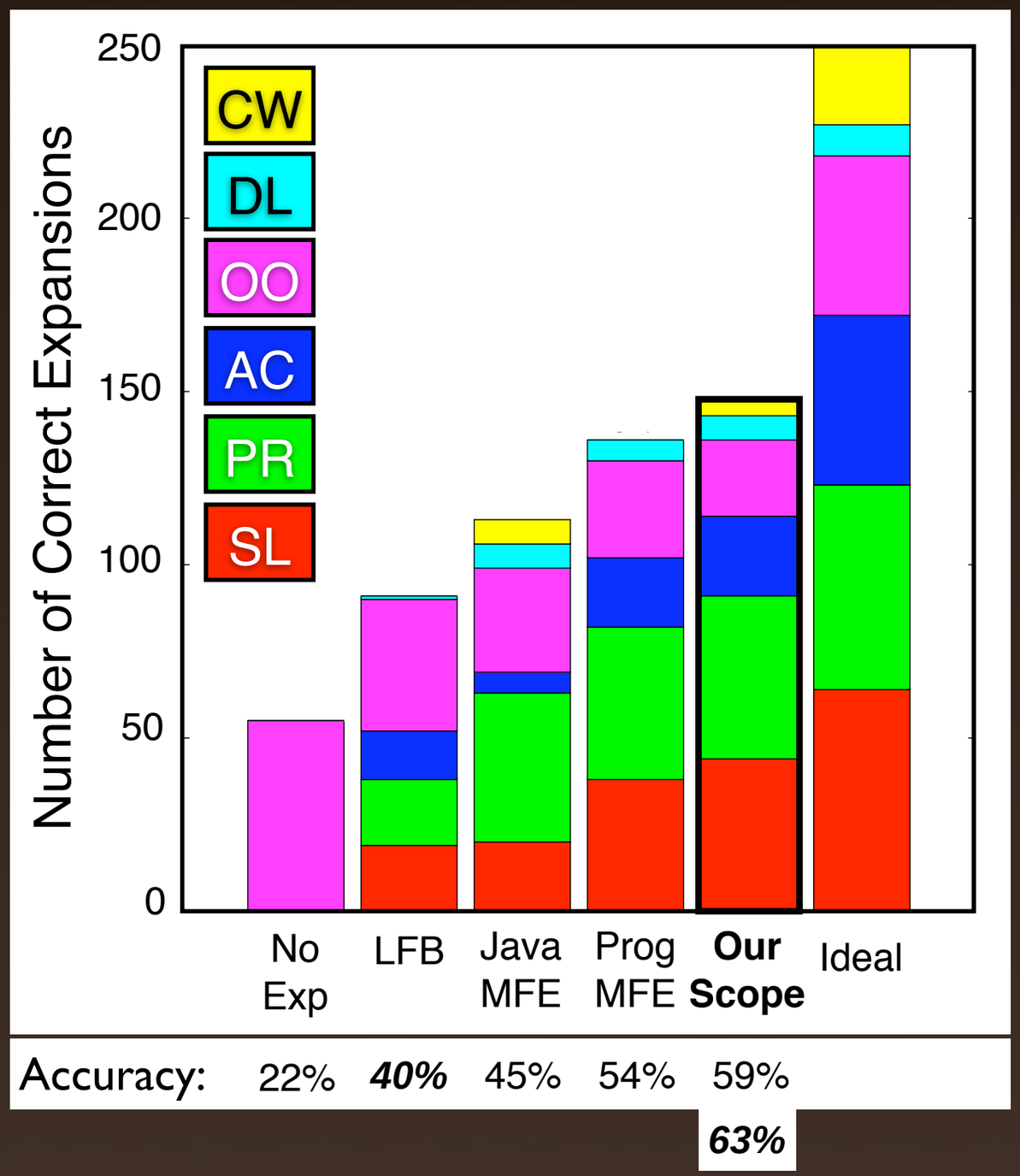

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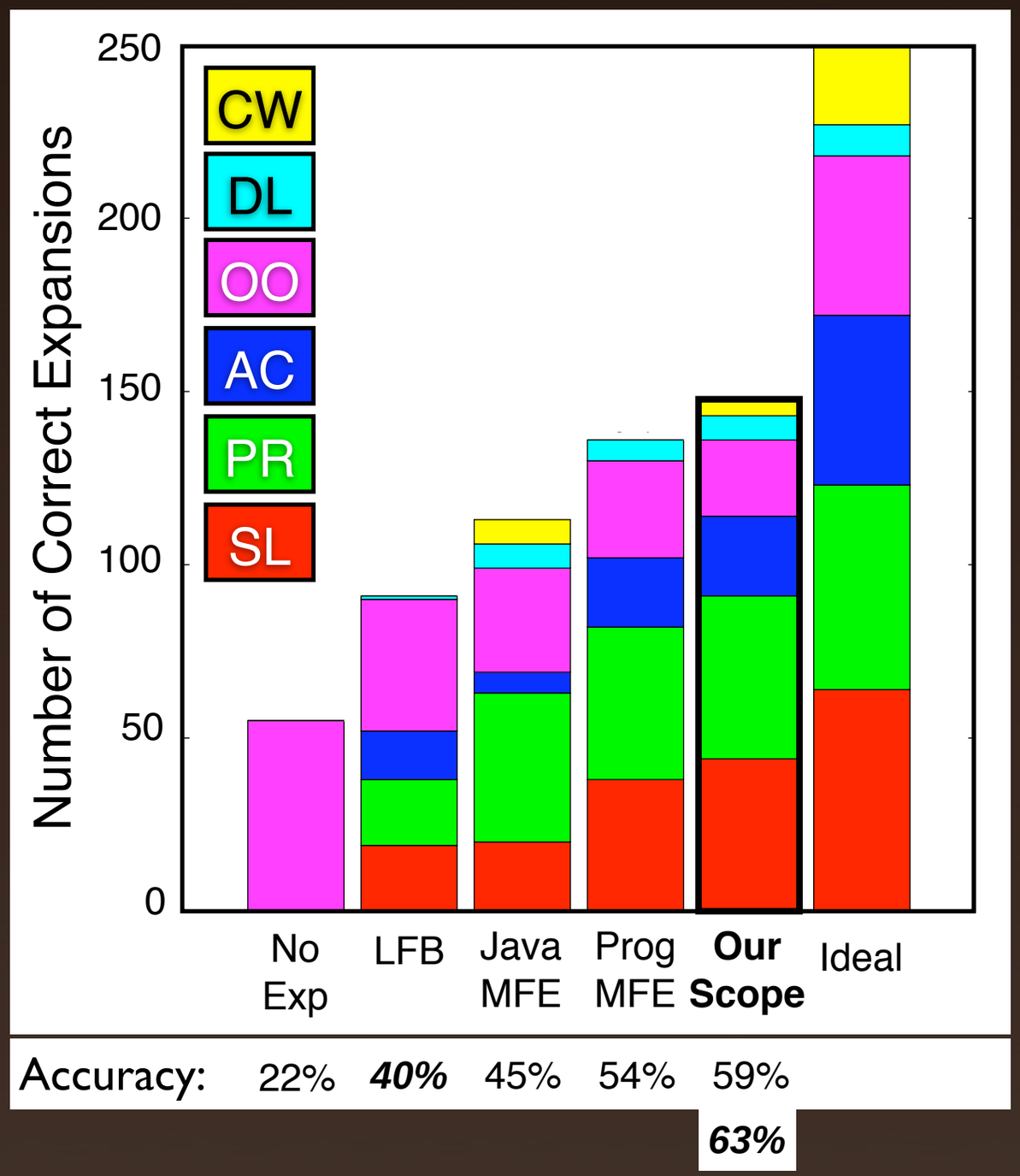

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- Room for improvement:
  AC: Acronym,
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Conclusions & Future Work

- Scope 57% more accurate than state of art LFB
- Mine even larger set of programs
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`www.cis.udel.edu/~hill/amap`

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