ABL Code Analytics

Unique Tools for Deep Code Analysis and Inspection

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Agenda

- Background
- Abstract Syntax Trees (ASTs)
- TRee Processing Language (TRPL)
- Code Analytics
  - Predefined Reports
  - Search
  - Custom Reports
  - Call Graph
- Usage Tips
- Planned Improvements
- How to Get Started

What is FWD?

- Transformation, refactoring and modernization of entire ABL applications (both code and schemata).
- Fully automated, runs non-interactively.
- Handles projects of any size (proven in projects over 10+ MLOC).
- Designed to handle the full range of complexity in ABL applications.
- Open Source
- To our knowledge, this is the only technology which has successfully converted entire ABL applications from procedural to OO. By successful, we mean that the application was a drop-in replacement for the original and it is in production.
- ABL Code Analytics was born from this technology and is actively used to aid and enable automated transformation projects.

FWD

automated transformation

abl code analytics

develop in abl, deploy in java/web

- maximize the value of your ABL investment -

Who is Golden Code?

Golden Code is the team of engineers and computer scientists that created the FWD technology.

Using FWD, Golden Code works with clients to help them solve the toughest ABL refactoring, transformation and modernization problems.

www.goldencode.com

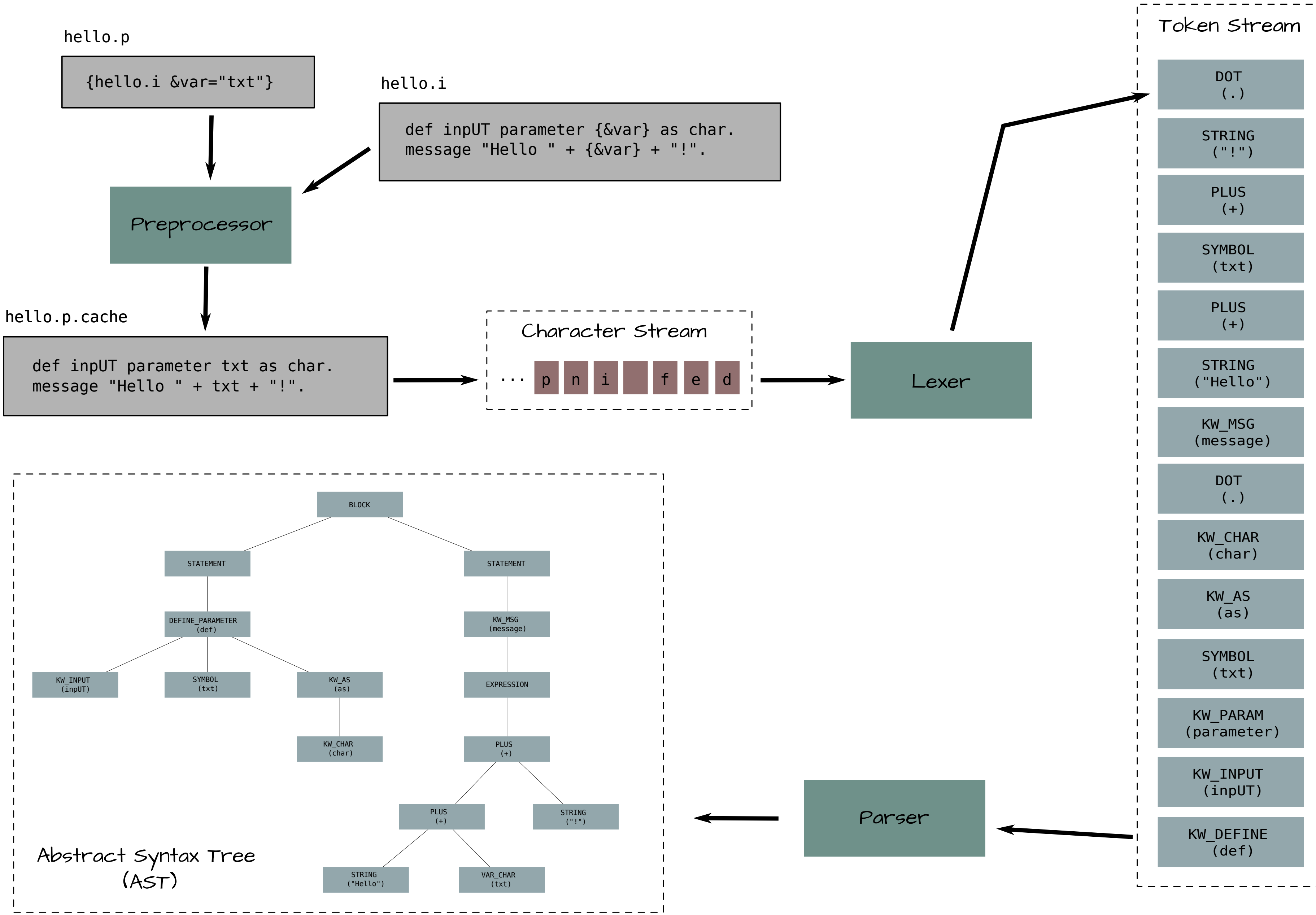
Why Use Code Analytics?

- Reduce effort.
- Improve code quality.
- Deeply understand and explore existing code.
- Empower developers to more capably handle:
    - the most complex refactoring, transformation and modernization problems
    - making changes at scale (across the largest of applications)

Your Source Is Not Helping

- Programmatic analysis of an application needs to be aware of the ABL language syntax.
- Your source code is text. That text is non-regular and ambiguous.
  - different text, same meaning (non-regular code)
  - same text different meaning (ambiguous code)
- To enable proper analysis of code, we must transform the text into a data structure that represents the purest form of the code.
- ASTs represent the code's language syntax without syntactic sugar. The result is regular and unambiguous.

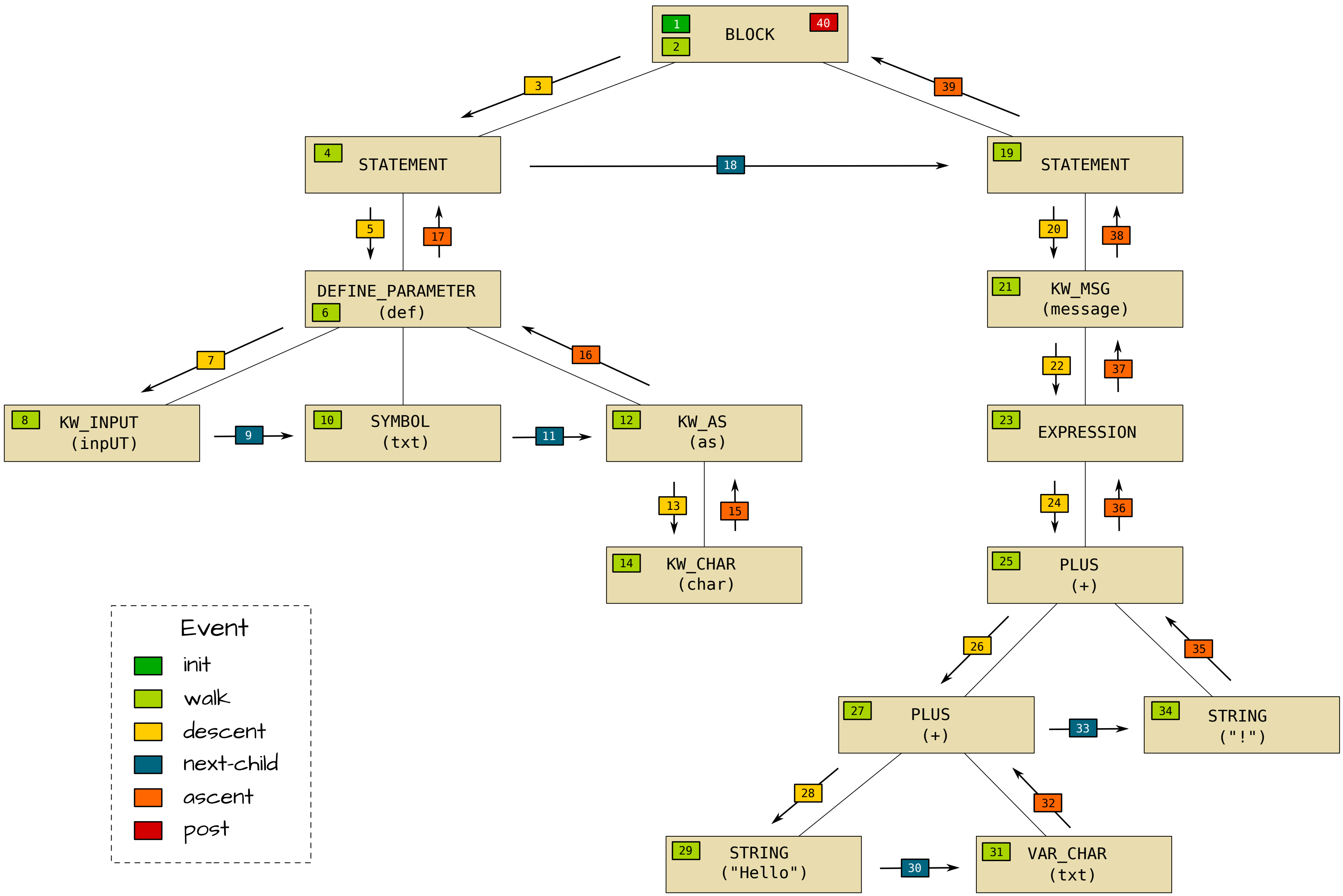
File -> Char -> Token -> Tree



TRee Processing Language (TRPL)

- FWD provides tools to parse an entire application.
- Each source file and each schema file (.df) will be represented as an AST.
- TRPL is the analysis and transformation toolset in FWD which can operate on the entire set of ASTs as a batch.
- When you process trees, it is commonly called a tree walk.
- TRPL includes an engine that handles the tree walking for programs written in the TRPL language.

TRee Processing Language (TRPL) Event Model



AST Design for Transformation

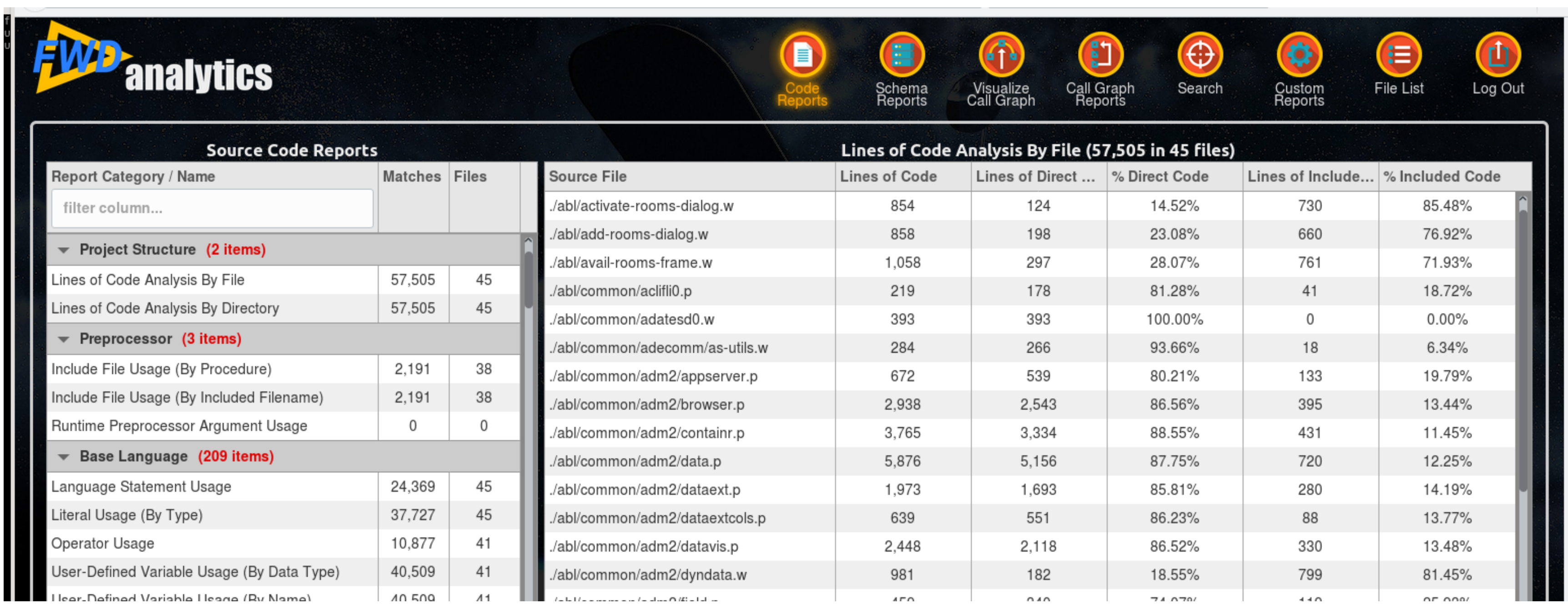
- At parse time, there is a great deal of knowledge about the code. Encoding that knowledge into the tree makes downstream work easier.
- Resolving data types of each expression component is very important. This allows downstream code to calculate the type of each subexpression or expression in the application.
- By tracking resources by scope and creating linkages between the references and the definition, it becomes easier to work with these resources later.
- Structuring the tree is important. This can make it easier to walk the tree, match patterns and transform.
  - Multiple nodes can be rewritten as a single unambiguous node (e.g. KW_DEFINE KW_PARAMETER can be written as DEFINE_PARAMETER).
  - Artificial nodes can be inserted to group multiple related nodes.
- Calculated values and context-specific information are stored in the associated nodes as annotations.
- The ASTs created by FWD were designed with these issues (and others) in mind.

Report Generation

- After the entire application has been parsed, we can run the report generation step.
- This is a non-interactive process that runs a set of pre-defined TRPL programs to calculate a few hundred reports.
- This can take minutes for a small project or hours for a large project.
- Both the parsing and the report generation can be scripted and used in CI or build servers.
- After the reports are generated, they can be accessed via an interactive web interface.

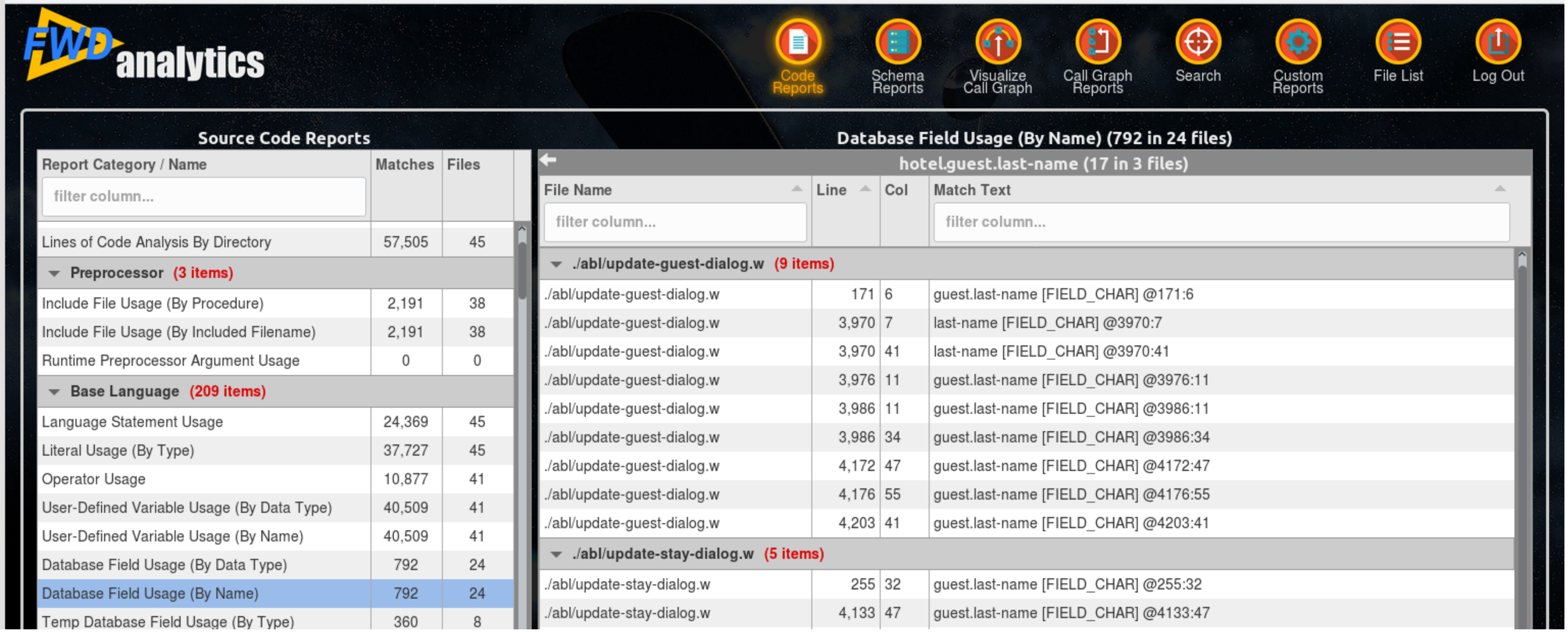
Reports

- List of predefined reports on left
- Currently viewed report on right
- Most reports are a set of mutually exclusive categories
- Summary statistics for the report at the top
- Individual categories have their own statistics
- Filter and sort columns using the column header
- Click on a row in the current report to see the exact list of matches
- Pagination controls at the bottom



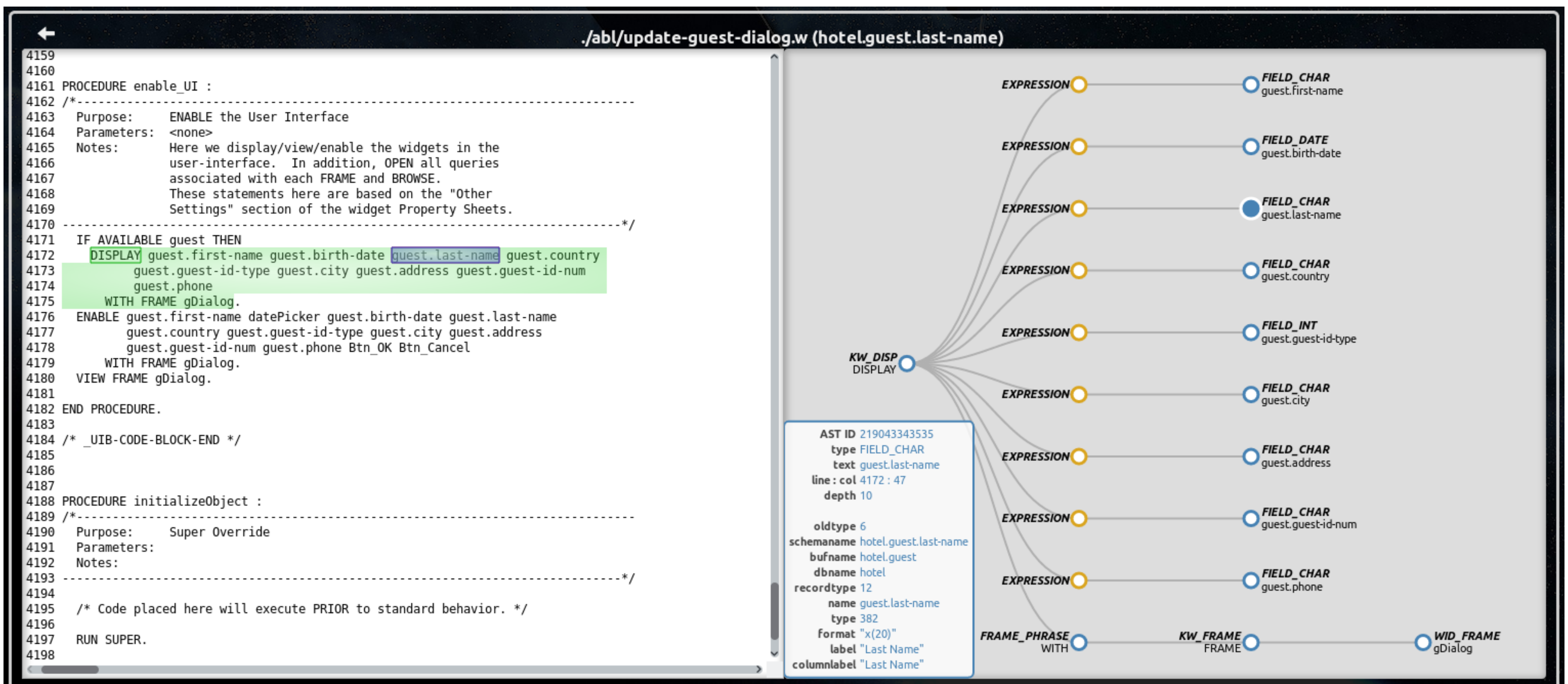
Category Details

- List of predefined reports on left
- Exact list of matches for the selected category on the right
- Grouped by the file in which they appear
- Category statistics at the top
- Each match has line/column numbers in the "cache" file (fully preprocessed file)
- Filter, sort and pagination controls
- Click on a row of a specific match to go to the source view at that exact location



Source/AST View

- Fully preprocessed file on left with the match selected in pink.
- Current selection in the AST on the right.
- Source and AST views are linked, a selection on either side is highlighted and made visible on the other side.
- Hover mouse over an AST node to get details.
- Shift-click on the “root” node of the subtree to traverse up the tree.
- Ctrl-click on a child node to traverse down the tree.



Search

- If grep (regex searching) was fully aware of ABL syntax it would still not be as good as this.
- Write expressions or arbitrary complexity that match based on the full richness of the AST.
- The TRPL engine does the tree walk, you just specify exactly what you want to match.
- The TRPL expression syntax has many features that make it easier to process AST concepts, including the knowledge of the current AST node being visited.
- Code that cannot be implemented in a single expression can be put into a callable TRPL function and accessed from expressions.
- All AST nodes and other data being accessed are actually Java objects. You can call Java instance methods (no statics or generics at this time) on these objects and you can pass those same objects to Java methods or to TRPL functions.
- TRPL has a wide range of advanced AST processing features that can be leveraged.

Search: Field References

All references to guest.last-name:

```
type == prog.field_char and
getNoteString("schemaname").equals("hotel.guest.last-
name")
```

Assignments to guest.last-name:

```
type == prog.field_char and
getNoteString("schemaname").equals("hotel.guest.last-
name") and parent.type == prog.assign and childIndex == 0
```

Search: Buffers That Hide Buffers

Version 1:

```
type == prog.define_buffer and
this.getChildAt(0).text.toLowerCase() ==
this.getChildAt(1).getChildAt(0).text.toLowerCase()
```

Version 2:

```
parent.type == prog.kw_for and parent.parent.type ==
prog.define_buffer and
text.equalsIgnoreCase(parent.prevSibling.text)
```

Version 3:

```
upPath("DEFINE_BUFFER/KW_FOR") and
text.equalsIgnoreCase(parent.prevSibling.text)
```

Search: FIND and NO-ERROR

- All FIND statements (62 matches):

```
type == prog.kw_find
```

- FIND statements **without** NO-ERROR (26 matches)

```
type == prog.kw_find and not

this.descendant(2, prog.kw_no_error)
```

- FIND statements **with** NO-ERROR (36 matches)

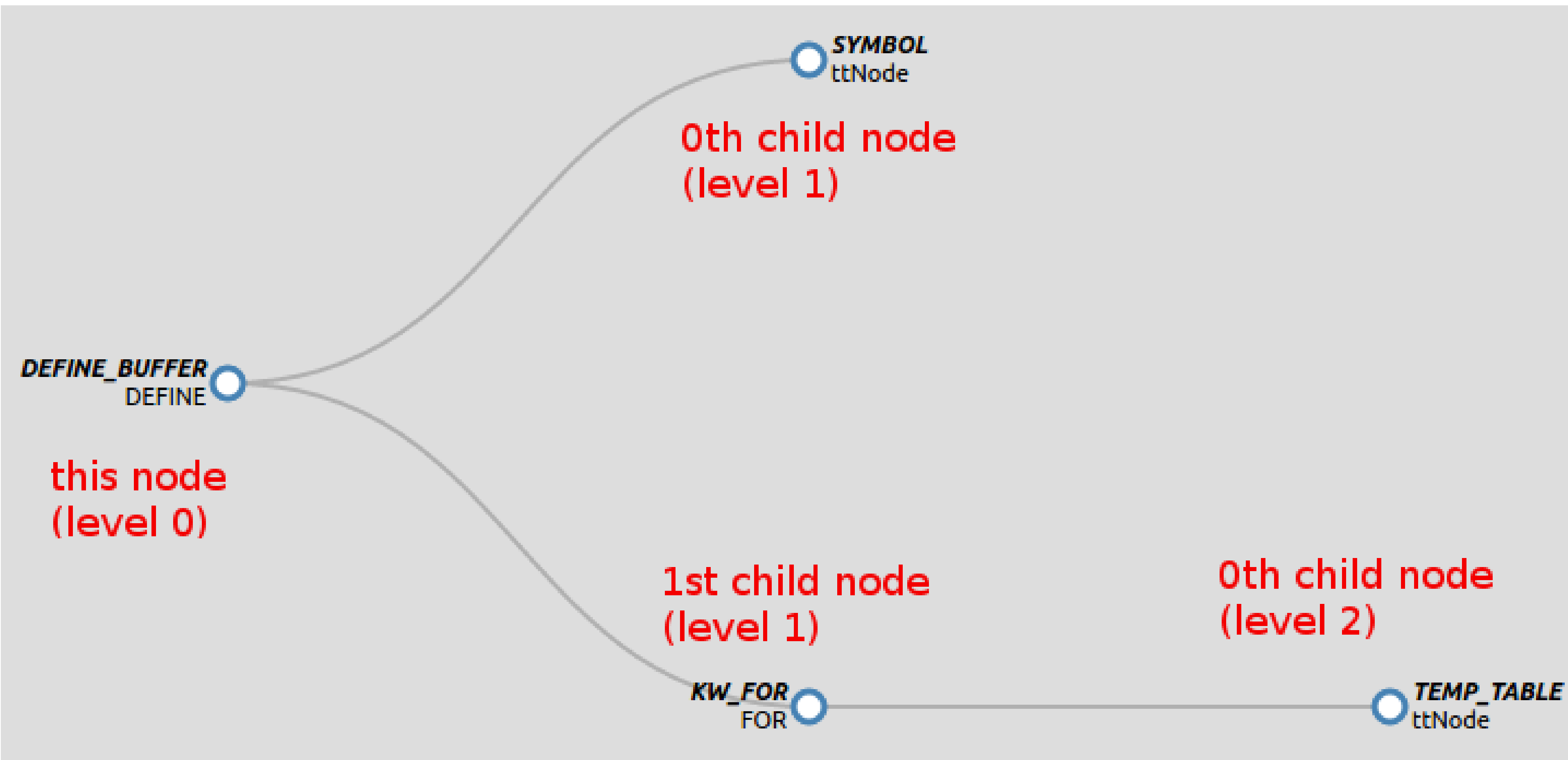
```
type == prog.kw_find and
downPath("RECORD_PHRASE/KW_NO_ERROR")
```

Writing a Search Expression

- Look at the AST structure that corresponds to the code you are trying to match.
    - Write a code snippet and parse it, then view it in the source/AST view.
    - Use the predefined reports to find locations that already exist.
- Decide which node is the best situated. Usually this is about finding the node that is most “centrally” located.
- All the context for the expression is written from that node’s “perspective”.
- Use the token type first, to roughly match a set of possible nodes.
- Refine this to get an exact match by addng use of tree structure, annotations and text.

Look at the AST

- Tree visualization of DEFINE BUFFER



Don’t Fight the Tree!

- Let the structure of the AST solve the problem for you.
- TRPL will walk the tree for you.
- Your expression is being executed at each possible location in the entire application.
- It is a “callback” model with the events determined by the tree structure.
- The tree structure is the pure form of the language syntax as represented in your code.
- Matching on the tree is matching on the syntax.
- If you are finding yourself doing something “unnatural”, ask: how can the tree structure help me?

Custom Reports

- Practice first with Custom Search
- Refine output with Custom Reports
  - Multiplex expressions to define “buckets”
  - Specify “dump” text preferences
- Persist the report definitions you find useful
- Organize by category and title
- Planned: Edit and Delete of custom reports

Custom Reports Example

- Title:

  FIND without NO-ERROR (by Buffer Name)

- Condition:

```
type == prog.kw_find and parent.type == prog.statement
and not this.descendant(2, prog.kw_no_error)
```

- Multiplex Expression:

```
this.getImmediateChild(prog.record_phrase,
null).getChildAt(0).getAnnotation("schemaname")
```

- Category:

  Database

Call Graph

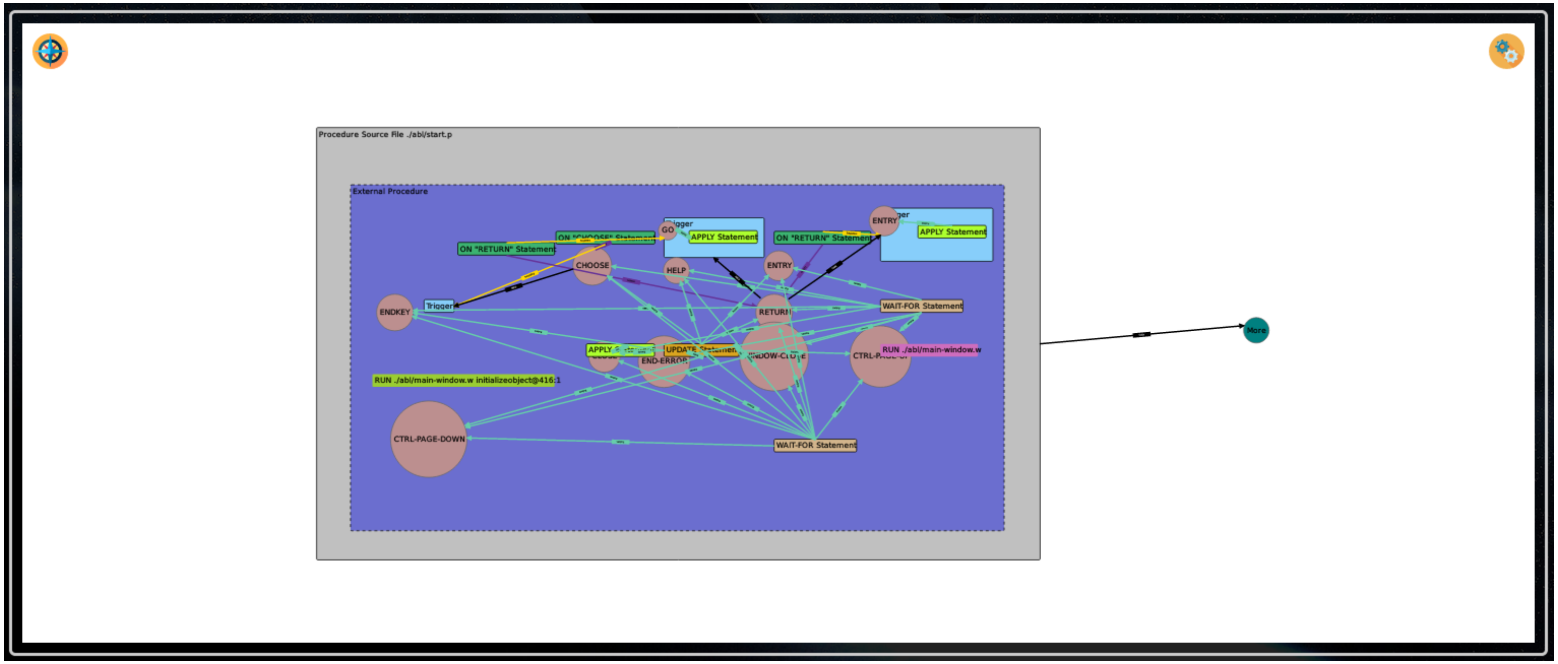
- Uses a graph database.
- Creates a “vertex” for every callable code block (e.g. function or internal procedure) in the application.
- Creates a “vertex” for every call-site (location that invokes one or more code blocks, e.g. RUN statement).
- Creates an “edge” between the call sites and the code blocks.
- Traversing from the a root entry point list (which you provide), we can walk the entire call graph of your application.
- This can be used to answer questions that are otherwise difficult or impossible to answer.

Call Graph Reports

- Ambiguous Call Sites
  - Caused by indirect calling conventions and runtime determination of call targets.
  - To complete the graph, you provide hints to tell the call graph analyzer how to traverse these.
  - Iterative process to define hints, run the analyzer, review the latest ambiguous listing, provide hints… until there are no further ambigous locations.
- Dead Code
  - In our experience, 25% to 40% of every non-trivial application of a certain age (10+ years) is dead code.
  - Once your graph is complete, this is an accurate list of the code you can delete.
  - Delete the code and put it through testing to confirm that the graph hints were correct.
- Missing Call Targets
- External Dependencies

Call Graph Visualization

- Live model of the call tree using a "force directed graph".
- User can load the graph from arbitrary locations.
- Traverse to "More" links with SHIFT-click (load just that node) or CTRL-click (add node to current graph snippet).
- Use this to explore the application.
- Useful to identify macro patterns that would be hard to see by reading source code.
- Zoom with mouse wheel, pan with drag on background.
- Still in very active development, this is an early version.
- Drag nodes to move them around. Hover to see details.
- SHIFT-click on AST nodes to go to the source/AST view.



Status

- The Code Analytics tools being used here are still in development.
- It is expected to be complete in the next 3 weeks.
- At that time it will be integrated into the FWD project trunk and the source will be released.
- An earlier version of the reports and call-graph functionality is currently available. It has most of the core features but lacks the interactive web UI and its call graph is less complete.
- Contact Golden Code if you need early access to the new version.

Planned Improvements

- Add more built-in call-graph analysis and reports. One example: identifying all locations that use a specific NEW SHARED variable (and the inverse).
- Move our existing transformation rules that calculate important properties to an early enough location that it can be integrated into reporting. This would include things like buffer scoping, frame scoping, index selection, transaction/block properties and more.
- Duplicate Code Identification. We can identify arbitrary code matches across the entire application using a bottom-up fingerprinting approach for each unique sub-tree in the application. By using fuzzy logic, we can match code that is the same whether it was cut and pasted or just independently coded the same way. Using these fingerprints we can turn duplicated code into common code.
- Improved TRPL syntax and structure, source level debugging.

How to Get Started

- Download and install FWD.
- Download one of the sample template projects (there is one for ChUI and one for GUI).
- Follow the “Getting Started” instructions to get the template project installed and configured for your application code, including placing your code and schemata into the template project.
- Run the `ant report_server` target.
- Start the report server.
- Access the server at port 9443 via a browser.
- Full details of this process and all documentation will be available on https://proj.goldencode.com/projects/p2j/wiki/Code_Analytics

FWD

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