DeltaForce

DELTAFORCE WHITE PAPER

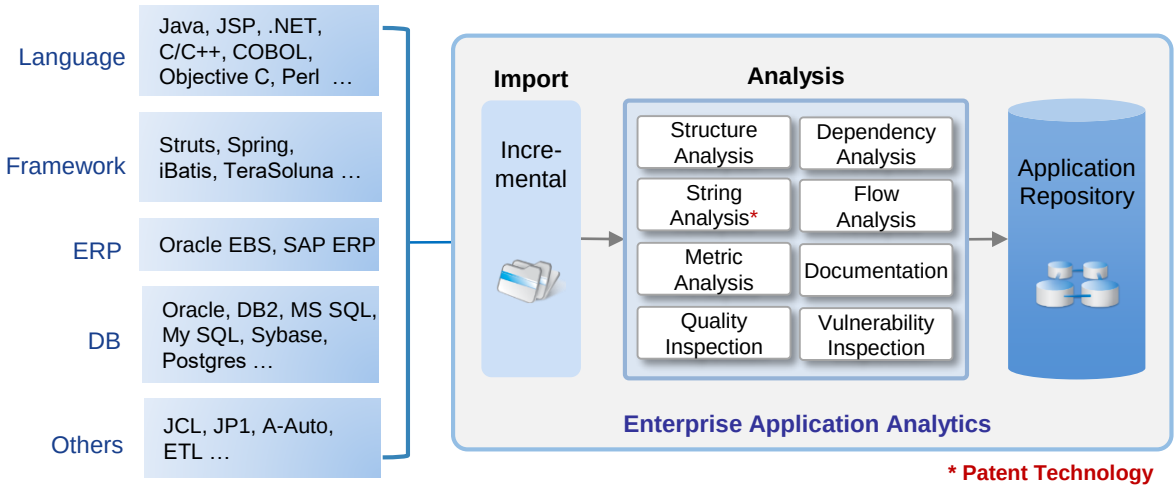
Robust string analysis engine enables the most accurate application change impact analysis!

GTONE
Governance Technology

What is DeltaForce?

DeltaForce is an application analytics tool that provides comprehensive insight into enterprise applications and databases. It enables organizations to improve development and maintenance productivity by delivering automated knowledgebase for complex applications using multiple languages and technologies.

DeltaForce automatically imports and analyzes both source files and database schema based on patent technology to find the overall detail object level dependencies among them. Because DeltaForce conducts everything based on fundamental user input configurations, user doesn't have to manually manage the object dependencies information.

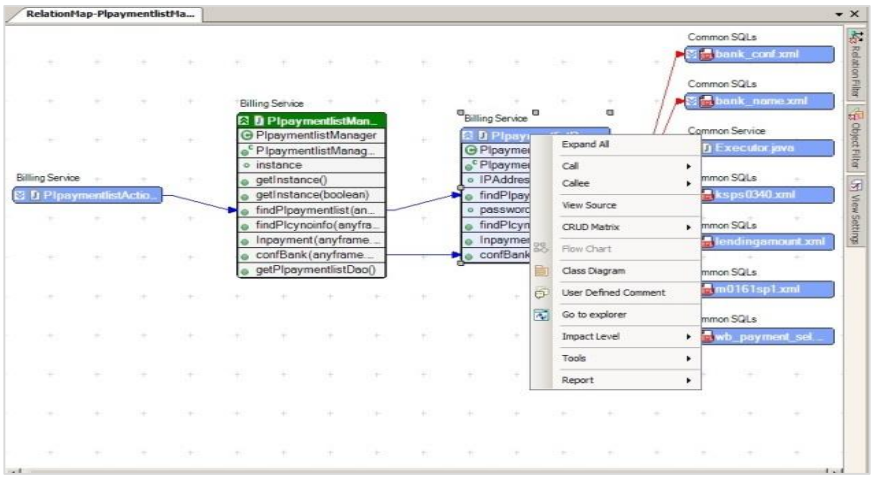


[Figure 1] Basic concept

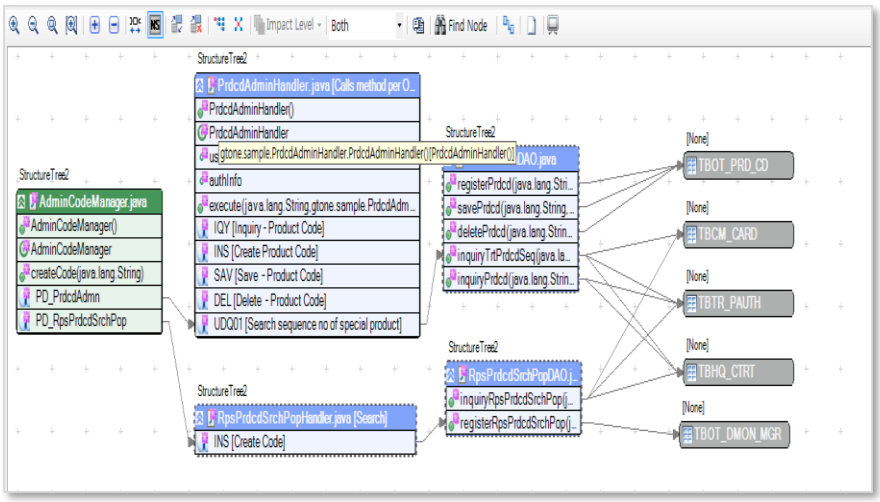
Information gained from DeltaForce is shared through its application repository equipped with robust documentation feature. Application team can access the application knowledgebase anywhere via the Internet and get rapid understanding of how their applications are structured and dependent.

One of DeltaForce's main usages is change impact analysis between application and database. For example, when a change is made in database schema, the potential consequences of the change need to be identified so that the application can be properly modified to maintain its integrity. With valuable analytics information such as end-to-end method call chain and CRUD[1] matrix, DeltaForce provides highly productive change impact analysis or variable level root cause tracking of application failures to development team.

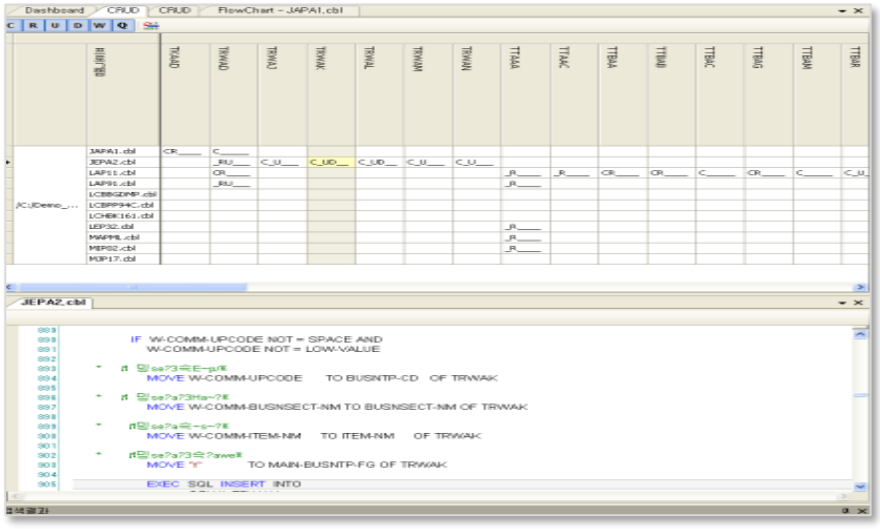
[1] CRUD (Create, Read, Update, Delete) matrix shows which database object is used by which program through SQL queries.



[Figure 2] Example of end-to-end method call graph



[Figure 3] Example of dependencies by condition values



[Figure 4] Example of CRUD Matrix

What makes the tool special?

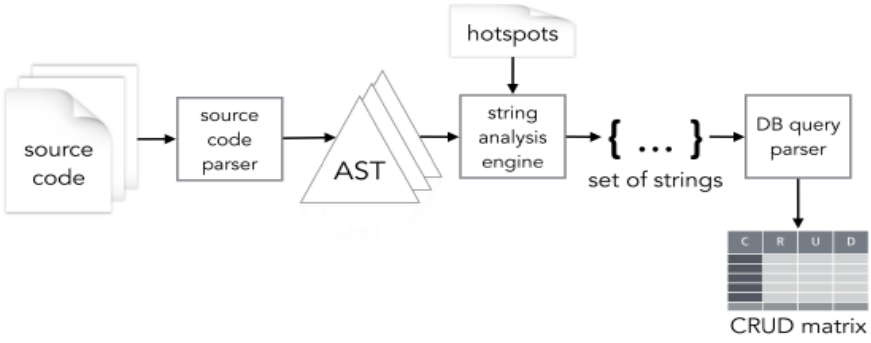
The Universal String Analyzer (USA) is the key technology that sets DeltaForce apart from its competitors.

It is hard to accurately analyze applications communicating with databases through SQL queries that are mostly composed at run-time by concatenating literal and user-supplied strings. To overcome the technical obstacle, DeltaForce uses not only lexical parsing technology which is widely used, but also special string analysis technology called Universal String Analyzer (patent).

The Universal String Analyzer embedded inside DeltaForce is a static string-analysis engine intended to work for applications written in any programming language. It has an ability to accurately extract dynamic strings in source code without running program based on the following advanced technologies:

- Inter-procedural path-sensitive analysis for reducing false positive
- Deep data structure analysis for high accuracy

The structure of USA is shown in Figure 5. The analysis engine takes an AST representation of a source code and generates a graph containing control-flow and data-flow. The graph is then simplified into a string graph that can be traversed to produce a set of query strings.



[Figure 5] The architecture of string-analysis engine

Because the engine is designed to support path-sensitive string analysis, each string expression contains path information about whether it is in true branch or false branch. For example, consider the code segment in Figure 6, it is made-up but simple enough to show why path-sensitive analysis is desirable. In lines 3 through 11, variables s1, s2, s3, s4, and s5 are assigned different string values according to given conditions. They are then later concatenated and assigned to a variable query. The number of different string queries line 12 can have is obviously four. However, since path-insensitive analysis does not use path information, it typically gives all combinations 1,024 (= 4^5) possible strings, resulting in that many false positives, not to mention the waste of time and space.

```
1  String query = “”;
2  String s1, s2, s3, s4, s5;
3  if (i > 0) {
4    s1 = “S1”; s2 = “S2”; s3 = “S3”; s4=”S4”; s5 = “S5”;
5    } else if (i > 1) {
6     s1 = “T1”; s2 = “T2”; s3 = “T3”; s4=”T4”; s5 = “T5”;
7     } else if (i > 2) {
8      s1 = “U1”; s2 = “U2”; s3 = “U3”; s4=”U4”; s5 = “U5”;
9     } else {
10    s1 = “V1”; s2 = “V2”; s3 = “V3”; s4=”V4”; s5 = “V5”;
11   }
12    query += “SELEC” + s1 + s2 + s3 + s4 + s5;
13    Target.hotspot (query);
```

[Figure 6] An example showing the need of path-sensitive analysis

Figure 7 shows a real world code example. In this example, 4 variables - company, dept, code, price – are used to create a query. Out of the 4 variables, three variables – company, dept, code – through three execution paths will get three possible strings. When general path-insensitive analysis is used, estimated query’s possible strings are - execution paths ^ variables = $3^3 = 27$.

When path-sensitive analysis is used, however, three variables – company, dept, code- through three execution paths will be assigned one possible string. Estimated number of possible query strings is number of execution paths, in this case, three; therefore, possible string’s proportion is 9:1. Which means path-sensitive analysis will have 9 times the accuracy than path-insensitive analysis.

```
1  public class Product {
2    public static final int LAPTOP = 1;
3    public static Product[] getProduct(int type, int price) {
4       String query = "";
5       String company, dept, code;
6
7       switch (code) {
8       case LAPTOP:
9       case TABLET:
10          company = "electronics"
11          dept = "gadget";
12          code = type + "";
13          break;
14       case SERVER:
15          company = "electronics"
16          dept = "enterprise";
16          code = type + "";
17          break;
18       case ANALYZER:
19          company = "software"
20          dept = "rnd";
21          code = "1004";
22          break;
23       default:
24          return;
25       }
26
27       query = "SELECT FROM t_" + company + " WHERE dept='" + dept
28            + "' AND code=" + code + " AND price <" + price;
29
30       return performSelectQuery(query);
31    }
32 }
```

[Figure 7] Sample code od dynamic query

When creating a query using real enterprise application, there are a lot of possible variables and execution paths which can be used. If there are two execution paths and ten variables in use, with path-insensitive analysis it will result in 2^10=1024 possible strings and with path-sensitive analysis it will result in 2 possible strings. With the path proportion 512:1, path-insensitive analysis needs to analyze over 500 unnecessary strings to get the necessary query number. This makes path-sensitive analysis extremely valuable. DeltaForce's embedded string analysis engine supports path-sensitive analysis

Let's take another simple example of string analysis. It shows engine's deep structure analysis capability.

```
1  String tables[] = new String[] {
2  "SQLP_SQL_TEXT" ,
3  "SQLP_SQL_PLAN" ,
4  "SQLP_SQL_PLAN_HIST" ,
5  "SQLP_DETECT_LINE" ,
6  "SQLP_EXECUTE_SUMMARY" ,
7  "SQLP_SQL"
8  };
9
10 Connection conn = null;
11 PreparedStatement ps = null;
12 try {
13    conn = DBUtil.getConnection(false);
14    for(int i=0; i<tables.length; i++) {
15      ps = conn.preparedStatement ("DELETE FROM " + tables[i] + where_clause);
16    // where_clause = WHERE ANALYZE_TYPE_ID <> ?
17    …
```

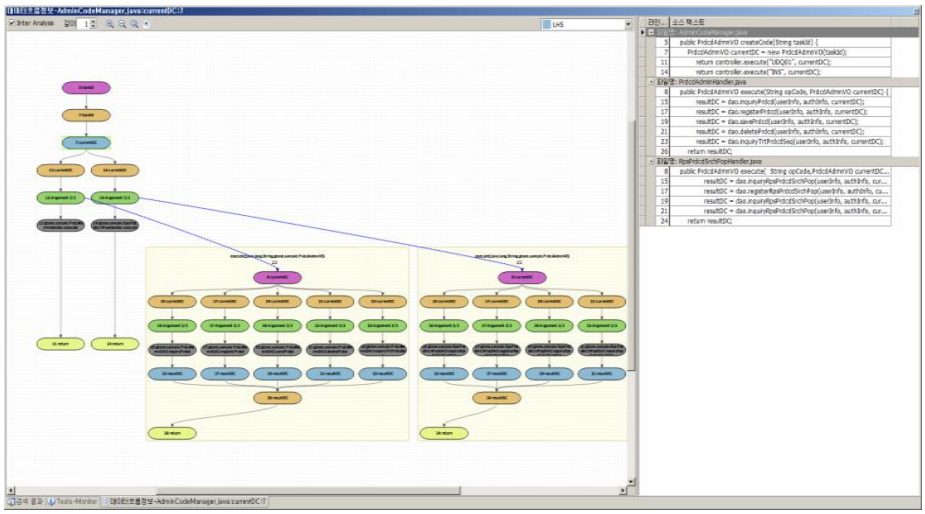
[Figure 8] Sample code of structured data

If an analysis engine doesn't understand the static array in the example above, it will just give user the following insufficient string:
"DELETE FROM null WHERE ANALYZE_TYPE_ID <> ?"

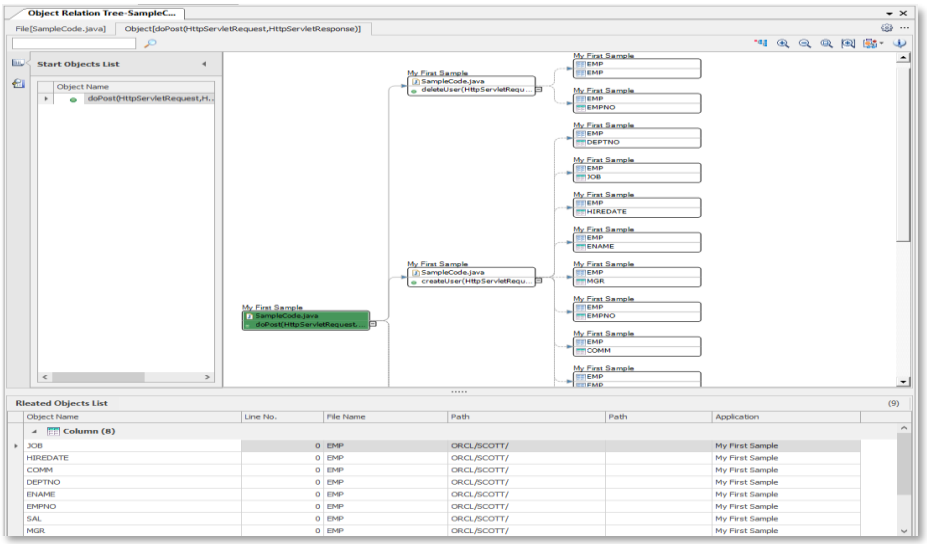
DeltaForce's engine, however, understands how to analyze static string array, which will give user the following strings (dynamic queries) exactly:
"DELETE FROM SQLP_SQL_TEXT WHERE ANALYZE_TYPE_ID <> ?"
"DELETE FROM SQLP_SQL_PLAN WHERE ANALYZE_TYPE_ID <> ?"
"DELETE FROM SQLP_SQL_PLAN_HIST WHERE ANALYZE_TYPE_ID <> ?"
"DELETE FROM SQLP_DETECT_LINE WHERE ANALYZE_TYPE_ID <> ?"
"DELETE FROM SQLP_EXECUTE_SUMMARY WHERE ANALYZE_TYPE_ID <> ?"
"DELETE FROM SQLP_SQL WHERE ANALYZE_TYPE_ID <> ?"

With this kind of deep structure data analysis accuracy, users will not miss dependencies between programs and database tables.

DeltaForce also offers unique and valuable features such as inter-procedural data flow analysis to track application failure root cause, various Structure Data Tree APIs which can be used to extract business point-of-view information and more.



[Figure 9] Example of inter-procedural data flow analysis



[Figure 10] Example of objects tree

Conclusion

The Universal String Analysis engine is minimizing false positives and enabling rapid analysis by only using branch's path information, avoiding complicated value analysis. Its advanced technology makes change impact analysis more accurate than ever before. Our analysis is especially effective when conditionals are nested, its branches assign multiple string variables, and the variables are concatenated afterwards. Even when false positives are inevitable, performance is generally improved in comparison to ones without path-sensitive analysis.

One of mega IT service companies in Japan saved time 75% by using DeltaForce's impact analysis. Before using DeltaForce, developers spent 95 minutes finding and documenting change impact scope of a particular table column across the overall architecture. With DeltaForce's end-to-end call chain and CRUD information, developers can finish the same amount of work within just 24 minutes.

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