Ampersand
Event-Condition-Action Rules

Test Plan

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Table 1: Revision History

Author	**Date**	**Comment**
Yuriy Toporovskyy	27 / 10 / 2015	Reorganized document
Yuriy Toporovskyy	27 / 10 / 2015	Initial version - template

Contents

Chapter 1

General Information

1.1 Purpose

This document outlines the test plan for ECA for Ampersand, including our general approach to testing, system test cases, and a specification of methodology and constraints. This test plan is centered around our contribution to Ampersand and ignores other elements of the Ampersand process such as the artifacts that are generated.

1.2 Objectives

Preparation for testing

The primary objective of this test plan is to gather all relevant information that could aid in creating effective tests for EFA. EFA in this regard is modularized and tested as an individual component before it is tested within the Ampersand system.

Communication

This test plan intends to clearly communicate to all developers of ECA for Ampersand their intended role in the testing process.

Motivation

The testing approach is based on the constraints and requirements presented in the Software Requirements Specification (i.e. SRS). This document focuses on how the

functional and non-functional requirements provided in the SRS will be tested for this project.

Environment

This test plan outlines the resources, tools, and software required for the testing process. This includes any resources needed to perform automated testing.

Scope

This test plan intends to better describe the scope of our contribution, ECA, within the Ampersand system.

1.3 Definitions

SRS

Software Requirements Specification. Document regarding requirements, constraints, and project objectives.

RA

Relation algebra. The mathematical language used in ADL files to specify business rules.

PA

Process algebra. The mathematical language used by ECA rules to describe the action to be taken to fix violations. A "PA clause" (also written as "PAclause"), or process algebra clause, is an imperative-style language which represents the *mathematical* process which Ampersand uses. The syntax of PA clauses, in EBNF notation, is as follows:

```
PAclause ::= 'One' '(' PAclause { ',' PAclause } ')' ;
           | 'Choice' '(' GPAclause { ',' GPAclause } ')' ;
           | 'All' '(' PAclause { ',' PAclause } ')' ;
           | ('Ins' | 'Del') '(' RExpr ',' RAtom ')' ;
           | 'Nop'
           | 'Blk'
```

```
GPAclause ::= RExpr '->' PAclause ;
```

where "RExpr" represents RA expressions, and "RAtom" (RA atom) represents *atomic* RA expressions (i.e. terms with no operators).

Table 1.1: Semantics of PAclause terminals

One($p_0 \dots p_n$)	Execute exactly one of $p_0 \dots p_n$.
Choice($g_0 \to p_0 \dots g_n \to p_n$)	Execute exactly one of p_i, such that g_i is a non-empty RA term.
All($p_0 \dots p_n$)	Execute all of $p_0 \dots p_n$.
<Ins/Del> (e, r)	Insert or delete the expression e from the relation r.
Nop	Do nothing.
Blk	The null command, which blocks forever.

The semantics of process algebra says that the "choice" operators (e.g. One and Choice) concurrently execute their subclauses; if *any* of the subclauses can be completed, the PA clause has restored the violation.

ECA Rule

Event-Condition-Action Rule. A rule which describes how to handle a constraint violation in a database. The syntax of ECA rules is as follows:

```
ECArule ::= 'On' ('Ins' | 'Del')
            '(' RExpr ',' RAtom ')'
            'Do' PAclause
```

HUnit

A Haskell library for unit testing. See section 3.2.

QuickCheck

A Haskell library for running automated, randomized tests. See section 3.2.

Sentinel Test

A test server accessible through **??** which executes a set of randomly generated tests on Ampersand on a daily basis. **??**.

Chapter 2

Plan

2.1 Software Description

Ampersand is a software tool that converts the formal specifications of business entities and rules, compiles it into various design artifacts (e.g. latex documents), and produces a prototype web application.

The business prototype implements business logic according to specifications provided by the user, it uses the entities and relationships that the user provides to form a relational database with a simple web application front-end.

ECA for Ampersand focuses on automatically restoring a particular class of database violations using an algorithm called AMMBR [Joo07]. This class of violations is realized within Ampersand as ECA rules – our contribution to Ampersand will add support for ECA rules, that will affect Ampersand's back-end as well as the generated prototype it provides.

2.2 Test Team

The test team which will execute the strategy outline in this document is comprised of

- Yuriy Toporovskyy
- Yash Sapra
- Jaeden Guo

2.3 Test Schedule

Dates	Tests to be performed
12-20-2015 - 01-07-2016	Unit testing, black box testing, white box testing with heavy use of QuickCheck
01-08-2016 - 01-20-2016	System testing EFA with Ampersand
01-20-2016-02-01-2016	Testing for abnormality and performance.

—

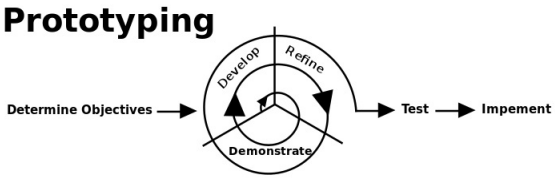
Note: More details for specific test will be provided in the future.

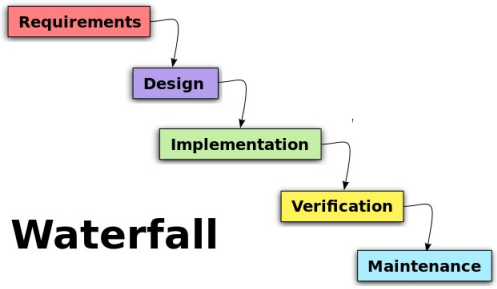
Chapter 3

Methods and constraints

3.1 Methodology

A Waterfall Development methodology is used in combination with Software Prototyping and will likely result in something similar to the spiral model. The Waterfall method help translate the requirements outlines in the SRS into functional and non-functional requirements that the design must include. Furthermore, as Software Prototyping is not a standalone method, but rather an approach to development activities these two compliment each other well.





3.2 Test tools

See section 3.2.3 for QuickCheck.

In addition to QuickCheck, Sentinel Test will be used for the completed Ampersand system test. Since EFA will be incorporated into Ampersand, it must pass all sets of randomly generated tests.

3.2.1 Static Typing

Programming languages can be classified by many criteria, one of which is their type systems. One such classification is static versus dynamic typing. Our implementation language, Haskell, has a static type system. Types will be checked at compile-time, allow us to catch errors even before the code is run, reducing the errors that need to be found and fixed using testing techniques.

3.2.2 Formal verification

A part of our project deals with generating source code annotated with the proof of derivation of that source code, which will act as a correctness proof for the system. In particular, when we generate code to restore a database violation using ECA rules, then the generated code will have a proof associated with it, which details how that code was derived from the original specification given by the user.

3.2.3 Random Testing

Random testing allows us to easily run a very large number of tests without writing them by hand, and also has the advantage of not producing biased test cases, like a programmer is likely to do.

We will be using QuickCheck [hac] for random testing. The existing Ampersand code base using QuickCheck for testing, therefore, using QuickCheck has the added benefit of easier integration with the existing Ampersand code base.

QuickCheck allows the programmers to provide a specification of the program, in the form of properties. A property is essentially a boolean valued Haskell function of any number of arguments. QuickCheck can test that these properties hold in a large number of randomly generated cases. QuickCheck also takes great care to produce a large variety of test cases, and generally produces good code coverage. QuickCheck will be used for individualized module testing and well as provide a fair array of random tests for the combination of all modules [hac].

3.2.4 Unit Testing

Unit testing is comprised of feeding some data to the functions being tested and compare the actual results returned to the expected results. We will be using HUnit for unit testing of the new source code in Ampersand. HUnit is a library providing unit testing capabilities in Haskell. It is an adaption of JUnit to Haskell that allows you to easily create, name, group tests, and execute them.

3.3 Requirements

3.3.1 Functional requirements

The functional requirements for ECA for Ampersand are detailed in the SRS; they are also briefly summarized here. Our implementation must

F1 provably implement the desired algorithm.

F2 accept its input in the existing PAClause format.

F3 produce an output compatible with the existing pipeline.

F4 annotated generated code with proofs of correctness or derivations, where appropriate.

F5 automatically fix database violations in the mock database of the prototype.

F6 not introduce appreciable performance degradation.

F7 provide diagnostic information about the algorithm to the user, if the user asks for such information.

3.3.2 Non-Functional requirements

The functional requirements for ECA for Ampersand are detailed in the SRS; they are also briefly summarized here. Our implementation must

N1 produce output which will be easily understood by the typical user, such as a requirements engineer, and will not be misleading or confusing.

N2 be composed of easily maintainable, well documented code.

N3 compile and run in the environment currently used to develop Ampersand.

N4 be a pure function; it should not have side effects.

3.4 Data recording

Not Available at this time.

3.5 Constraints

Not applicable at this time.

3.6 Evaluation

Due to the early stage of development, this is not available at this time.

Chapter 4

System Test Descriptions

Many test cases use domain specific language to indicate inputs and outputs, for both clarity and brevity. This includes the syntax and semantics of ECA rules and Abstract SQL. For the full syntax and semantics of these , as well as related definitions, see section 1.3.

T1 ECA rule executing "All" subclauses

Test type Dynamic, white box, automated
Schedule Term 2
Requirements F1

Input

The input is an ECA rule of the form:

On Ins(Δ, r_0) **Do All**(**Ins**(e_1, r_1), **Ins**(e_2, r_2))
where r_0, r_1, r_2 := Atomic Relation
e_1, e_2, Δ := Expression

Output

The output is an abstract SQL function of the form:

```
f (delta, r_0):
  INSERT INTO <r_1_table> VALUES <e_1_query>;
  INSERT INTO <r_2_table> VALUES <e_2_query>;
```

Description

ECA rules of the input format are generated using QuickCheck, converted to abstract SQL, then compared against the expected output format using HUnit.

T2 ECA rule executing "Choice" subclauses

Test type	Dynamic, white box, automated
Schedule	Term 2
Requirements	F1

Input

The input is an ECA rule of the form:

On Ins(Δ, r_0) **Do Choice**(p_0, p_1)
where r_0 := Atomic Relation
Δ := Expression
p_0, p_1 := PA Clause

Output

The output is an abstract SQL function of the form:

```
no idea
```

Description

ECA rules of the input format are generated using QuickCheck, converted to abstract SQL, then compared against the expected output format using HUnit.

T3 ECA rule with empty PA clause

Test type	Dynamic, white box, automated
Schedule	Term 2
Requirements	F1

Input

The input is an ECA rule of the form:

On {**Ins**/**Del**}(Δ, r_0) **Do Nop**
where C_0, C_1 := Concept
r_0 := Atomic Relation

Output

The output is the empty abstract SQL statement; that is, a statement of the form:

```
f (delta, r_0): {} \\ Do nothing
```

Input

ECA rules of the input format are generated using QuickCheck, converted to abstract SQL, then compared against the expected output format using HUnit.

T4 ECA rule inserting into Identity relation

Test type	Dynamic, white box, automated
Schedule	Term 2
Requirements	F1

Input

The input is an ECA rule of the form:

On {**Ins**/**Del**}(Δ, r_0) **Do** {**Del**/**Ins**}$(e_0, \mathbb{I}_{C_0})$
where C_0 := Concept
r_0 := Atomic Relation
e_0 := Expression

Output

The output is an abstract SQL statement of the form:

```
f (delta, r_0):
  {INSERT INTO/DELETE FROM} <C_0_Population> VALUES <e_0_query>;
```

where `C_0_Population` is the table corresponding to $\mathbb{I}_{C_0}$.

Description

ECA rules of the input format are generated using QuickCheck, converted to abstract SQL, then compared against the expected output format using HUnit.

T5 EFA System Compatibility

Test type Functional/Black box/
Schedule Dec 2015
Requirements F3

Input

ADL File Input 1:
Based on the Rule: Only members who have relevant experience may apply for this job
Using Sets: JOBS-AVAIL, APPLICANTS, EMPLOYEES-WITH-RELEVANT-EXPERIENCE
With ECA rules:
ADL Files Input 2:
Based on the Rule: Only members who have relevant experience may apply for this job
Using Sets: JOBS-AVAIL, APPLICANTS, EMPLOYEES-WITH-RELEVANT-EXPERIENCE
With ECA rules: APPLICANTS must be a member of both EMPLOYEES-WITH-RELEVANT-EXPERIENCE AND have a relation to (i.e. applied for) JOBS-AVAIL

Output

EFA User Output for Input 1:
Reading <file>.adl..
Generating..
Rules Done..
Sets Done..
No Errors
No Violations
EFA User Output for Input 2:
Reading <file>.adl..
Generating..
Rules Done..
Sets Done..
ECA Rules Done..
No Errors

No Violations

Description

Two different version of the same script is given as input, the first is without ECA rules the second is with ECA rules that this project adds. Both of these scripts should pass through the Ampersand generator without causing errors or violations. If the second script which contains ECA rules successfully passes through each part of Ampersand then the new additions generated by EFA is compatible with the old Ampersand system.

T6 EFA Pure Function

Test type Dec 2015
Schedule F4
Requirements Two conditions must hold for a function to be considered a pure function 1. The fu

Input

The input is an ECA rule of the form:

```
ECA = {Condition that triggers action: Insertion of <new field into table>,
            Change that initiated trigger: Insertion of <e2> into current data scheme,
                  Action to be done : ∀
                        {(take the difference of the previous result of the expressions
                              (take result of intersection of the returned result
                                    (composition of the result
                                          (Simple declaration of the result of the conversion
                                                (convert expression e2 using the identity relation
                                           of e1
                                          )
                                    )
                              with e1)
                        with e1)
                  with e1 where e1 is another expression)}
      }
```

Output

asdfasdf

T7 EFA User Feed Back

Test type Functional
Schedule January 2016
Requirements F6,N1

Brief Explanation Concerning Context

Only those who are qualified can be cast into roles, the actor must have relevant experience.

Input

The input shall be ECA rules specifying invariants that must be maintained throughout the program.

Example concerning how roles are cast for a theater performance:

User Input:

RULE "who's cast in roles" : cast; instantiates —- qualifies;comprises MEANING "an Actor may appear in a Performance of the Play only if the Actor is skilled for a Role that the Play comprises "

EFA INPUT:

ECA = {
ECA Trigger: if cast member does not have relevant experience or enough experience
ECA Violation: lack of experience
ECA Action: Remove actors without enough relevant experience
}

Output

User feed back if file has no errors:
Reading file theatreCasting.adl..
Done.
Done.

User feed back if file has errors:
Reading file theater.adl
Error(s) found:
Type error, cannot match:
the concept "Role" (Tgt of qualifies)
and concept "Performance" (Src of instantiates)
if you think there is no type error, add an order between concepts "Role" and "Performance".
Error at symbol () in file theater.adl at line 26 : 44
==========
No declarations match the relation: actor
Error at symbol () in file theater.adl at line 26 : 62
==========
ECA Rule Violation:
Error at Rule declaration and structure in file theater.adl at line 33 : 41
Error: Structure and Meaning do not match

T8 EFA Code Walk-through

Test type Non-functional
Schedule January 2016
Requirements N2

Brief Explanation

Input and output are not available for this test, as it requires each member of the design team to walk through the code line by line to check if it is easy to understand by another programmer and well documented. If it is easy to read and understand but not only the individual who wrote it but those around them, then it should be easy to maintain.

T9 Degradation Test

Test type Non-functional
Schedule First Week of February 2016
Requirements F6

Brief Explanation

Degradation shall be measured through a comparison of Ampersand before EFA and Ampersand after EFA. The amount of time Ampersand takes to compile a prototype will measure performance degradation; if Ampersand takes substantially longer to compile after the addition of EFA then it is an appreciable difference. A Linux distribution will be used to time multiple trials of Ampersand with and without EFA. The test materials used will be taken off of the Ampersand-models github.

T10 EFA Annotated Code

Test type Non-functional
Schedule January 2016
Requirements N4

Description

There is no input, however there will be annotations available for output, this is used for debugging purposes and the user will never see this.

Bibliography

[hac] QuickCheck: Automatic testing of Haskell programs. `https://hackage.haskell.org/package/QuickCheck`. Accessed: 2015-10-29.

[Joo07] Stef Joosten. AMMBR: A Method to Maintain Business Rules. 2007.