FOREPOST: A Tool For Finding Performance Problems Automatically with Feedback-Directed Learning Software Testing

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*University of Illinois at Chicago

UIC

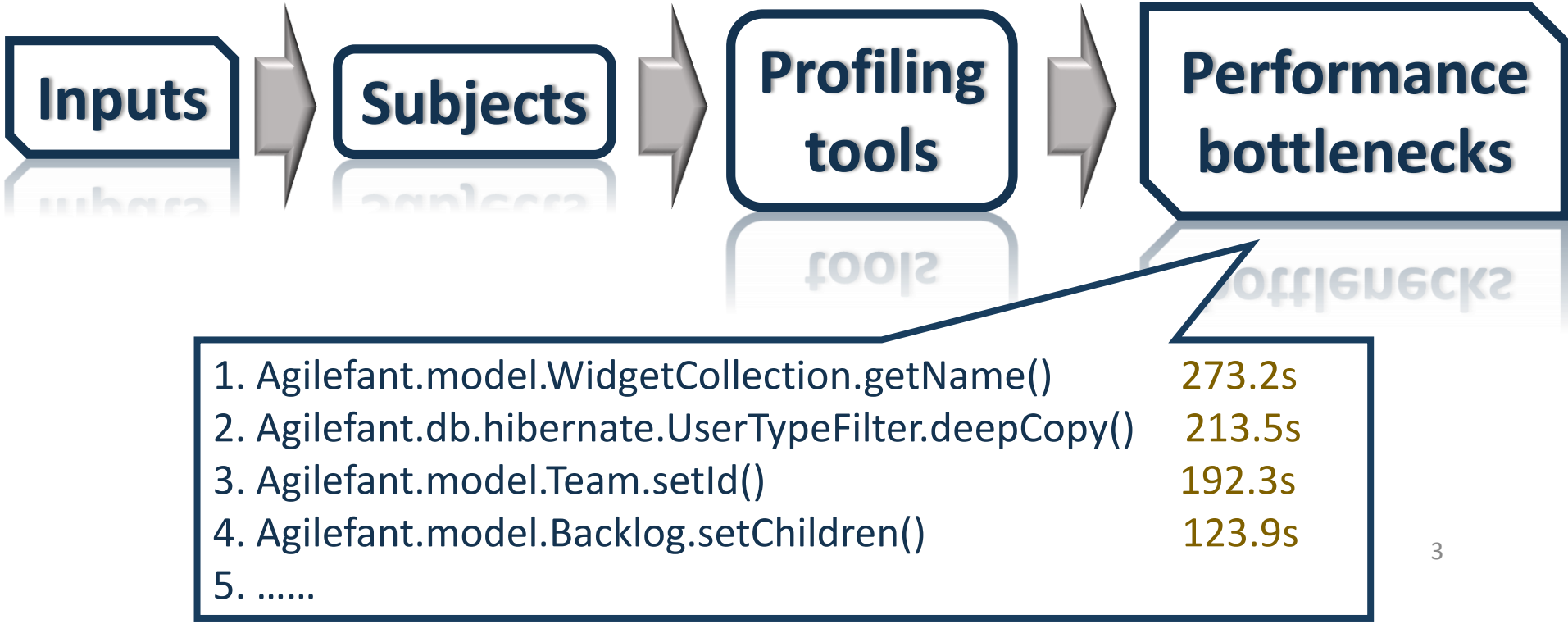
ICSE 2016

Austin, TX, U.S.

Performance Testing

Package	<Base Time (seconds)	Average Base Time (seconds)	Cumulative Time (seconds)	Calls
com.ibm.team.collaboration.internal.core.service	249.406940	0.313325	253.997890	796
DefaultCollaborationService$CollaborationServiceJobQueue	244.485136	12.224257	244.485136	20
dequeue() com.ibm.team.collaboration.core.service.CollaborationServiceJob	244.484838	40.747473	244.484838	6
enqueue(com.ibm.team.collaboration.core.service.CollaborationServiceJob) vo	0.000133	0.000027	0.000133	5
isDisposed() boolean	0.000118	0.000017	0.000118	7
DefaultCollaborationService$CollaborationServiceJobQueue()	0.000036	0.000036	0.000036	1
dispose() void	0.000011	0.000011	0.000011	

Performance Testing



78 Million customer profiles

78 Million customer profiles

902 Days !!!

Facts:

1. California and Texas

Facts:

1. California and Texas
2. Southwestern

Facts:

1. California and Texas
2. Southwestern
3. Oklahoma

Facts:

1. **California and Texas**
2. **Southwestern**
3. **Oklahoma**

WILDFIRE => bottlenecks

Feedback-ORiEnted PerfOrmance Software Testing (FOREPOST)

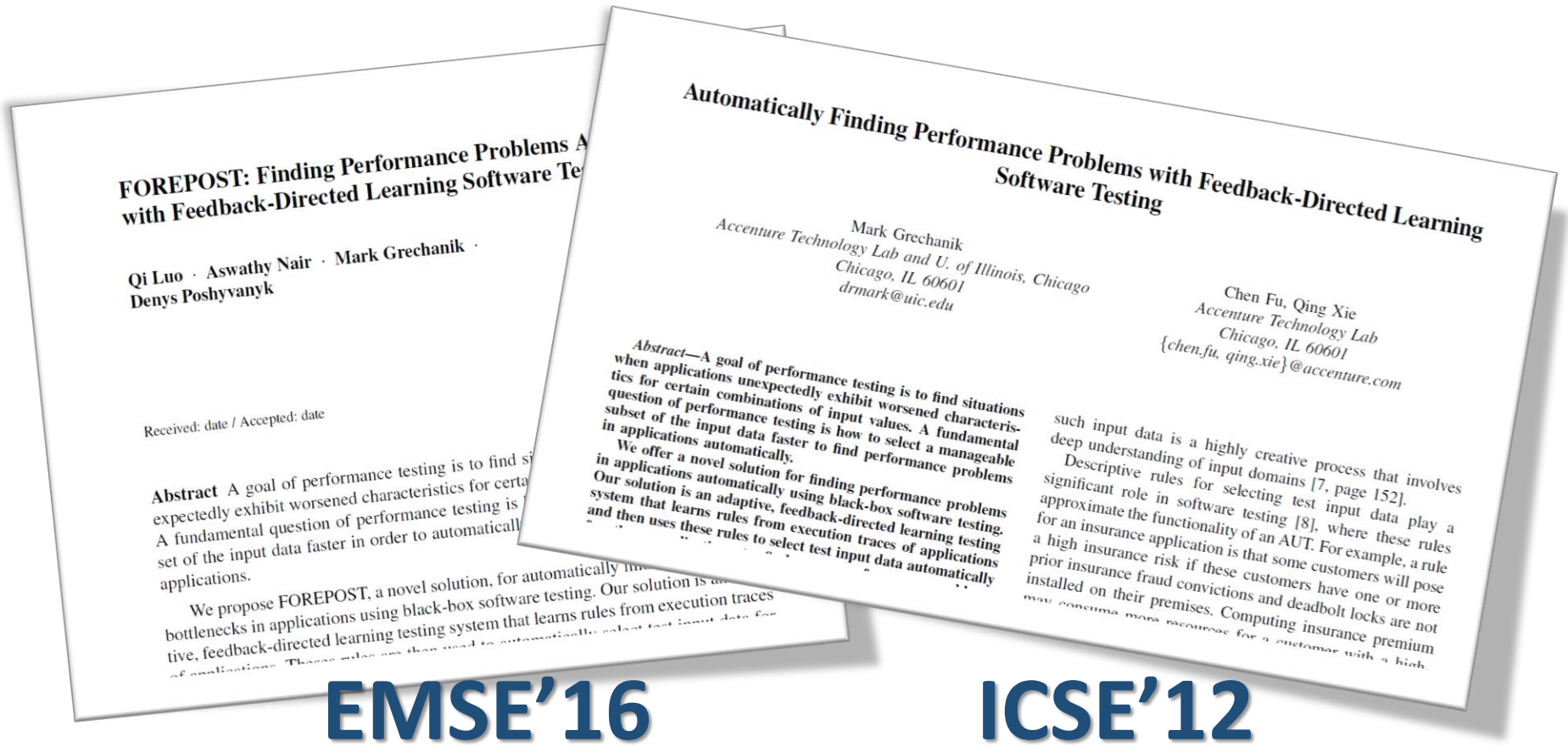
- Using machine learning algorithms to extract rules for selecting test input data
- Using Independent Component Analysis (ICA) to identify performance bottlenecks automatically

Feedback-ORiEnted PerfOrmance Software Testing (FOREPOST)

- Using machine learning algorithms to extracts rules for selecting test input data
- Using Independent Component Analysis (ICA) to identify performance bottlenecks automatically

Input: test input data and binary code
Output: a set of rules, a ranked list of methods

FOREPOST Foundation



FOREPOST: Finding Performance Problems A
with Feedback-Directed Learning Software Te

Qi Luo · Aswathy Nair · Mark Grechanik ·
Denys Poshyvanyk

Received: date / Accepted: date

Abstract A goal of performance testing is to find si
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A fundamental question of performance testing is
set of the input data faster in order to automatic
applications.

We propose FOREPOST, a novel solution, for automatically
bottlenecks in applications using black-box software testing. Our solution is
tive, feedback-directed learning testing system that learns rules from execution traces

EMSE'16

Automatically Finding Performance Problems with Feedback-Directed Learning Software Testing

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***Abstract*—A goal of performance testing is to find situations when applications unexpectedly exhibit worsened characteristics for certain combinations of input values. A fundamental question of performance testing is how to select a manageable subset of the input data faster to find performance problems in applications automatically.**

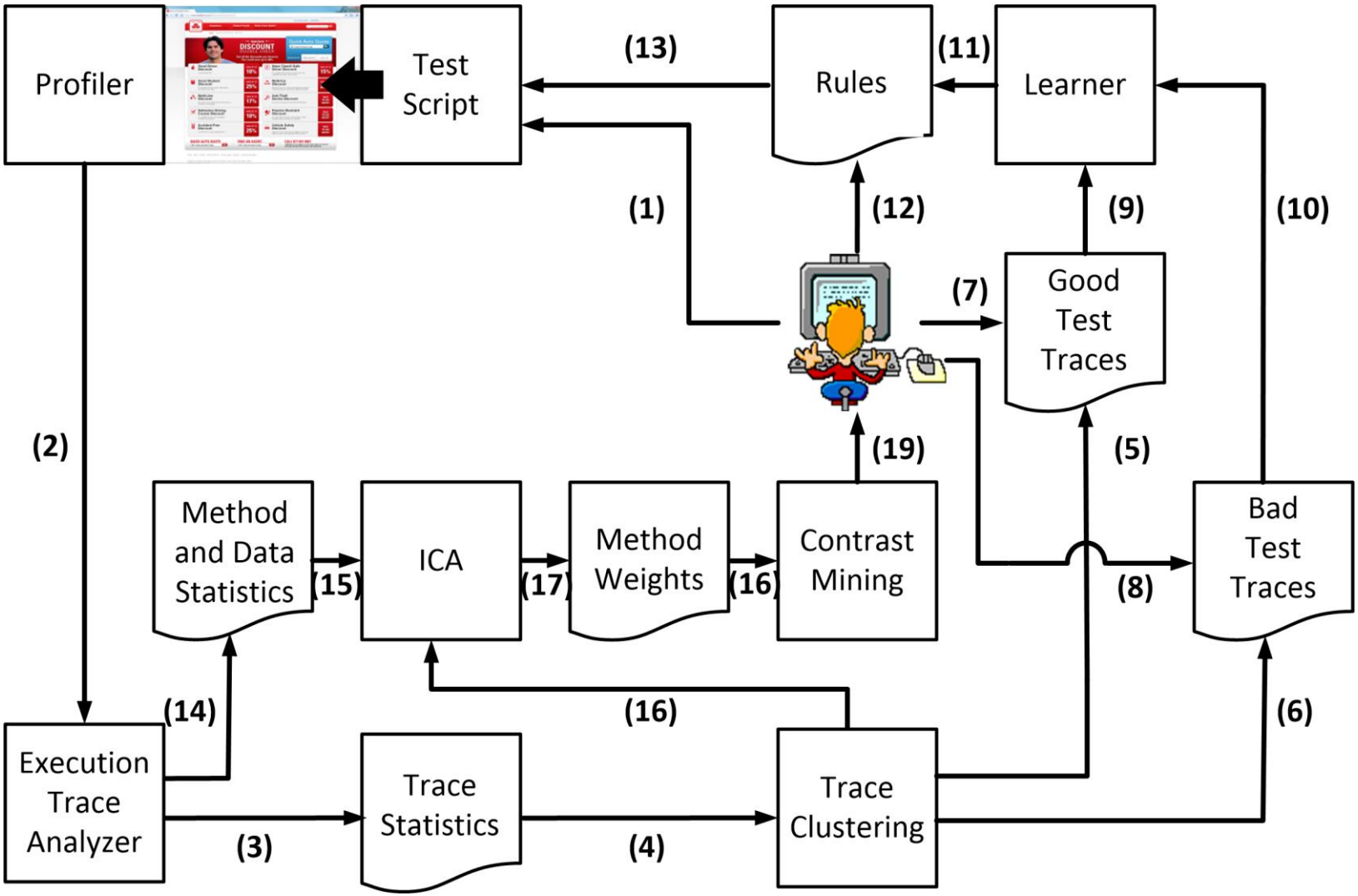
We offer a novel solution for finding performance problems in applications automatically using black-box software testing. Our solution is an adaptive, feedback-directed learning testing system that learns rules from execution traces of applications and then uses these rules to select test input data automatically

such input data is a highly creative process that involves deep understanding of input domains [7, page 152].

Descriptive rules for selecting test input data play a significant role in software testing [8], where these rules approximate the functionality of an AUT. For example, a rule for an insurance application is that some customers will pose a high insurance risk if these customers have one or more prior insurance fraud convictions and deadbolt locks are not installed on their premises. Computing insurance premium

ICSE'12

FOREPOST


Profiler
Test Script
Rules
Learner
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Good Test Traces
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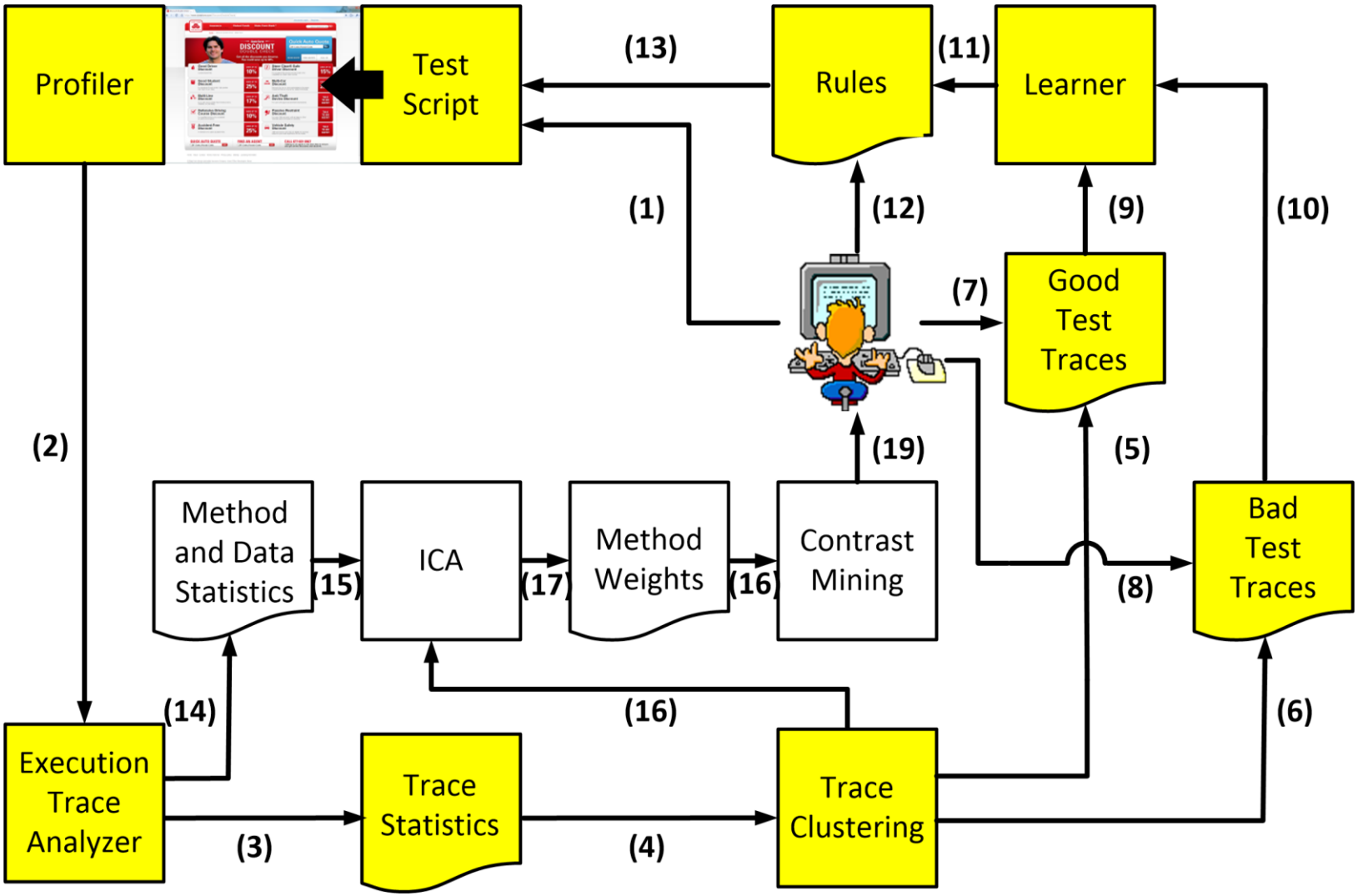
Execution Trace Analyzer
(3)
Trace Statistics
(4)
Trace Clustering

FOREPOST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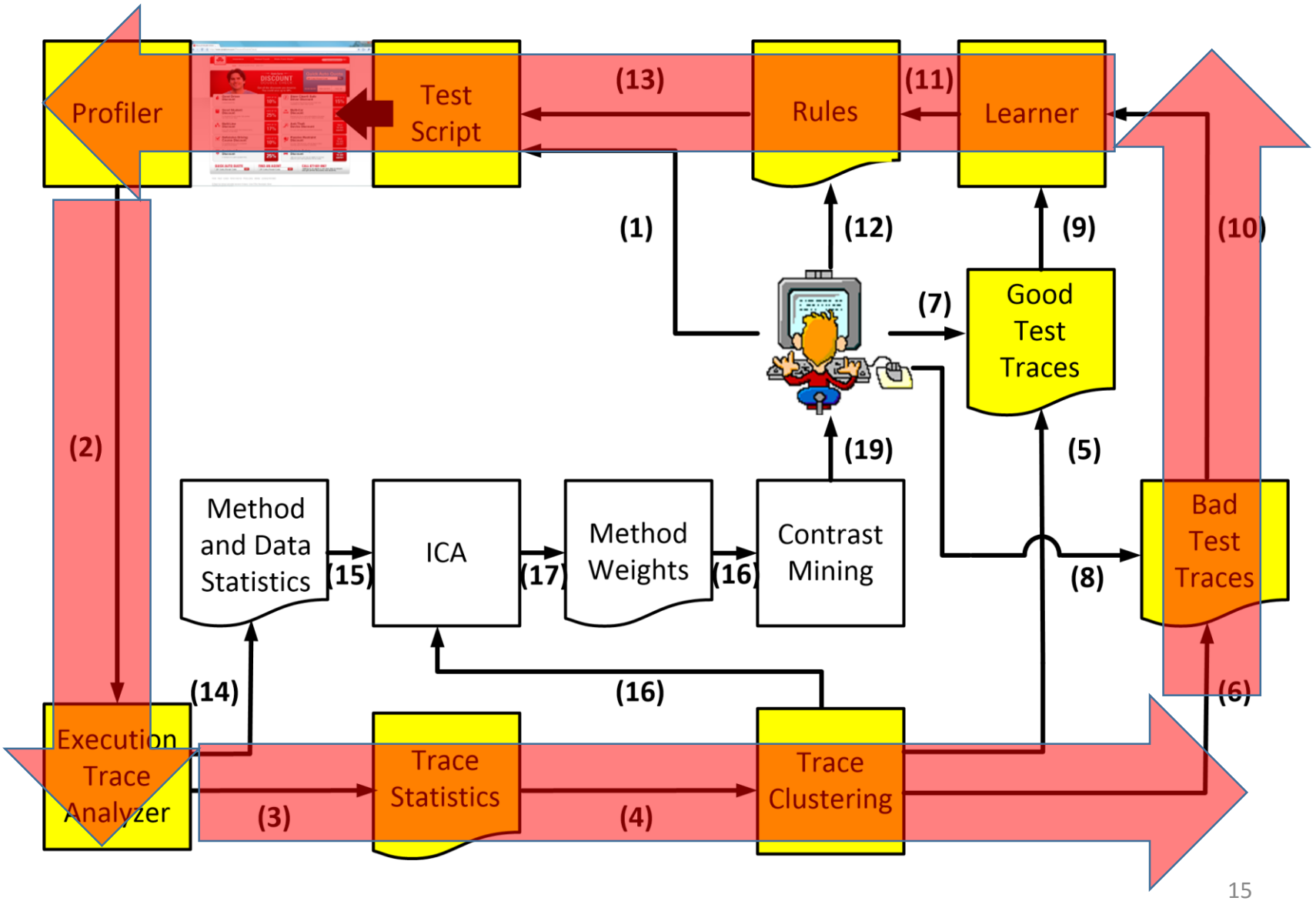
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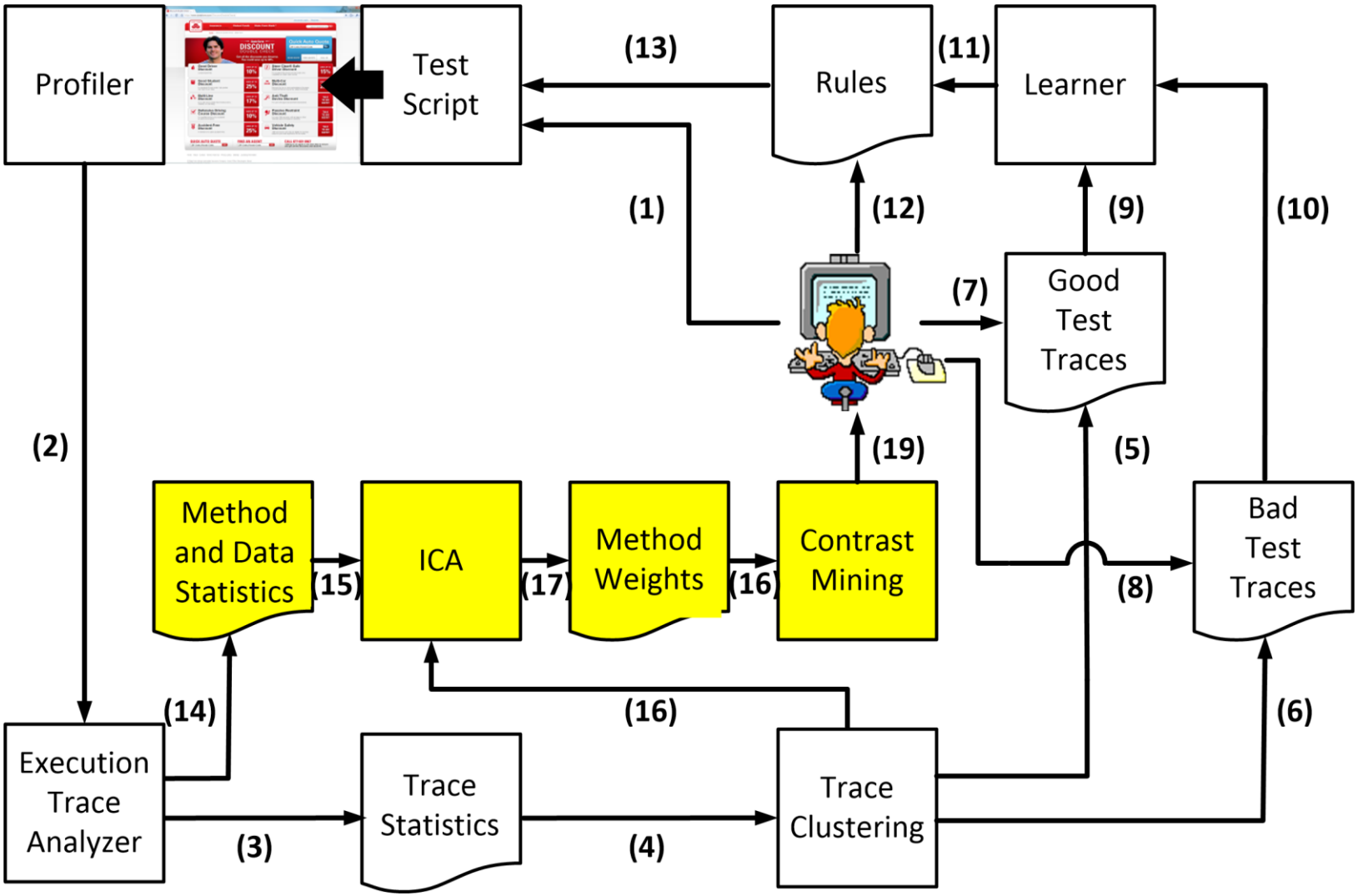
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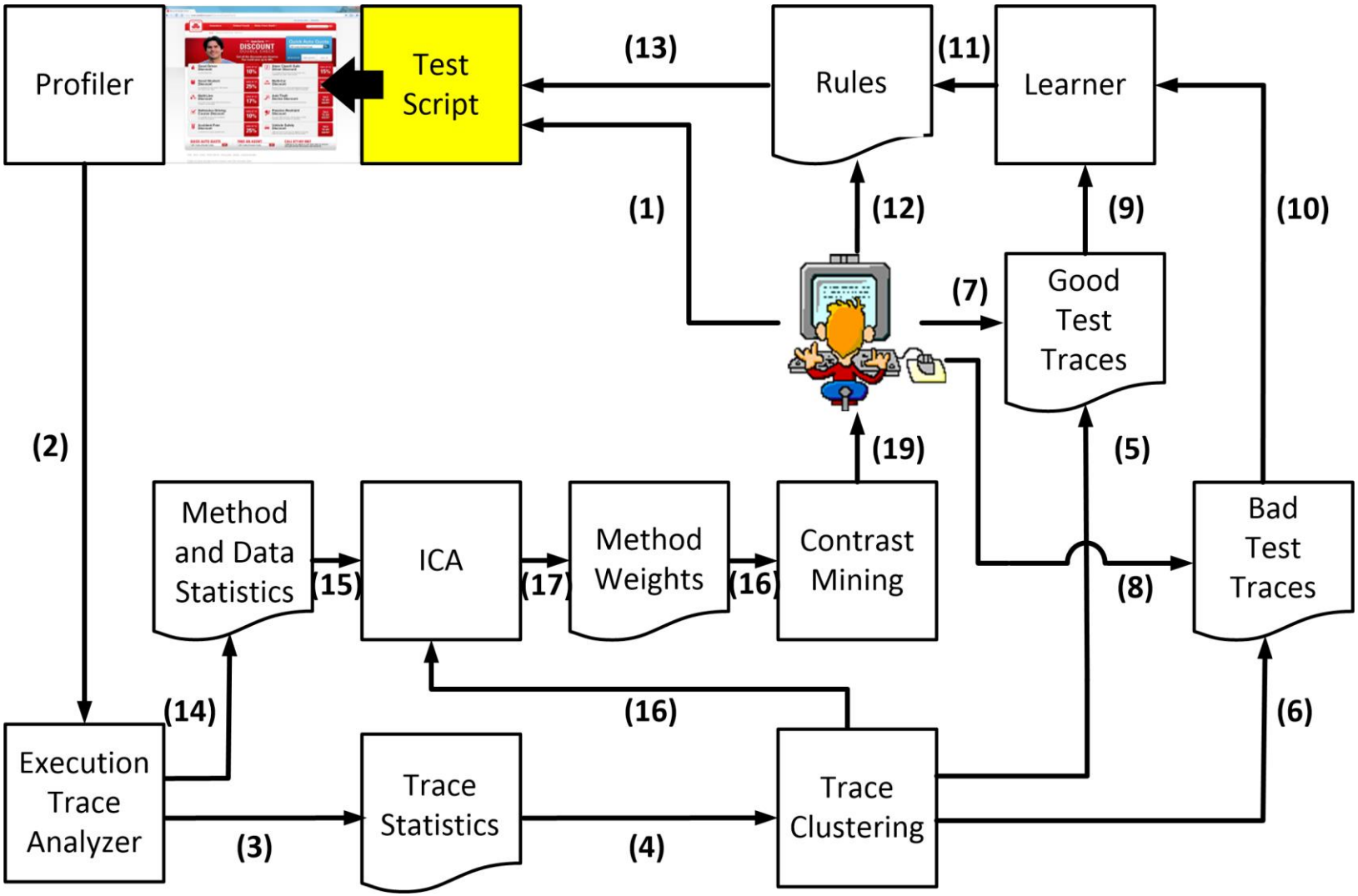
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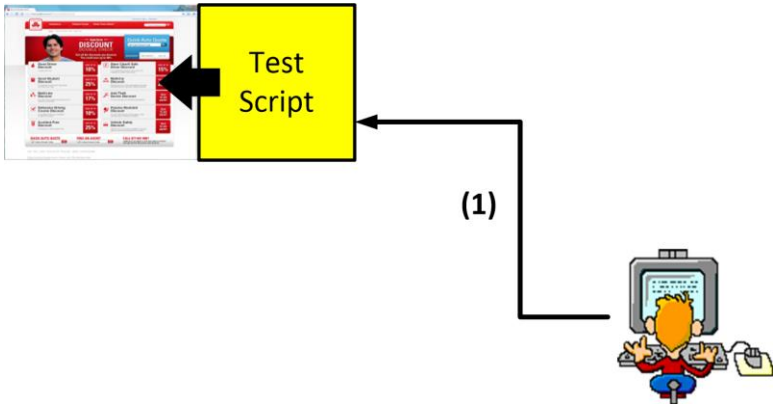
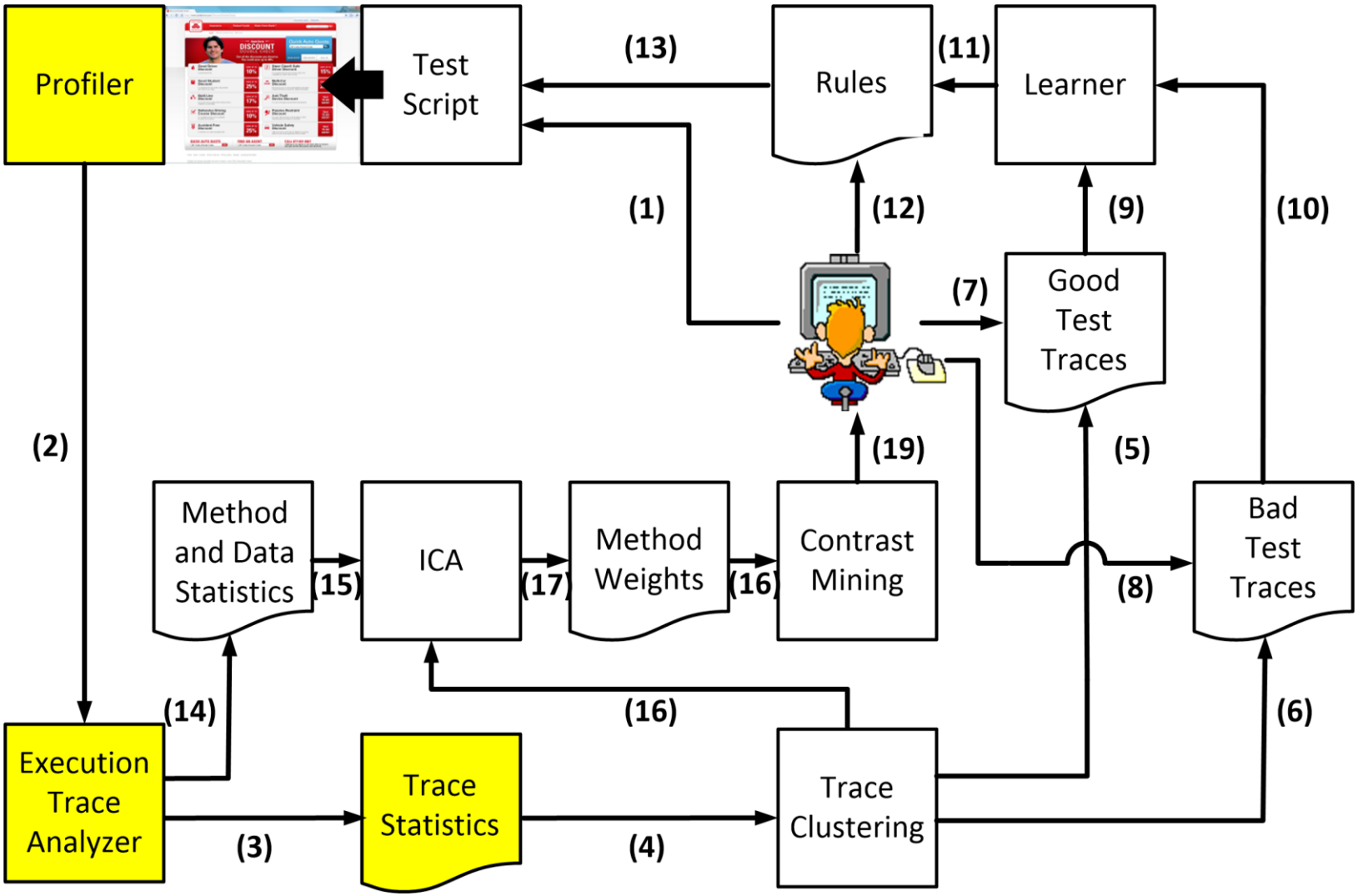


- **Test input data comes from existing repositories or databases**

- **Test scripts**

FOREPOST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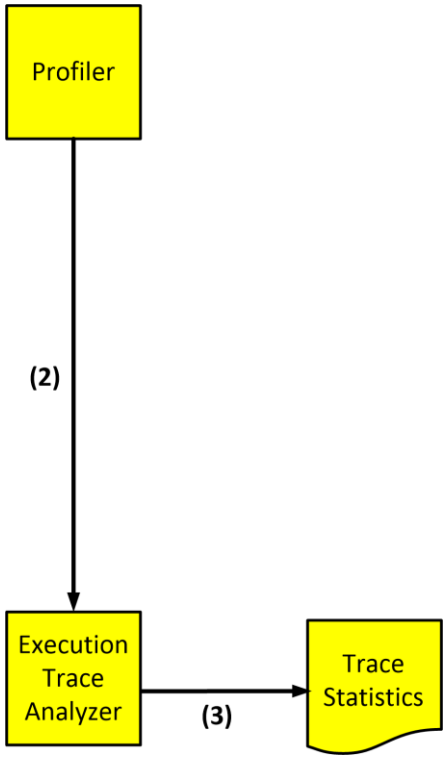
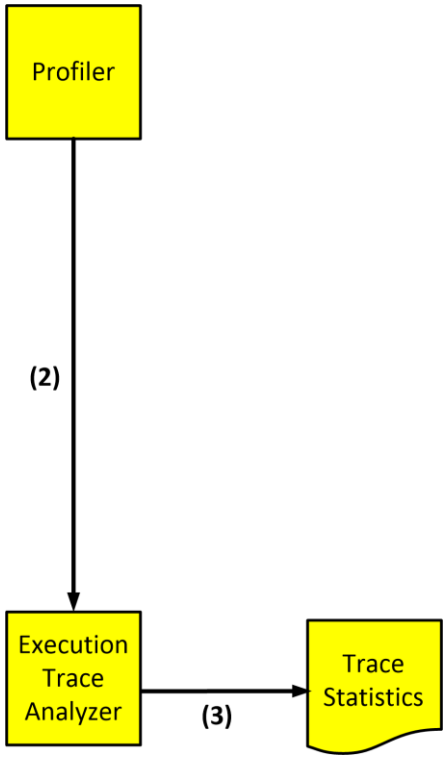


The Eclipse Test & Performance Tools Platform (TPTP) Profiling tool



The Eclipse Test & Performance Tools Platform (TPTP) Profiling tool

FrameDemo

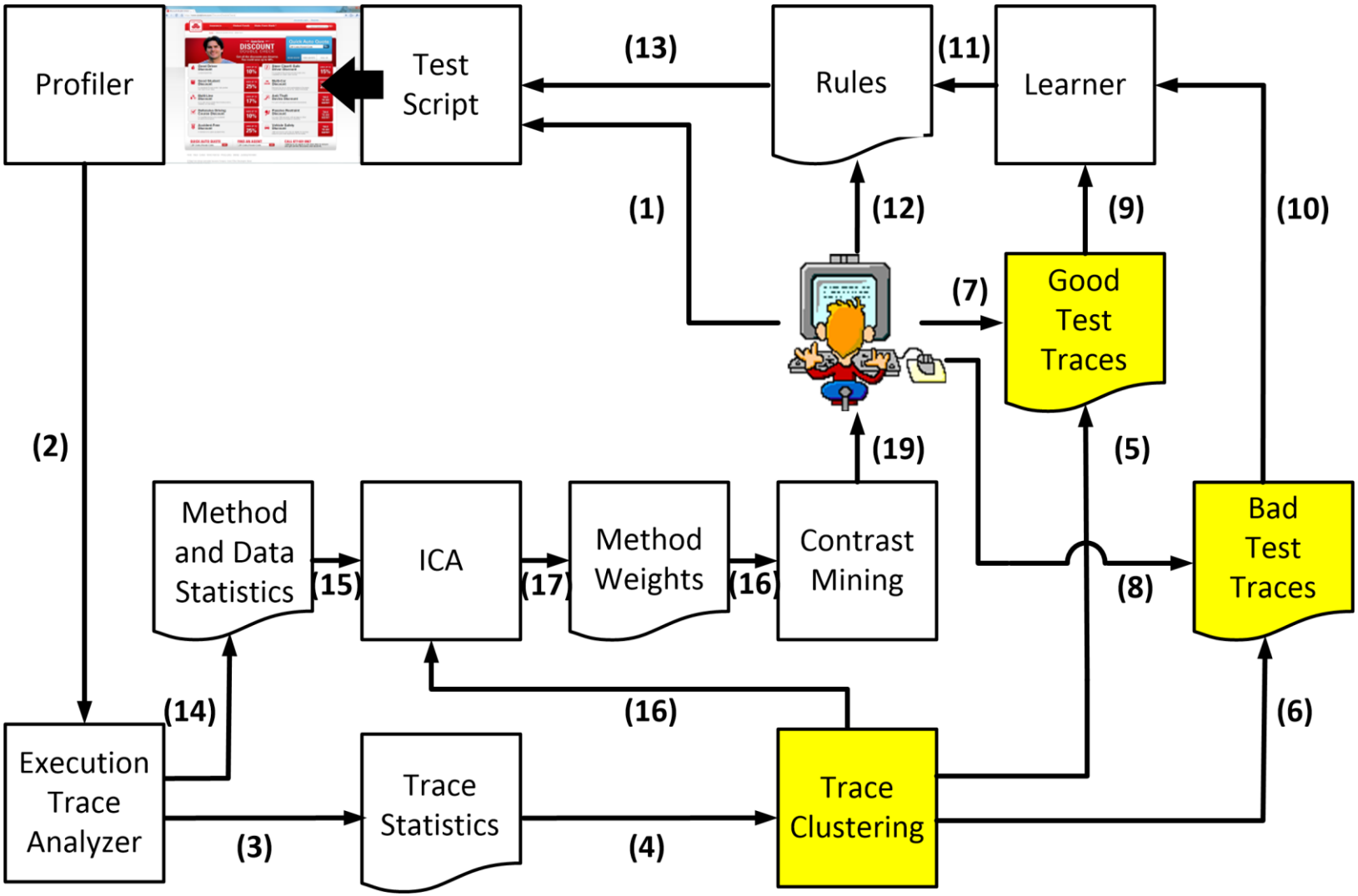
File Control Help

Status Rules Profiles Configuration Analysis Bottlenecks Recommendations

Profile No	Elapsed Time	Methods	Invocations	Attribu...	Data in ...	Class	Exclude
1	9.139721943E9	1072	102666	0	0	Unassigned	false
2	6.813736663E9	905	111258	0	0	Unassigned	false
3	7.726661705E9	1008	120986	0	0	Unassigned	false
4	6.783510083E9	1050	107740	0	0	Unassigned	false
5	7.606158768E9	934	144952	0	0	Unassigned	false
6	7.042365854E9	1021	126279	0	0	Unassigned	false

Profile No	Elapsed Time	Methods	Invocations
1	9.139721943E9	1072	102666
2	6.813736663E9	905	111258
3	7.726661705E9	1008	120986

FOREPOST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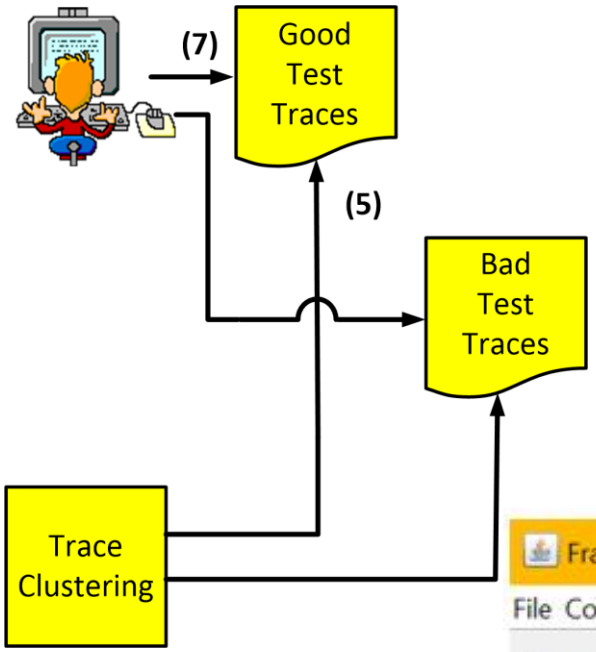
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Good Test Traces
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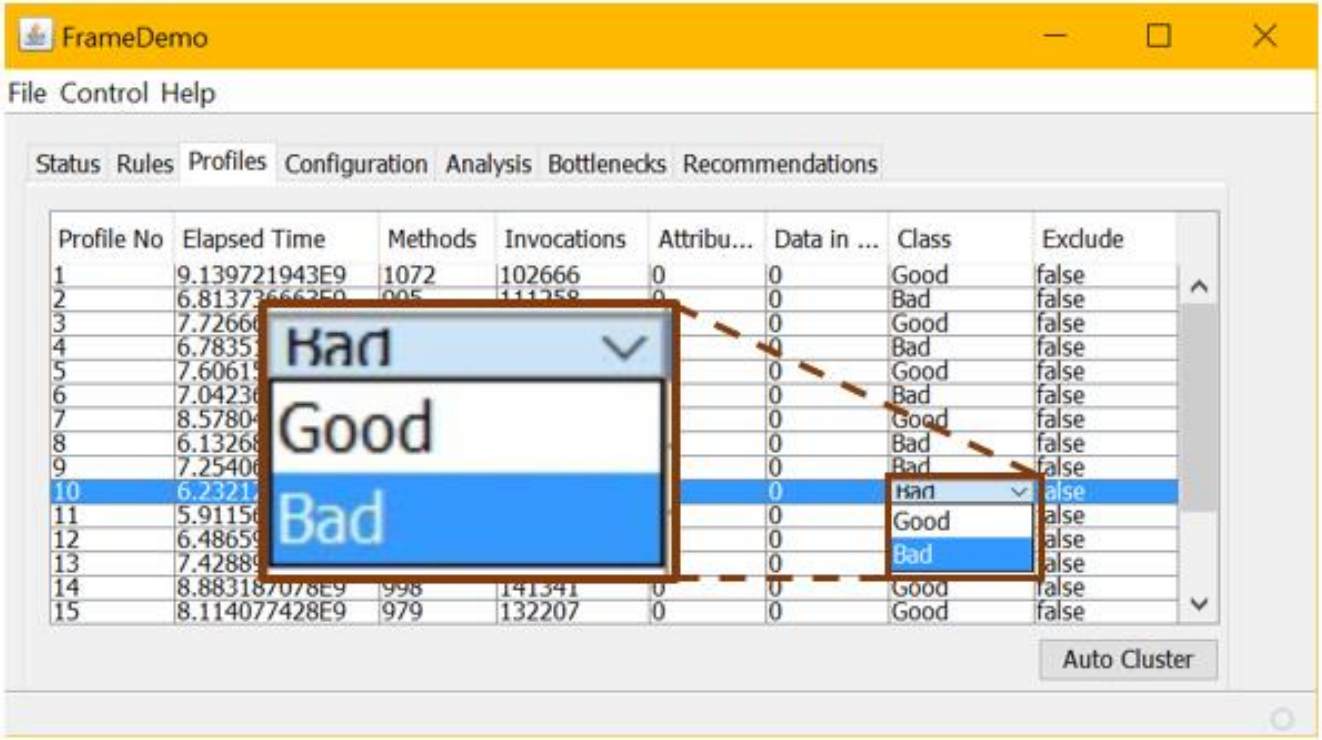
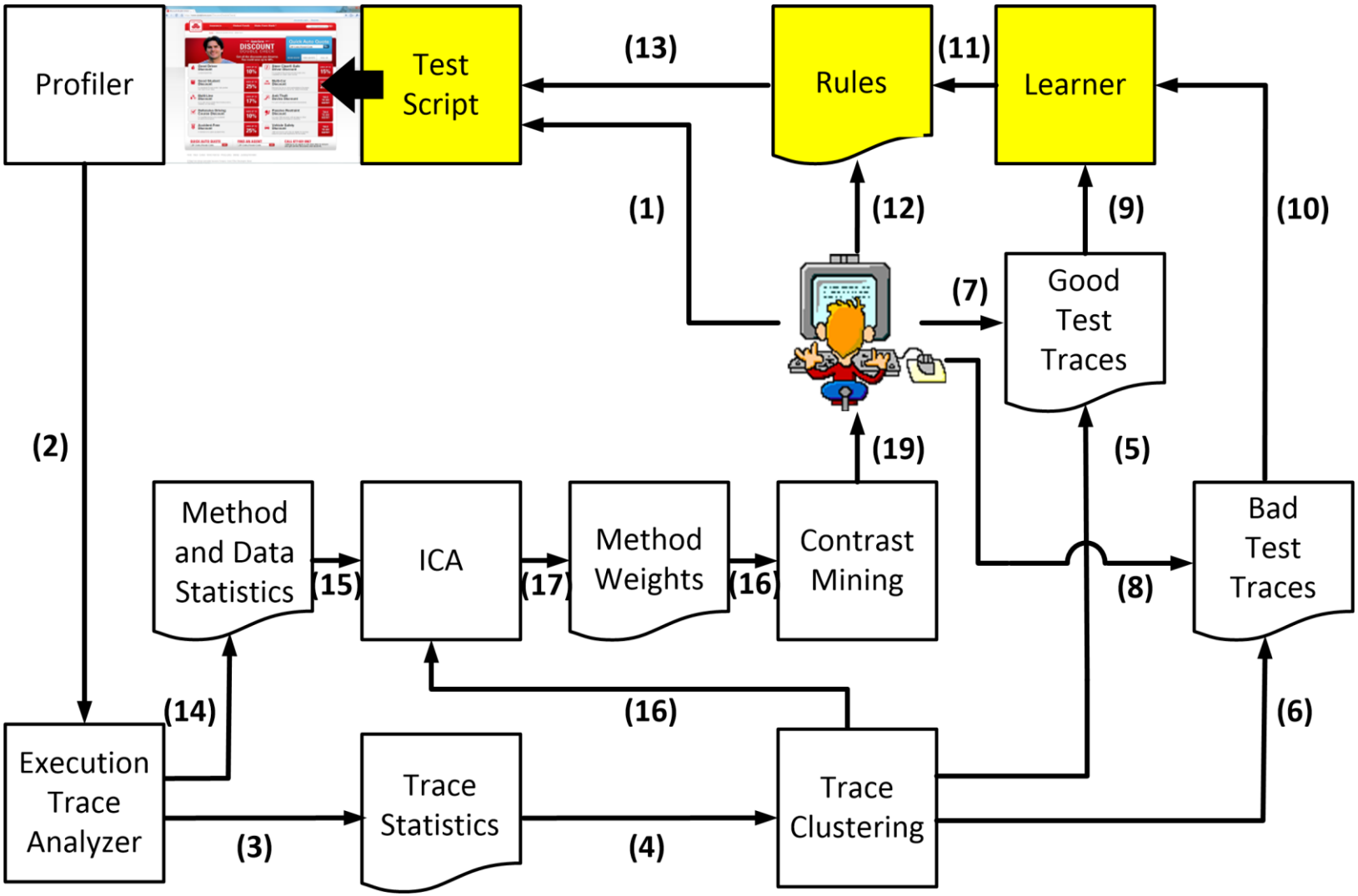
Bad Test Traces
Trace Clustering


FrameDemo
File Control Help
Status Rules Profiles Configuration Analysis Bottlenecks Recommendations
Profile No Elapsed Time Methods Invocations Attribu... Data in ... Class Exclude
1 9.139721943E9 1072 102666 0 0 Good false
2 Bad false
3 Good false
4 Bad false
5 Good false
6 Bad false
7 Good false
8 Bad false
9 Bad false
10 Bad false
11 Good false
12 Bad false
13 false
14 Good false
15 8.114077428E9 979 132207 0 0 Good false
Bad
Good
Bad
Auto Cluster

FOREPOST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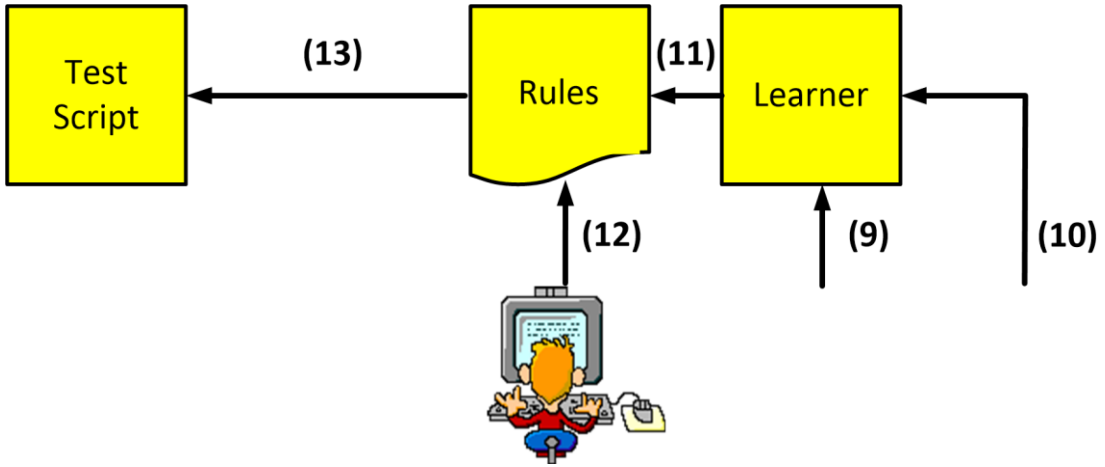
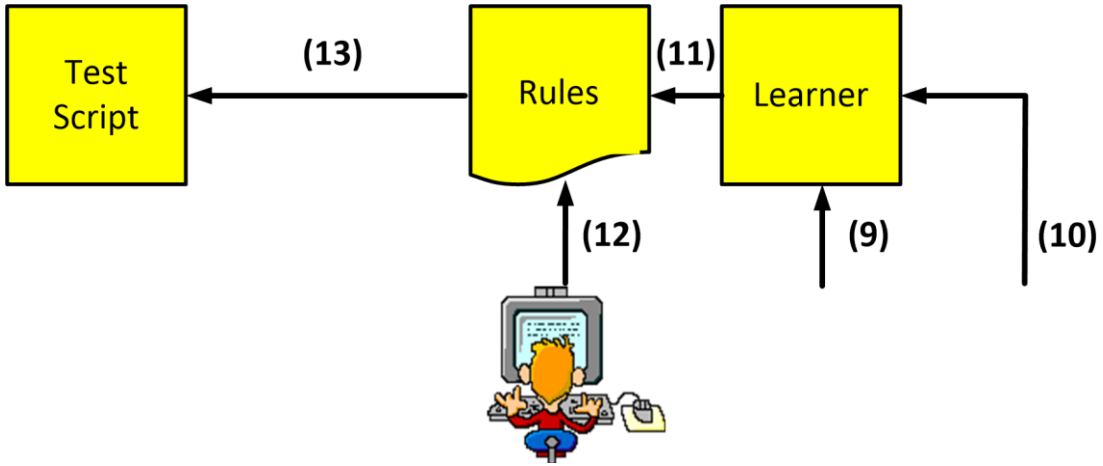


Examples of rules:

- (childOrAdultCareDetails.numberPersonsCaredForChild>3) => Good
- (browse_title_ACADEMY_AFRICAN_2 > 5) => Bad
- (viewPrdct_K9RT01 > 5) and (viewItem_EST16 > 5) => Bad
- (storeStory3 > 100) and (storeProject6 < 25) => Bad



FrameDemo

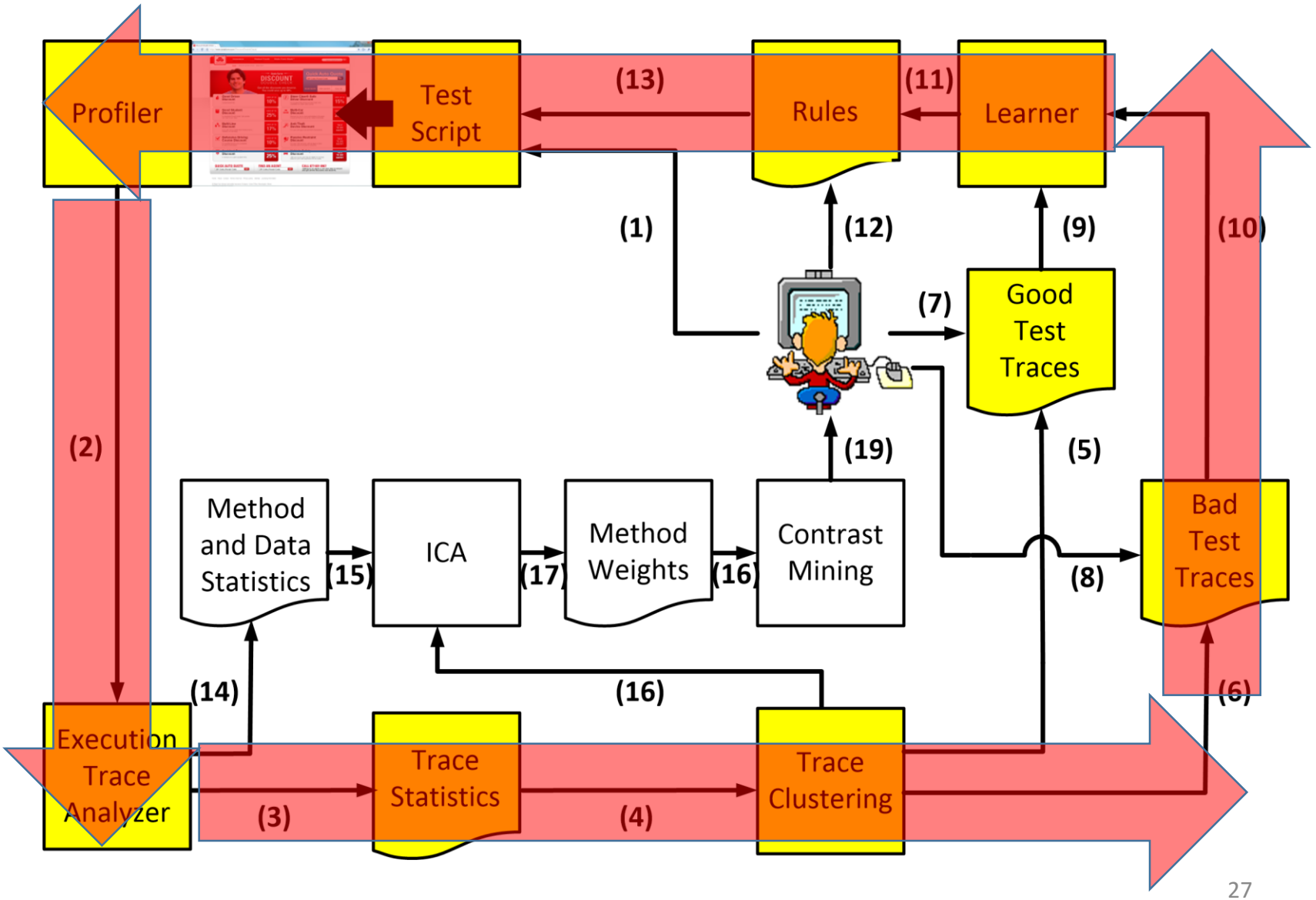
File Control Help

Status | Rules | Profiles | Configuration | Analysis | Bottlenecks | Recommendations

Active	Rule	Class
true	(accessRights1 >= 1) and (login1 <= 1)	Bad
true	(portlets1 <= 0) and (productChooserData1 <= 0)	Bad
true	(menuData1 >= 5)	Bad

Rule	Class
(accessRights1 >= 1) and (login1 <= 1)	Bad
(portlets1 <= 0) and (productChooserData1 <= 0)	Bad
(menuData1 >= 5)	Bad

FOREPOST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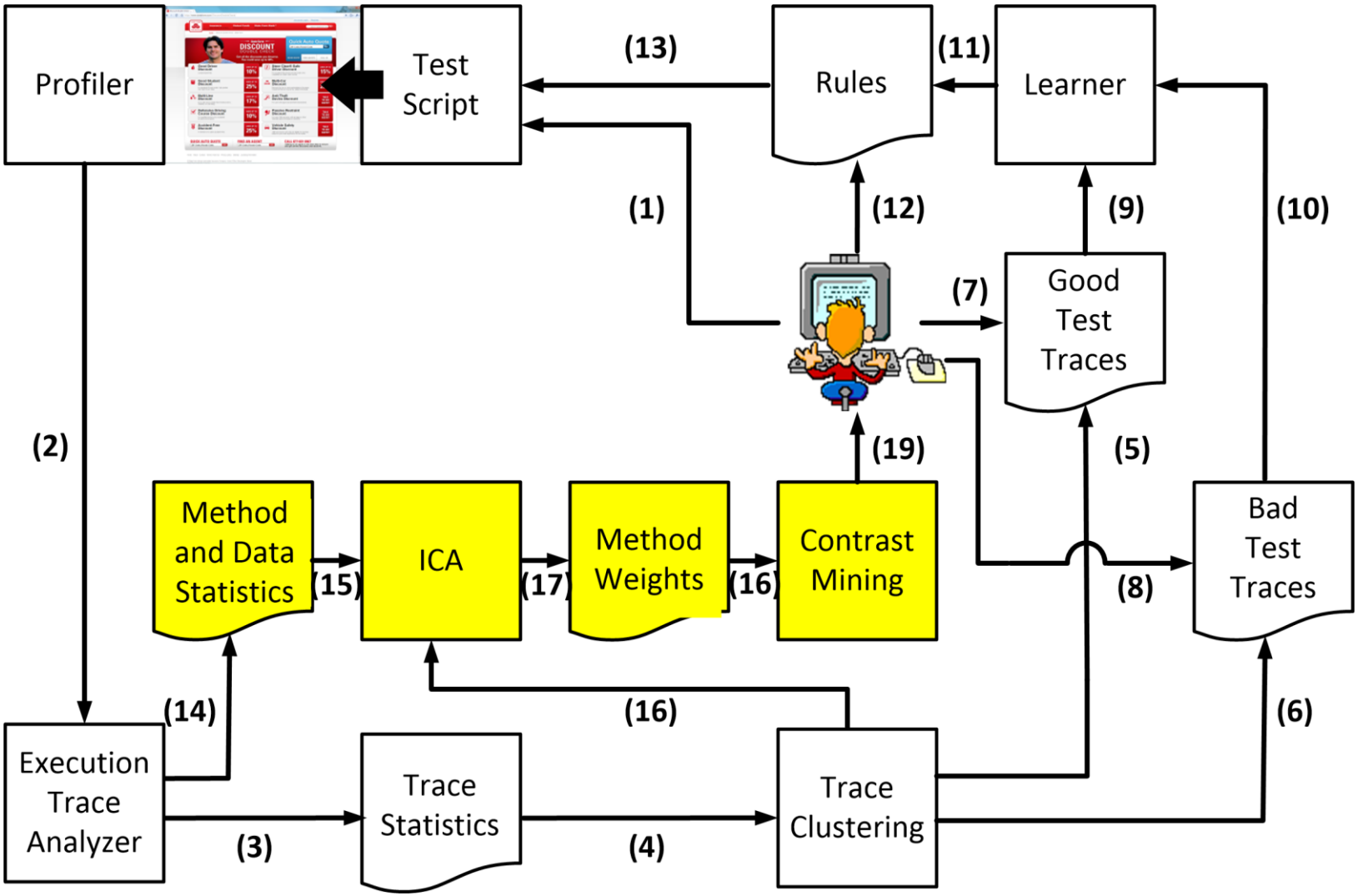
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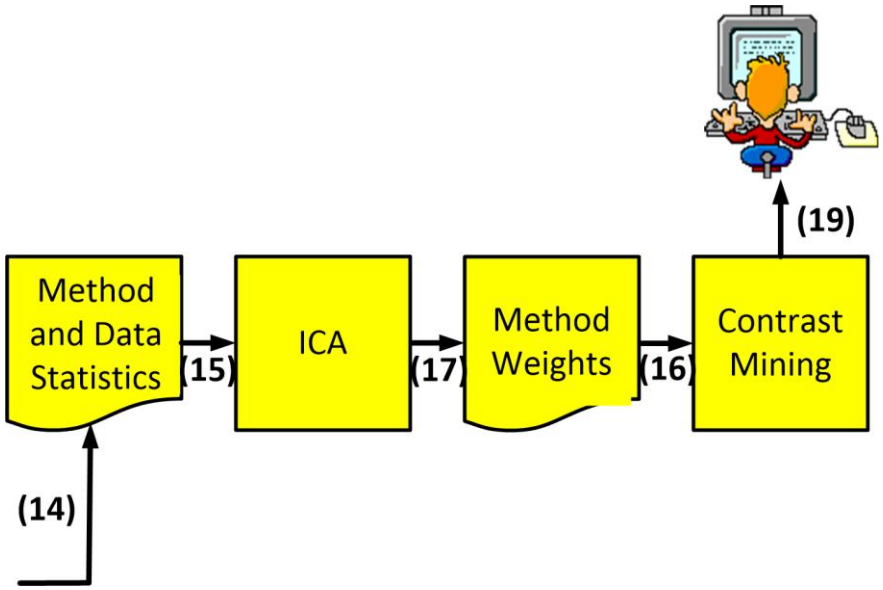
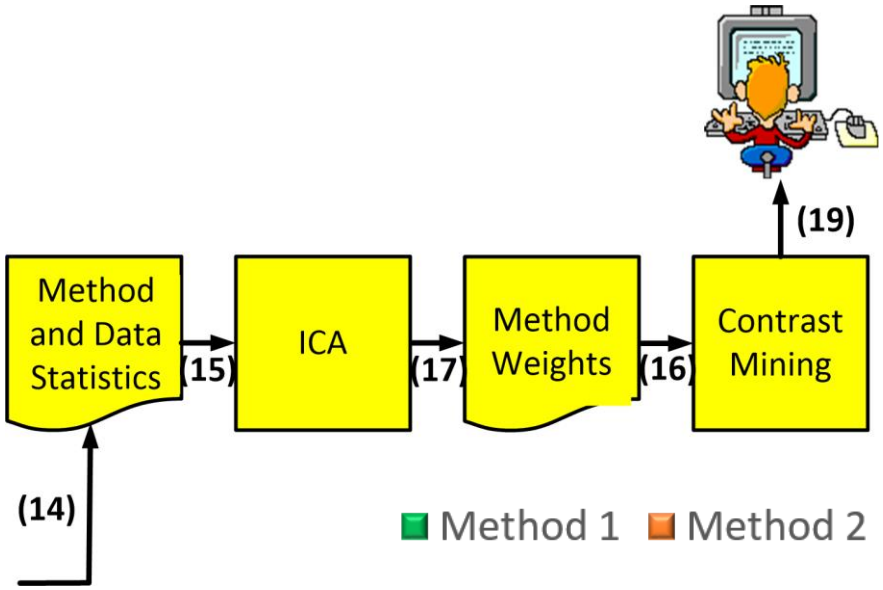


Bottlenecks => the most significant methods that occur in good traces but are not invoked or have little significance in bad traces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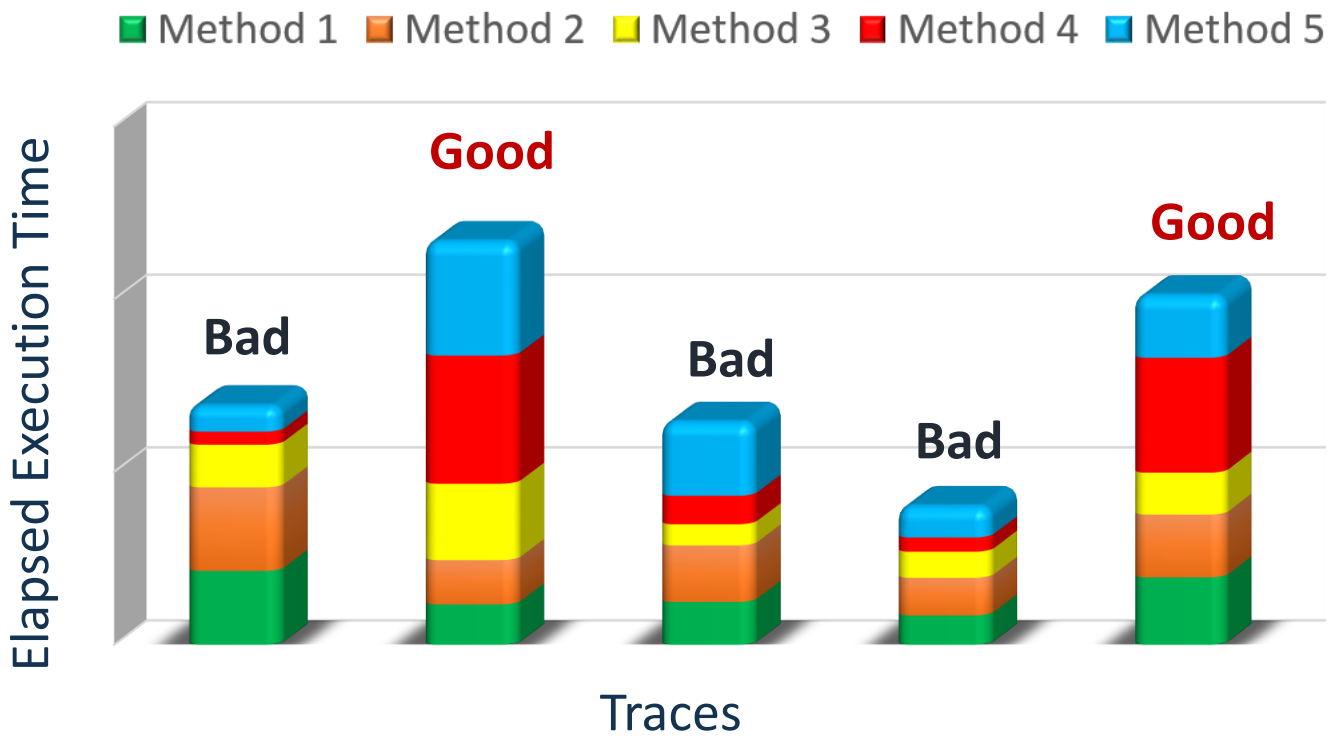
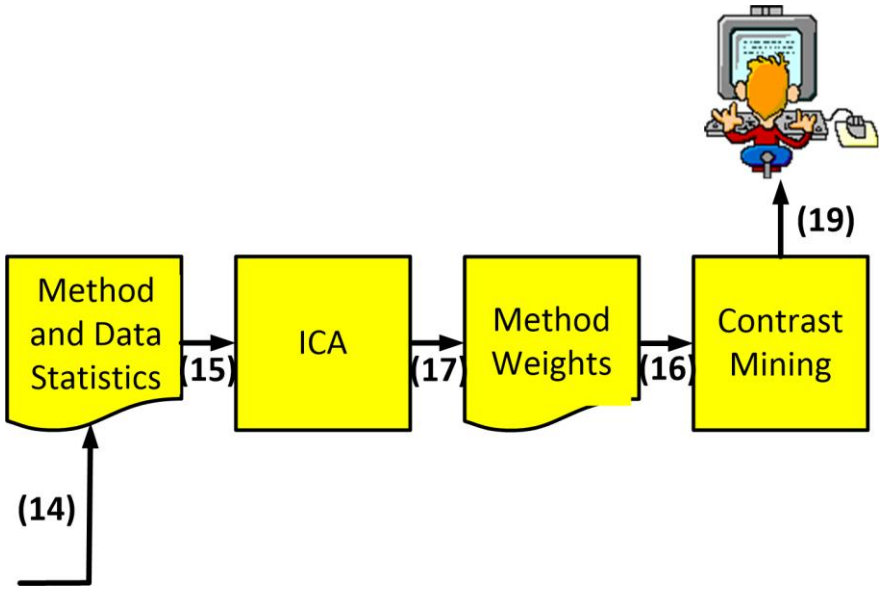

Method 1
Method 2
Method 3
Method 4
Method 5
Elapsed Execution Time
Bad
Good
Bad
Bad
Good
Traces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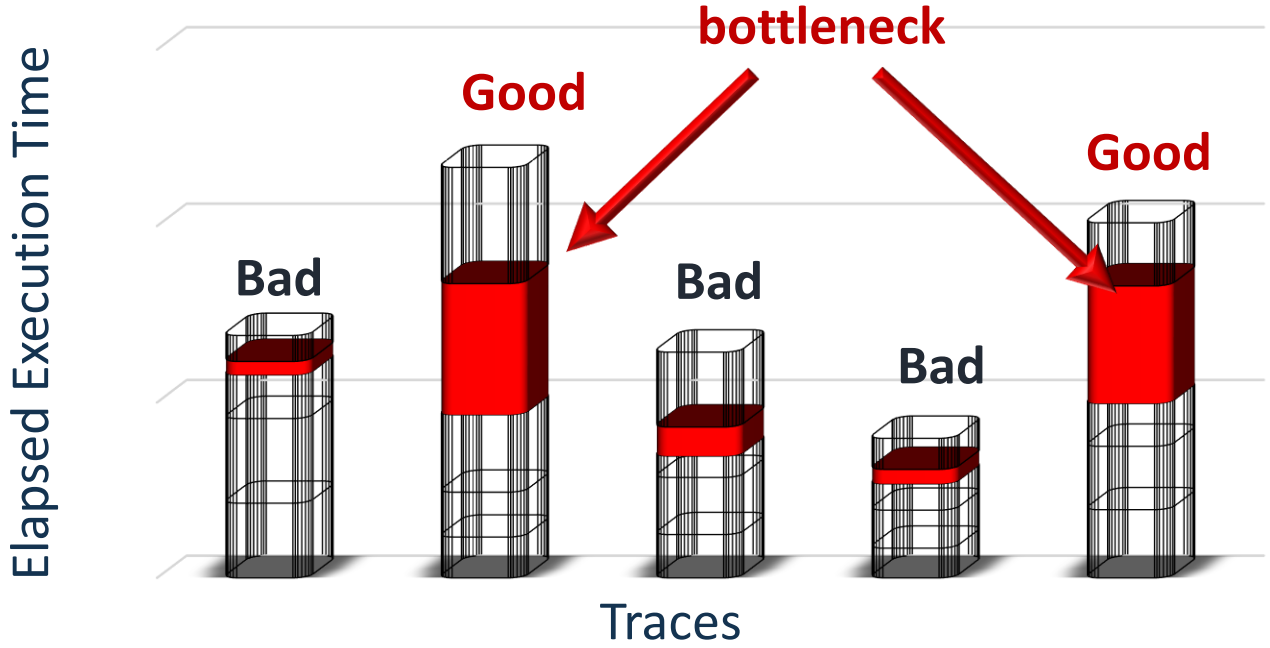
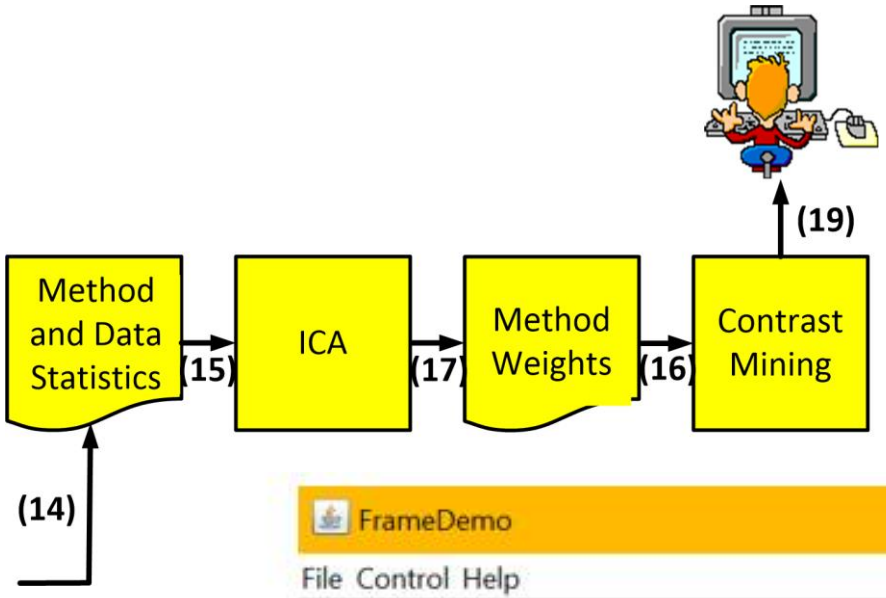

bottleneck
Good
Good
Bad
Bad
Bad
Elapsed Execution Time
Traces



FrameDemo

File Control Help

Status Rules Profiles Configuration Analysis Bottlenecks Recommendations

Class	Method	Weight
fi/hut/soberit/agilefant/db/hiber...	uniqueResult(Lorg/hibernate/Cri...	40.69105914481415
fi/hut/soberit/agilefant/db/hiber...	asList(Lorg/hibernate/Criteria;)L...	36.6321501202829
fi/hut/soberit/agilefant/db/hiber...	get(I)Ljava/lang/Object;	30.030236606060956
fi/hut/soberit/agilefant/web/Setti...	intercept(Lcom/opensymphony/...	17.06411844007046
fi/hut/soberit/agilefant/web/Tas...	store()Ljava/lang/String;	16.812430860678777
fi/hut/soberit/agilefant/web/Proj...	store()Ljava/lang/String;	14.824737582896939
fi/hut/soberit/agilefant/db/hiber...	equals(Ljava/lang/Object;Ljava/l...	13.119174923693715
fi/hut/soberit/agilefant/web/Stor...	store()Ljava/lang/String;	10.756980806040403
fi/hut/soberit/agilefant/business/...	updateStates(Lfi/hut/soberit/agil...	4.976398782345011
fi/hut/soberit/agilefant/web/Tea...	store()Ljava/lang/String;	4.8337150282050105

Class	Method	Weight
fi/hut/soberit/agilefant/db/hiber...	uniqueResult(Lorg/hibernate/Cri...	40.69105914481415
fi/hut/soberit/agilefant/db/hiber...	asList(Lorg/hibernate/Criteria;)L...	36.6321501202829
fi/hut/soberit/agilefant/db/hiber...	get(I)Ljava/lang/Object;	30.030236606060956

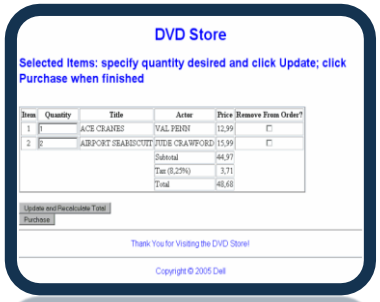
Experimental Design

Renters

Agilefant

JPetStore

Dell DVD Store



Experimental Design

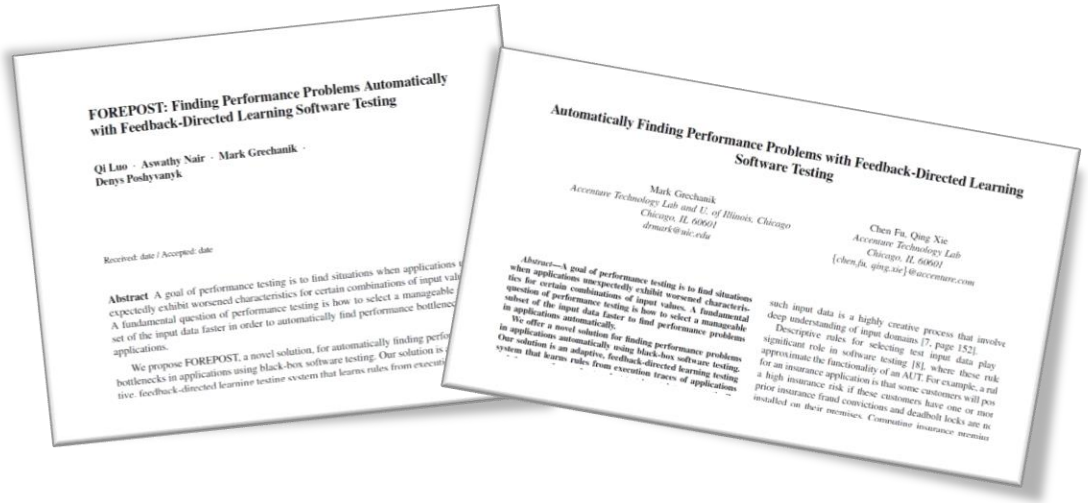
- Effectively finding input test data
  - FOREPOST & Random
- Identifying performance bottlenecks effectively
  - Injected performance bottlenecks
  - Real performance bottlenecks

Experimental Results

- Effectively finding input test data that expose performance bottlenecks
- Identifying performance bottlenecks effectively

Demo

Thank you!



Tool, source code, more materials:

http://www.cs.wm.edu/semeru/data/ICSE16-FOREPOST/

SEMERU

UIC