Synthesizing Client Load Models for Performance Engineering via Web Crawling

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Outline

- Introduction
- Motivation and Related Work
- MaramaMTE+
- Example Usage
- Design and Implementation
- Conclusions and Discussions
- Summary

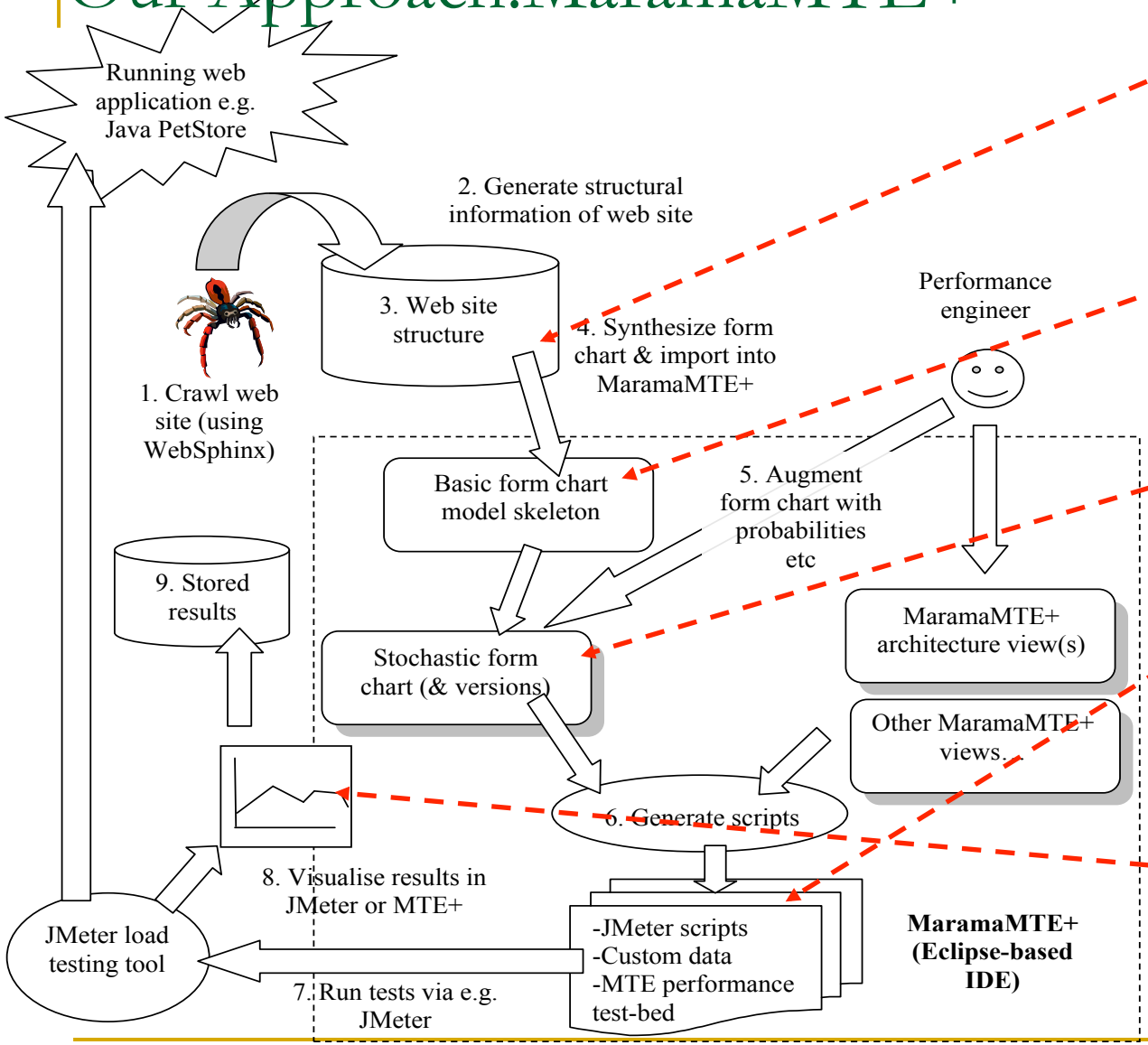
Motivation

- Web load testing needed to ensure performance requirements met
- Current load testing environments (e.g. JMeter, MS ACT) support complicated testing plans
- BUT - it's tedious and error-prone to manually script these

Motivation

- Ideally web load testing tool support must allow users to:
  - easily change client load model testing parameter values
  - generate multiple testing plans/scripts automatically
- Tool should be well-integrated within a generic performance engineering environment
  - allows realistic client behavior model to influence the design of other parts of software system e.g. the software architecture.

Our Approach:MaramaMTE+



1. Crawl target web site to extract structure into database
2. Synthesize a form chart model from the web structure database in MaramaMTE+
3. Engineer augments with probabilities = “stochastic form chart” formal model
4. Generate JMeter etc load test plans/scripts
5. Run & analyse the performance tests. Potentially change probabilities/ restructure form charts & compare results

Example Usage

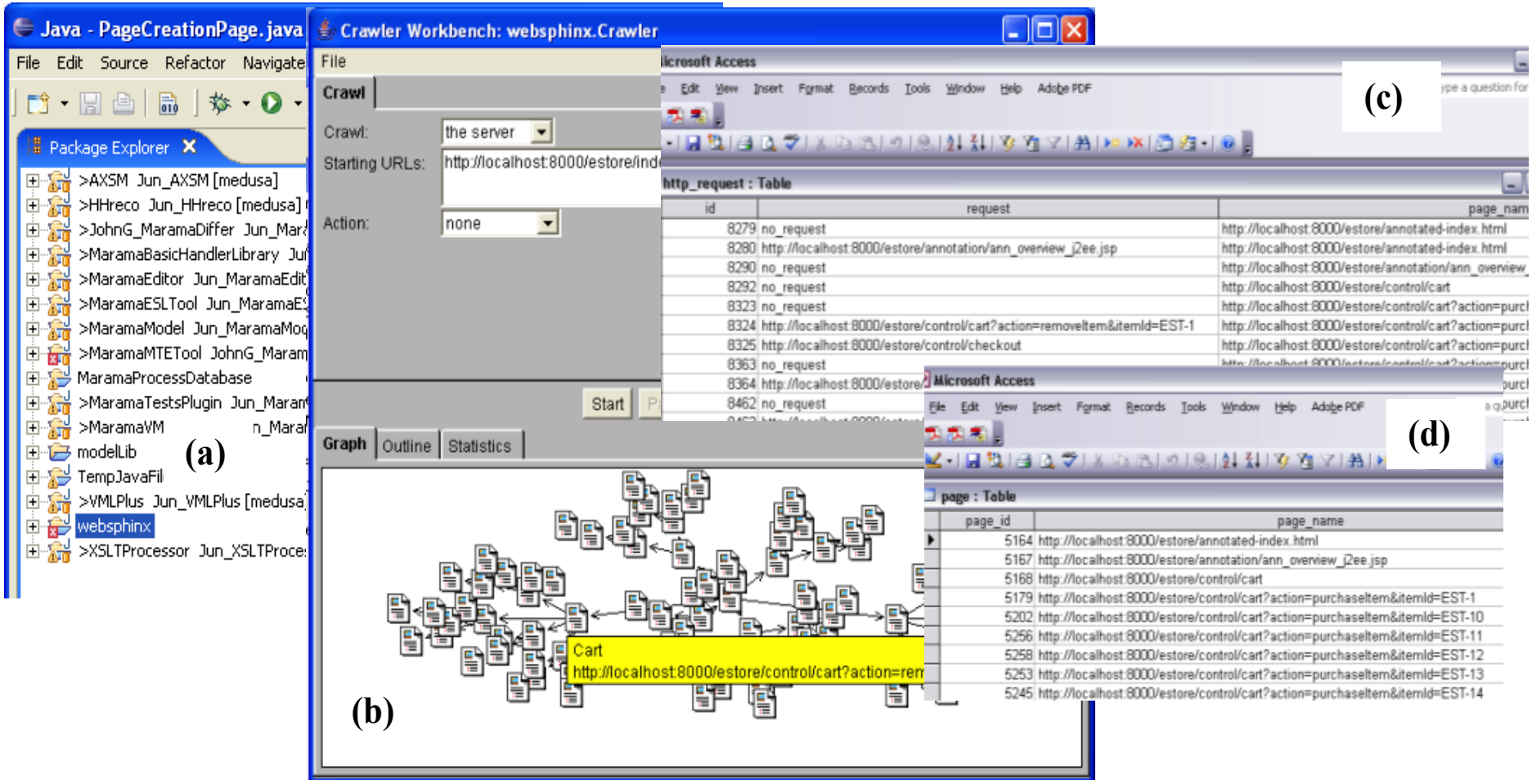
- Use Java Pet Store reference application to illustrate effectiveness of our MaramaMTE+ approach

  http://java.sun.com/developer/releases/petstore/

- Shows the main steps of load testing PetStore legacy system in MaramaMTE+:
  - HTTP request extraction from target web site
  - Form chart augmentation by engineer
  - Load test generation (target tool JMeter)
  - Running generated JMeter tests

Example Usage - HTTP Request Extraction

- WebSphinx used to extract Pet Store structural information
  - User supplies target web site information to the crawler
  - Crawler explores the main screens, hyper links, and http requests, parameters and values for target web site
- MaramaMTE+ collects data into a purpose-built crawler/result/http request database
- E.g.:
  - "http_request" table holds http requests and associated pages
  - "page" table holds information about page ids and names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8290 no_request http://localhost:8000/estore/annotation/ann_overview
8292 no_request http://localhost:8000/estore/control/cart
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8324 http://localhost:8000/estore/control/cart?action=removeItem&itemId=EST-1 http://localhost:8000/estore/control/cart?action=purcl
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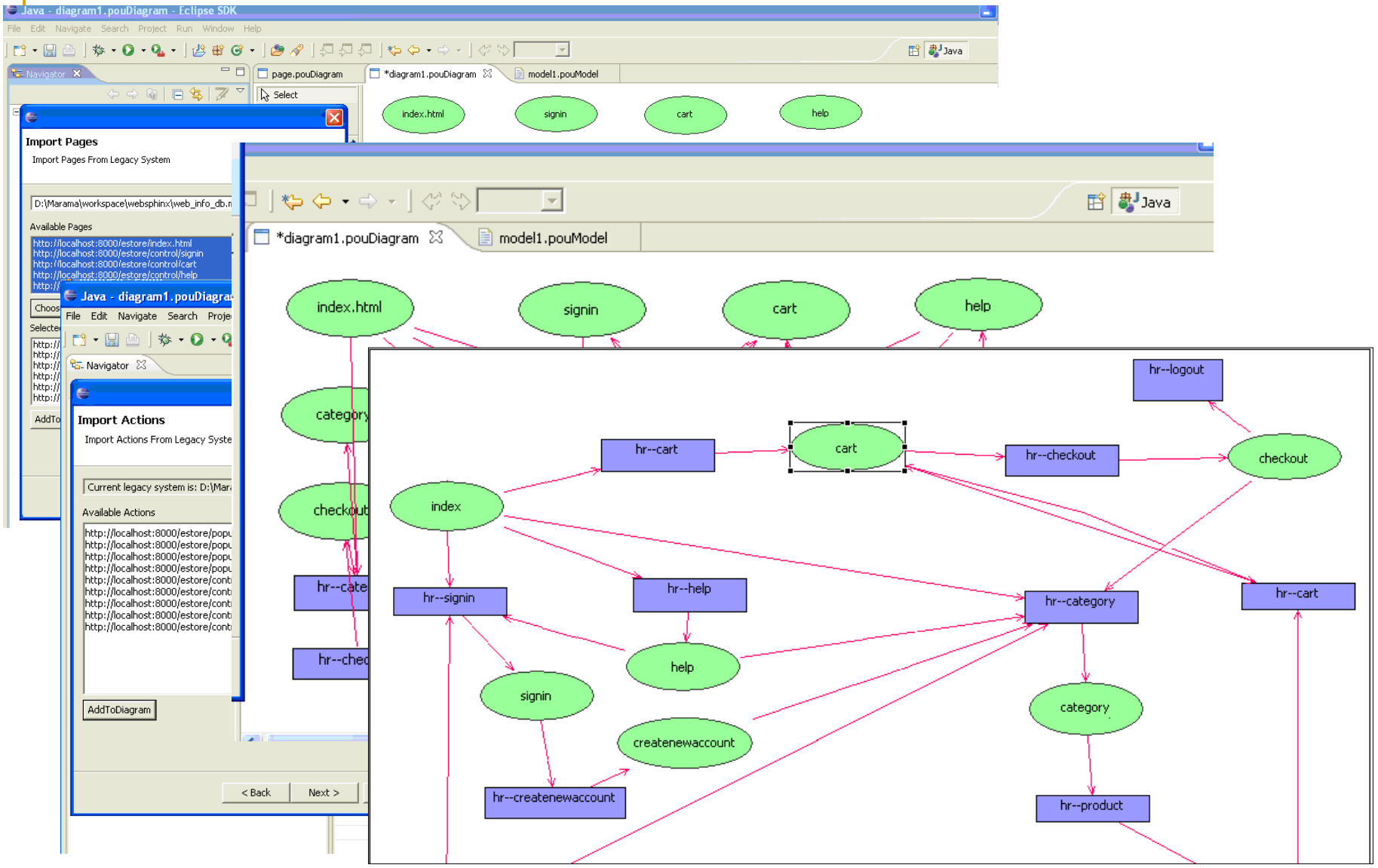
5167 http://localhost:8000/estore/annotation/ann_overview_j2ee.jsp
5168 http://localhost:8000/estore/control/cart
5179 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-1
5202 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-10
5256 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-11
5258 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-12
5253 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-13
5245 http://localhost:8000/estore/control/cart?action=purchaseItem&itemId=EST-14

Example Usage - Form Chart Extraction

- MaramaMTE+ uses crawler data to generate an initial form chart model structure
  - Includes forms, actions, transitions, links to underlying web site structure (URLs)
- For large web sites engineers can view and edit partial form charts in multiple diagrams that share a single model
- Diagram and model versioning mechanism allows alternate versions of the form charts to be created, then compared, differentiated and merged.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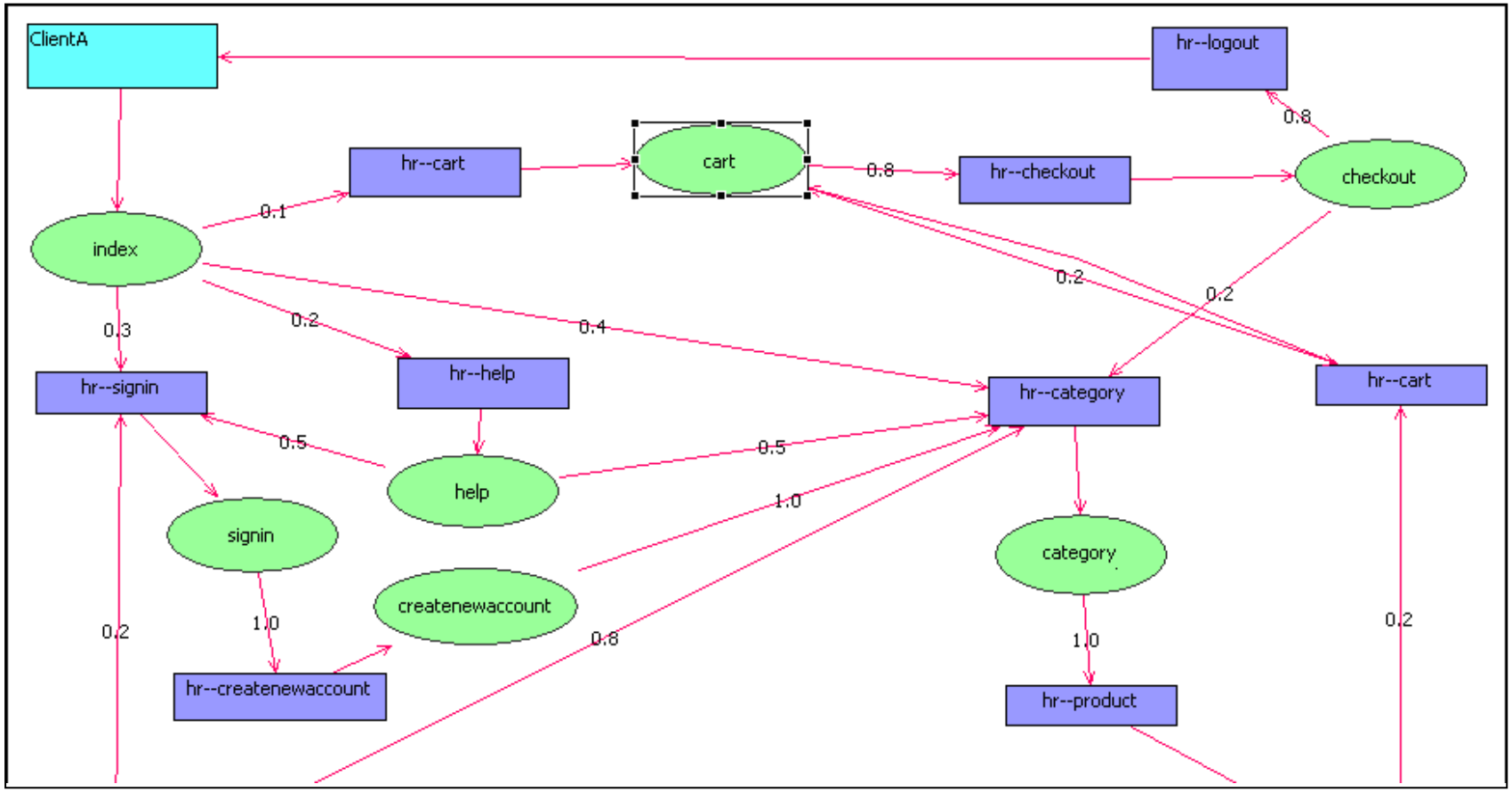
Example Usage ------ Form Chart Augmentation

- MaramaMTE+ uses the generated form chart in two ways:
  - model of user interaction behaviour from which to generate testing tool scripts e.g. for JMeter (system developed and under stress test)
  - with other MaramaMTE+ models (e.g. the architecture design models, business process models and service composition models) to generate a performance evaluation test bed for server-side (system under design)
- For either, engineer needs to augment model with properties that specify user interaction behaviours and code generation information
- Can version form chart and add different probabilities etc to compare performance under different user behaviours (i.e. loading conditions)


ClientA
hr--logout
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hr--cart
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category
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hr--createnewaccount
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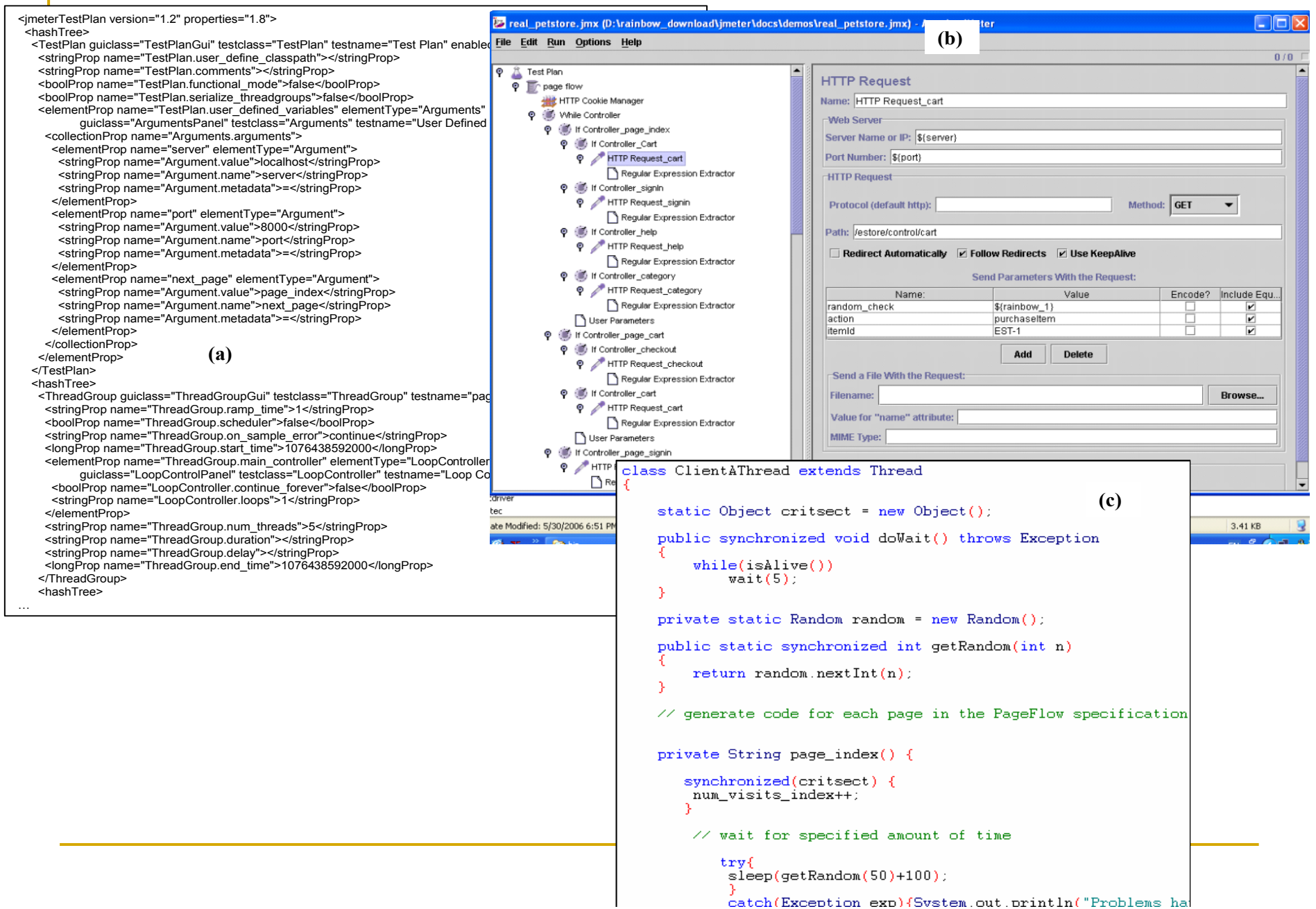
Example Usage ------ Loading Test Generation

- MaramaMTE+ uses stochastic form chart to generate e.g. JMeter testing plan and associated scripts:
  - MaramaMTE+ form chart "Page" = state of the website;
  - "Action" = JMeter http requests to obtain certain web pages;
  - "Transition" = transitions between web pages via "Actions";
  - "Probability" and "URL" properties used to generate the logic controllers of the JMeter testing plan
- MaramaMTE+ may also generate a Java load testing programme for client and/or server-side (if system under design):
  - uses a state machine implementation
    - web pages = states
    - linked by form chart actions = http requests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guiclass="LoopControlPanel" testclass="LoopController" testname="Loop Co
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</elementProp>
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real_petstore.jmx (D:\rainbow_download\jmeter\docs\demos\real_petstore.jmx)
(b)
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Test Plan
page flow
HTTP Cookie Manager
While Controller
If Controller_page_index
If Controller_Cart
HTTP Request_cart
Regular Expression Extractor
If Controller_signin
HTTP Request_signin
Regular Expression Extractor
If Controller_help
HTTP Request_help
Regular Expression Extractor
If Controller_category
HTTP Request_category
Regular Expression Extractor
User Parameters
If Controller_page_cart
If Controller_checkout
HTTP Request_checkout
Regular Expression Extractor
If Controller_cart
HTTP Request_cart
Regular Expression Extractor
User Parameters
If Controller_page_signin
HTTP Request
Name: HTTP Request_cart
Web Server
Server Name or IP: ${server}
Port Number: ${port}
HTTP Request
Protocol (default http):
Method: GET
Path: /estore/control/cart
Redirect Automatically
Follow Redirects
Use KeepAlive
Send Parameters With the Request:
Name: Value: Encode? Include Equ...
random_check ${rainbow_1}
action purchaseItem
itemId EST-1
Add Delete
Send a File With the Request:
Filename: Browse...
Value for "name" attribute:
MIME Type:
3.41 KB
class ClientAThread extends Thread
{
(c)
static Object critsect = new Object();
public synchronized void doWait() throws Exception
{
while(isAlive())
wait(5);
}
private static Random random = new Random();
public static synchronized int getRandom(int n)
{
return random.nextInt(n);
}
// generate code for each page in the PageFlow specification
private String page_index() {
synchronized(critsect) {
num_visits_index++;
}
// wait for specified amount of time
try{
sleep(getRandom(50)+100);
}
catch(Exception exp){System.out.println("Problems ha

Example Usage ------ Running Load Tests

- Run the generated JMeter testing plan against the web application server (Java PetStore).
- Analyse important performance measurements, e.g. :
  - visited web pages
  - sample numbers,
  - average response time,
  - min and max response time,
  - throughput, etc.
- Results presented using generated JMeter tabular result viewer
  - Can also use other JMeter-supplied result analysis tools and visualisations
  - Supports exploratory performance engineering for web applications in early-phase design or reengineering.

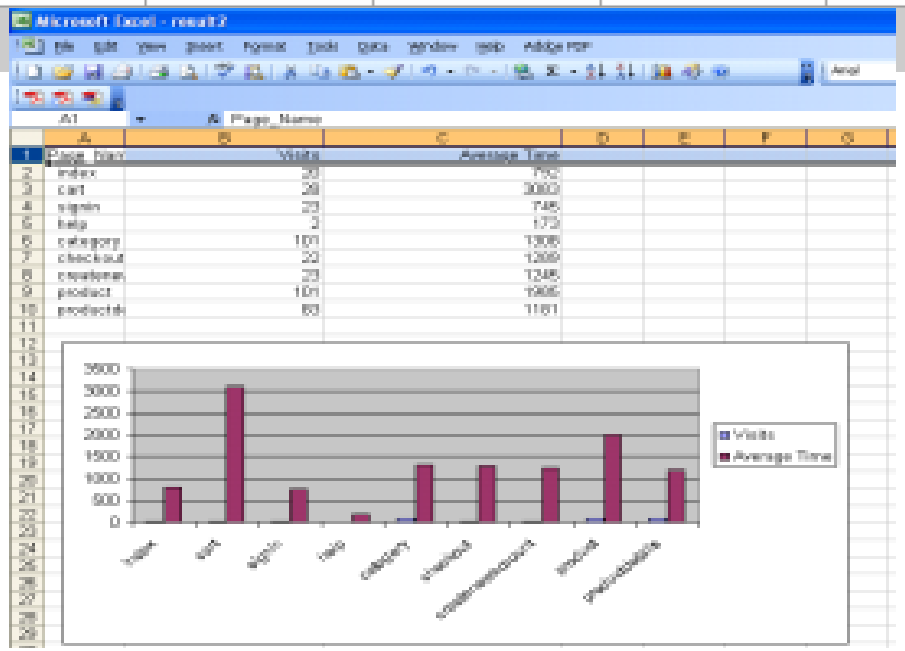
Summary Report

Name: Summary Report

Write All Data to a File

Filename | Browse... | Log Errors Only | Configure

Label	# Samples	Average	Min	Max	E
HTTP Request_help	2	200	50	351	0.00%
HTTP Request_signin	9	189	20	461	0.00%
HTTP Request_createnewaccount	9	252	20	601	0.00%
HTTP Request_category	45	377	40	711	0.00%
HTTP Request_getProduct	45	506	171	982	0.00%
HTTP Request_productdetails	38	766	241	1422	0.00%
HTTP Request_cart	8	1009	401	1612	0.00%
HTTP Request_checkout	7	472	210	761	0.00%
HTTP Request_logout	5	198	40	361	0.00%
TOTAL	168	509	20	1612	0.00%



Design and Implementation of MaramaMTE+

- Implemented as a set of Eclipse IDE plug-ins using Marama meta-tool
- Eclipse Java Emitter Templates (JET) scripts used to generate form chart-based test plans and scripts
  - JET template generates root JMeter test plan from client form chart component and its properties (name, host(s), threads etc)
  - JMeter initialisation components/scripts generated e.g. to set up timing monitors (WhileController).
  - First form chart page transformed to an initial http request on target web application (IfController).
  - Transitions to Actions in the form chart generate decision logic in the JMeter test script implementing a state machine model
    - Via JMeter's RegexExtractor, UserParameters, etc
  - Probabilities in form chart model may be simple random, fixed times, or complex stochastic probability models
    - Implemented as JMeter's BeanShellTimer, Gaussian Random Timer, etc

Discussion - Key advantages to MaramaMTE+

- The use of a formal stochastic form chart model for client load behavior modeling
  - Models user behavior in terms of probabilistic interactions
  - Model can be both reasoned about and used to generate test plans and scripts.
- The ability to extract basic form chart model structure from a web application via web crawling
  - Much less costly than hand-crafting a user model

Discussion - Key advantages to MaramaMTE+

- Can version stochastic form charts to compare and contrast performance under different client behavior models
  - i.e. under different loadings on the server
- Model-based generation of 3rd party stress testing tool test plans and scripts –
  - means MaramaMTE+ can leverage 3rd party load testing tools' advanced features e.g. JMeter's sophisticated measurement, reporting, distributed test execution and test scheduling support features
- Can run and compare web application performance under numerous different loading models accurately and efficiently

Discussion - Limitations

- Engineer needs to manually augment generated form chart with probabilities
- Must live with 3rd party tool limitations:
  - Most web application stress testing tools have less rich client behavioural models than form charts.
  - Thus we need to simplify the model when test scripts are generated or extend the testing tool (if possible)
  - Sometimes implementing form chart-specified behaviour is quite complex in the 3rd party testing tool
    - e.g. implementing a probabilistic state machine in JMeter is challenging
  - It is not always easy to control such tools in the way we are able to when generating our own client load test implementation

Summary: MaramaMTE+

- Automates retrieval of website structural data from a web user's perspective
- Generates a formal model of user interaction behaviour and load testing plans
- Effectiveness demonstrated through a case study, Java Pet Store:
  - site crawled, structural data extracted, a form chart model automatically generated and manually augmented, JMeter testing plans generated and executed, and load testing results collected
- Future plans:
  - will combine the generated form chart with a generated design level model of a legacy system
  - will make it possible for ordinary tool users to make rigorous comparisons between different products (e.g. Java PetStore and .NET PetShop)

Thank you!

Questions?

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