The Future of Metadata-Oriented Testing of Research Software: Automated Generation of Test Regimes and Other Benefits

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• Software engineering research and development since early 1970s (mainframe, PC, web, mobile)

• > 75 operational systems in numerous sectors developed with metadata-driven technology
Philosophy

• Refocus the role of
  – Computer scientists (less design/coding, remove a bottleneck/“gatekeeper”), focus on the technical/logic challenges

• “Big red button” approach
  – Enable partners to access and manage their own data, interface, partnerships
In Practice

• A modest amount of common code, very rarely changed
  – Listings (multiple records), Forms (editable fields), Reports (usually one detailed record)

• Data (datasources, tables and columns) selected using “metadata”, i.e., additional data that describes how listings, forms and reports should be constructed/presented
Common Usage

• Metadata is initially set up by an application developer

• Presentation details (layouts, formatting details, system navigation, …) defined by a designer, incorporated by application developer (CSS, possibly some JavaScript, …)

• Reasonably detailed logs of requests and significant actions/transactions are recorded
System Testing

- Objective is to make testing as easy as possible
- Web-based test facility connects php-webdriver (Selenium Grid Server with php interface) to database tables and columns with sequences of test directives
- Any test can be entered manually (the usual listings, forms have been set up to access them) but it can be a bit tedious
Test Results

• Tests can be run on demand (click a link) or more automatically (timed, from a DB trigger, etc.)
• Results of each step and collection of steps (“suite”) are recorded in DB tables
• Results can be marked as a “comparison standard” – i.e., a desirable result; subsequent test runs are compared against these
Test Generation

• Tests can also be entered using other database queries, including queries that access the application definition metadata
  – For example, a form with a numeric input field that accepts integer values in the range 0 – 99 should be tested for inputs of at least -1, 100, probably 100,000,000, 1.5, 0, 1, 50, 98, 99, blank (empty), a space, “x” and any other values that the form creator deems to be significant
Scientific/Modelling Applications

- Input value domain testing extends to all “significant” values in an application domain
  - E.g., modelling for solar radiation received over a calendar year by latitude – a partner (“domain expert”) asked “how could it possibly be wrong?” regarding a 20,000 line code sequence to model stream flows – except it failed (math exception) when a station was moved a few degrees north (they forgot to convert degrees to radians)
  - A similar “concern” involved an open stream temperature that was calculated to be 107°C, in Canada in January
Workflow Applications

• Workflows have been captured as a data representation (Graham Twaddle, Michael A. Jackson, 1997)

• Tests of workflow scenarios can be generated from the workflow definition
Declarative Software Agents

• Data is used to describe an agent’s input, rules and actions; results are logged to DB tables

• Actions such as comparisons between distributed, disparate databases (i.e., copies of data in different formats) can enable routine consistency checking – can change the usual rules of data access
Future Testing

• “checkpointDB” / “compareDBWithCheckpoint”
• Did everything that was supposed to happen as a result of an action actually happen?
• Did only that which was supposed to happen actually happen?
Conclusions

• As systems are used, maintained and age, automated testing and detailed logging are two facilities that will help to keep systems operating as intended.

• As more aspects of systems are described with metadata, we claim that it will be possible to automate more testing and more aspects of testing, in particular: what, when, how to test.
Thank You!

• Questions?
Welcome to the Flowing Waters Information System (FWIS)

FWIS helps Ontario’s conservation practitioners to manage information on aquatic systems, including data about fisheries, benthos, habitat and more. Currently, FWIS can be used to:

- Review and map locations where data is collected
- Identify where and what type of data has been collected
- Identify which conservation organization collected the data and request data for specific sampling locations
- View/edit fish and site data collected at sampling locations
- Query fish locations collected using OSAP standards across Ontario
- Download fish and site data from sampling locations

Using FWIS

Click here to download the FWIS guide, *Using the Flowing Waters Information System Portal (May, 2014)*.

American Fisheries Society 2014 (Quebec City) Presentation "Nothing Ventured, Nothing Gained - Lessons Learned from Developing a Flowing Waters Information Management System" (Click here to download a PDF of the presentation)

Data included within FWIS are at present all collected using the Ontario Stream Assessment Protocol. The OSAP manual and videos that illustrate the methods as well as information on upcoming courses are available at [http://www.trca.on.ca/osap/](http://www.trca.on.ca/osap/).

In the near future, FWIS will enable users to:

- Access other OSAP datasets
- Determine the protocol used to collect the data

[https://www.comap.ca/fwis/adminListings.php?ListType=SiteProj&MenuId=49](https://www.comap.ca/fwis/adminListings.php?ListType=SiteProj&MenuId=49)
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<th>Stream Code</th>
<th>Site Code</th>
<th>Year</th>
<th>Sample Event</th>
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<th>Site Identification</th>
<th>Site Features</th>
<th>(Electro) Fish Sampling</th>
<th>Channel Morphology</th>
<th>Benthic Survey</th>
<th>Benthic Tally</th>
<th>Channel Stability</th>
<th>Headwaters</th>
<th>Discharge (Hydrograph)</th>
<th>Discharge (Historical)</th>
<th>Hydrograph</th>
<th>RAM - Physical Habitat</th>
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<th>Cross Section Data</th>
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Project(s): St. Clair Region Conservation Authority 2014
1993 Stream Juvenile Migratory Salmonid Index; Training
Jim Bowby's graduate research data
Edit a site identification sample event

Choose File: No file chosen  
Bulk CSV Upload (?)

Return/navigate to Sampling listing

This form shows what is currently recorded about this site. You can change any of the values and the system will, by default, record your changes with an approval status of "Review Requested" (in the external field). Please provide a rationale for your change(s) on the "Site Description" tab by selecting one of the rationale drop-down values or, in the case of "Other," enter a brief explanation in the comment field.

Be sure to click on the "Update" button at the bottom of the page to save your changes.

Stream name (Code): Aberarder Creek (ABARD)  
Site code: ABA01  
Sample event date (Sample number): 2014-06-05

Location  
Site Description  
Site Marker Descriptions  
Sketch Descriptions  
Photo Descriptions  
Unsampleable Site

To move an existing location marker on the map to a different location, click in one of the coordinate entry fields to be changed and then drag the corresponding marker to the preferred location.

To specify a new geographic location for the site, a point must be marked on the map. If you know the UTM or decimal latitude and longitude coordinates for the site, you can enter them into the appropriate map area. If you do not know the coordinates, click in any of the UTM or Latitude/Longitude boxes to "activate" either the Uncorrected, Corrected or FWIS mapping coordinate choices. Then click on the map to position the location on the screen. After you have the point on the map, enter the corresponding UTM or decimal latitude and longitude coordinates in the appropriate box.

Automatically Update Geographic Fields

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<th>Conservation Authority</th>
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