A Compendium Platform for Reproducible, R-based Research with a focus on Statistics Education

UseR! 2008 - Patrick Wessa - K.U.Leuven Association, Lessius Dept. of Business Studies

Introduction

- Acknowledgments
- Motivation (based on frustration)
- Reproducible Research and the Compendium:
  - Literature
  - The compendium redefined
  - Proposed solution
- Screenshots
- Conclusions & Future work

http://www.freestatistics.org >> Publications
http://www.wessa.net/download/user2008.pdf

Acknowledgments

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  - K.U.Leuven Association, OOF 2007/13
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- Contributors:

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My frustration

- Teaching Time Series Analysis
- Exam question:
  Compute (1-B) Y[t] if you know that
  Y[t] = {5, 8, 2, 3, 7, 1, 4}
  BY[t] = Y[t-1]

My frustration

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  Compute (1-B) Y[t] if you know that
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- Result
  - Less than 8% of students got it right.
  - More than 90% of students could prove Wold's decomposition theorem!

Conclusion?

- I am an extremely bad educator.
- I shouldn't have asked that silly question: Students can only reproduce theories – they are no required to understand them!
- ...
- Or maybe there is something wrong with our approach towards statistics education?

A new approach is needed

- Within the pedagogical paradigm of (social) constructivism:
  - Interaction & collaboration (peer review)
  - Experimentation
  - Responsibility (social control)

  => learning & computing technology

  => we need to Free Statistics of irreproducible research

  => www.FreeStatistics.org

Computing Reproducible ~~Research~~ and the Compendium

Green's comment

- Now the methodology is often so complicated and computationally intensive that the standard dissemination vehicle of the 16-page refereed learned journal paper is no longer adequate. ...
  Most statistics papers, as published, no longer satisfy the conventional scientific criterion of reproducibility: could a reasonably competent and adequately equipped reader obtain equivalent results if the experiment or analysis were repeated?

*Source: Peter J. Green

Claerbout's principle*

- An article about computational science in a scientific publication is not the scholarship itself, it is merely advertising of the scholarship. The actual scholarship is the complete software development environment and that complete set of instructions that generated the figures.

*Source: Jan de Leeuw

Jan de Leeuw's comments*

- First, there is no reason to single out figures. The same ``Principle'' obviously applies to tables, standard errors, and so on. The fact that figures often happen to be easier to reproduce, does not preclude that we should apply the same rule to any form of computer-generated output.
- Second, there is no reason to limit the Claerbout's Principle to published articles. We can make exactly the same statement about our lectures and teaching, certainly in the context of graduate teaching. We must be able to give our students our code and our graphics files, so that they can display and study them on their own computers (and not only on our workstations, or in crowded university labs).
- And third, and perhaps most importantly, it is not clearly defined what a ``software environment'' is. Buckheit and Donoho apply the principle in such a way that everybody who wants to check their results is forced to buy MatLab(R). Not Mathematica(R), Macsyma(R), or S-plus(R). Those you may need to buy for other articles. This violates the Freeware Principle...

*Source: Jan de Leeuw, Reproducible Research: the Bottom Line, 2001, online

Sweave package

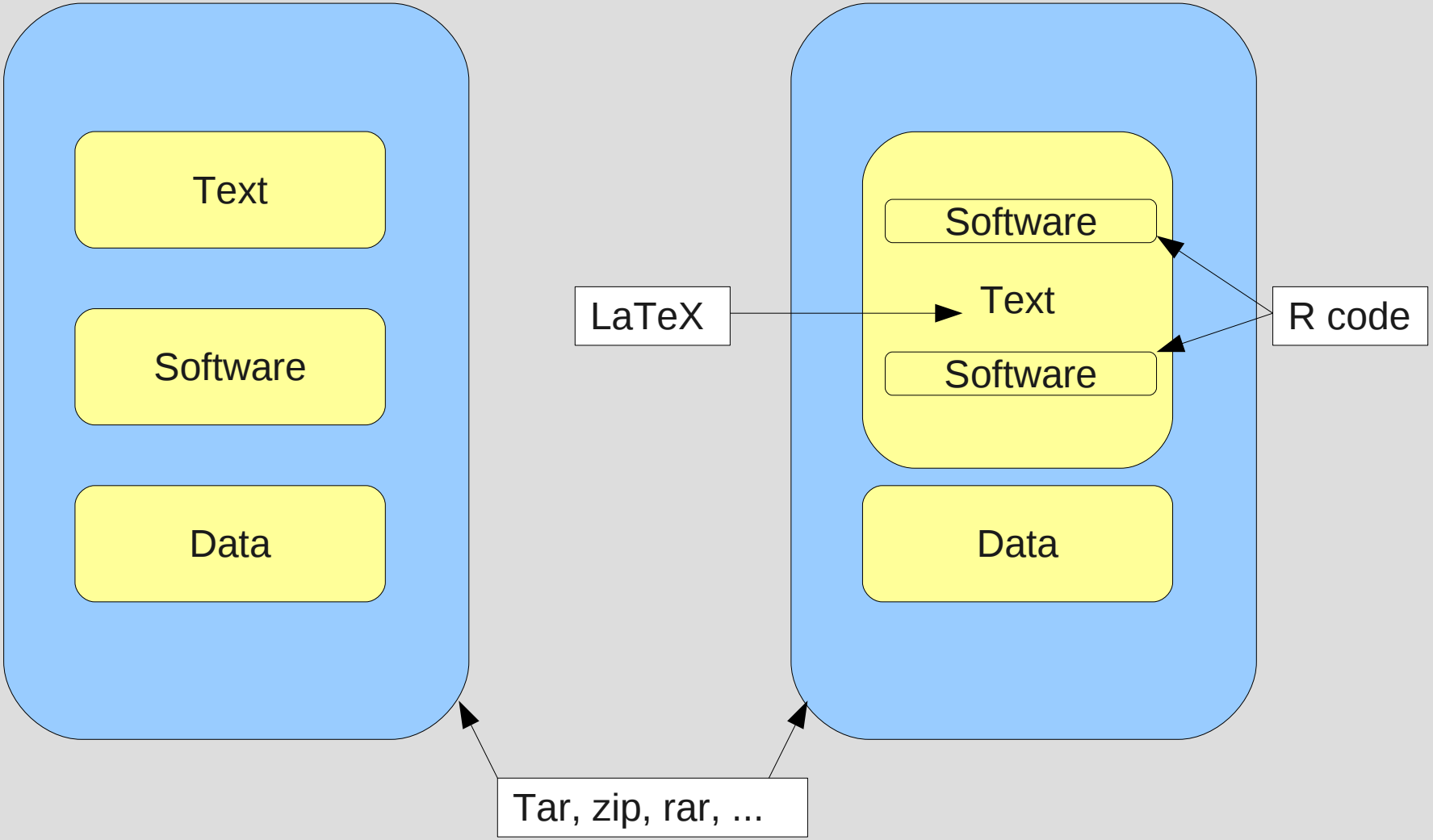
- Excellent solution (in general)
- Somewhat impractical for education because the student:
  - is required to DIE (Download, Install, Execute)
  - must have a working knowledge of LaTeX and R
  - must recreate a working compendium (for each submission)
- Not designed with educational research in mind: there is no way to monitor/measure the actual learning activities

Compendium

- Original definition:

  An electronic collection of Text, Data and Software that allows the reader to reproduce the research that is presented in the document

Compendium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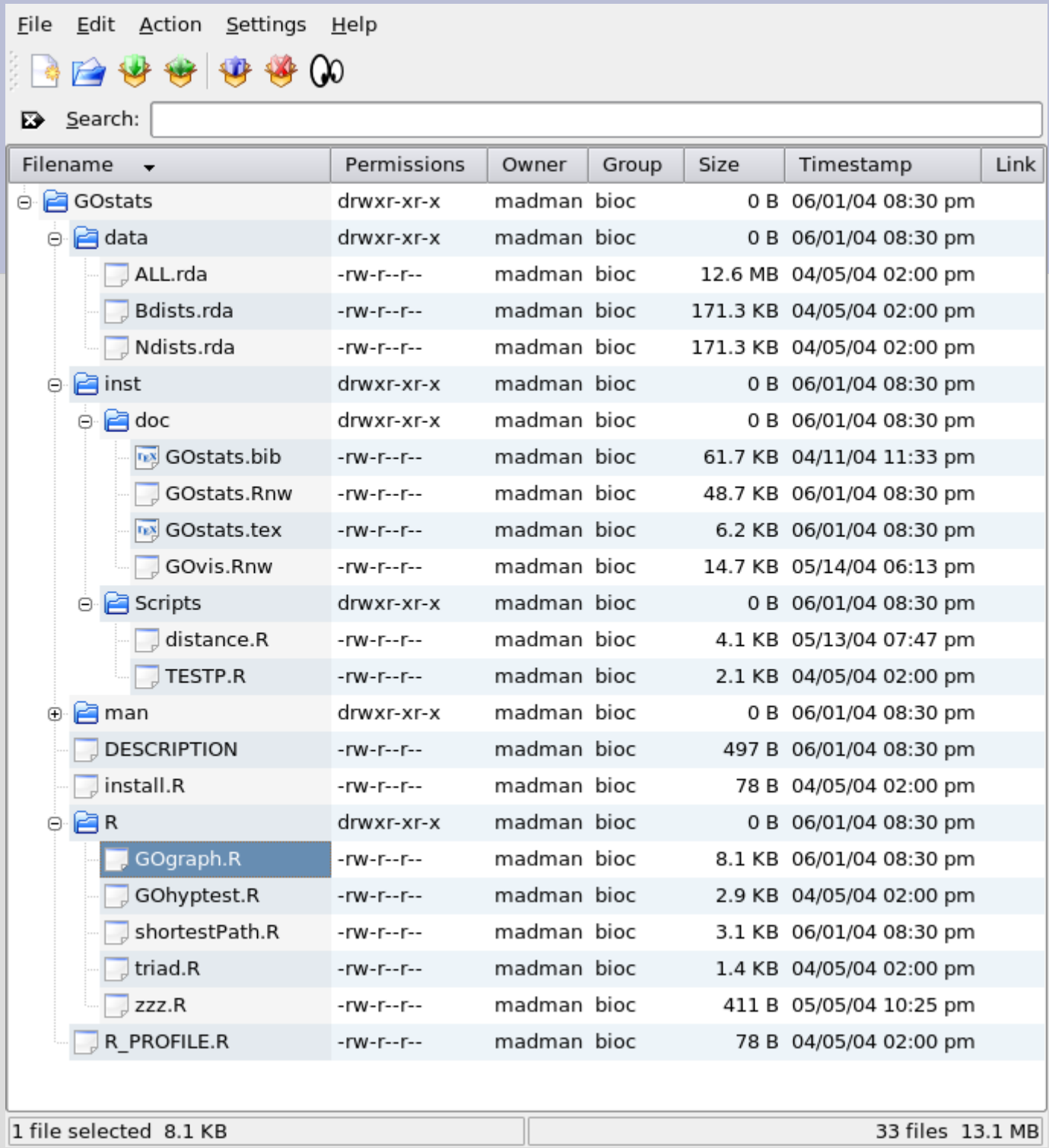
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Compendium redefined

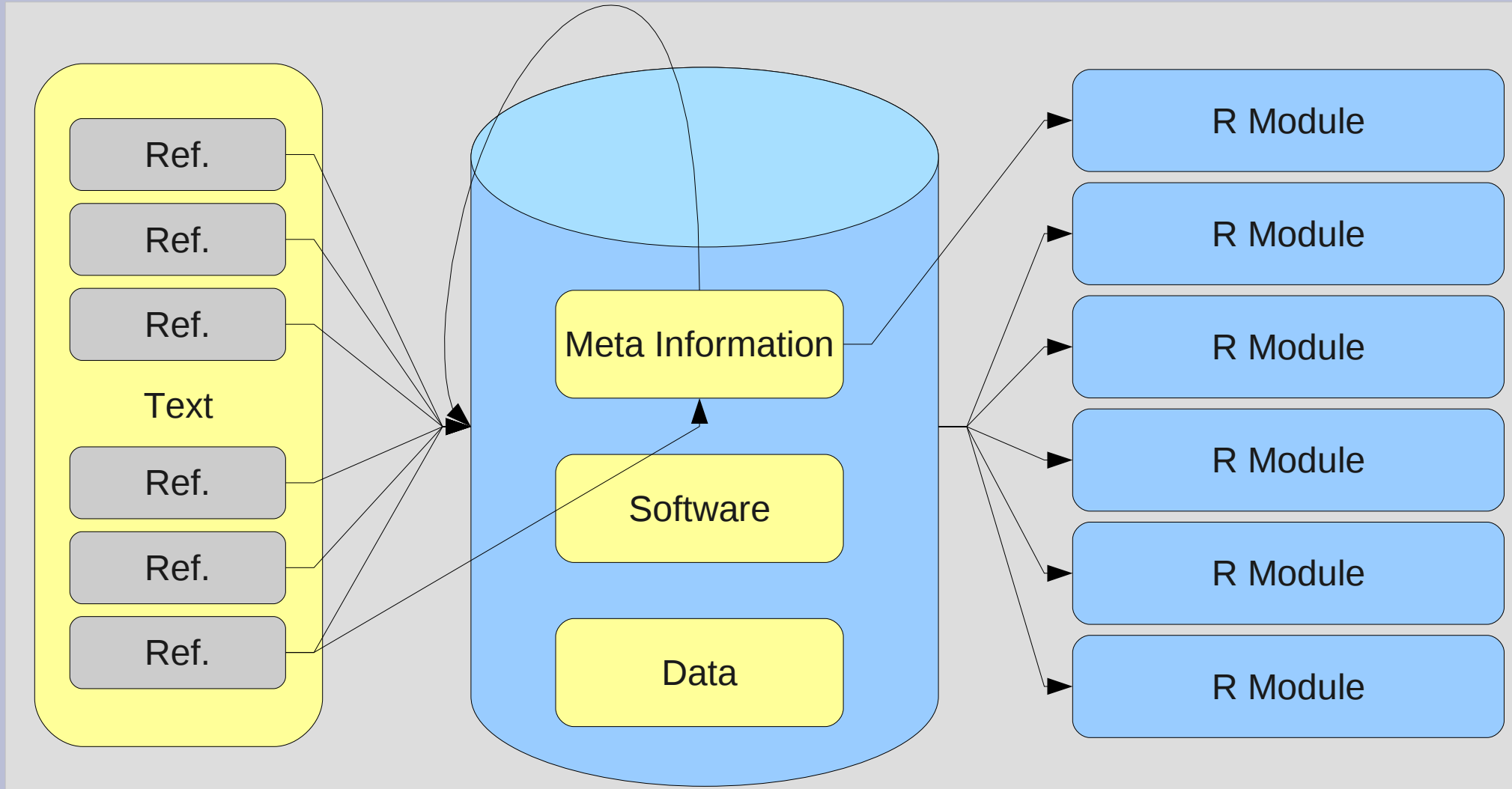
- New definition:

  A document with (open-access) references to (remotely) archived Computations (including Data, Meta-data, and Software) that allow us to reproduce, and reuse the underlying analysis

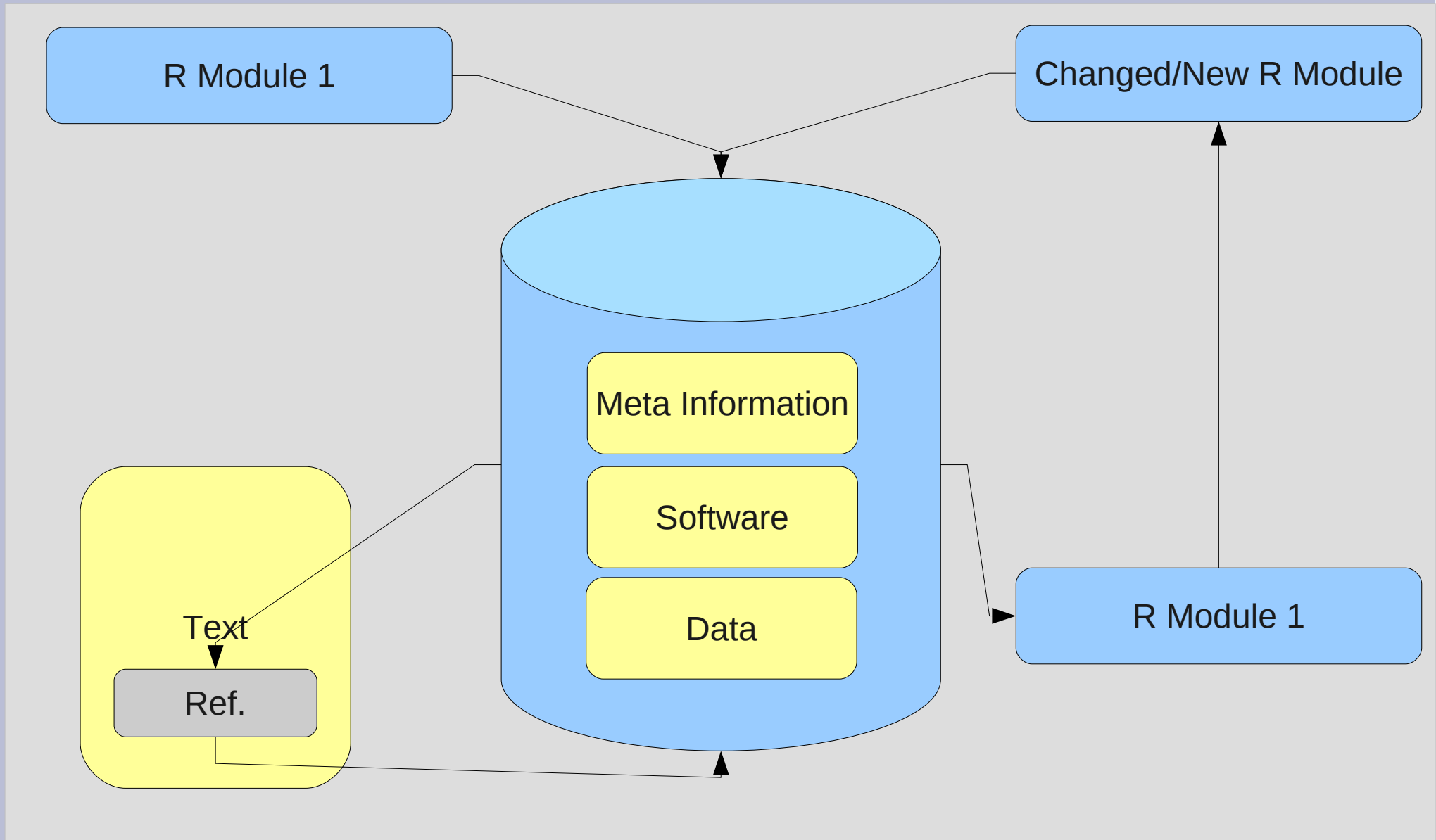
- Complete separation of:
  - text and computing
  - computational result and computing infrastructure

  => the compendium platform is a tool for collaboration, dissemination, and monitoring.

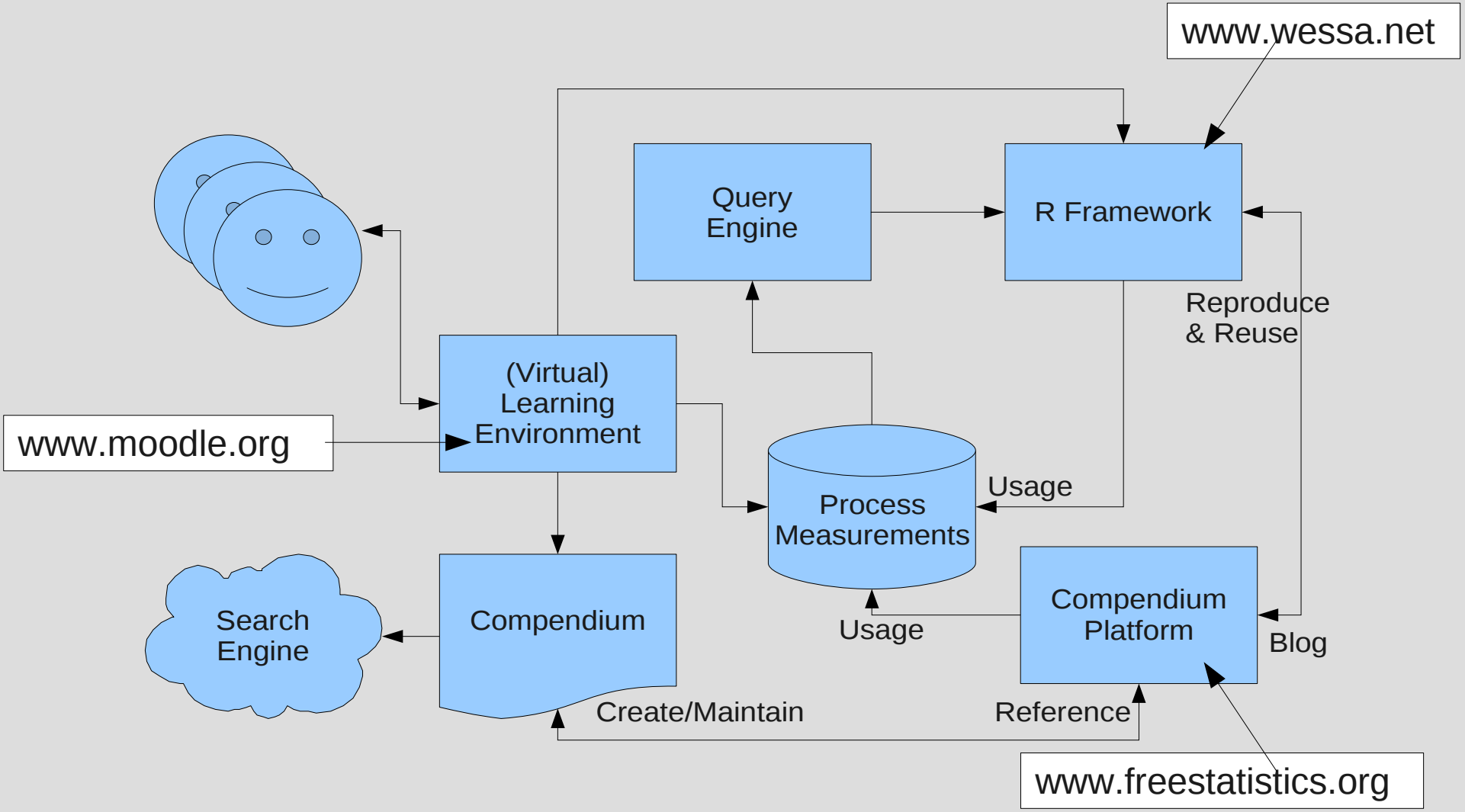
Computations Database



Compendium Dynamics



Learning System or Educational Laboratory?

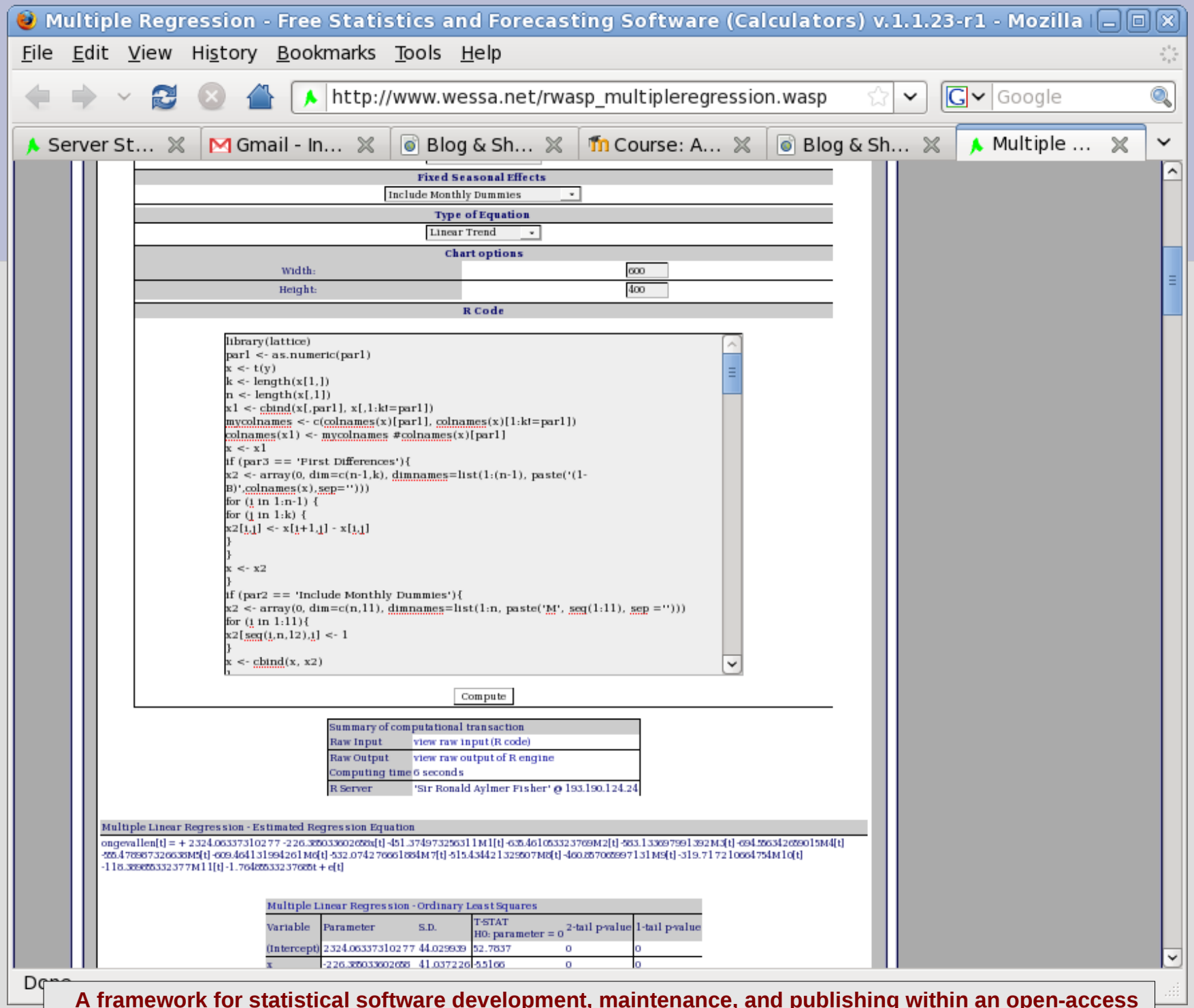


Examples of Compendia

http://www.wessa.net/download/tutorial.pdf
(Descriptive Statistics – Central Tendency)
http://www.wessa.net/download/tutorial1.pdf
(Time Series Analysis - Introduction)

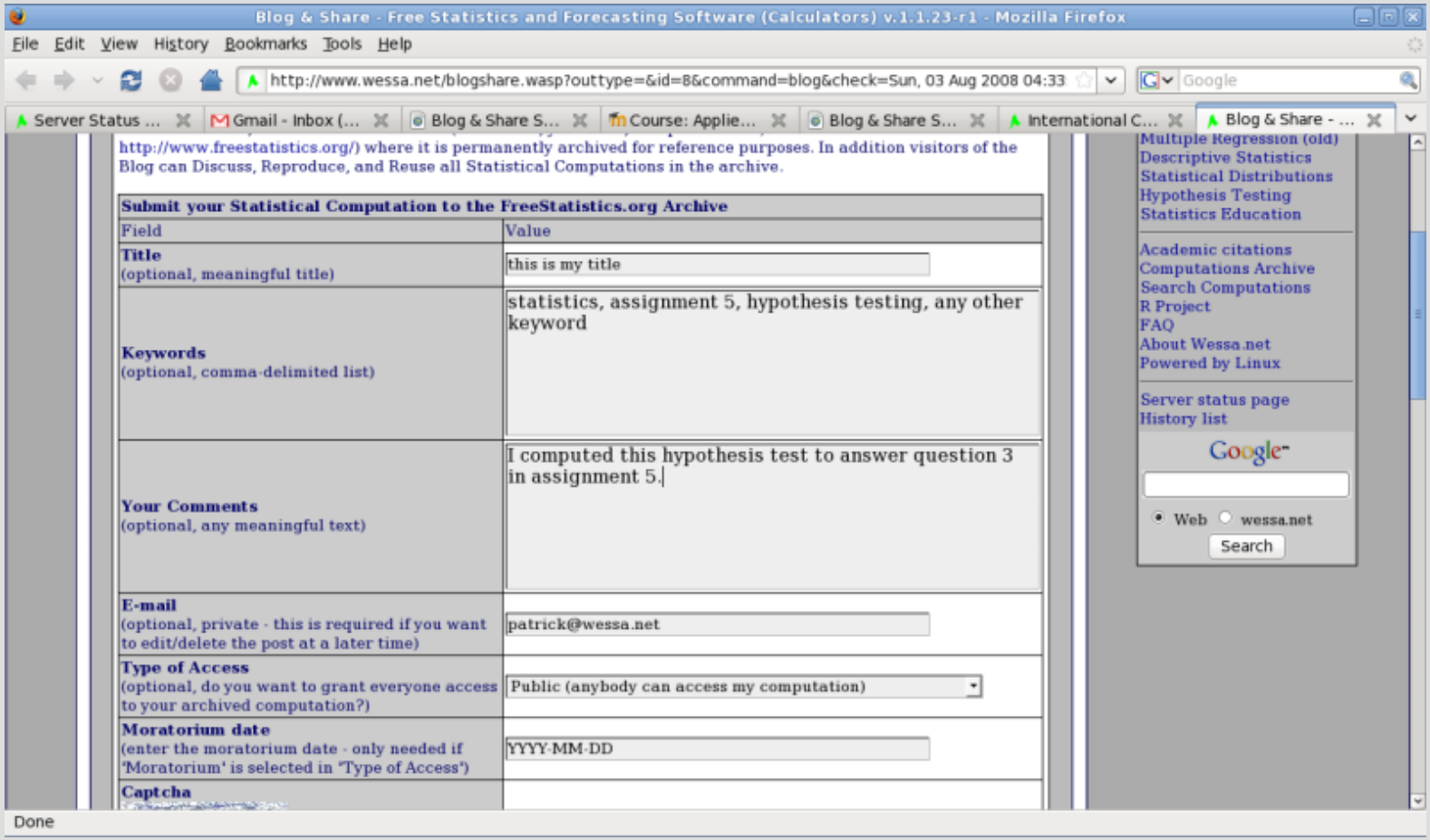
Note: both documents are “work in progress”
Please, send corrections & suggestions to
patrick@wessa.net

Screenshots



A framework for statistical software development, maintenance, and publishing within an open-access business model, 2008, Computational Statistics

Computations are “blogged” (not archived)



workshop - OpenOffice.org Writer

File Edit View Insert Format Table Tools Window Help

Equation Expand Config

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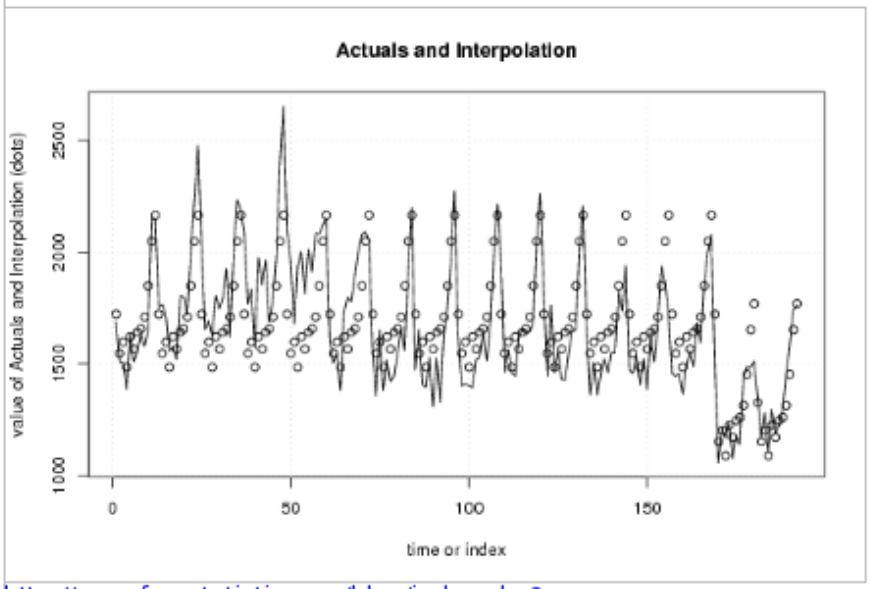
Question 2: Investigate the prediction errors of the model that you used in question 1. Are the underlying regression assumptions satisfied?

De Adjusted R-squared is gelijk aan 0,6412. Dit wil zeggen dat we 64% van de wijzigingen van het aantal verkeersslachtoffers kunnen verklaren. Het resterende gedeelte (36%) kunnen we niet verklaren aan de hand van ons model maar zijn bijvoorbeeld te wijten aan uitzonderlijke weersomstandigheden.

Het volgende waar we heen zullen kijken is de Interpolation Plot. De stippellijn op deze grafiek geeft het werkelijke aantal slachtoffers weer. De volle lijn geeft het aantal verkeersslachtoffers weer die voorspeld zijn door het model.

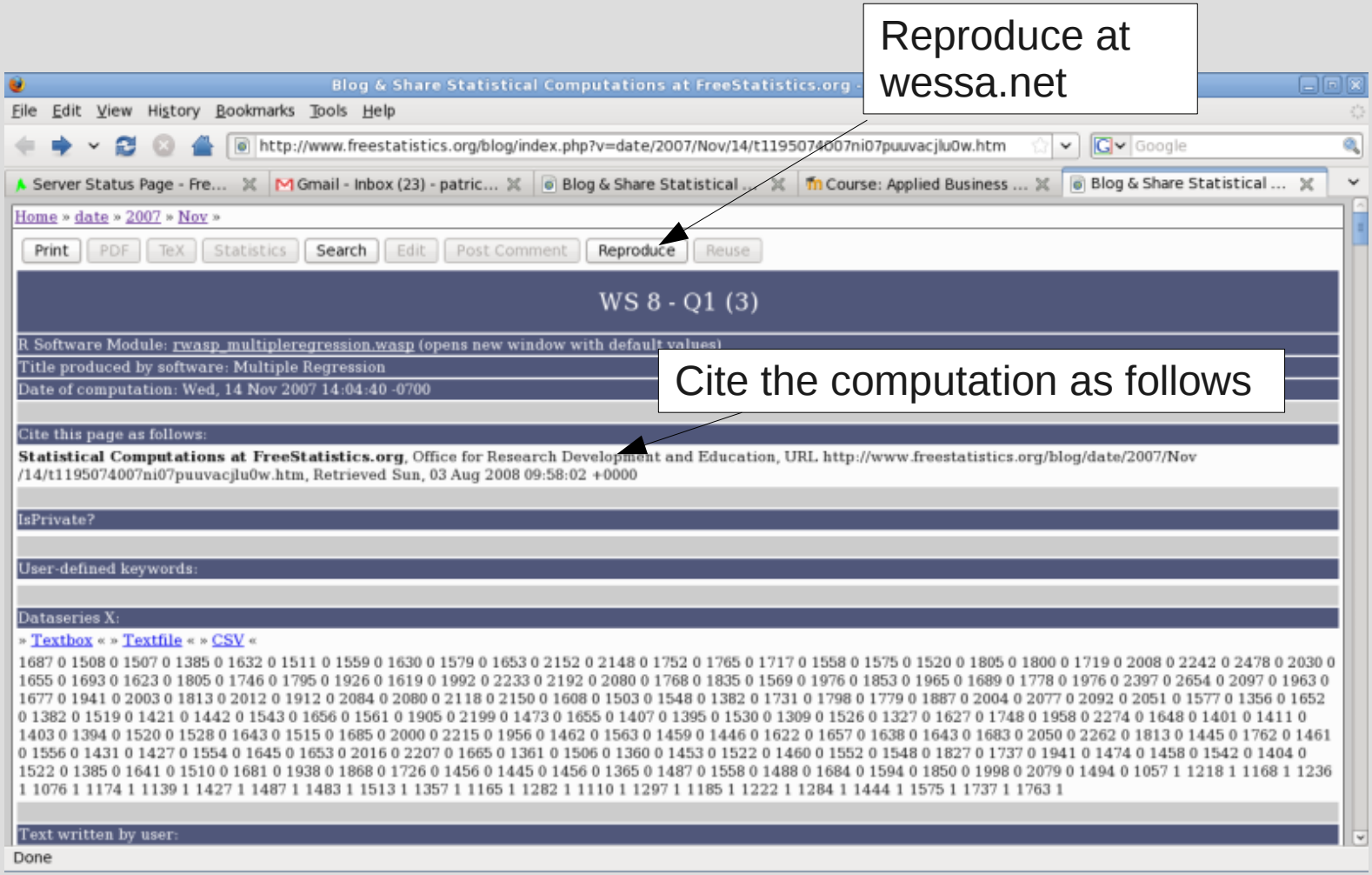


http://www.freestatistics.org/blog/index.php?v=date/2007/Nov/14/t1195074007ni07puuvacjlu0w.htm

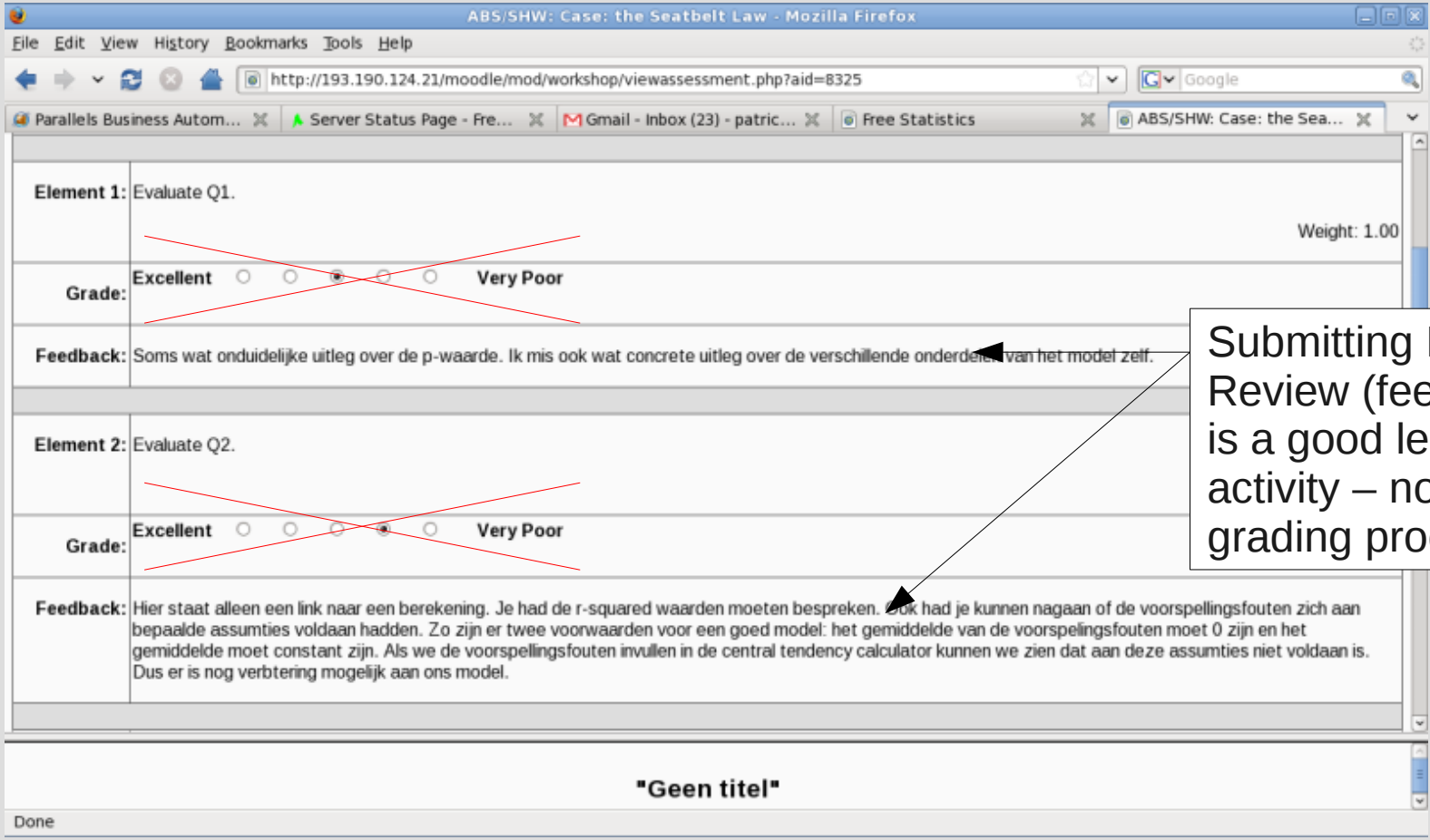
We zien ook hier een dalende trend op lange termijn. Op het einde zien we een structurele breuk, dit is het effect van de seatbelt law (-395). Er treedt ook een

Learning Statistics based on the Compendium and Reproducible Computing, Proceedings of the International Conference on Education and Information Technology (ICEIT'08), Berkeley, San Francisco, USA

Snapshot of “Blogged” Computation

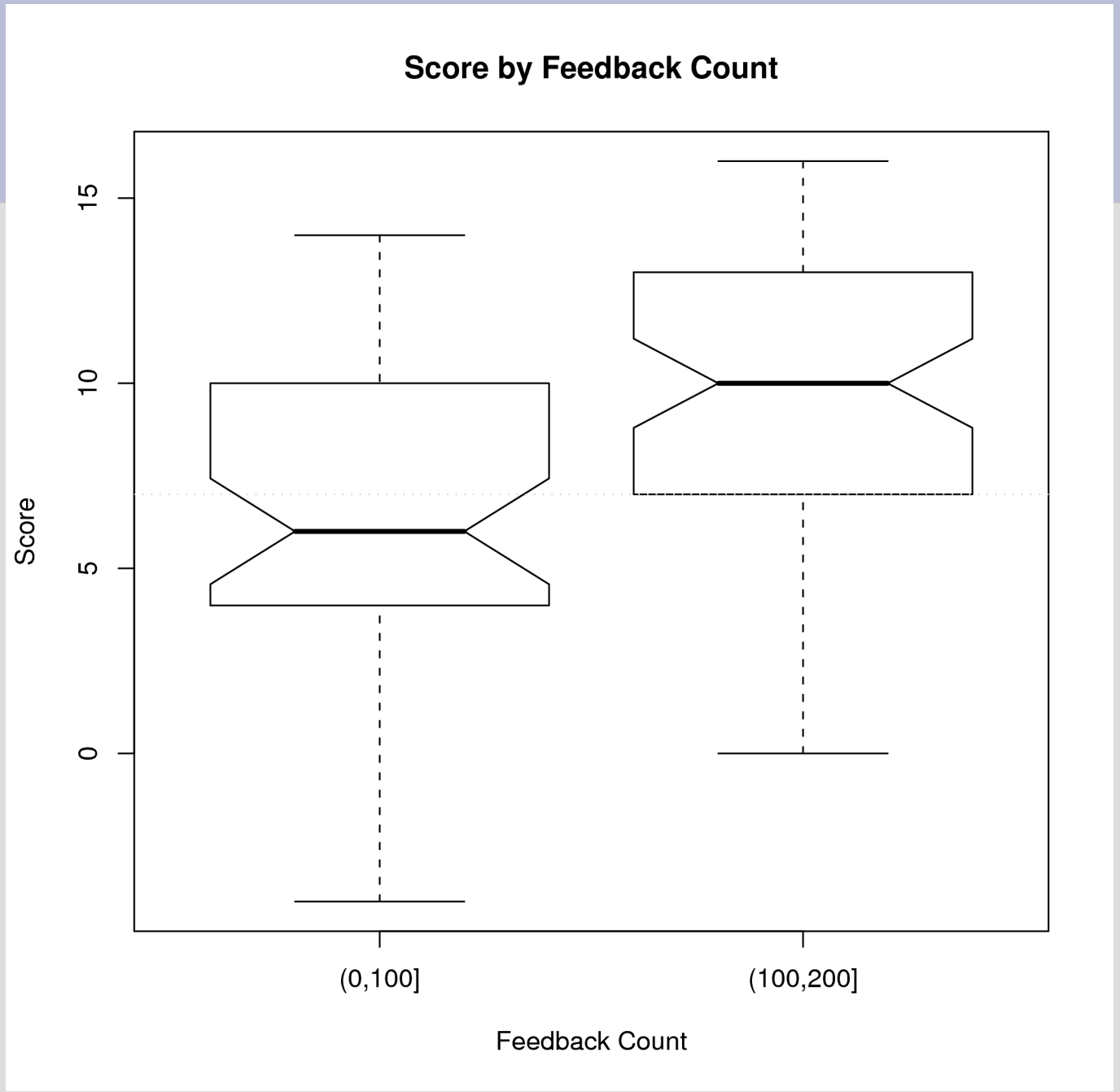


Feedback (Peer Review)



Submitting Peer Review (feedback) is a good learning activity – not a good grading procedure

How Reproducible Research Leads to Non-Rote Learning Within a Socially Constructivist E-Learning Environment, Proceedings of the 7th European Conference on e-Learning (ECEL'08), Cyprus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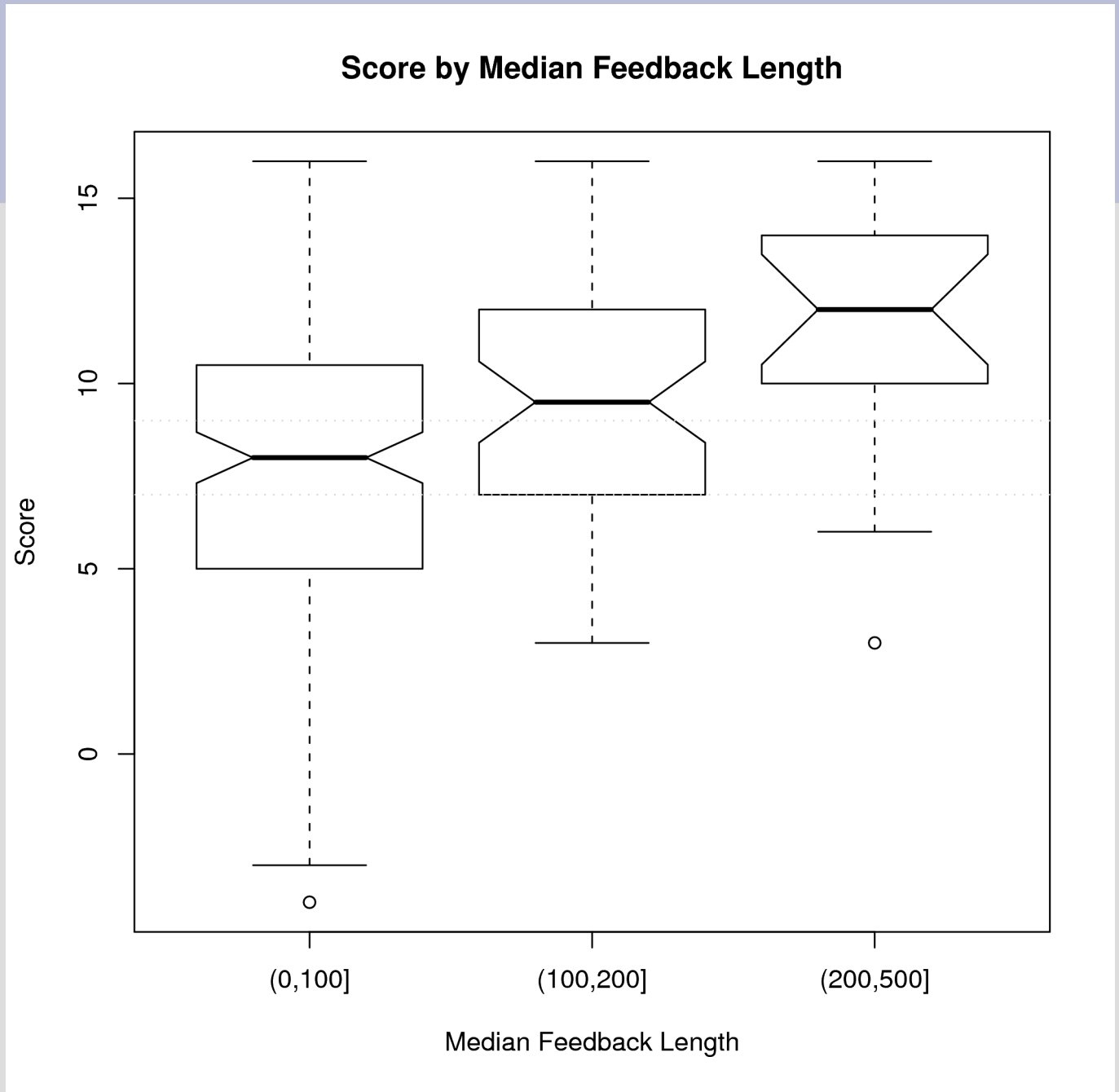
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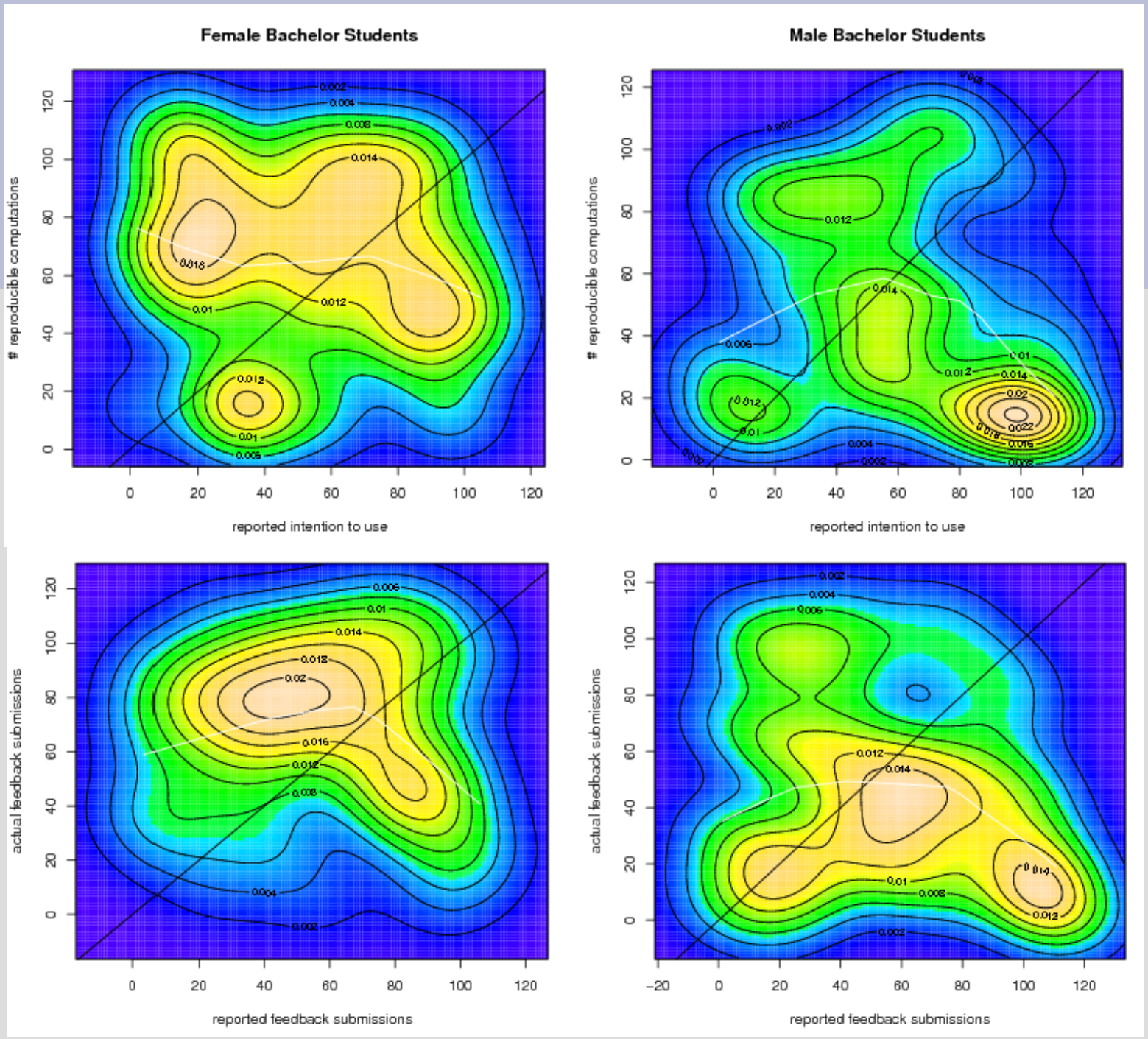
Median Feedback Length



Measurement and Control of Statistics Learning Processes based on Constructivist Feedback and Reproducible Computing, Proceedings of the 3rd International Conference on Virtual Learning (ICVL '08), Romania

http://www.wessa.net/rwasp_icvl2008.wasp

Conclusions & Future work

- Reproducible Computing can be made easy (for students)
- RC improves statistics learning
- RC allows us to research learning activities (based on actual – not reported – data)

- New features (social interaction, collaboration)
- RC for scientists
- RC for scientific publishing

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All documents will be available at http://www.freestatistics.org/index.php?action=10 in the near future.