LifeStats: An Interactive Environment for Teaching Statistics

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Interface 2008
Risk : Reality

Outline

LifeStats

LifeStats:

- is an interactive book with embedded (popup) applets;
- has interactive notes with embedded (popup) applets;
- has a five-step simulator;
- illustrates probability and statistical concepts using applets;
- provides an interactive data analysis environment;
- acts a a front-end to R.

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Assessment of Student Learning

Student Scores

- Scores are simple and straightforward, but they provide little information on how to improve student learning.
- We need a way to provide personalized, targeted, and automated feedback to students.

Knowledge Structures

- The fundamental units of knowledge consist of discrete cognitive attributes.
- Meta-cognitive attributes are built on fundamental cognitive attributes.
- Cognitive attributes are organized hierarchically.

Measuring Knowledge

Questions provide an indirect measure of knowledge:

- A question is linked to one or more cognitive attribute(s)
- A correct answer to a question provides evidence that the associated cognitive attributes have been learned.
- The probability of mastery of an attribute, given a student's scores, is estimated.

Outline

Hierarchical Bayesian Cognitive Models

The cognitively diagnostic assessment system builds on the DINA (Deterministic Input; Noisy "And" Gate) and NIDA (Noisy Input; Deterministic "And" Gate) models.

- The DINA model is a simplified form of Anderson's "knowledge tracing model."
- The DINA model is relatively simple and forms the basis of several cognitive models, including ALEKS (http://www.aleks.com).
- The NIDA model is a relatively simple discrete attribute model that provides a foundation for cognitively more complex models. Specifically, the NIDA model can be augmented by multiplicative or additive IRT terms.

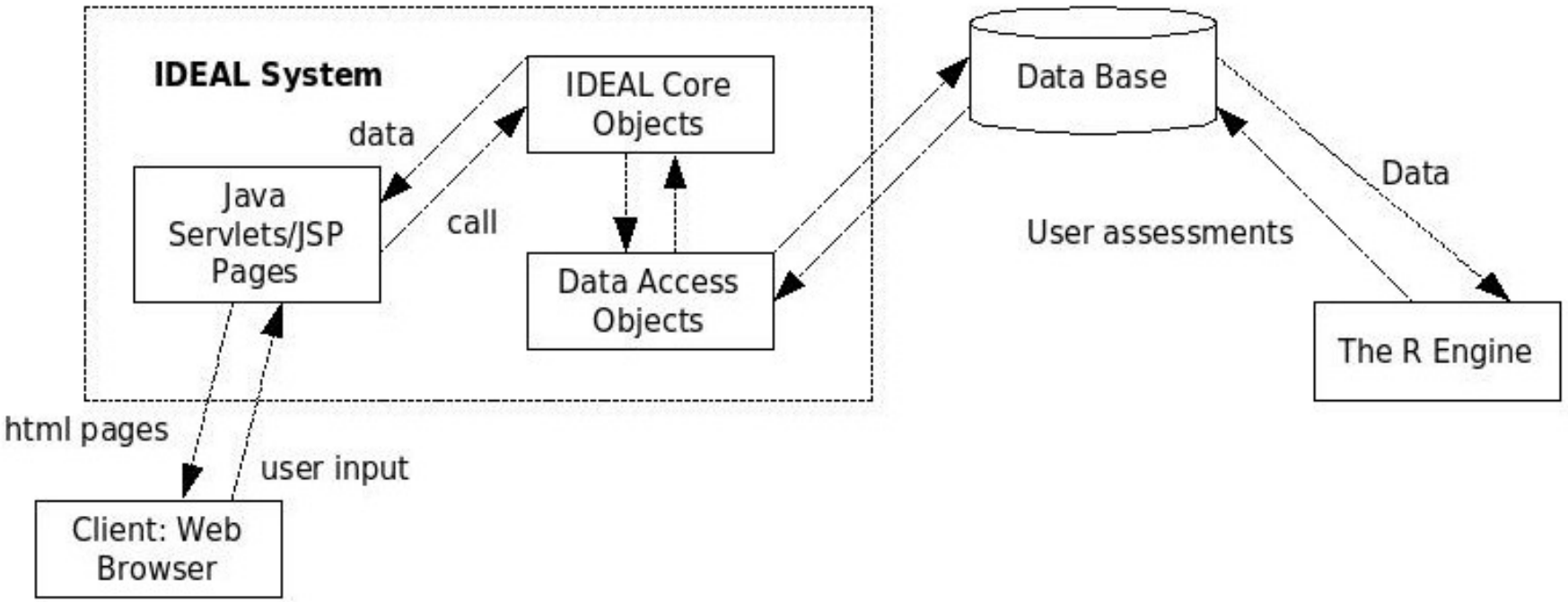
Outline

IDEAL
(Intelligent Distributed Environemnt for Adaptive Learning)

IDEAL:

- is an online course system developed and used by the WVU Dept. of Statistics;
- is a multi-tier Java web application based on open-source software;
- uses advanced Java frameworks such as Spring and Hibernate
- will provide personalized cognitive feed back.

IDEAL/R Architecture

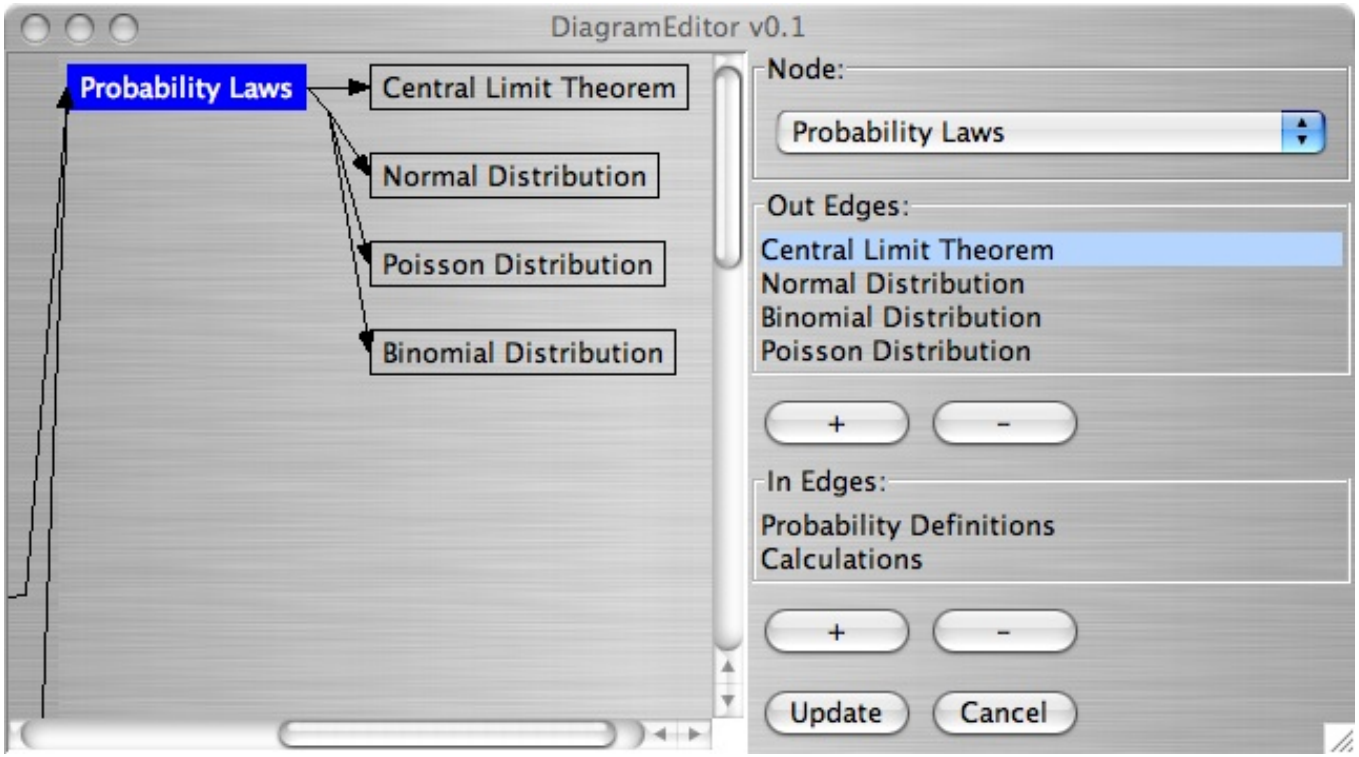


Defining the Knowledge Structure

Two layers of abstraction: modules and cognitive attributes within modules

- Problem: Too many cognitive attributes with too little data (questions and student answers)
- Solution: Group cognitive attributes as the basic units of analysis (estimation)

Screen Shot Defining Module Dependences



Outline

Using R as a Background Computational Engine

- Difficult to build statistical software from scratch
- Simplify the process by building the software on R
- Launch R in batch mode
- Share data through a database
  - Access databases from Java using JDBC
  - Access databases from R using RMySQL

Using R as a Background Computational Engine

How and when to launch R

- Periodically launch R (e.g., using a cron tab under unix)
- Launch R on demand (e.g., waiting for a request from IDEAL)

Other issues:

- Operational vs. analytical system
- Data pre-processing may be necessary before launching R

JavaStat

JavaStat:

- is a highly interactive data analysis environment;
- is a Java front-end for R;
- uses R as a compute engine (the basic version);
- allows the user to have a permanent workspace (the enhanced version);
- has a common code base with LifeStats.

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Communicating with R

- R batch mode (stdin/out/err)
- TCP/IP sockets
- C/Fortran interface
- JRI (Java/R Interface)

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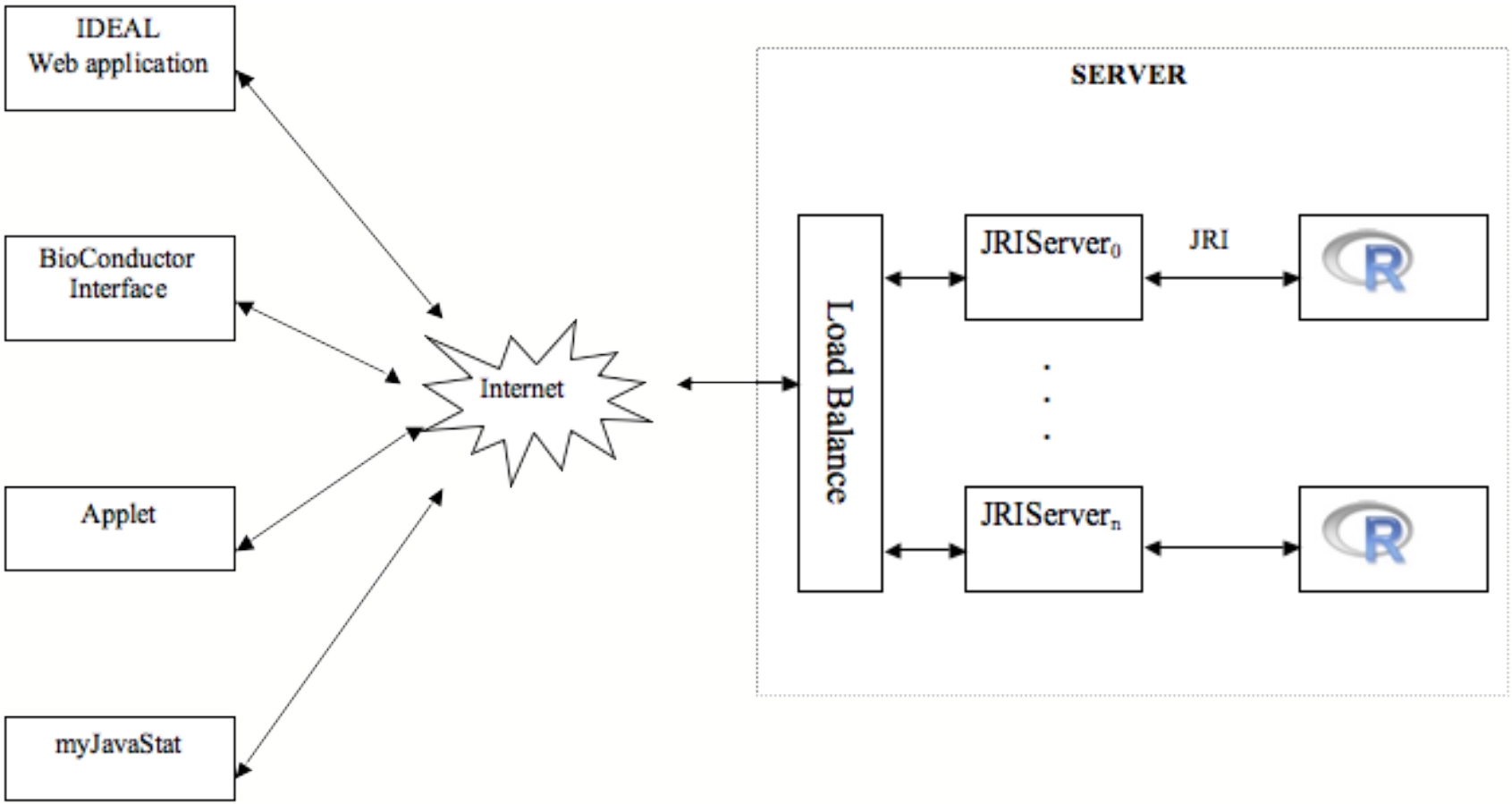
JRI:

- runs R within Java as a single thread (http://rosuda.org/JRI/)
- loads the R dynamic library and provides a Java API to R
- converts R objects (limited) into Java objects

Outline

JavaStat/R Basic Architecture



JavaStat/R Basic Architecture

The following are the principal characteristics of the JavaStat/R basic architecture:

- R is on the server.
- R results are wrapped to increase efficiency and speed
- Multiple servers with multiple instances of R
  - running in parallel with separate workspaces
- Load balanced
- Stateless
  - no relationship among consecutive requests

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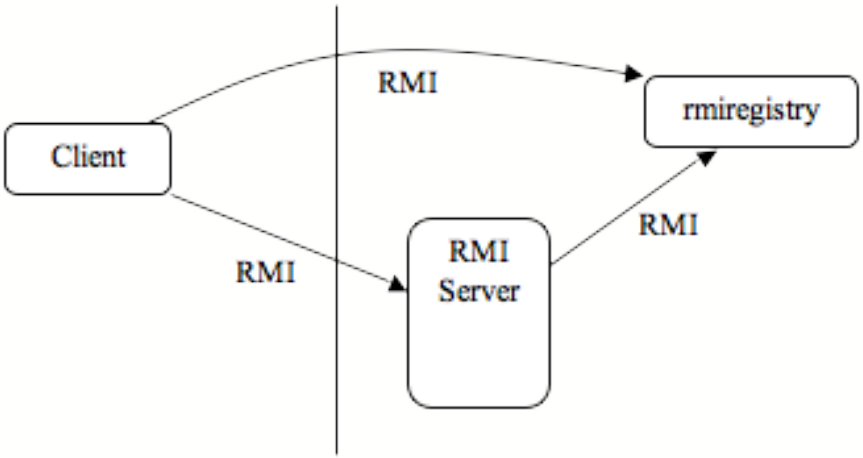
Java RMI



Remote Method Invocation

- client-server architecture
- pure Java-to-Java talk
- rmiregistry (for server reference list)
- load balancing

JavaStat/R Basic Architecture vs. Rserve

	JavaStat	Rserve
R backend	$\surd$	$\surd$
Connection	RMI	TCP/IP
Language	Java	C/C++, Java
Transmission	Wrap up many commands	Each command
Purpose	App dependent	General

Table: Comparing JavaStat/R to Rserve

JavaStat/R Interface Limitations

JavaStat/R currently cannot be used as a general interface.

- Drawbacks:
  - Time consuming for complex models
  - Large datasets not feasible
- Solution:
  - Use RMI Callback.
  - Save & load workspace on server.

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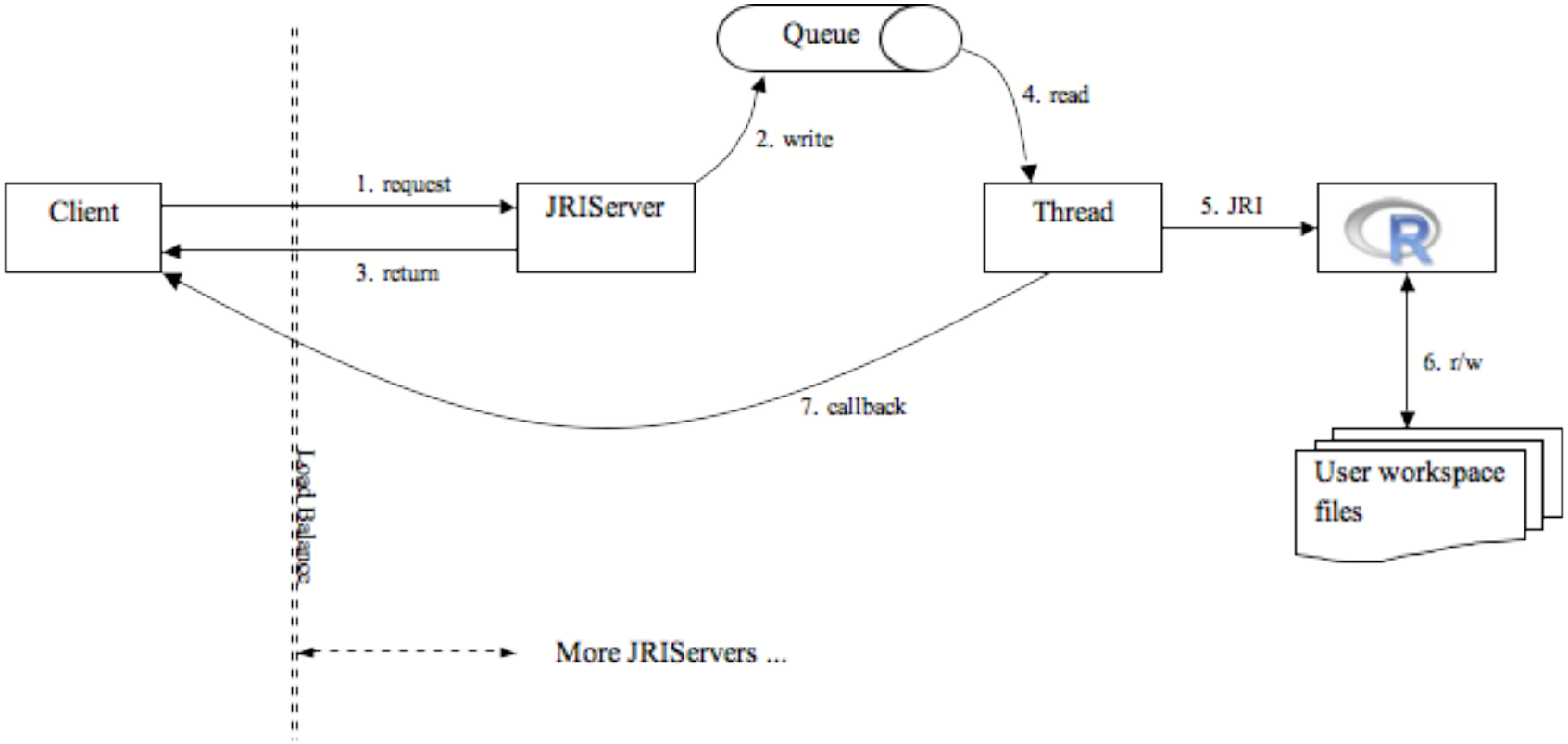
JavaStat/R Enhanced Architecture



Summary

- LifeStats is a powerful, interactive environment for learning statistics.
- LifeStats is a front-end to IDEAL/R.
- IDEAL/R is a statistical assessment system and potentially a statistical tutoring system.
- JavaStat/R is a powerful, interactive data analysis environment.
- The enhanced version of JavaStat/R is an interactive R front-end for complex models and large datasets, e.g., analyses using Bioconductor.