ASISTEMBE
Analytics, Simulations and Inquiry in STEM and Business Education Research Group

How students learn Statistics?
From tracing student's activity in R Commander to the visualization of their work through a Shiny app

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Analytics, Simulations and Inquiry in STEM and Business Education Research Group

- **ASISTEMBE, IQS School of Management (URL)**
- **Departament de Genètica, Microbiologia i Estadística (UB)**

Research groups involved

- Open-ended activities
- Using traces to capture students' work
- R Commander TR
- Traces and milestones
- RCmdrTR dashboard

Outline

- **Open-ended activities are commonly used in teaching STEM disciplines (problems, cases, projects...)**
- **Assessment is commonly done through reports or closed-form questionnaires**
  - Difficult to grade (Time-consuming)
  - Activities are hard to evaluate
  - Assessment does not reflect students' work and/or students' learning difficulties

Open-ended activities

- **Different types of traces and logs are used in educational settings**
  - web logs
  - logs in LMS, where LA tools start to appear
  - MOOCs
  - educational research environments, as
    - LearnLab
    - ASSISTments
  - tutors, pseudotutors and other AIED tools

Using traces to capture students' work

- **Tracing user actions provides powerful information for educational research and for generating useful feedback for users and instructors:**
  - classification of students
  - identification of plagiarism
  - adaptive behaviour detection
  - disengagement detection
- **Approach to an assisted assessment of open-ended activities**

Using traces to capture students' work

- **R Commander**
  - It's a graphical user interface (GUI) widely used for teaching Statistics.
  - R Commander allows the use of R without compromising the learning process as command line interface to R can be an obstacle to many students (Fox, 2005).

R Commander TR

- **R Commander TR**
  - We intercept the functions *justDoIt* and *doItAndPrint* to obtain most activity done in R Commander
  - To capture the manual editing of data, we intercept the *activeDataSet* function
  - We have created a *trace* function that collects all the information we need and writes it in a *log* file in the working directory

http://asistembe2.iqs.edu/rcmdrtr/

R Commander TR

- **Traces**
  - Log of students' actions in an interactive environment
  - Include time, user, session, action (and parameters when needed)
  - In R Commander TR
    - Instructions sent by the user (active actions)
    - Results provided by R (reactive actions)

Traces and milestones

```
<EVENT application='Rcmdr-20140521' action='EXECUTE' user=
'user_879903' session='20150410093206.769' number='3' time=
'20150410094141.474' type='active'><PARAM name='Command' value=
'pbinom(c(0),%20size=9,%20prob=0.3294556,%20lower.tail=FALSE)' />
</EVENT>
<EVENT application='Rcmdr-20140521' action='EXECUTE' user=
'user_879903' session='20150410093206.769' number='4' time=
'20150410094141.474' type='reactive'><PARAM name='Result' value=
'0.9725938608172 54' /></EVENT>
<EVENT application='Rcmdr-20140521' action='EXECUTE' user=
'user_879903' session='20150410093206.769' number='5' time=
'20150410094336.308' type='active'><PARAM name='Command' value=
'0.3294556*9' /></EVENT>
<EVENT application='Rcmdr-20140521' action='EXECUTE' user=
'user_879903' session='20150410093206.769' number='6' time=
'20150410094336.318' type='reactive'><PARAM name='Result' value=
'2.9651004' /></EVENT>
```

Traces and milestones

- **Milestones**
  - Relevant events that can be identified from the traces
  - They may correspond to
    - resolution steps
    - expected partial results
    - possible errors or mistakes

- **We divide milestones into observation milestones and assessment milestones**

Traces and milestones

- **Observation milestones, which are defined by**
  - A regular expression
    - Which is a way of indicating a search pattern
    - It can include the extraction of parts of the trace
  - A logical expression
    - Which compares the extracted parts to expected values

- **Observation milestones**
  - A minimal example
    - Regular expression

```
value='9%2A(..)'
```

%2A is the asterisk character (*)

maps to

	user wrote
value='9%2A89'	9*89
value='9%2A11'	9*11
value='9%2A.3'	9*.3

but not to

```
value='9%2A891'
value='9%2A1'
```

Traces and milestones

- **Observation milestones**
  - A minimal example
    - Logical expression

```
as.numeric(m[1])>30
```

takes as valid

```
value='9%2A89'
```

but not

```
value='9%2A11'
value='9%2A.3'
```

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- **Observation milestones**
  - A real example from a study run at UB in 2015

```
pnorm[(]c[(][^,]*?[)],%20mean=([^,]*?),%20sd=([^,
]*?),%20lower[.]tail=TRUE

as.numeric(m[[1]])>100 && as.numeric(m[[1]])<170
&& as.numeric(m[[2]])>19 && as.numeric(m[[2]])<41
```

- **Assessment milestones**
  - Logical expression built from observation milestones

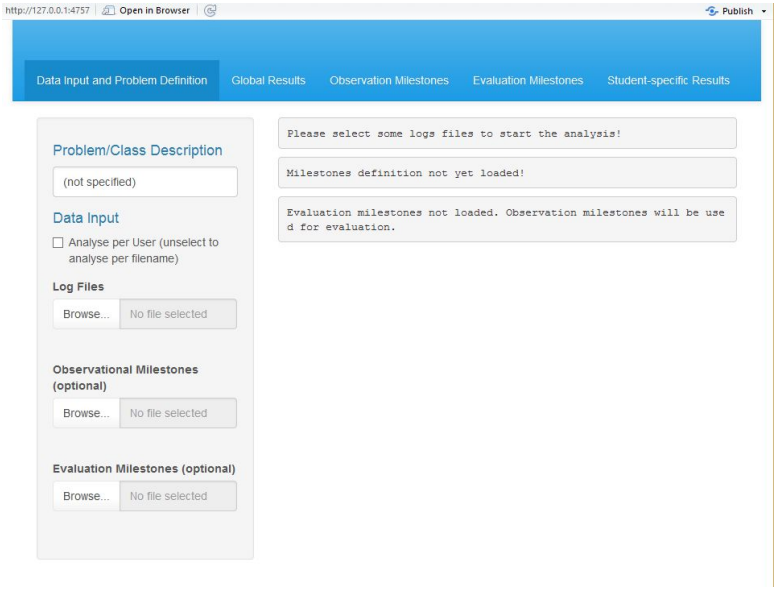
```
om['P02M03'] | om['P02M04'] | om['P02M05']

om['P02M18'] | (om['P02M19A'] & om['P02M19B'])
```

Observation milestone

Traces and milestones

- **Dashboard**
  - We have created a web platform that allows the visualization and analysis of the collected traces



RCmdrTR dashboard

Let's see it running...

http://asistembe2.iqs.edu/rcmdrtr/rcmdrbd_demo/

RCmdrTR dashboard

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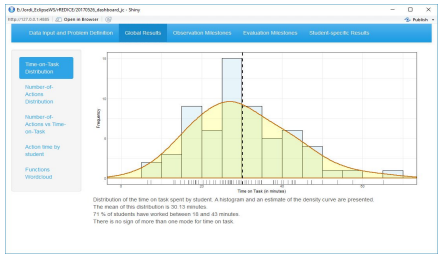
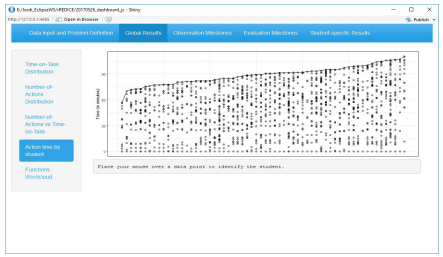
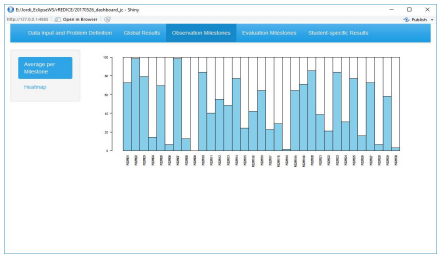
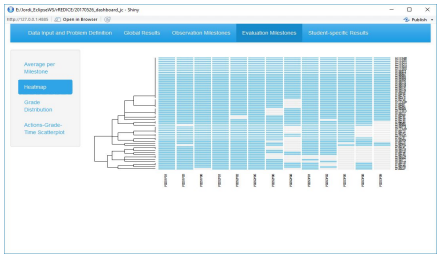
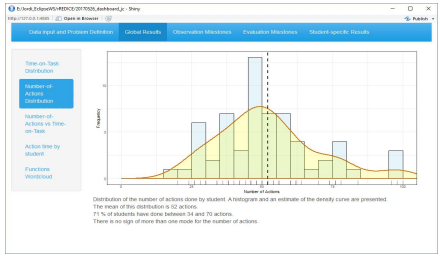
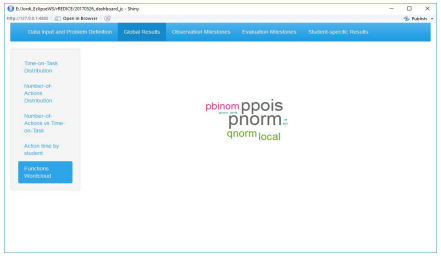

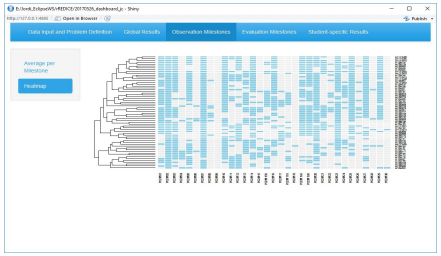
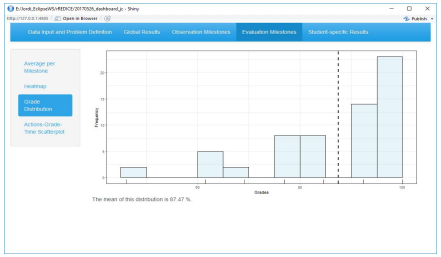
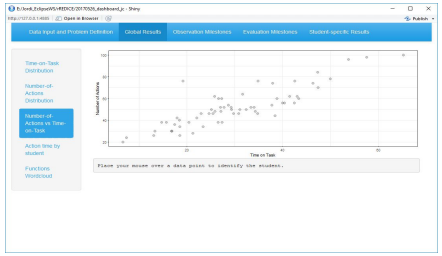
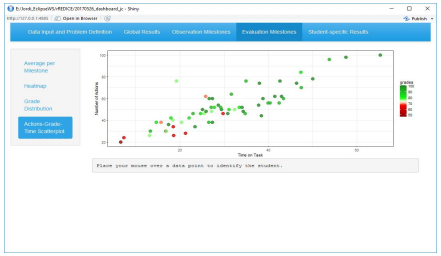

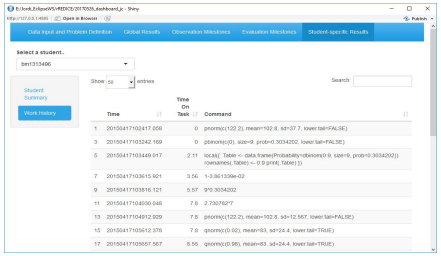

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RCmdrTR dashboard

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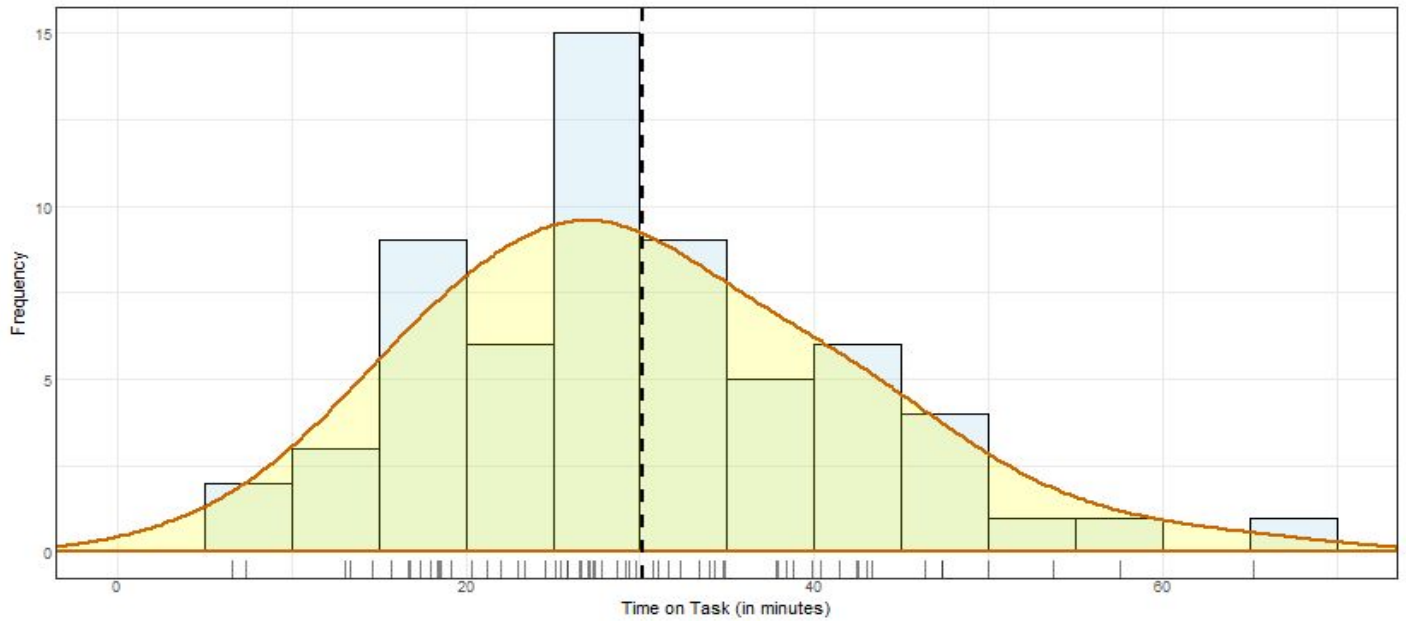
Data Input and Problem Definition | Global Results | Observation Milestones | Evaluation Milestones | Student-specific Results

- Time-on-Task Distribution
- Number-of-Actions Distribution
- Number-of-Actions vs Time-on-Task
- Action time by student
- Functions Wordcloud



Distribution of the time on task spent by student. A histogram and an estimate of the density curve are presented.
The mean of this distribution is 30.13 minutes.
71 % of students have worked between 18 and 43 minutes.
There is no sign of more than one mode for time on task.

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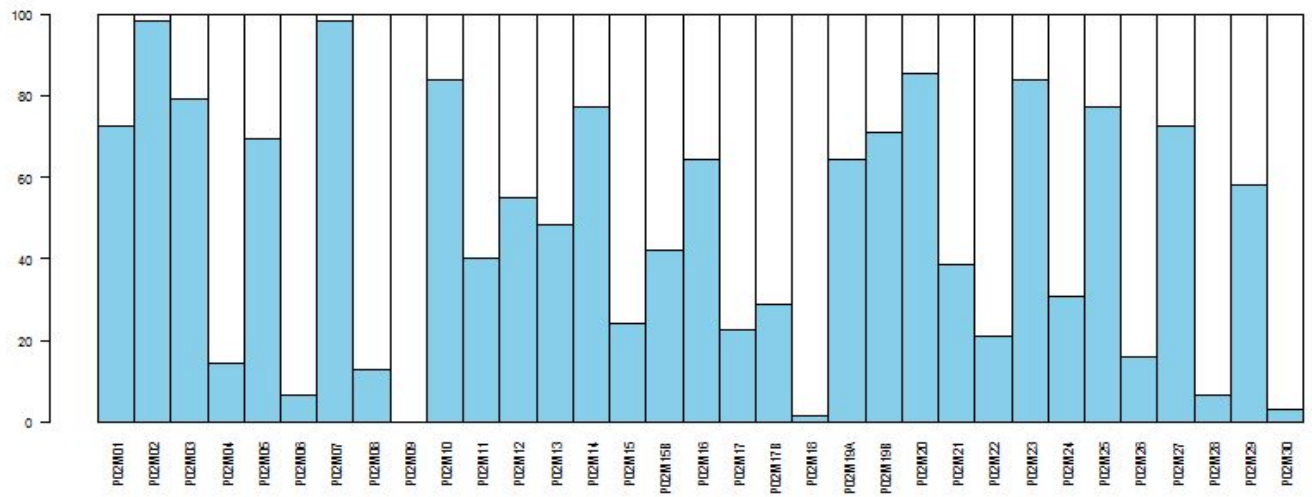
Average per Milestone

Heatmap



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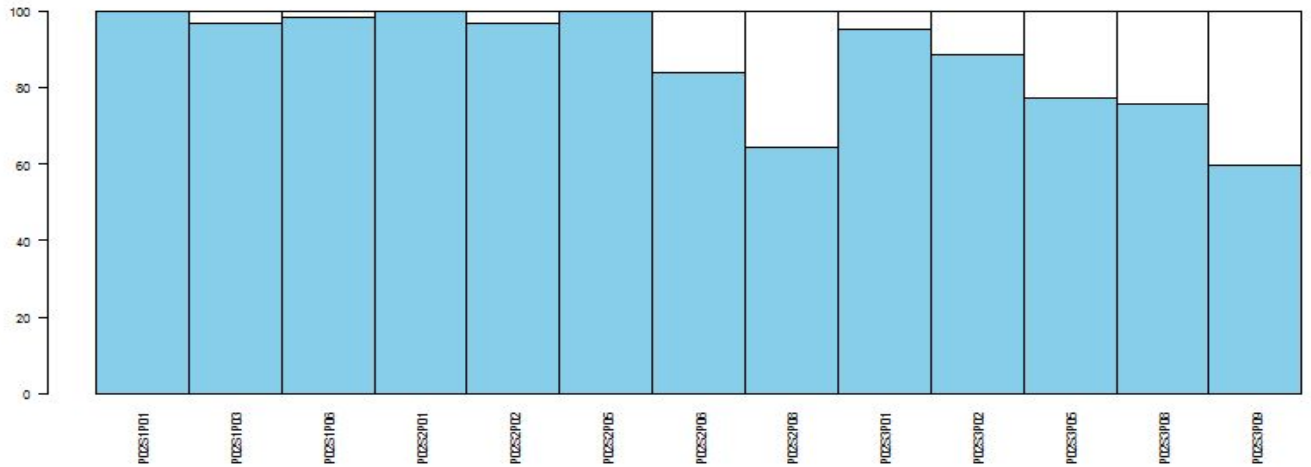
- Average per Milestone
- Heatmap
- Grade Distribution
- Actions-Grade-Time Scatterplot



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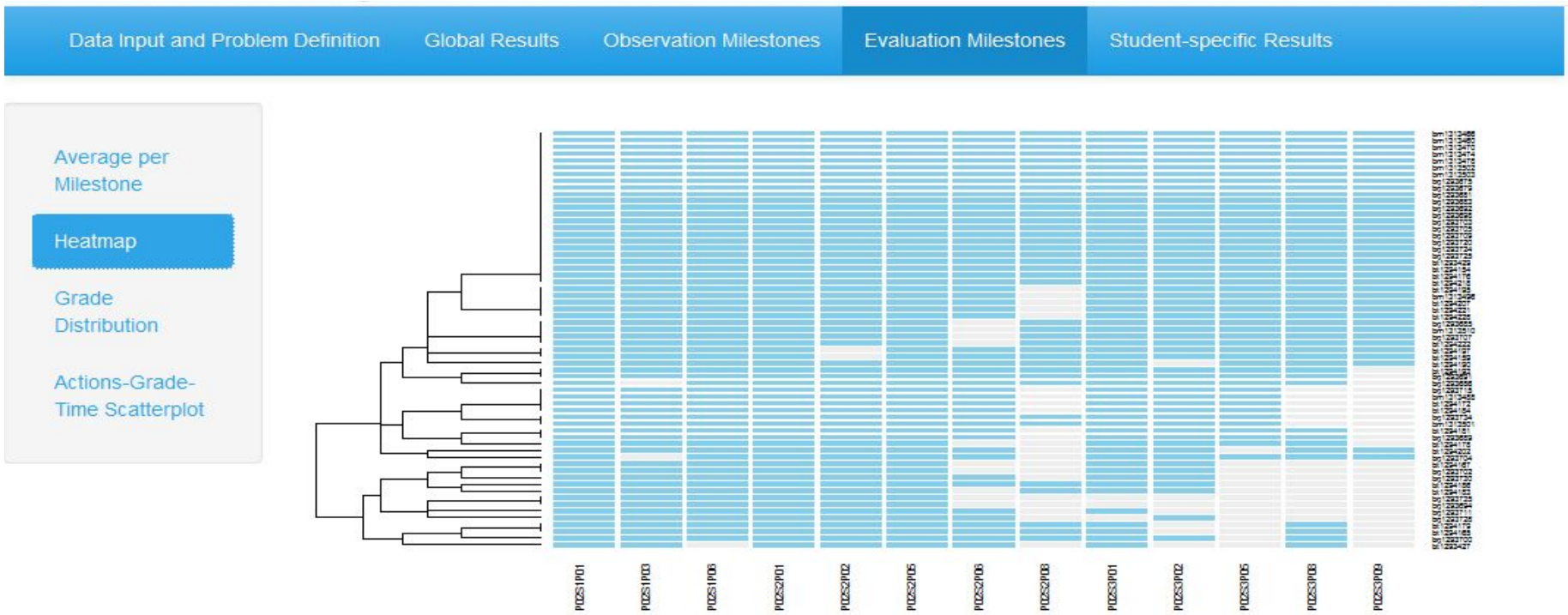

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AND YOU FOR YOUR ATTENTION!

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Acknowledgments

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