

Reduce Friction, Increase Learning

Keep Your Trombone On A Stand!

David Dalpiaz

February 9, 2023

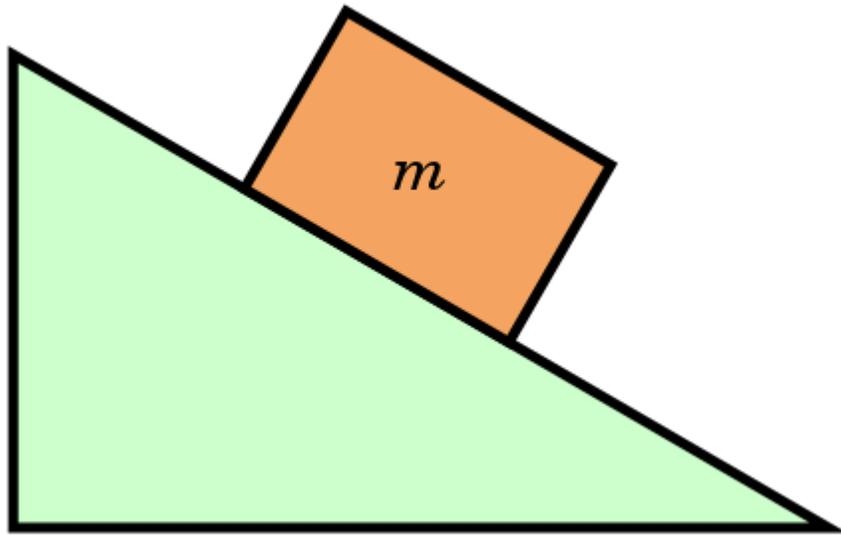
Introduction

Trombones

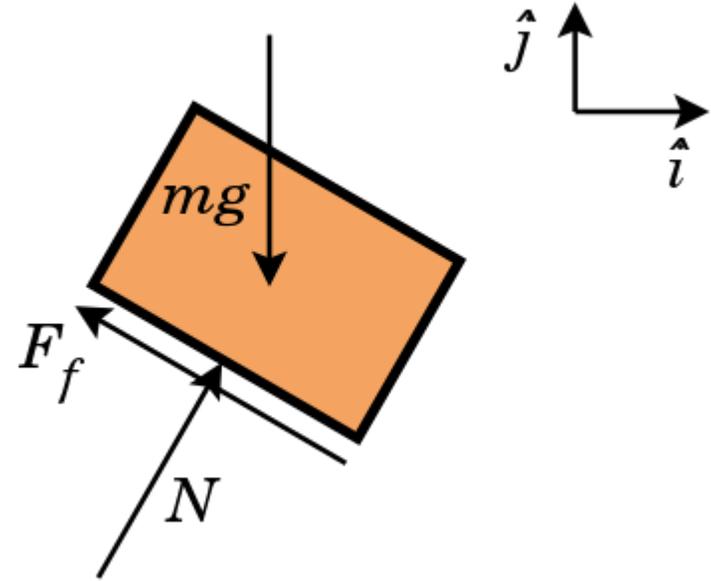


Figure 1: Two trombones, each disassembled and in a case.

Friction



(a) A block with mass m on a slope.



(b) Free body diagram of the block on a ramp. The force of friction, F_f points uphill.

Figure 2: Friction represented by a block on a ramp.

Trombones, But Less Friction



Figure 3: A trombone, assembled, resting on a stand.

Barriers to Education

- Admissions
- Finances
- Registration
- ...

These are largely outside the control of course instructors.

Friction in Education

In the presence of friction, some kinetic energy is always transformed to thermal energy, so mechanical energy is not conserved.

- Source: [Friction | Wikipedia](#)

Courses convert students' motivation, effort, and prior knowledge to learning. ([Ambrose et al. 2010](#)) Friction in education results in wasted motivation and effort.

The Metaphor, Overexplained

- Barriers to education keep the block off the ramp.
- Students' *motivation, effort, and prior knowledge* are **potential** energy.
- We want to convert this potential energy into **kinetic** energy, *learning*.
- **Friction** is *motivation and effort* that is not converted from **potential** to **kinetic** energy.

Potential Sources of Friction

- Modality of course activities
- Course material accessibility and costs
- Deadlines
- Time to feedback
- Exam proctoring
- ...

What can we do to reduce these frictions?

Current Work

Lecture Modality

Are in-person lectures a source of friction?



Figure 4: A beautiful but empty classroom.

Lecture Modality, Continued

A natural experiment occurred in STAT 385, Statistical Programming Methods.

Section A

- Online
- Asynchronous
- Pre-recorded videos

Section B

- In-person
- Synchronous.
- Equal access to videos

Result

Less than 10% in-person attendance by Week 14.

Course Communication

What channels do we use to communicate with students? Are they the right choices? For me, currently:

- One email per week, at the start of the week
- Discussion forum: [Ed Discussion](#)
 - I love this! Do students?
- Office hours
- Email

What about ~~Stack~~ Discord?

Course Communication, Ed

Testing R Code #35



David Dalpiaz **INSTRUCTOR**

Last year in **General**



PIN



STAR



WATCHING

29

VIEWS



Just a post to test some R code.

```
▶ Run R [ ]  
1 x = 1:10  
2 y = 1:2  
3  
4 x + y  
5 hist(rnorm(100))
```

Comment Edit Delete Endorse ...

Sort by Newest ▾

🗨 Add comment



David Dalpiaz **INSTRUCTOR** 1y

This is... incredibly useful.

♡ Reply Edit Delete ...



David Dalpiaz **INSTRUCTOR** now

Responses are threaded!

♡ Reply Edit Delete ...

Figure 5: A course instructor talking to himself to demonstrate the features of Ed, including executable code and threaded responses.

Time To Feedback

Autograding is wonderful! [PrairieLearn](#) (West, Herman, and Zilles 2015) in particular!

- Scale!
- Flexibility!
- Instant feedback!
- ...

PrairieLearn R Autograder

Joint work with Dirk Eddelbuettel and Alton Barbehenn

- [R Autograder](#), Docker image and entrypoint
- [plr](#), R package containing helper functions for using the PrairieLearn R autograder

Recent improvements to [plr](#):

- Security!
- Reduced computation required to grade student code
- Ease of test case authoring

PrairieLearn R Autograder Example

Sum Each Vector

Write a function named `sum_three` with arguments:

- `v1`: a numeric vector.
- `v2`: a numeric vector.
- `v3`: a numeric vector.

The function should *return* a vector of length three that contains the sums of the three input vectors, in order same order as arguments.

```
submission.R
1 sum_three = function(v1, v2, v3) {
2   sum(v1, v2, v3)
3 }
4
```

Restore original file

Save & Grade Save only New variant

(a) Question statement

Submitted answer
Submitted at 2023-02-08 21:10:14 (CST) 27%

Files

submission.R
uploaded

Download Show preview

Score: **3/11 (27.27%)**

Test Results

- ✓ [1/1] Is code free of illegal functions, code, and packages?
- ✓ [1/1] Does code run without errors?
- ✓ [1/1] Does the function return an object with the correct type?
- ✗ [0/1] Does the function return an object with the correct length?
- ✗ [0/1] Does the function return the correct object with `v1 = 1:2, v2 = 1:3, v3 = 1:4` as input?
- ✗ [0/1] Does the function return the correct object with random input?
- ✗ [0/1] Does the function return the correct object with random input?
- ✗ [0/4] Does the function return the correct object with random input?

(b) Grading results

✗ [0/1] Does the function return an object with the correct length? ^

Max points: 1

Earned points: 0

Output

```
expect_equal_with_diff(current = length(std$sum_three(v1 = 1:2, v2 = 1:3, v3 = 1:4)), target = 3)
- current - target
@@ 1 @@   @@ 1 @@
- [1] 1 - [1] 3
```

✗ [0/1] Does the function return the correct object with `v1 = 1:2, v2 = 1:3, v3 = 1:4` as input? ^

Max points: 1

Earned points: 0

Output

```
expect_equal_with_diff(current = std$sum_three(v1 = 1:2, v2 = 1:3, v3 = 1:4), target = c(3, 6, 10))
- current - target
@@ 1 @@   @@ 1 @@
- [1] 19 - [1] 3 6 10
```

(c) Test case details with diffs

Figure 6: An autograded Prairielearn question for R code
davidalpiazz.org

Deadlines

Use flexible deadlines!

- Far fewer last-minute extension requests.
- Preferred to using *drops* for some number of assignments.

How? *Buffer* points. Consider a homework with deadlines:

- 105% Credit: **Thursday**, February 2, 11:59 PM
- 100% Credit: **Thursday**, February 9, 11:59 PM
- 75% Credit: **Thursday**, February 16, 11:59 PM

Importantly: Buffer points are *not* extra credit.

Office Hours

In-person or online? My current preference is **online**.

- One click access!
 - Could use scheduled reminders
- Screen sharing!
- Remote control!

Computer Literacy

- A lot of exciting work is hidden behind “drudgery.” ([Bryan 2020](#))
- Students are often interested in data and data applications, but “bad with computers.”
- These students are unaware of “simple” things like window management with `[alt] + [tab]`, let alone more “advanced” techniques.
- How can we remove this friction?

Exam Proctoring



Figure 7: A testing facility, the Computer-Based Testing Facility (CBTF) (Zilles et al. 2015) at University of Illinois, containing numerous computers arranged in rows.

Exam Proctoring, Continued

Does Zoom-based online proctoring reduce friction?

Tools:

- [PrairieLearn](#), the best platform for online assessments
- [PrairieTest](#), an exam scheduling and proctoring system

Observations:

- Familiar versus unfamiliar environments for students
- Security, time, and flexibility trade-offs

Content Accessibility

- Where are all the syllabi?
- Learning management systems or public websites?
 - stat385.org
- Access for students with disabilities?
 - [Universal Design for Learning \(CAST 2018\)](#)
- Additional costs? Books? Computers?
 - RStudio Cloud, [ATLAS Share](#)

Future Work

Robust Feedback

Instant feedback is great, but what is that feedback?

In addition to feedback being quick and frequent, it should be **robust**.

Two small trials:

- Video feedback for final projects
- Reactive and tutorial style lecture content
 - Can we learn anything from eSports and streaming?

Multimedia Feedback

... designing quiz feedback to instantly (dynamically) deploy a multimedia video that covers the topic has the greatest impact on learning performance. Students who had the opportunity to learn the concept visually through the use of pictures, video and audio performed 5.3 times better than a student who did not receive multimedia feedback. This was true of all learners independent of age, gender, level of education and English-language ability. It was also true across four different types of questions reflecting the first four levels of Bloom's taxonomy.

Fein ([2017](#)) *Multimedia Learning: Principles of Learning and Instructional Improvement in Massive, Open, Online Courses (MOOCS)*

Multimedia Feedback, Expert View

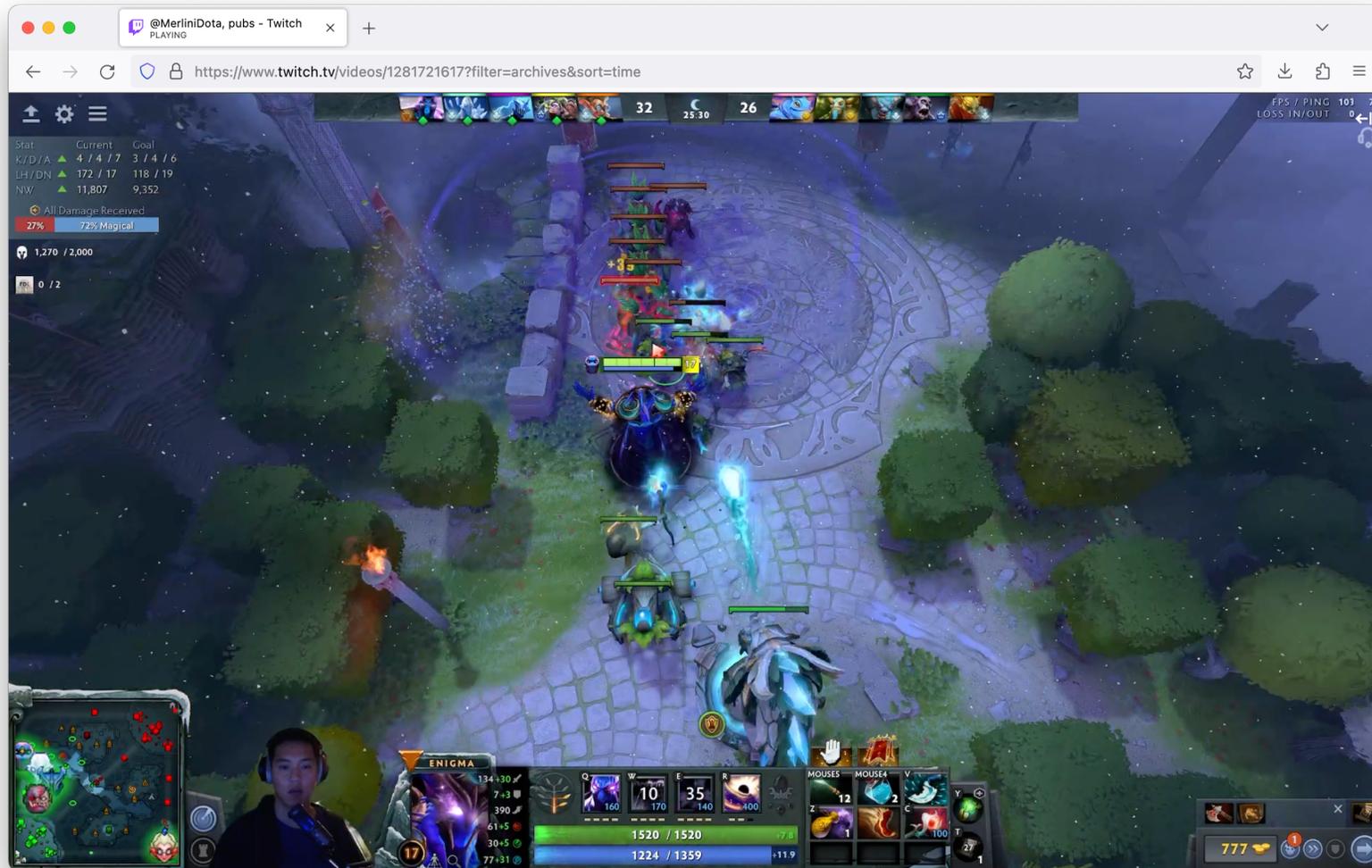


Figure 8: Ben “Merlini” Wu streams a game of Dota 2 on [Twitch](https://www.twitch.tv).

Authentic Autograded Experiences

PrairieLearn is the interface to learning with the least friction that I have used.

Can we go further?

The interface to learning should be as similar as possible to the interface to doing.

My Interface To Doing

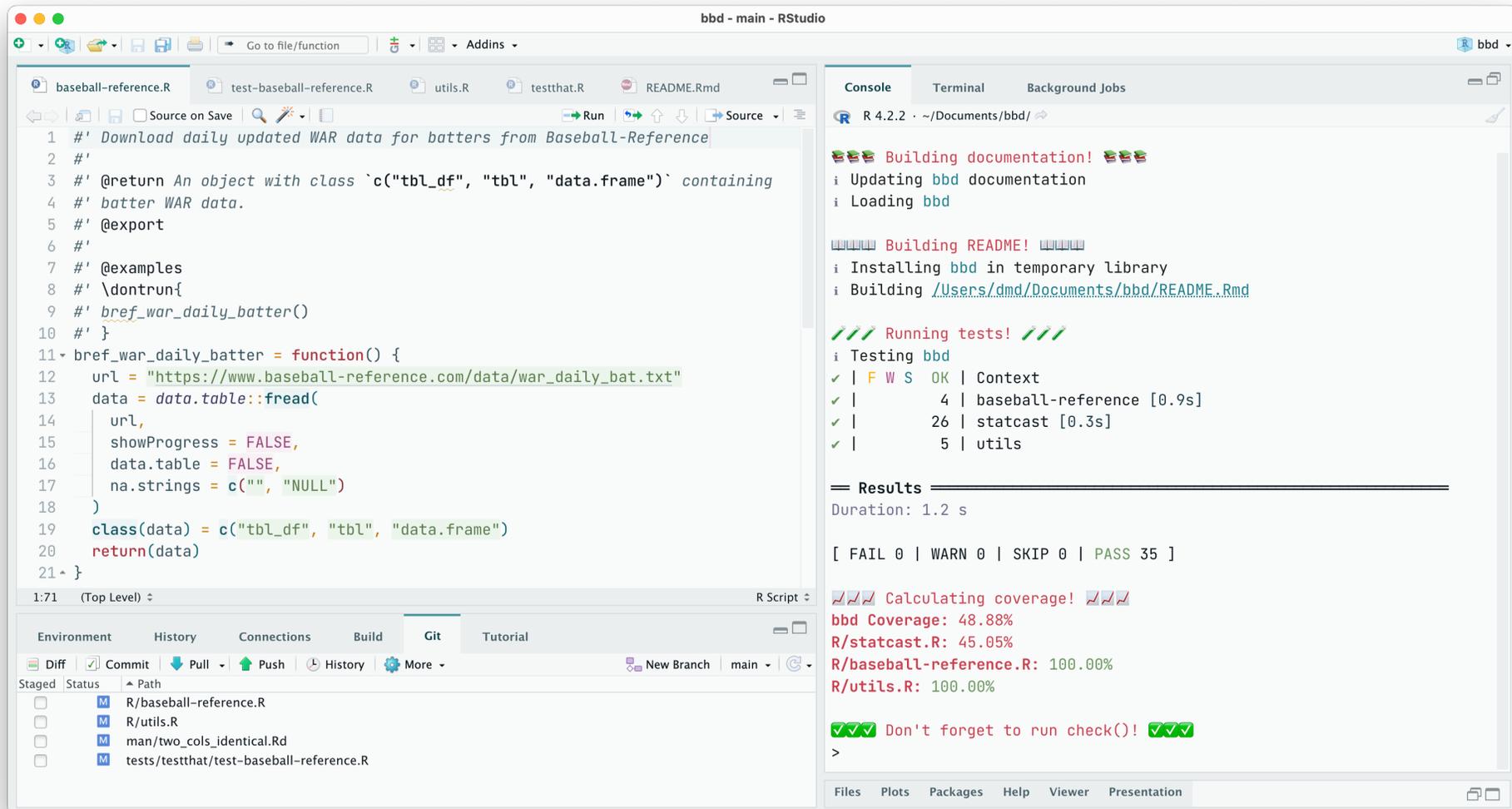


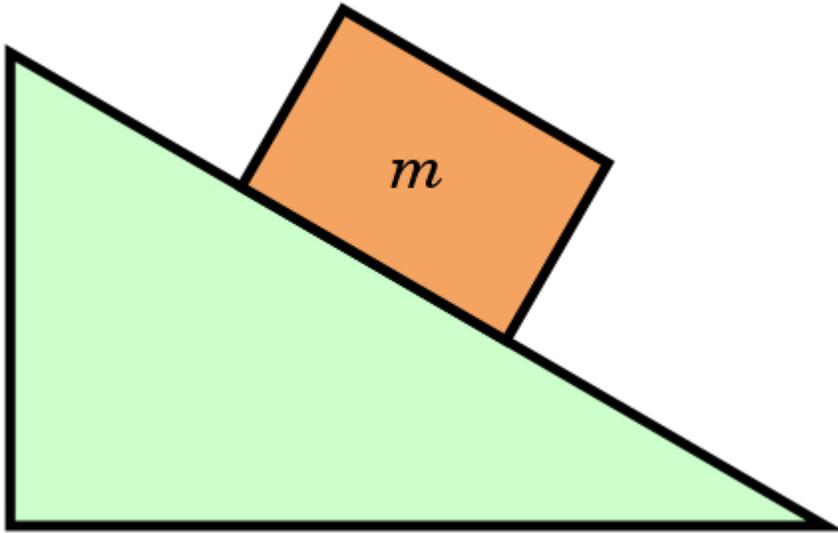
Figure 9: A screenshot of the RStudioIDE during package development.

Related Work

Is this mostly solved already?

- [PrairieLearn Workspaces](#)
 - [VSCode](#)
 - [JupyterLab](#)
 - [RStudio](#)
- [Data Science Discovery MicroProjects](#)
- [illinois/autograding](#)
 - [GitHub Action-based autograding](#)

**Reduce Friction,
Increase Learning**



(a) A block on a ramp.



(b) A trombone.

Figure 10: Trombones, blocks, and ramps as an over-complicated metaphor about friction and learning.

References

- Ambrose, Susan A, Michael W Bridges, Michele DiPietro, Marsha C Lovett, and Marie K Norman.** 2010. *How Learning Works: Seven Research-Based Principles for Smart Teaching*. John Wiley & Sons.
- Bryan, Jenny.** 2020. “Object of Type ‘Closure’ Is Not Subsettable.” RStudio. January 31, 2020. <https://github.com/jennybc/debugging/>.
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- Zilles, Craig, Robert Timothy Deloatch, Jacob Bailey, Bhuwan B Khattar, Wade Fagen-Ulmschneider, Cinda Heeren, David Mussulman, and Matthew West.** 2015. “Computerized Testing: A Vision and Initial Experiences.” In *2015 ASEE Annual Conference & Exposition*, 26–387.

