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# Academic Presentations

## A LaTeX Template Using the beamer Class

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**Name of the Inviting Institution/Seminar Series**

January 22, 2020

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# Outline

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- 1 Introduction
  - 2 Study Design
  - 3 Results
  - 4 Discussion
  - 5 Math “Torture” Test
  - 6 References
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# Introduction

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## Introduction 1: Choice of a Reasonable Aspect Ratio

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When preparing a presentation, we often do not know whether the native aspect ratio of the projector in the seminar room/lecture hall will be 4:3 or 16:9 (or 16:10).

In this case, it may be a good idea to choose an **intermediate aspect ratio**, see <https://github.com/josephwright/beamer/issues/497>. The idea behind this recommendation is that it minimizes the average loss of available space.

Hence, these templates include a presentation in the **14:9 aspect ratio** (see [https://en.wikipedia.org/wiki/14:9\\_aspect\\_ratio](https://en.wikipedia.org/wiki/14:9_aspect_ratio)): while it is imperfect for probably every projector that you will encounter, it is good on average for all of them.

(Please note that  $14:9 \doteq 1.556$ , which is pretty close to the “officially” recommended  $20:13 \doteq 1.5385$ .)

## Introduction 2

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*Great Minds Discuss Ideas.  
Average Minds Discuss Events.  
Small Minds Discuss People.*

—<https://quoteinvestigator.com/2014/11/18/great-minds/>

### Background

- Temporal discounting is key concept in economics.
- Normative model: exponential discounting. However, observed decisions are hard to explain (e.g., Dohmen, Falk, Huffman, and Sunde, 2012).
- One alternative: the “focusing model” by Köszegi and Szeidl (2013).

## Introduction 3

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### Research Question

- The composition of latex and of typical rubbers is given below.
- Is it true that trees are regularly tapped and the coagulated latex which exudes is collected and worked up into rubber?

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- The composition of latex and of typical rubbers is given below.
- Is it true that trees are regularly tapped and the coagulated latex which exudes is collected and worked up into rubber?

### Preview of the Results

- There is no feasible method at present known of preventing the inclusion of the resin of the latex with the rubber during coagulation.
- ⇒ Although the separation of the resin from the solid caoutchouc by means of solvents is possible, it is not practicable or profitable commercially.

## Introduction 4: Beamer block Environments

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**Block title example: 0123456789 äöüß ÄÖÜ Often finding flowers in official fjords**

The block environment. The block environment. The block environment. The block environment. The block environment. Block title example: 0123456789 äöüß ÄÖÜ Often finding flowers in official fjords.

**An exemplary example**

I am the exampleblock environment. Use me for examples.

**Summary: Things to remember**

The alertblock environment. Use this environment for really important stuff. The alertblock environment.



## Introduction 5: Beamer block Environment with Different Colors

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### A block in the default color

The block environment. The block environment. The block environment. The block environment. A block in the default color.

### A block in yellow

The block environment. The block environment. The block environment. The block environment. A block in yellow.

### A block in the default color

The block environment. The block environment. The block environment. The block environment. A block in the default color.

## Introduction 6: Beamer definition and theorem Environments

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### Definition (A Very, Very, Very, Very, Very, Very Long Name of a Concept that Spans Two Lines)

The definition environment. Upright.

### Theorem (Theorem's name)

*The theorem environment. Italic.*

### Lemma (Lemma's Name)

*The lemma environment. Italic.*

### Corollary (Corollary's Name)

*The corollary environment. Italic.*

### Proof of Theorem's Name

The proof environment. Upright.



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## Study Design

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## Study Design 1: Design of the Study

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- The latex of the best rubber plants furnishes from 20% to 50% of rubber.
- As the removal of the impurities of the latex is one of the essential points to be aimed at, it was thought that the use of a centrifugal machine to separate the caoutchouc as a cream from the watery part of the latex would prove to be a satisfactory process.

## Study Design 2: Design of the Study

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The watery portion of the latex soaks into the trunk, and the soft spongy rubber which remains is kneaded and pressed into lumps or balls:

**BAL<sub>1:1</sub><sup>I</sup>, BAL<sub>1:1</sub><sup>II</sup>:** Each payment transferred on single day.

**UNBAL<sub>1:n</sub><sup>I</sup>:** Earlier payoff concentrated, while later payoff dispersed over  $n = 2, 4, \text{ or } 8$  dates.

**UNBAL<sub>n:1</sub><sup>II</sup>:** Earlier payoff dispersed over  $n = 2, 4, \text{ or } 8$  dates, while later payoff concentrated.

## Study Design 3: Control Experiment

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- Control for alternative explanations.
- Many of the example sentences were taken from <http://sentence.yourdictionary.com/latex>.

## Study Design 4: An Example enumerate List

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1. First itemtext
  - a. First itemtext
    - i. First itemtext
    - ii. Second itemtext
    - iii. Last itemtext
    - iv. First itemtext
  - b. Second itemtext
  - c. Last itemtext
  - d. First itemtext
2. Second itemtext
3. Last itemtext
4. First itemtext

## Study Design 5: An Example itemize List

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- First itemtext
  - First itemtext
    - First itemtext
    - Second itemtext
    - Last itemtext
    - First itemtext
  - Second itemtext
  - Last itemtext
  - First itemtext
- Second itemtext
- Last itemtext
- First itemtext



## Study Design 6: Some Example Text

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### Let's include some Greek letters: $\alpha$ , $\beta$ , $\sigma$

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.  $\alpha$ ,  $\beta$ ,  $\sigma$

Test:  $\chi\rho\sigma\tau$   $\chi\rho\varsigma$   $\tau$   $\chi\rho\sigma$   $\tau$ . Math mode, upright:  $\sigma$

## Study Design 7: Some Example Formulas

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Let's include some additional Greek letters:  $\gamma, \phi, \sigma_\epsilon, c^\alpha$

$$p(R, \phi) \sim \int_{-\infty}^{\infty} \frac{\tilde{W}_n(\gamma) \exp \left[ iR/a \left( \sqrt{k^2 a^2 - \gamma^2} \cos \phi \right) \right]}{(k^2 a^2 - \gamma^2)^{3/4} H_n^{(1)} \left( \sqrt{k^2 a^2 - \gamma^2} \right)} d\gamma$$

## Study Design 7: Some Example Formulas

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Let's include some additional Greek letters:  $\gamma$ ,  $\phi$ ,  $\sigma_\epsilon$ ,  $c^\alpha$

$$p(R, \phi) \sim \int_{-\infty}^{\infty} \frac{\tilde{W}_n(\gamma) \exp \left[ i R / a \left( \sqrt{k^2 a^2 - \gamma^2} \cos \phi \right) \right]}{(k^2 a^2 - \gamma^2)^{3/4} H_n^{(1)} \left( \sqrt{k^2 a^2 - \gamma^2} \right)} d\gamma$$

Let's also include some upright Latin letters in math mode: d, e (next slide)

$$\int_a^b f(x) dx = F(b) - F(a)$$

## Study Design 7: Some Example Formulas

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Let's also include some upright Latin letters in math mode: **d**, **e** (next slide)

$$\int_a^b f(x) dx = F(b) - F(a)$$

Let's test the math bold style

$$\Sigma := \text{Cov}(\mathbf{X}) = \begin{bmatrix} \text{Var}(X_1) & \cdots & \text{Cov}(X_1, X_n) \\ \vdots & \ddots & \vdots \\ \text{Cov}(X_n, X_1) & \cdots & \text{Var}(X_n) \end{bmatrix}$$

## Study Design 8: Additional Example Formulas (with upright $\pi$ )

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Only variables are set in italics according to ISO style—hence, we use upright “d,” “e,” and “ $\pi$ ” ( $\backslash\mathrm{d}$ ,  $\backslash\mathrm{e}$ , and  $\backslash\mathrm{\pi}$ ), respectively).

### Theorem (simplest form of the *Central Limit Theorem*)

Let  $X_1, X_2, \dots$  be a sequence of i.i.d. random variables with mean 0 and variance 1 on a probability space  $(\Omega, \mathcal{F}, \mathbb{P})$ . Then

$$\mathbb{P}\left(\frac{X_1 + \dots + X_n}{\sqrt{n}} \leq y\right) \rightarrow \mathfrak{N}(y) := \int_{-\infty}^y \frac{e^{-v^2/2}}{\sqrt{2\pi}} \, dv \quad \text{as } n \rightarrow \infty,$$

or, equivalently, letting  $S_n := \sum_{k=1}^n X_k$ ,

$$\mathbb{E}f\left(S_n/\sqrt{n}\right) \rightarrow \int_{-\infty}^{\infty} f(v) \frac{e^{-v^2/2}}{\sqrt{2\pi}} \, dv \quad \text{as } n \rightarrow \infty, \text{ for every } f \in \mathcal{BC}(\mathbb{R}).$$

## Study Design 9: An siunitx Example Table

**Table 1.** Overview of the choice lists presented to subjects (adapted from Gerhardt, Schildberg-Hörisch, and Willrodt, 2017).

	Alternative A				Alternative B			
	$C_{A,1}$	$P_{A,1}$	$C_{A,2}$	$P_{A,2}$	$C_{B,1}$	$P_{B,1}$	$C_{B,2}$	$P_{B,2}$
<i>Choice List I: risky/risky</i> ( $x = €22.00$ , $r = €7.50$ , $k = €11.50$ ; 25 rows)								
Top row	€ 3.00	50%	€22.00	50%	€ 3.00	50%	€ 7.00	50%
Center row	€ 3.00	50%	€22.00	50%	€ 9.00	50%	€13.00	50%
Row with $m = 0$	€ 3.00	50%	€22.00	50%	€10.50	50%	€14.50	50%
Bottom row	€ 3.00	50%	€22.00	50%	€15.00	50%	€19.00	50%
<i>Choice List II: safe/risky</i> ( $x = €16.00$ , $r = €5.00$ , $k = €5.00$ ; 19 rows)								
Top row	€11.00	100%			€11.00	50%	€21.00	50%
Center row	€11.00	100%			€ 6.50	50%	€16.50	50%
Row with $m = 0$	€11.00	100%			€ 6.00	50%	€16.00	50%
Bottom row	€11.00	100%			€ 2.00	50%	€12.00	50%
<i>Choice List III: "long shot"</i> ( $x = €14.00$ , $r = -€36.00$ , $k = €7.00$ ; 21 rows)								
Top row	€ 7.00	90%	€50.00	10%	€ 7.00	90%	€10.00	10%
Row with $m = 0$	€ 7.00	90%	€50.00	10%	€11.00	90%	€14.00	10%
Center row	€ 7.00	90%	€50.00	10%	€12.00	90%	€15.00	10%
Bottom row	€ 7.00	90%	€50.00	10%	€17.00	90%	€20.00	10%
<i>Choice List IV: delayed payoffs</i> ( $x = €18.00$ , $r = €6.00$ , $k = €8.50$ , paid in one week; 20 rows)								
Top row	€ 9.50	50%	€12.00	50%	€ 9.50	50%	€24.00	50%
Above-center row	€ 9.50	50%	€12.00	50%	€ 5.00	50%	€19.50	50%
Below-center row	€ 9.50	50%	€12.00	50%	€ 4.50	50%	€19.00	50%
Row with $m = 0$	€ 9.50	50%	€12.00	50%	€ 3.50	50%	€18.00	50%
Bottom row	€ 9.50	50%	€12.00	50%	€ 0.00	50%	€14.50	50%

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## Results

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## Results 1: Overview

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1. As a secondary function we may recognize the power of closing wounds, which results from the rapid coagulation of exuded latex in contact with the air:



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  - a. In some cases (*Allium*, *Convolvulaceae*, etc.) rows of cells with latex-like contents occur.
  - b. However, the walls separating the individual cells do not break down.

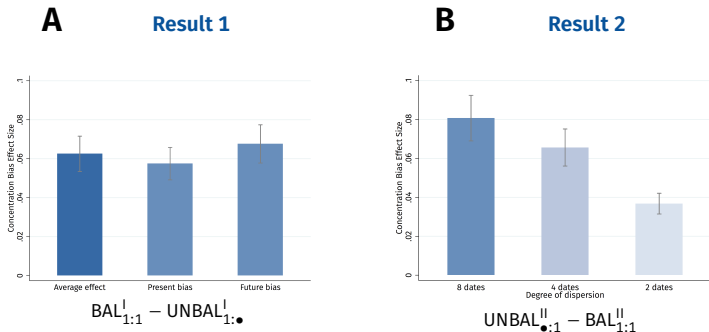
## Results 1: Overview

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1. As a secondary function we may recognize the power of closing wounds, which results from the rapid coagulation of exuded latex in contact with the air:
  - a. In some cases (Allium, Convolvulaceae, etc.) rows of cells with latex-like contents occur.
  - b. However, the walls separating the individual cells do not break down.
2. The rows of cells from which the laticiferous vessels are formed can be distinguished (6.3 p.p. vs. 2.6 p.p.;  $p < 0.01$ ).

## Results 2: Our Main Results

The charts are taken from Dertwinkel-Kalt, Gerhardt, Riener, Schwerter, and Strang (2017).



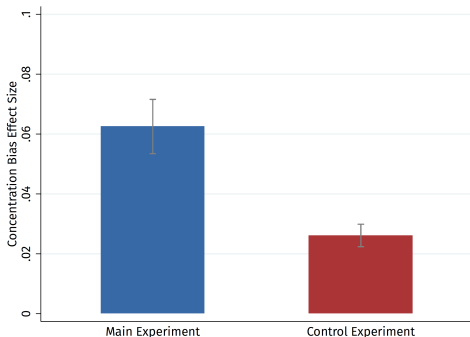
**Figure 1.** (A) Difference between treatment and control condition. (B) Heterogeneity.

## Results 3: Main vs. Control Experiment

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Rule out some alternative explanations.

### Result 3



## Results 4: Another siunitx Example Table

**Table 2.** Example of a regression table (adapted from Gerhardt, Schildberg-Hörisch, and Willrodt, 2017). Never forget to mention the dependent variable (here,  $m_{\sim}$ )!

	(1)	(2)	(3)	(4)	(5)
Treatment	-0.390 (+0.352)	-0.228 (-0.205)	-0.729* [+0.377]	-0.449* [-0.245]	-0.453** {+0.204}
Female	0.948*** (0.354)	0.061 (0.233)	0.188 (0.372)	0.305 (0.226)	0.385* (0.222)
Female $\times$ Treatment	0.169 (0.514)	0.251 (0.325)	0.892* (0.533)	0.454 (0.341)	0.439 (0.307)
Final high school grade	-0.101 (0.198)	0.013 (0.144)	0.076 (0.224)	0.117 (0.146)	0.039 (0.133)
Trait self-control	-0.016 (0.016)	0.002 (0.010)	-0.016 (0.015)	-0.000 (0.010)	-0.007 (0.009)
Constant	2.357*** (0.239)	1.512*** (0.144)	-0.322 (0.265)	2.158*** (0.161)	1.437*** (0.152)
Observations	303	289	295	304	1191
$R^2$	0.057	0.008	0.039	0.043	0.024
Treatment $\times$ (1 + Female)	-0.221	0.023	0.163	0.004	-0.014
$p_F$ [Treatment $\times$ (1 + Female) = 0]	0.327	0.008	0.192	0.000	0.003

Notes: Dependent variable:  $m_{\sim}$ . Robust standard errors (cluster-corrected for column 5) in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Missing observations ( $N < 308$ ) due to exclusion of trials in which subjects behaved irrationally (i.e., chose a dominated option). The regressors Final high school grade and Trait self-control are mean-centered.

## Results 5: Yet Another siunitx Example Table

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**Table 3.** Figure grouping via siunitx in a table.

(1)	(2)	(3)
-0.100*	-0.100 01*	-123 456.444***
(2.871)	(2.871 23)	[+50 000.123]

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## Discussion

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## Discussion 1

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- The latex exhibits a neutral, acid, or alkaline reaction, depending on the plant from which it was obtained.



## Discussion 1

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- The latex exhibits a neutral, acid, or alkaline reaction, depending on the plant from which it was obtained.
- The latex is therefore usually allowed to coagulate on the tree (Kőszegi and Szeidl, 2013).
  - ⇒ The latex, which is usually coagulated by standing or by heating, is obtained from incisions.

## Discussion 1

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- The latex is therefore usually allowed to coagulate on the tree (Kőszegi and Szeidl, 2013).
  - ⇒ The latex, which is usually coagulated by standing or by heating, is obtained from incisions.
- See also Dohmen et al. (2012) and Bordalo, Gennaioli, and Shleifer (2013).

## Discussion 2: Conclusion

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- When exposed to air, the latex gradually undergoes putrefactive changes accompanied by coagulation.
- The addition of a small quantity of ammonia or of formalin to some latices has the effect of preserving them.
- There is, however, reason to believe the following.
- The coagulation of latex into rubber is not mainly of this character.

## Discussion 3: An Automated Animation

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The automated transition to the next slide (= page in the PDF document) only works in full-screen mode.

- The feature is available in Adobe Acrobat and Acrobat Reader.
- Unfortunately, it is (currently, January 22, 2020) not available in macOS Preview, Skim, and SumatraPDF.



**Figure 2.** Step 1—Angle: 30.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 2—Angle: 60.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 3—Angle: 90.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 4—Angle: 120.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 5—Angle: 150.0°



## Discussion 3: An Automated Animation

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**Figure 2.** Step 6—Angle: 180.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 7—Angle: 210.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 8—Angle: 240.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 9—Angle: 270.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 10—Angle: 300.0°

## Discussion 3: An Automated Animation

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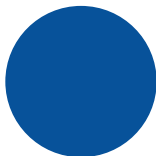
**Figure 2.** Step 11—Angle: 330.0°

## Discussion 3: An Automated Animation

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**Figure 2.** Step 12—Angle: 360.0°

## Discussion 4: Testing the allowframebreaks option

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Let's test automatic numbering with the allowframebreaks option.

On this slide, **no** number should be included in the frame title.



## Discussion 5: Testing the allowframebreaks Option (1/3)

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Let's test automatic numbering with the allowframebreaks option.

On this slide, "(1/3)" should appear in the frame title.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

## Discussion 6: Testing the allowframebreaks Option (2/3)

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Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

## Discussion 7: Testing the allowframebreaks Option (3/3)

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Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

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## Math “Torture” Test

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## Math “Torture” Test (1/8)

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Most of the following examples are taken from *The T<sub>E</sub>Xbook* (Knuth, 1984, see <https://ctan.org/pkg/texbook>) and were adapted for L<sup>A</sup>T<sub>E</sub>X from Karl Berry’s torture test for plain T<sub>E</sub>X math fonts.

$$x + y - z, \quad x + y * z, \quad z * y / z, \quad (x + y)(x - y) = x^2 - y^2,$$

$$x \times y \cdot z = [xyz], \quad x \circ y \bullet z, \quad x \cup y \cap z, \quad x \sqcup y \sqcap z,$$

$$x \vee y \wedge z, \quad x \pm y \mp z, \quad x = y / z, \quad x := y, \quad x \leq y \neq z, \quad x \sim y \simeq z \quad x \equiv y \not\equiv z, \\ x \subset y \subseteq z$$

$$\sin 2\theta = 2 \sin \theta \cos \theta, \quad O(n \log n \log n), \quad \Pr(X > x) = \exp(-x/\mu),$$

$$(x \in A(n) \mid x \in B(n)), \quad \bigcup_n X_n \parallel \bigcap_n Y_n$$

$$\text{In-text matrices } \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix} \text{ and } \begin{pmatrix} a & b & c \\ 1 & m & n \end{pmatrix}.$$

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

$$\binom{p}{2} x^2 y^{p-2} - \frac{1}{1-x} \frac{1}{1-x^2} = \frac{a+1}{b} \Big/ \frac{c+1}{d}.$$

$$\sqrt{1 + \sqrt{1 + \sqrt{1 + \sqrt{1 + \sqrt{1 + x}}}}}$$

$$\sqrt[n]{1 + \sqrt[k]{1 + \sqrt[5]{1 + \sqrt[4]{1 + \sqrt[3]{1 + x}}}}}$$

$$\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right) |\varphi(x+iy)|^2 = 0$$

$$\pi(n) = \sum_{m=2}^n \left[ \left( \sum_{k=1}^{m-1} \lfloor (m/k) / \lceil m/k \rceil \rfloor \right)^{-1} \right].$$

$$\int_0^\infty \frac{t - ib}{t^2 + b^2} e^{iat} dt = e^{ab} E_1(ab), \quad a, b > 0.$$

$$\mathbf{A} := \begin{pmatrix} x - \lambda & 1 & 0 \\ 0 & x - \lambda & 1 \\ 0 & 0 & x - \lambda \end{pmatrix}.$$

$$\begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix} \begin{pmatrix} u & x \\ v & y \\ w & z \end{pmatrix}$$

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{pmatrix}$$

$$\mathbf{M} = \begin{matrix} & C & I & C' \\ \begin{matrix} C \\ I \\ C' \end{matrix} & \begin{pmatrix} 1 & 0 & 0 \\ b & 1-b & 0 \\ 0 & a & 1-a \end{pmatrix} \end{matrix}$$



$$\sum_{n=0}^{\infty} a_n z^n \text{ converges if } |z| < \left( \limsup_{n \rightarrow \infty} \sqrt[n]{|a_n|} \right)^{-1}.$$

$$\frac{f(x + \Delta x) - f(x)}{\Delta x} \rightarrow f'(x) \quad \text{as } \Delta x \rightarrow 0.$$

$$\|u_i\| = 1, \quad u_i \cdot u_j = 0 \quad \text{if } i \neq j.$$

The confluent image of  $\left\{ \begin{array}{l} \text{an arc} \\ \text{a circle} \\ \text{a fan} \end{array} \right\}$  is  $\left\{ \begin{array}{l} \text{an arc} \\ \text{an arc or a circle} \\ \text{a fan or an arc} \end{array} \right\}.$

$$\begin{aligned}T(n) &\leq T(2^{\lceil \lg n \rceil}) \leq c(3^{\lceil \lg n \rceil} - 2^{\lceil \lg n \rceil}) \\&< 3c \cdot 3^{\lg n} \\&= 3c n^{\lg 3}.\end{aligned}$$

$$\begin{aligned}(x + y)(x - y) &= x^2 - xy + yx - y^2 \\&= x^2 - y^2 \\(x + y)^2 &= x^2 + 2xy + y^2.\end{aligned}$$

$$\begin{aligned}\left(\int_{-\infty}^{\infty} e^{-x^2} dx\right)^2 &= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-(x^2+y^2)} dx dy \\ &= \int_0^{2\pi} \int_0^{\infty} e^{-r^2} dr d\theta \\ &= \int_0^{2\pi} \left( e^{-\frac{r^2}{2}} \Big|_{r=0}^{r=\infty} \right) d\theta \\ &= \pi.\end{aligned}$$

$$\prod_{k \geq 0} \frac{1}{(1 - q^k z)} = \sum_{n \geq 0} z^n / \prod_{1 \leq k \leq n} (1 - q^k).$$

$$\sum_{\substack{0 < i \leq m \\ 0 < j \leq n}} p(i, j) \neq \sum_{i=1}^p \sum_{j=1}^q \sum_{k=1}^r a_{ij} b_{jk} c_{ki} \neq \sum_{\substack{1 \leq i \leq p \\ 1 \leq j \leq q \\ 1 \leq k \leq r}} a_{ij} b_{jk} c_{ki}$$

$$\max_{1 \leq n \leq m} \log_2 P_n \quad \text{and} \quad \lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$$

$$p_1(n) = \lim_{m \rightarrow \infty} \sum_{v=0}^{\infty} (1 - \cos^{2m}(v!^n \pi/n))$$

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## References

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## Appendix

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## Appendix: Modeling Concentration Bias

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Subjects consider a sequences of consequences  $\mathbf{c}$  from choice set  $\mathbf{C}$ .

- **Standard discounted utility:** Suppose that the instantaneous utility function  $u$  satisfies  $u' > 0$  and  $u'' \leq 0$ , and that earlier consequences are preferred over later consequences of the same magnitude, i.e.,  $D(t) \leq 1$ :

$$U(\mathbf{c}) := \sum_{t=1}^T D(t) u(c_t), \quad \text{where, e.g., } D(t) = \delta^t \text{ or } D(t) = \frac{1}{1+kt}.$$

- **Focusing model (Kőszegi and Szeidl, 2013):**

$$\tilde{U}(\mathbf{c}, \mathbf{C}) := \sum_{t=1}^T g_t D(t) u(c_t), \quad \text{where}$$

$$g_t \equiv g[\max_{c' \in \mathbf{C}} u(c'_t) - \min_{c' \in \mathbf{C}} u(c'_t)]$$

- Weighting function  $g[\cdot]$  increases in difference of maximum and minimum possible utility at a point in time.
- Subjects overweight intertemporal consequences with a greater range.