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The State of Computing in Introductory Statistics

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Background

- The proliferation of data and the increased demand for a data-literate workforce has led to calls by several statisticians to update the introductory statistics curriculum to provide students with the computational tools and data-related capacity imperative for dealing with modern data structures.[1, 2]
- Although there seems to be a growing consensus that computing and data are core skills for students, it is unclear to what extent introductory statistics instructors have incorporated these skills into their courses.[3, 4, 5]

Research Questions

1. To what extent are ideas of statistical computing being integrated into the introductory statistics curricula?

2. Are students receiving experiences with modern data structures in the introductory statistics curricula?

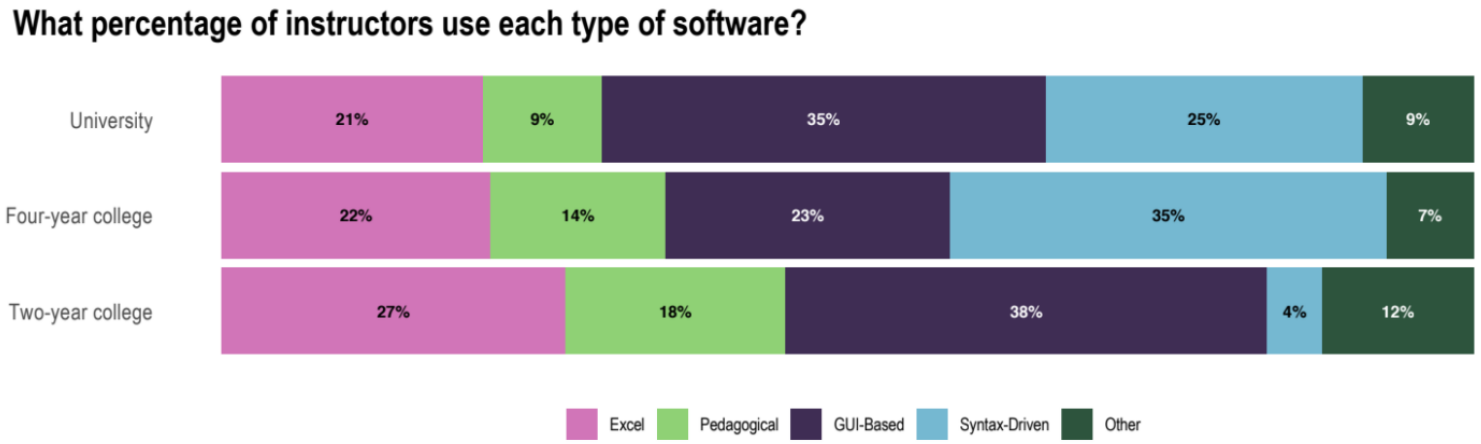
Methods: Instrument Development

- A survey of introductory statistics instructors, the *Statistics Teaching Inventory* (STI)[6] was modified to better align with current recommendations for teaching introductory statistics[7], and to measure the extent to which computing and ideas of computational thinking were being embedded into the introductory statistics curriculum.[8]
- After the STI instrument was modified, think-aloud interviews were conducted with three statisticians/statistics educators, which informed revision of several items.

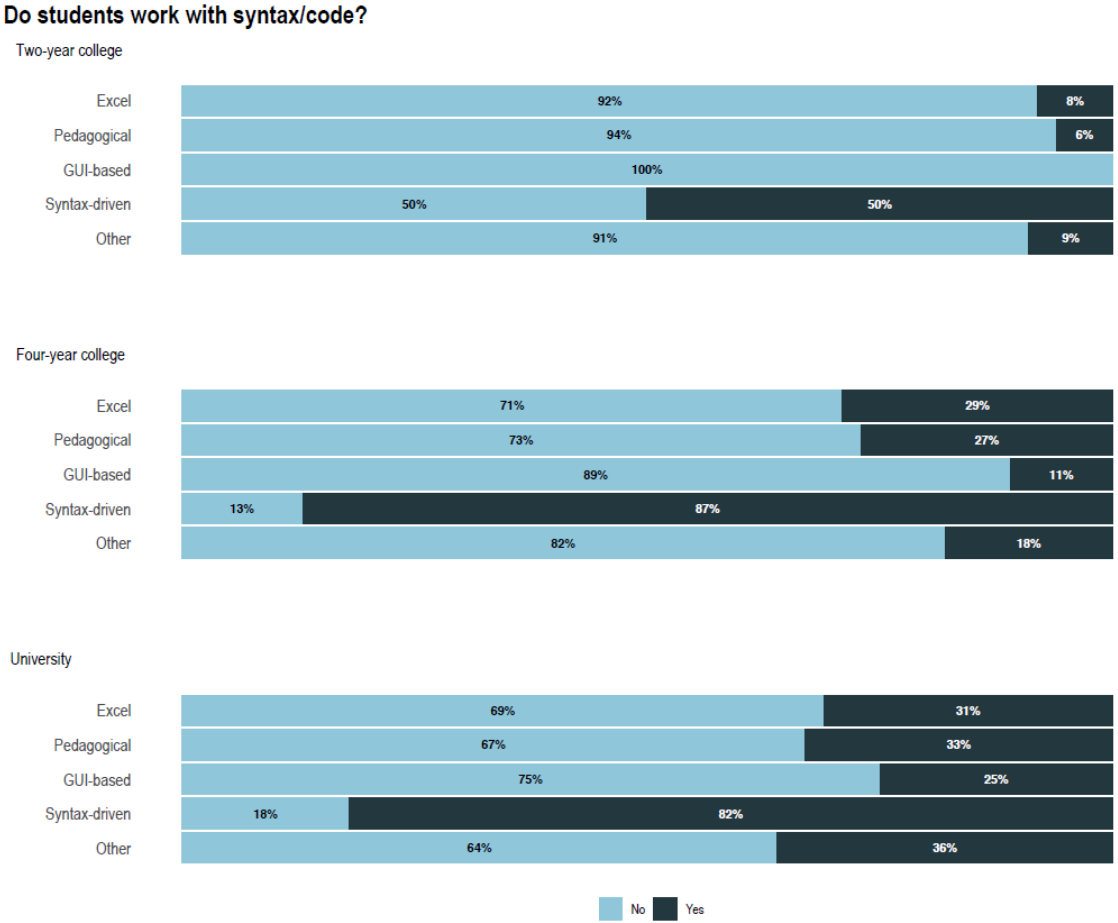
Methods: Data Collection

- During fall 2019, tertiary-level statistics instructors subscribed to three different statistics education listservs were sent an e-mail invitation to complete the STI survey online.
- A total of 293 participants responded.
- Although the STI questions were related to various aspects of teaching practices, results of instructors' responses to items specifically related to computational thinking are highlighted in this poster.

Results

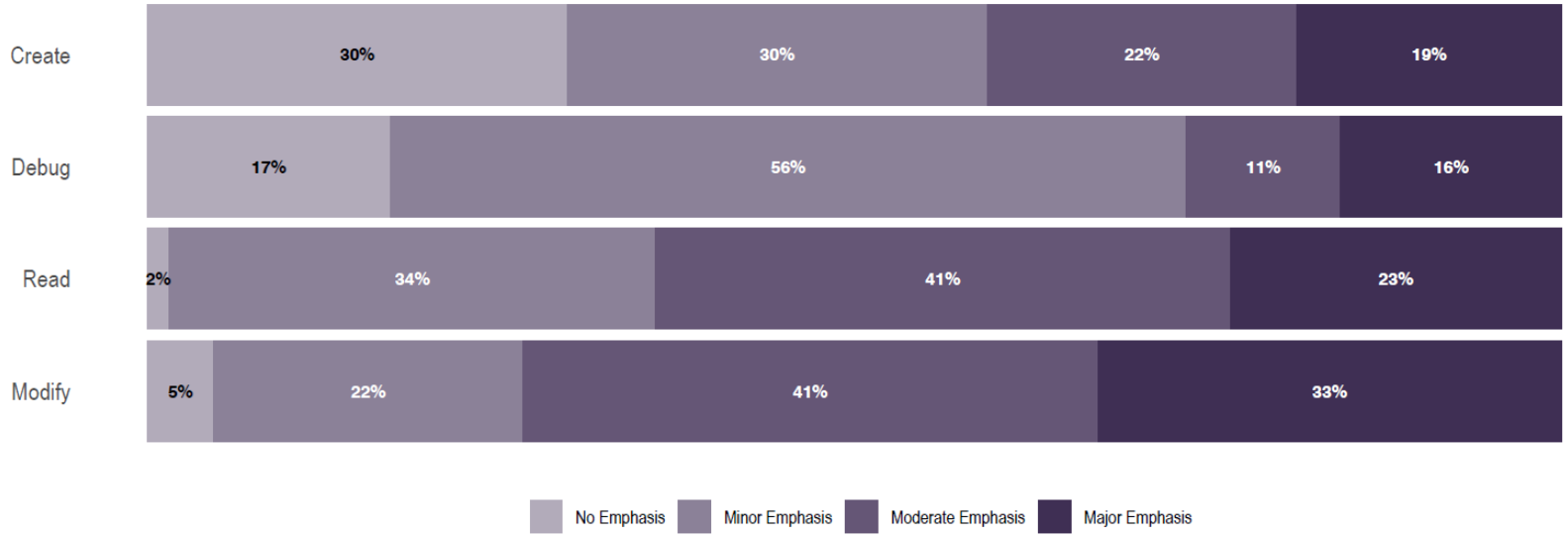


Excel and GUI-based software are popular choices across institution types. Syntax-driven softwares are more commonly adopted in four-year colleges and universities than in two-year colleges.

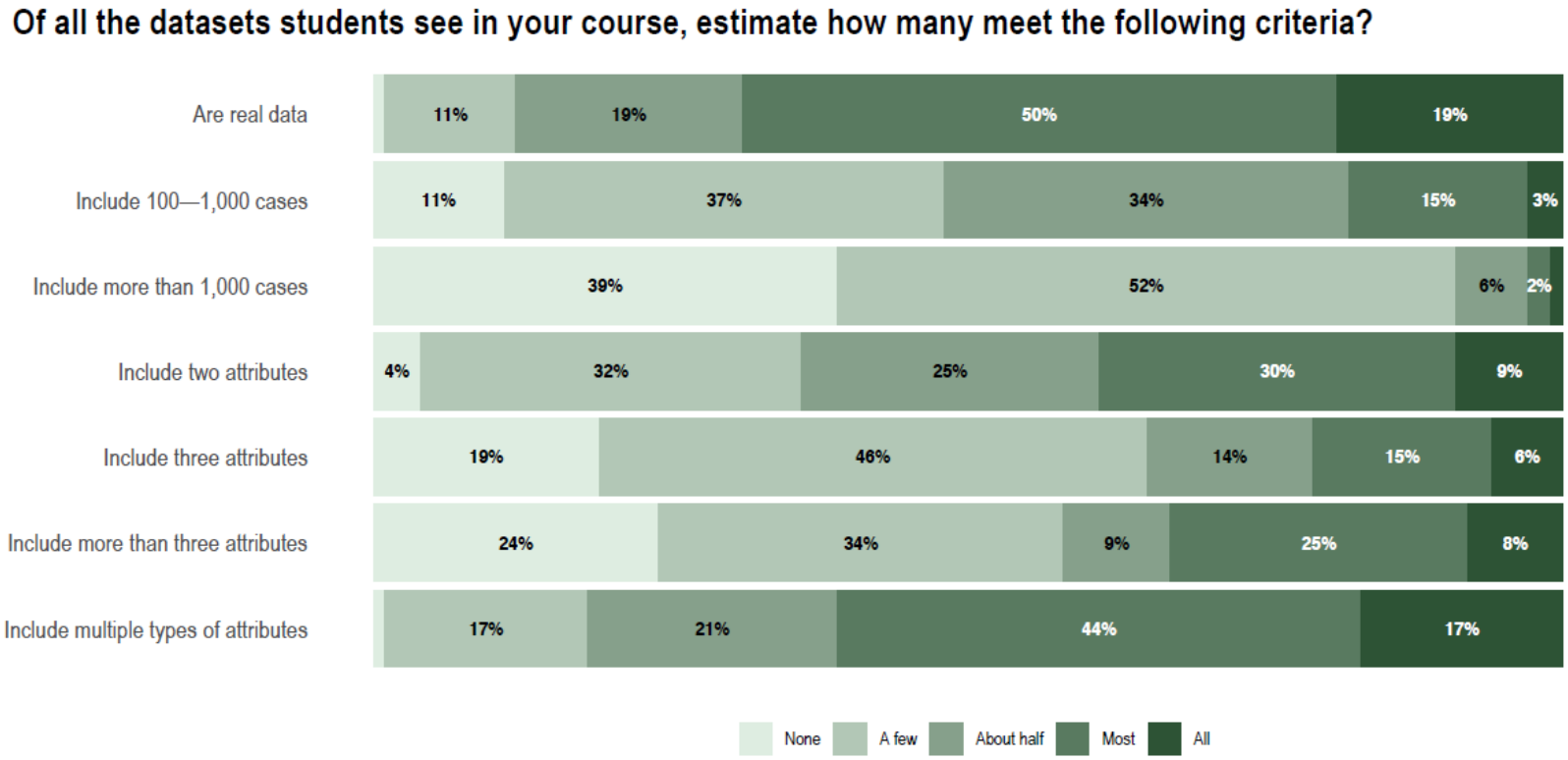


Coding is not commonly taught in introductory statistics courses. Instructors who adopt syntax-driven software are the ones primarily teaching coding, but not all of them.

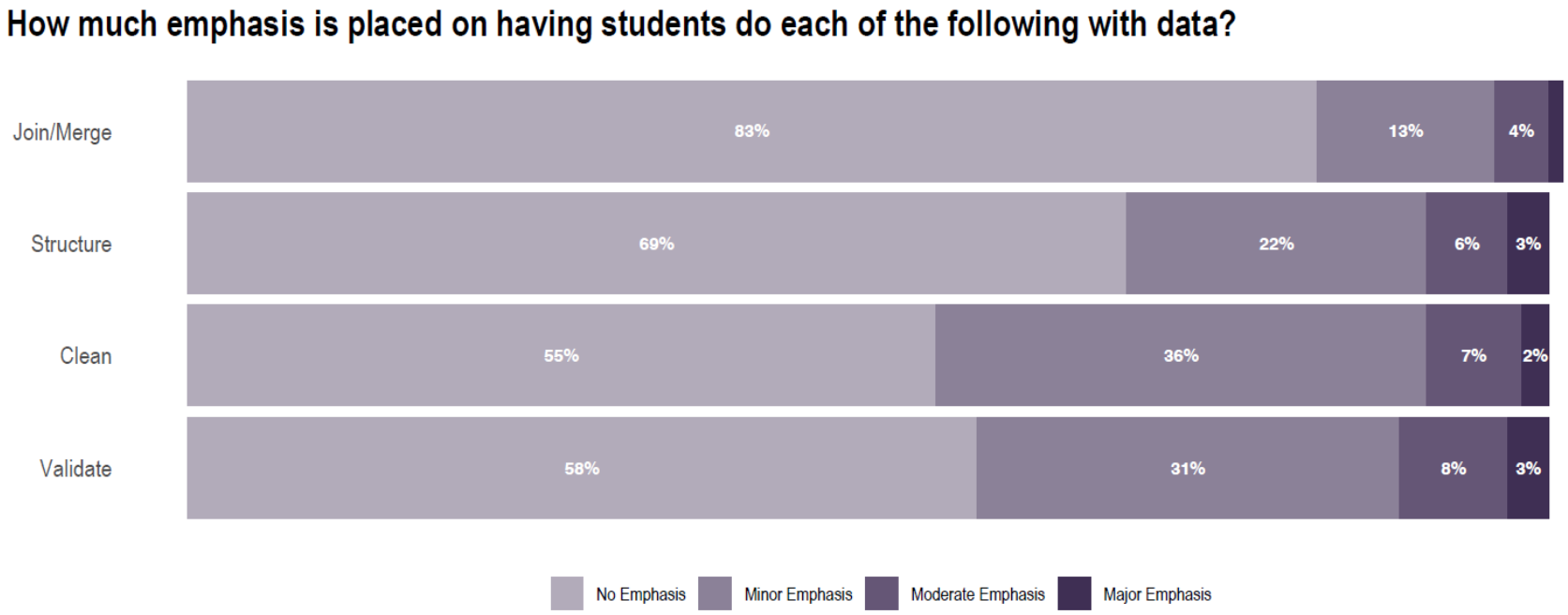
How much emphasis is placed on each of the following when students work with syntax/code?



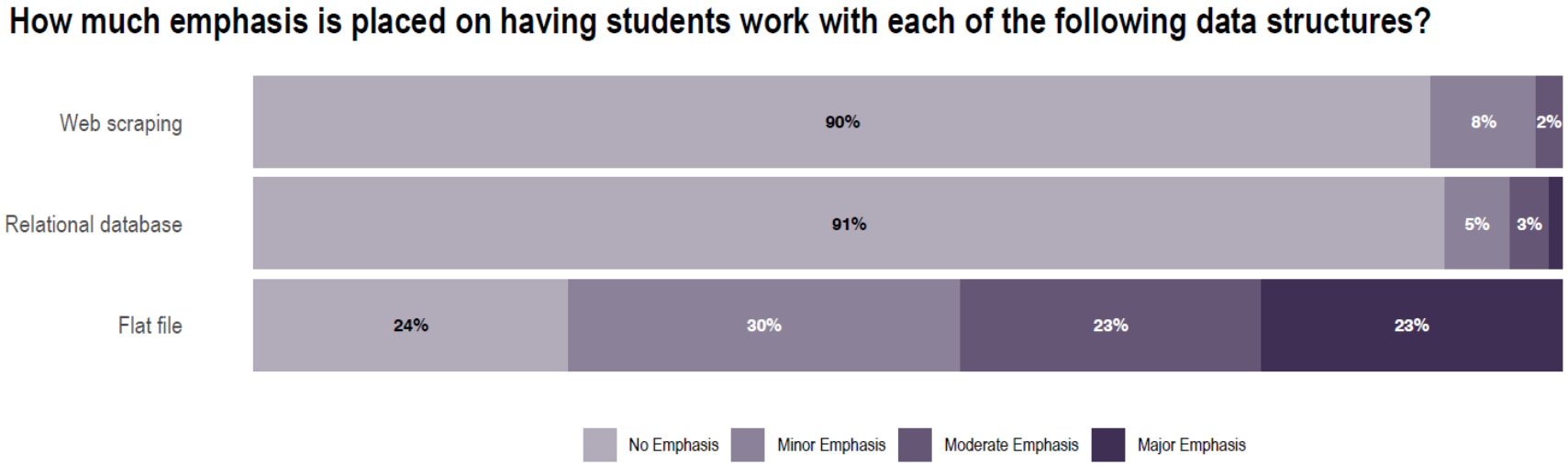
Instructors who teach coding tend not to emphasize debugging nor creation of syntax— higher-order skills associated with deeper and more critical thinking.[8, 9]



Most instructors use real data as recommended by GAISE.[7] The majority of datasets include multiple types of attributes (e.g., categorical and quantitative attributes), but tend to be small (less than 1,000 cases, fewer than three attributes).



Manipulating data to get it into a useable form is not emphasized, yet it is an important part of data analysis.



Students encounter flat files (e.g., CSV) more often than relational databases and web scraping.

Limitations

- Responses were collected from a convenience sample of introductory statistics instructors subscribed to statistics education listservs. Therefore, we suspect that they are more likely to adapt recommended practices, including computational practices, than the general population of instructors who teach introductory statistics.
- Item non-response may also positively bias the results.

Conclusions/Future Work

- In general, many introductory statistics courses are not providing students experiences with computation and data structures essential for modern scientific inquiry.
  - Many instructors are not teaching coding or having students use syntax-driven software, especially at two-year colleges.
  - Instructors who do teach coding are placing more emphasis on reading and modifying code than on creating and debugging code.
  - Although most instructors are using real data as recommended by GAISE[7], not many of them are giving students experience with data wrangling or working with large, complex, modern data sets.
- We are extending this work to develop an instrument to measure the extent to which computation practices (specifically, data, simulation, and coding practices) are included in the introductory statistics curriculum.

References

1. Horton, N. J., Baumer, B. S., & Wickham, H. (2014). Teaching precursors to data science in introductory and second courses in statistics. *arXiv:*1401.3269 [stat.CO]. https://arxiv.org/

2. Nolan, D., & Temple Lang, D. (2010). Computing in the statistics curricula. *The American Statistician, 64*(2), 97–107. https://doi.org/10.1198/tast.2010.09132

3. Cobb, G. (2015). Mere renovation is too little too late: We need to rethink our undergraduate curriculum from the ground up. *The American Statistician, 69*(4), 266–282. https://doi.org/10.1080/00031305.2015.1093029

4. Horton, N. J., & Hardin, J. S. (2015). Teaching the next generation of statistics students to "think with data". *The American Statistician*, *69*(4), 259–265. https://doi.org/10.1080/00031305.2015.1094283

5. Ridgway, J. (2016). Implications of the Data Revolution for Statistics Education: The Data Revolution and Statistics Education. *International Statistical Review*, *84*(3), 528–549. https://doi.org/10.1111/insr.12110

6. Zieffler, A., Park, J., Garfield, J., Delmas, R., & Bjornsdottir, A. (2012). The Statistics Teaching Inventory: A survey on statistics teachers' classroom practices and beliefs. *Journal of Statistics Education, 20*(1). https://doi.org/10.1080/10691898.2012.11889632

7. American Statistical Association. (2016). Guidelines for assessment and instruction in statistics education: College report. Author. http://www.amstat.org/education/gaise/

8. Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology, 25*(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5

9. DeLiema, D., Dahn, M. Flood, V. J., Asuncion, A., Abrahamson, D., Enyedy, N., & Steen, F. F. (2020). Debugging as a context for collaborative reflection on problem-solving processes. In E. Manolo (Ed.), *Deeper learning, communicative competence, and critical thinking: Innovative, research-based strategies for development in 21st century classrooms* (pp. 209–228). Routledge.

Additional Information