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1. CONGRATULATIONS!

Congratulations on running the reproduction pipeline! You can now follow the checklist in the `README.md` file to customize this pipeline to your exciting research project.

Just don't forget to *never* use numbers or fixed strings (for example database urls like <https://fits.gsfc.nasa.gov/samples>) directly within your \LaTeX source. Read them directly from your configuration files or outputs of the programs as part of the reproduction pipeline and import them into \LaTeX as macros through the `tex/pipeline.tex` file. See the several examples within the pipeline for a demonstration. For some recent real-world examples, the reproduction pipelines for Sections 4 and 7.3 of Bacon et al. (2017) are available at [zenodo.1164774](https://zenodo.org/record/1164774)¹, or [zenodo.1163746](https://zenodo.org/record/1163746)². Working in this way, will let you focus clearly on your science and not have to worry about fixing this or that number/name in the text.

Figure 1 shows a simple plot as a demonstration of creating plots within \LaTeX (using the PGFPlots package). The minimum value in this distribution is 1.000, and 2500.000 is the maximum. Take a look into the \LaTeX source and you'll see these numbers are actually macros that were calculated from the same dataset (they will change if the dataset, or function that produced it, changes).

The individual PDF file of Figure 1 is available under the `tex/build/tikz/` directory of your build directory. You can use this PDF file in other contexts (for example in slides showing your progress or after publishing the work). If you want to directly use the PDF file in the figure without having to let TiKZ decide if it should be remade or not, you can also comment the `makepdf` macro at the top of this \LaTeX source file.

Figure 2 is another demonstration of showing images (datasets) using PGFPlots. It shows a small crop of an image from the

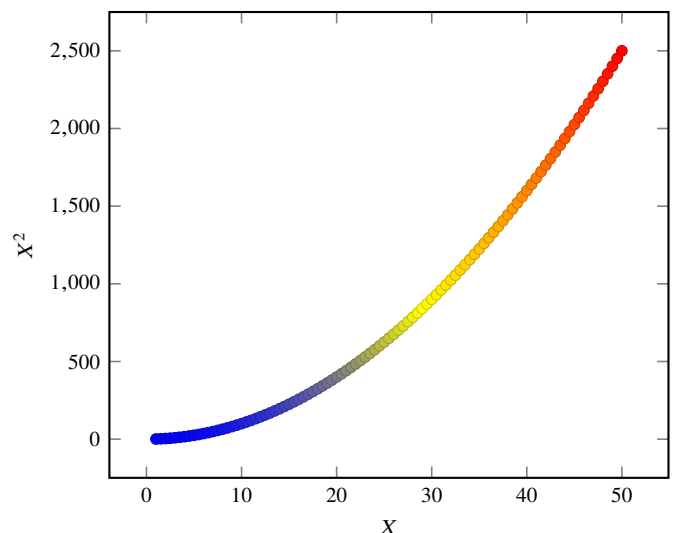


Figure 1: A very basic X^2 plot for demonstration.

Wide-Field Planetary Camera 2, on board the Hubble Space Telescope from 1993 to 2009. This cropped image is one of the sample FITS files from the FITS file standard webpage³. Just as another basic reporting of measurements on this dataset within the paper without using numbers in the \LaTeX source, the mean is 5.12 and the median is 0.86. The skewness in the histogram of Figure 2(b) explains this difference between the mean and median. The dataset was prepared for demonstration here with Gnuastro's `ConvertType` program and the histogram and basic statistics were generated with Gnuastro's `Statistics` program.

PGFPlots⁴ is a great tool to build the plots within \LaTeX and removes the necessity to add further dependencies (to create the plots) to your reproduction pipeline. There are high-level language libraries like Matplotlib which also generate plots. How-

¹ <https://gitlab.com/makhlaghi/muse-udf-origin-only-hst-magnitudes>

² <https://gitlab.com/makhlaghi/muse-udf-photometry-astrometry>

³ https://fits.gsfc.nasa.gov/fits_samples.html

⁴ <https://ctan.org/pkg/pgfplots>

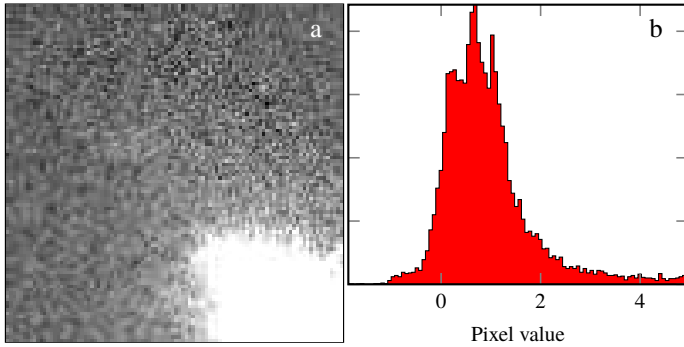


Figure 2: (a) An example image of the Wide-Field Planetary Camera 2, on board the Hubble Space Telescope from 1993 to 2009. This is one of the sample images from the FITS standard webpage, kept as examples for this file format. (b) Histogram of pixel values in (a).

ever, the problem is that they require many dependencies (Python, Numpy and etc). Installing these dependencies from source, is not easy and will harm the reproducibility of your paper. Note that after several years, the binary files of these high-level libraries, that you easily install today, will no longer be available in common repositories. Therefore building the libraries from source is the only option to reproduce your results.

Furthermore, since PGFPlots is built by \LaTeX it respects all the properties of your text (for example line width and fonts and etc). Therefore the final plot blends in your paper much more nicely. It also has a wonderful manual⁵.

This pipeline also defines two \LaTeX macros that allow you to mark text within your document as *new* and *notes*. For example, *this text has been marked as new*. [While this one is marked as *tonote*.] If you comment the line (by adding a ‘%’ at the start of the line or simply deleting the line) that defines `highlightchanges`, then the one that was marked *new* will become black (totally blend in with the rest of the text) and the one marked *tonote* will not be in the final PDF. You can thus use `highlightchanges` to easily make copies of your research for existing coauthors (who are just interested in the new parts or notes) and new co-authors (who don’t want to be distracted by these issues in their first time reading).

2. NOTICE AND CITATIONS

To encourage other scientists to publish similarly reproducible papers, please add a notice close to the start of your paper or in the end of the abstract clearly mentioning that your work is fully reproducible.

For the time being, we haven’t written a specific paper only for this reproduction pipeline, so until then, we would be grateful if you could cite the first paper that used the first version of this pipeline: Akhlaghi and Ichikawa (2015).

After publication, don’t forget to upload all the necessary data, software source code and the reproduction pipeline to a long-lasting host like Zenodo (<https://zenodo.org>).

⁵ <http://mirrors.ctan.org/graphics/pgf/contrib/pgfplots/doc/pgfplots.pdf>

3. ACKNOWLEDGEMENTS

Please include the following two paragraphs in the Acknowledgement section of your paper. This reproduction pipeline was developed in parallel with Gnuastro, so it benefited from the same grants. If you don’t use any of these packages in the final/customized pipeline, please remove them.

This research was partly done using GNU Astronomy Utilities (Gnuastro, ascl.net/1801.009) version 0.7.63-39ab, and reproduction pipeline v0-121-g22ac6cc. Work on Gnuastro and the reproduction pipeline has been funded by the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) scholarship and its Grant-in-Aid for Scientific Research (21244012, 24253003), the European Research Council (ERC) advanced grant 339659-MUSICOS, European Union’s Horizon 2020 research and innovation programme under Marie Skłodowska-Curie grant agreement No 721463 to the SUNDIAL ITN, and from the Spanish Ministry of Economy and Competitiveness (MINECO) under grant number AYA2016-76219-P.

The following free software tools were also critical component of this research (in alphabetical order): Bzip2 1.0.6, CFITSIO 3.45, CMake 3.12.4, cURL 7.62.0, Discoteq flock 0.2.3, Git 2.19.1, GNU Bash 4.4.18, GNU Coreutils 8.30, GNU AWK 4.2.1, GNU Grep 3.1, GNU Libtool 2.4.6, GNU Make 4.2.90, GNU Sed 4.5, GNU Scientific Library (GSL) 2.5, GNU Tar 1.30, GNU Which 2.21, Lzip 1.20, GPL Ghostscript 9.26, Libgit2 0.26.0, Libtiff 4.0.10, WCSLIB 6.2, XZ Utils 5.2.4, and ZLib 1.2.11. The final paper was produced with \TeX Live 2018, using the following packages: \TeX 3.14159265, EC 1.0, NewTX 1.554, Fontaxes 1.0d, Keyval, 2.7a, Etoolbox 2.5f, Xcolor 2.12, Setspace 6.7a, Caption 2018-10-05, Footmisc 5.5b, Datetime 2.60, Fmtcount 3.05, Titlesec 2.10.2, Preprint 2011, Ulem 2016-06-24, Bib \LaTeX 3.12, Biber 2.12, Logreq 1.0, PGF/TiKZ 3.0.1a, PGFPlots 1.16, FP 2016-06-24, Courier 2016-06-24, \TeX -gyre 2.501, TXFonts 2016-06-24, Times 2016-06-24. We are very grateful to all their creators for freely providing this necessary infrastructure. This research would not be possible without them.

References

- Akhlaghi, M. and T. Ichikawa (Sept. 2015). *ApJS*, 220, 1.
 Bacon, R. et al. (Nov. 2017). *A&A*, 608, A1.