Not just for programmers: A friendly guide on the versatility/benefits of GitHub for accelerating collaborative research in Ecology and Evolution

Authors

- **Hermione Jean Granger**
  [XXXX-XXXX-XXXX-XXXX](#) · [hermionejeangranger](#) · [hermionejeangranger](#)
  Department for the Regulation and Control of Magical Creatures, British Ministry of Magic, United Kingdom; Department of Magical Law Enforcement, British Ministry of Magic, United Kingdom · Funded by Hogwarts Grant XXXXXX-XX.

- **Dylan G. E. Gomes**
  [0000-0002-2642-3728](#) · [dylangomes](#)
  Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Oregon State University, Newport, OR, United States

- **Cole B. Brookson**
  [0000-0003-1237-4096](#) · [colebrookson](#)
  Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada

- **Robert Crystal-Ornelas**
  [0000-0002-6339-1139](#) · [robcrystalornelas](#) · [rob_c_ornelas](#)
  Earth and Environmental Sciences Area, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

- **Ali Guncan**
  [0000-0003-1765-648X](#) · [Aguncan](#) · [aliguncan](#)
  Department of Plant Protection, Faculty of Agriculture, Ordu University, 52200, Ordu, Turkey

- **Brandon P.M. Edwards**
  [0000-0003-0865-3076](#) · [BrandonEdwards](#)
  Department of Biology, Carleton University, Ottawa, ON K1S 5B6, Canada

Abstract

Importance

Introduction

High-level/general background about GitHub

contributors to this section: RCO,

The software development community has used the web platform GitHub, and its underlying version control system Git to collaboratively work on code. Now has over 73 million registered users (GitHub, 2020). As ecologists and evolutionary biologists start to use and collaborate on computer code as part of their research many are interacting with GitHub for the first time. We are focusing on how researchers in EEB can leverage existing tools to make the most out of their research and collaboartive projects. Acknowledge that some of the GitHub features are made with software development in mind, and that one of the goals of this paper is to 'translate' the features into uses for EEB

What's already been written about GitHub

contributors to this section: There's lots of detailed info in other papers about version control. Much less about using it as a tool for **collaboration**! We'll avoid going into the underlying version control language (called git) since that discussion can get very technical very quick, and there are already many papers (Blischak et al. 2016; Perez-Riverol, 2016), books (Bryan 2018), tutorials go into that. More importantly, the GitHub platform is so robust at this point, that you can take advantage of many collaborative aspects without knowing even a line of Git code.

What's already been done with GitHub in EcoEvo

contributors to this section: Very friendly description of what GitHub is and the main uses and advantages of using it in the natural sciences back in 2016 (Perkel 2016) What's missing about GitHub in EcoEvo and our objective: Introducing the GitHub ecosystem that's composed of many different elements!

What's missing about GitHub in EcoEvo and our objective

contributors to this section: Simple habits (of which github is one component) can do a lot to make research more reproducible and collaborative (Alston and Rick 2021). In EcoEvo Github use is predicated on an understanding in R. This close connection has some benefits, but other programming languages are frequently used by researchers (e.g. Python, Julia). Lots of ways to use GitHub that are independent from R. We have in this hackathon a definite focus on R tools for interacting with GitHub, but sometimes the issues we present at 'Github' issues might be more about the ways that we interact with Github (i.e. through R vs. bash shell)

Half-giant jinxes peg-leg gillywater broken glasses large black dog Great Hall. [1] Nearly-Headless Nick now string them together, and answer me this, which creature would you be unwilling to kiss? Poltergeist sticking charm, troll umbrella stand flying cars golden locket Lily Potter. Pumpkin juice Trevor wave your wand out glass orbs, a Grim knitted hats. Bred in captivity fell through the veil, quaffle blue flame ickle diddykins Aragog [2]. Yer a wizard, Harry Doxycide the woes of Mrs. Weasley Goblet of Fire.

Discussion

Topic A

Padfoot snargaluff seeker: Hagrid broomstick mischief managed. Snitch Fluffy rock-cake, 9 ¾ dress robes I must not tell lies. Mudbloods yew pumpkin juice phials Ravenclaw's Diadem 10 galleons Thieves Downfall.

GitHub in EcoEvo examples (Part 1)

Storing and archiving version-controlled data

contributors to this section: Another potential use case/user perspective: Some people are just using GitHub to backup their data, use their code on differnt machines. Just push and pull (Box 1) from their own repo. GitHub integrates with Zenodo, a popular, free data archiving service funded by CERN. After linking your GitHub account to Zenodo and turning on archiving, any time a release (Box 1) is made, a snapshot of the entire repository is archived in Zenodo with a versioned, citable DOI

Virtual lab notebook

contributors to this section: commits as a way to record daily progress issues as a way to keep track of short-term objectives/goals, and progress towards them

Responding to reviewer comments

contributors to this section: using github issues (Box 1) to organize and respond to reviewer comments on a manuscript. See example [here](#)

Classroom teaching / educational materials

contributors to this section: Matthew D. Beckman, Mine Çetinkaya-Rundel, Nicholas J. Horton, Colin W. Rundel, Adam J. Sullivan & Maria Tackett (2021) Implementing Version Control With Git and GitHub as a Learning Objective in Statistics and Data Science Courses, Journal of Statistics and Data Science Education, 29:sup1, S132-S144, DOI: 10.1080/10691898.2020.1848485

Discussion

Topic A

Padfoot snargaluff seeker: Hagrid broomstick mischief managed. Snitch Fluffy rock-cake, 9 ¾ dress robes I must not tell lies. Mudbloods yew pumpkin juice phials Ravenclaw's Diadem 10 galleons Thieves Downfall.

GitHub in EcoEvo examples (Part 2)

Project management

Contributors to this section: issue & discussion features - can assign tasks, seek feedback, bounce ideas around, troubleshoot problems. Can talk about ESS-DIVE's project management using ZenHub/Jira

Building website

Contributors to this section: Seems like the technical aspect of this is discussed in Dawson, Chris (2016). Building Tools with GitHub: Customize Your Workflow. O'Reilly Media GitHub pages allows any .html document to be rendered as a website with a URL. This could be, for example, a report written in markdown or R Markdown rendered into a .html file.

Making code citable

Contributors to this section: Linking with Zenodo, etc. to achieve a DOI helps work become findable, gives proper attribution (Hampton et al. 2015) It is important to remember that GitHub is NOT a long-term data/code repository by itself (accounts can be deleted at will), so adding GitHub links in papers (which I've seen plenty of times), is not a good practice (imo). Instead, including a DOI (like above bullet) is better.

Collaborative (code) editing

Contributors to this section: Is it worth walking through how collaborative code editing works through GitHub, or just pointing to all the available resources for this? (e.g. https://docs.github.com/en/pull-requests/collaborating-with-pull-requests/incorporating-changes-from-a-pull-request/merging-a-pull-request)

Writing manuscript

contributors to this section: Caveat that GitHub has been called out for not being so user-friendly for manuscript development (Ram 2013). But getting better? Tools that link with GitHub have been developed with synchronous writing in mind. HackMD provides a collaborative writing platform based on Markdown that integrates with GitHub.
We used this platform early on in the process of writing this manuscript to generate an outline.

Topic C

Padfoot snargaluff seeker: Hagrid broomstick mischief managed. Snitch Fluffy rock-cake, 9 ¾ dress robes I must not tell lies. Mudbloods yew pumpkin juice phials Ravenclaw's Diadem 10 galleons Thieves Downfall.

GitHub in EcoEvo examples (Part 3)

Open science discussion

Contributors to this section: https://github.community/ GitHub new discussion tool

Project continuity

Contributors to this section: 'thus preserving the long-term integrity of the project even as collaborations form and shift.' (Hampton et al. 2015) better to have old versions on GitHub than on somebody's personal hard drive!

Asycnhronous working

Contributors to this section:

GitHub organizations

Contributors to this section: Lab organization as a place to house research compendia as well as codes of conduct, protocols, training documents, etc. (documents that evolve over time and are shaped collaboratively) Students can have full ownership over repositories in organization, but stay with the lab after they've left.

Misc other uses

Contributors to this section: Developing data standards - This is pretty specific case from our team at Berkeley Lab, so I can write about it in a sentence or two here. Code review rOpenSci's code review process, and also caught mistakes in code of published papers that could have been caught in peer code review. Also maybe say something about ReproHack.

Conclusion

Discussion

General pargrah on what GitHub can enable in EcoEvo

General paragraph on GitHub on how, given all the potential uses of GitHub, it can enable more collaborative EcoEvo research Despite all the awesomeness of GitHub, there are still plenty of times when you might look to other plantforms for collaboration

Why aren't more people using GitHub?

Learning to use Github requires time, but the payoff is *[may be?]* worth it. Time vs. effort examples or analyses to demonstrate the payoff can help drive the point home to convince people to learn these tools

Limitations

Our own limitations since we are mostly writing from the EcoEvo perspective/ additional github limitation Reliance on R since we are generally in EcoEvo Discussion of free vs. paid plans. When projects get highly collaborative may have to add / pay for accounts. At this point, little difference between paid and free.

Using GitHub is a good start, but lots of practices to make repo more user friendly

end off with our 5/10 tips for how to gain knowledge/practice with GitHub here

Conclusion

Acknowledgements

Code and data availability

The source code and data for this manuscript are available at https://github.com/SORTEE-Github-Hackathon/manuscript.

Section to be deleted

This manuscript is a template (aka "rootstock") for [Manubot](#), a tool for writing scholarly manuscripts. Use this template as a starting point for your manuscript.

The rest of this document is a full list of formatting elements/features supported by Manubot. Compare the input (`.md` files in the `/content` directory) to the output you see below.

Basic formatting

Bold text

Semi-bold text

<div align="center">Centered text</div>

<div align="right">Right-aligned text</div>

Italic text

Combined *italics and **bold***

~~Strikethrough~~

1. Ordered list item
2. Ordered list item
   a. Sub-item
   b. Sub-item
      i. Sub-sub-item
3. Ordered list item
   a. Sub-item

- List item
- List item
- List item

subscript: H_2O is a liquid

superscript: 2^{10} is 1024.

[unicode superscripts](#)^{0123456789}

[unicode subscripts](#)$_{0123456789}$

A long paragraph of text. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Putting each sentence on its own line has numerous benefits with regard to [editing](#) and [version control](#).

Line break without starting a new paragraph by putting
two spaces at end of line.

Document organization

Document section headings:

Heading 1

Heading 2

Heading 3

Heading 4

Heading 5

Heading 6

A heading centered on its own printed page

Horizontal rule:

`Heading 1`'s are recommended to be reserved for the title of the manuscript.

`Heading 2`'s are recommended for broad sections such as *Abstract*, *Methods*, *Conclusion*, etc.

`Heading 3`'s and `Heading 4`'s are recommended for sub-sections.

Links

Bare URL link: https://manubot.org

Long link with lots of words and stuff and junk and bleep and blah and stuff and other stuff and more stuff yeah

Link with text

Link with hover text

Link by reference

Citations

Citation by DOI [3].

Citation by PubMed Central ID [4].

Citation by PubMed ID [5].

Citation by Wikidata ID [6].

Citation by ISBN [7].

Citation by URL [8].

Citation by alias [9].

Multiple citations can be put inside the same set of brackets [3,7,9]. Manubot plugins provide easier, more convenient visualization of and navigation between citations [4,5,9,10].

Citation tags (i.e. aliases) can be defined in their own paragraphs using Markdown's reference link syntax:

Referencing figures, tables, equations

Figure 5

Figure 6

Quotes and code

> Quoted text

> Quoted block of text
>
> Two roads diverged in a wood, and I—
> I took the one less traveled by,
> And that has made all the difference.

Code `in the middle` of normal text, aka `inline code`.

Code block with Python syntax highlighting:

```python
from manubot.cite.doi import expand_short_doi

def test_expand_short_doi():
    doi = expand_short_doi("10/c3bp")
    # a string too long to fit within page:
    assert doi == "10.25313/2524-2695-2018-3-vliyanie-enhansera-copia-i-
        insulyatora-gypsy-na-sintez-ernk-modifikatsii-hromatina-i-
        svyazyvanie-insulyatornyh-belkov-vtransfetsirovannyh-geneticheskih-
        konstruktsiyah"
```

Code block with no syntax highlighting:

```
Exporting HTML manuscript
Exporting DOCX manuscript
Exporting PDF manuscript
```
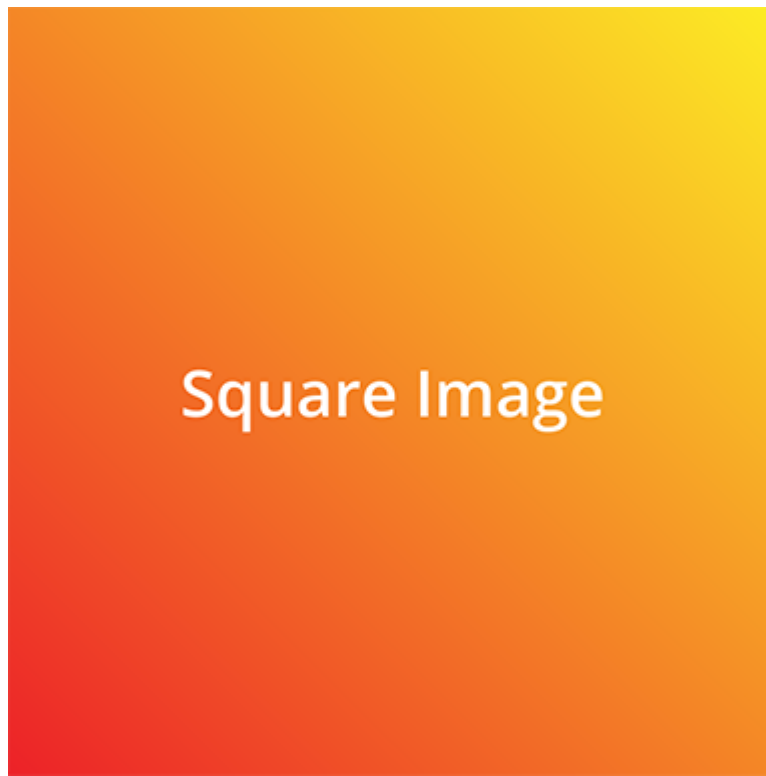
Figures

Figure 1: A square image at actual size and with a bottom caption. Loaded from the latest version of image on GitHub.
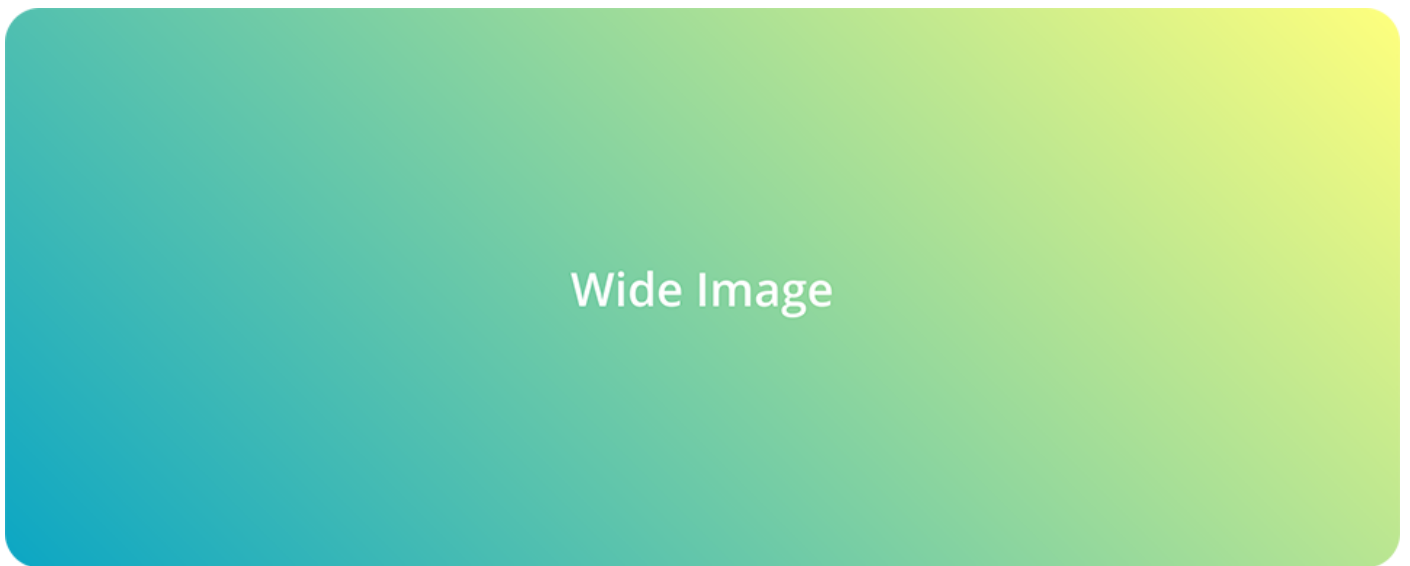

Figure 2: An image too wide to fit within page at full size. Loaded from a specific (hashed) version of the image on GitHub.
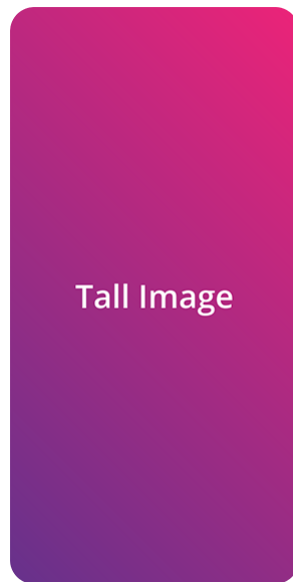
Figure 3: A tall image with a specified height. Loaded from a specific (hashed) version of the image on GitHub.

Figure 4: A vector `.svg` image loaded from GitHub. The parameter `sanitize=true` is necessary to properly load SVGs hosted via GitHub URLs. White background specified to serve as a backdrop for transparent sections of the image.

Tables

Table 1: A table with a top caption and specified relative column widths.

Bowling Scores	Jane	John	Alice	Bob
Game 1	150	187	210	105
Game 2	98	202	197	102
Game 3	123	180	238	134

Table 2: A table too wide to fit within page.

	Digits 1-33	Digits 34-66	Digits 67-99	Ref.
pi	3.14159265358979323 846264338327950	28841971693993751 0582097494459230	78164062862089986 2803482534211706	`piday.org`
e	2.71828182845904523 536028747135266	24977572470936999 5957496696762772	40766303535475945 7138217852516642	`nasa.gov`

Table 3: A table with merged cells using the `attributes` plugin.

	Colors	
Size	**Text Color**	**Background Color**
big	blue	orange
small	black	white

Equations

A LaTeX equation:

$$\int_0^\infty e^{-x^2} dx = \frac{\sqrt{\pi}}{2} \tag{1}$$

An equation too long to fit within page:

$$\begin{aligned}
x = a + b + c + d + e + f + g + h + i + j + k + l + m + n + o + p + q + r + s + t \\
+ u + v + w + x + y + z + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9
\end{aligned} \tag{2}$$

Special

⚠ **WARNING** *The following features are only supported and intended for* `.html` *and* `.pdf` *exports. Journals are not likely to support them, and they may not display correctly when converted to other formats such as* `.docx` *.*

[**LINK STYLED AS A BUTTON**]

Adding arbitrary HTML attributes to an element using Pandoc's attribute syntax:

> Manubot Manubot Manubot Manubot Manubot. Manubot Manubot Manubot Manubot. Manubot Manubot Manubot. Manubot Manubot. Manubot.

Adding arbitrary HTML attributes to an element with the Manubot `attributes` plugin (more flexible than Pandoc's method in terms of which elements you can add attributes to):

> Manubot Manubot Manubot Manubot Manubot. Manubot Manubot Manubot Manubot. Manubot Manubot Manubot. Manubot Manubot. Manubot.

Available background colors for text, images, code, banners, etc:

white `lightgrey` `grey` `darkgrey` `black` `lightred` `lightyellow` `lightgreen` `lightblue` `lightpurple` `red` `orange` `yellow` `green` `blue` `purple`

Using the [Font Awesome](#) icon set:

✔ ? ★ 🔔 ✖ ⋯

> 📜 **Light Grey Banner**
> useful for *general information* - <ins>manubot.org</ins>

> ℹ️ **Blue Banner**
> useful for *important information* - <ins>manubot.org</ins>

> 🚫 **Light Red Banner**
> useful for *warnings* - <ins>manubot.org</ins>

Acknowledgements

Code and data availability

The source code and data for this manuscript are available at https://github.com/SORTEE-Github-Hackathon/manuscript.

Section to be deleted

This manuscript is a template (aka "rootstock") for [Manubot](#), a tool for writing scholarly manuscripts. Use this template as a starting point for your manuscript.

The rest of this document is a full list of formatting elements/features supported by Manubot. Compare the input (`.md` files in the `/content` directory) to the output you see below.

Basic formatting

Bold text

Semi-bold text

<div align="center">Centered text</div>

<div align="right">Right-aligned text</div>

Italic text

Combined *italics and **bold***

~~Strikethrough~~

1. Ordered list item
2. Ordered list item
   a. Sub-item
   b. Sub-item
      i. Sub-sub-item
3. Ordered list item
   a. Sub-item

- List item
- List item
- List item

subscript: H_2O is a liquid

superscript: 2^{10} is 1024.

[unicode superscripts](#)⁰¹²³⁴⁵⁶⁷⁸⁹

[unicode subscripts](#)₀₁₂₃₄₅₆₇₈₉

A long paragraph of text. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Putting each sentence on its own line has numerous benefits with regard to [editing](#) and [version control](#).

Line break without starting a new paragraph by putting
two spaces at end of line.

Document organization

Document section headings:

Heading 1

Heading 2

Heading 3

Heading 4

Heading 5

Heading 6

A heading centered on its own printed page

Horizontal rule:

`Heading 1`'s are recommended to be reserved for the title of the manuscript.

`Heading 2`'s are recommended for broad sections such as *Abstract*, *Methods*, *Conclusion*, etc.

`Heading 3`'s and `Heading 4`'s are recommended for sub-sections.

Links

Bare URL link: https://manubot.org

[Long link with lots of words and stuff and junk and bleep and blah and stuff and other stuff and more stuff yeah](#)

[Link with text](#)

[Link with hover text](#)

[Link by reference](#)

Citations

Citation by DOI [3].

Citation by PubMed Central ID [4].

Citation by PubMed ID [5].

Citation by Wikidata ID [6].

Citation by ISBN [7].

Citation by URL [8].

Citation by alias [9].

Multiple citations can be put inside the same set of brackets [3,7,9]. Manubot plugins provide easier, more convenient visualization of and navigation between citations [4,5,9,10].

Citation tags (i.e. aliases) can be defined in their own paragraphs using Markdown's reference link syntax:

Referencing figures, tables, equations

Figure [5](#)

Figure [6](#)

Quotes and code

> Quoted text

> Quoted block of text
>
> Two roads diverged in a wood, and I—
> I took the one less traveled by,
> And that has made all the difference.

Code `in the middle` of normal text, aka `inline code`.

Code block with Python syntax highlighting:

```python
from manubot.cite.doi import expand_short_doi

def test_expand_short_doi():
    doi = expand_short_doi("10/c3bp")
    # a string too long to fit within page:
    assert doi == "10.25313/2524-2695-2018-3-vliyanie-enhansera-copia-i-
        insulyatora-gypsy-na-sintez-ernk-modifikatsii-hromatina-i-
        svyazyvanie-insulyatornyh-belkov-vtransfetsirovannyh-geneticheskih-
        konstruktsiyah"
```

Code block with no syntax highlighting:

```
Exporting HTML manuscript
Exporting DOCX manuscript
Exporting PDF manuscript
```
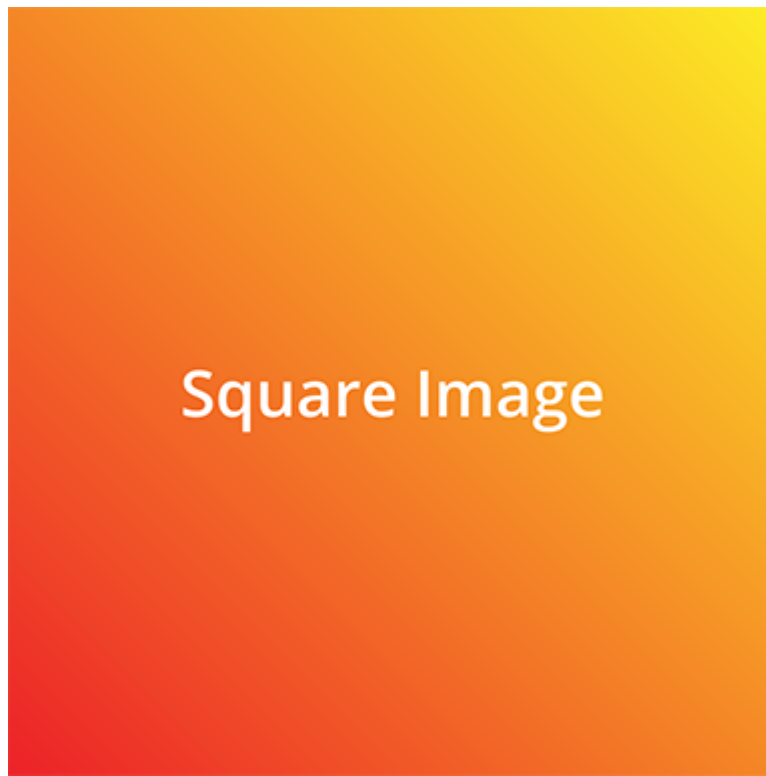
Figures

Figure 5: A square image at actual size and with a bottom caption. Loaded from the latest version of image on GitHub.
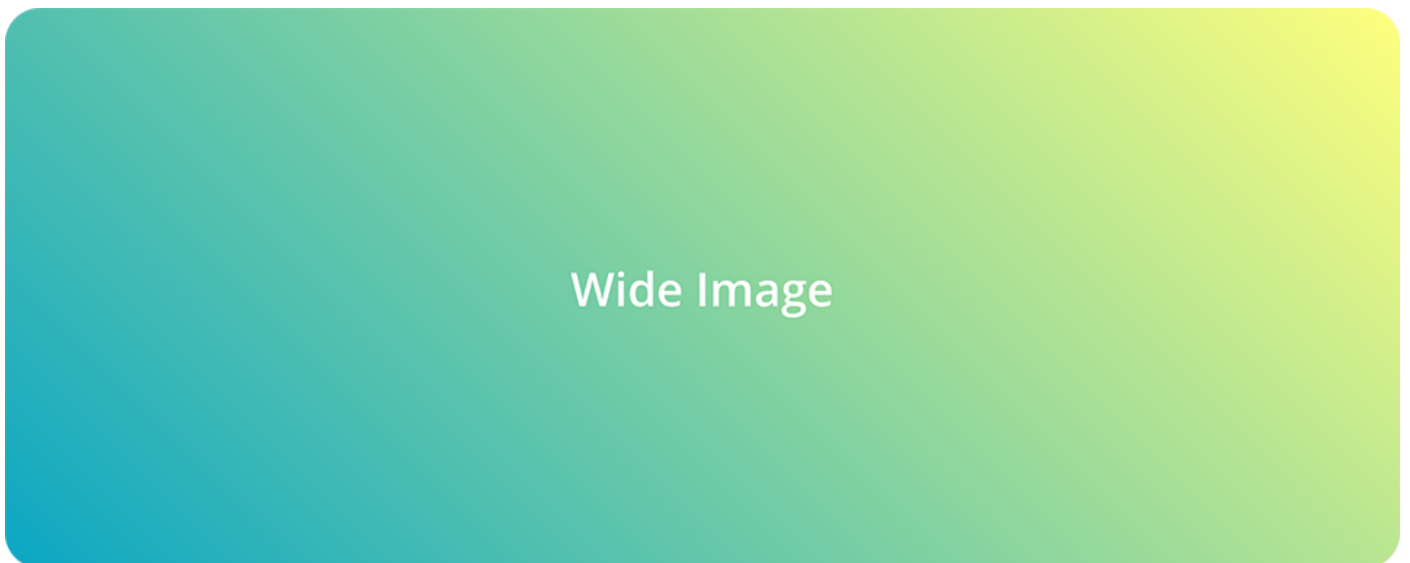

Figure 6: An image too wide to fit within page at full size. Loaded from a specific (hashed) version of the image on GitHub.
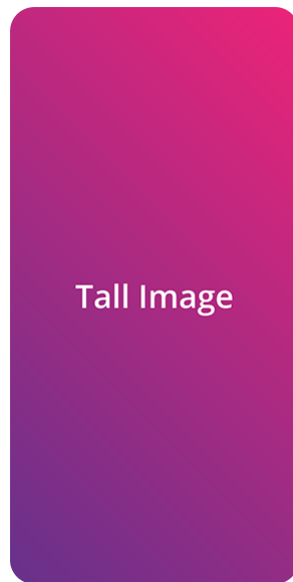
Figure 7: A tall image with a specified height. Loaded from a specific (hashed) version of the image on GitHub.

Figure 8: A vector `.svg` image loaded from GitHub. The parameter `sanitize=true` is necessary to properly load SVGs hosted via GitHub URLs. White background specified to serve as a backdrop for transparent sections of the image.

Tables

Table 4: A table with a top caption and specified relative column widths.

Bowling Scores	Jane	John	Alice	Bob
Game 1	150	187	210	105
Game 2	98	202	197	102
Game 3	123	180	238	134

Table 5: A table too wide to fit within page.

	Digits 1-33	Digits 34-66	Digits 67-99	Ref.
pi	3.14159265358979323 846264338327950	28841971693993751 0582097494459230	78164062862089986 2803482534211706	`piday.org`
e	2.71828182845904523 536028747135266	24977572470936999 5957496696762772	40766303535475945 7138217852516642	`nasa.gov`

Table 6: A table with merged cells using the `attributes` plugin.

	Colors	
Size	**Text Color**	**Background Color**
big	blue	orange
small	black	white

Equations

A LaTeX equation:

$$\int_0^\infty e^{-x^2} dx = \frac{\sqrt{\pi}}{2} \tag{3}$$

An equation too long to fit within page:

$$x = a + b + c + d + e + f + g + h + i + j + k + l + m + n + o + p + q + r + s + t \\ + u + v + w + x + y + z + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 \tag{4}$$

Special

⚠ **WARNING** *The following features are only supported and intended for* `.html` *and* `.pdf` *exports. Journals are not likely to support them, and they may not display correctly when converted to other formats such as* `.docx` *.*

> LINK STYLED AS A BUTTON

Adding arbitrary HTML attributes to an element using Pandoc's attribute syntax:

> Manubot Manubot Manubot Manubot Manubot. Manubot Manubot Manubot Manubot. Manubot Manubot Manubot. Manubot Manubot. Manubot.

Adding arbitrary HTML attributes to an element with the Manubot `attributes` plugin (more flexible than Pandoc's method in terms of which elements you can add attributes to):

> Manubot Manubot Manubot Manubot Manubot. Manubot Manubot Manubot Manubot. Manubot Manubot Manubot. Manubot Manubot. Manubot.

Available background colors for text, images, code, banners, etc:

`white` `lightgrey` `grey` `darkgrey` `black` `lightred` `lightyellow` `lightgreen` `lightblue` `lightpurple` `red` `orange` `yellow` `green` `blue` `purple`

Using the [Font Awesome](#) icon set:

✔ ? ★ 🔔 ✖ ⋯

🏮 Light Grey Banner

useful for *general information* - manubot.org

ⓘ Blue Banner

useful for *important information* - manubot.org

🚫 Light Red Banner

useful for *warnings* - manubot.org

References

1. **Harry Potter and the sorcerer's stone**
   JK Rowling, Mary GrandPr??, Scholastic Inc
   (1998)
   ISBN: 9780590353427

2. **Using Placeholder Text in Narrative Open-Ended Questions in Web Surveys**
   Tanja Kunz, Franziska Quoß, Tobias Gummer
   Journal of Survey Statistics and Methodology (2021-11-01) https://doi.org/gnqqcf
   DOI: 10.1093/jssam/smaa039

3. **Sci-Hub provides access to nearly all scholarly literature**
   Daniel S Himmelstein, Ariel Rodriguez Romero, Jacob G Levernier, Thomas Anthony Munro,
   Stephen Reid McLaughlin, Bastian Greshake Tzovaras, Casey S Greene
   eLife (2018-03-01) https://doi.org/ckcj
   DOI: 10.7554/elife.32822 · PMID: 29424689 · PMCID: PMC5832410

4. **Reproducibility of computational workflows is automated using continuous analysis**
   Brett K Beaulieu-Jones, Casey S Greene
   Nature biotechnology (2017-04) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6103790/
   DOI: 10.1038/nbt.3780 · PMID: 28288103 · PMCID: PMC6103790

5. **Bitcoin for the biological literature.**
   Douglas Heaven
   Nature (2019-02) https://www.ncbi.nlm.nih.gov/pubmed/30718888
   DOI: 10.1038/d41586-019-00447-9 · PMID: 30718888

6. **Plan S: Accelerating the transition to full and immediate Open Access to scientific publications**
   cOAlition S
   (2018-09-04) https://www.wikidata.org/wiki/Q56458321

7. **Open access**
   Peter Suber
   MIT Press (2012)
   ISBN: 9780262517638

8. **Open collaborative writing with Manubot**
   Daniel S Himmelstein, Vincent Rubinetti, David R Slochower, Dongbo Hu, Venkat S Malladi,
   Casey S Greene, Anthony Gitter
   Manubot (2020-05-25) https://greenelab.github.io/meta-review/

9. **Opportunities and obstacles for deep learning in biology and medicine**
   Travers Ching, Daniel S Himmelstein, Brett K Beaulieu-Jones, Alexandr A Kalinin, Brian T Do,
   Gregory P Way, Enrico Ferrero, Paul-Michael Agapow, Michael Zietz, Michael M Hoffman, …
   Casey S Greene
   Journal of The Royal Society Interface (2018-04-04) https://doi.org/gddkhn
   DOI: 10.1098/rsif.2017.0387 · PMID: 29618526 · PMCID: PMC5938574

10. **Open collaborative writing with Manubot**
    Daniel S Himmelstein, Vincent Rubinetti, David R Slochower, Dongbo Hu, Venkat S Malladi,
    Casey S Greene, Anthony Gitter
    PLOS Computational Biology (2019-06-24) https://doi.org/c7np