# Predicting Compressive strength of Concrete using Machine learning

This manuscript (<u>permalink</u>) was automatically generated from <u>uiceds/cee-492-term-project-fall-2022-avk@870d592</u> on September 23, 2022.

## **Authors**

#### Andrew Bushnell

• • andrewb7777

Department of CEE, University of Illinois

#### Kanchan Kulhalli

• • Kanchan-uiuc

Department of CEE, University of Illinois

#### • Vikram Gadge

· 🗘 vgadge2

Department of CEE, University of Illinois

Using a data set covering the concrete compressive strength of a variety of different mixture components, we are going to create a machine learning program that will be able to predict when concrete failures will occur, which components and the combinations of these components will work best based on strength requirements of certain structures, and predict maximum allowable loads that can be achieved based on the mixtures.

Using these future trends we will we be able to reach certain conclusions on the future improvements, designs, and materials that should be used in certain structures that we will be able to present to individuals in the fields that use these structures. They then can use these recommendations in their future projects. We will be using the data set of "Concrete Compressive Strength" which was obtained using Kaggle.com (1). We will compile all of the data into specific tables and use them to create the future trends we stated above. The Data set consists of 8 quantitative inputs and 1 quantitative output as columns and toatl 1030 instances that are presented as rows.

We will be creating new tables and figures that will be of comparisons of: when the concrete fails vs the concrete material, strength of concrete vs water to cement ratio, concrete composition vs concrete strength, max allowable loads vs concrete material, max allowable loads vs concrete permutations.

We intend to use Julia to compile these new tables using machine learning tools that can be used to predict permutations and combinations, concrete to water ratios, etc that are not specifically included within the data set so we can accurately predict these unknown values that can than be used to run theoretical tests in real life construction project scenarios.

This manuscript is a template (aka "rootstock") for <u>Manubot</u>, 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

Centered text

Right-aligned text

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<sub>2</sub>O is a liquid

superscript: 2<sup>10</sup> is 1024.

unicode superscripts<sup>0123456789</sup>

unicode subscripts<sub>0123456789</sub>

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 <u>editing</u> and <u>version</u> <u>control</u>.

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



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

<u>Long link with lots of words and stuff and junk and bleep and blah and stuff and other stuff and more stuff yeah</u>

Link with text

Link with hover text

Link by reference

### **Citations**

Citation by Kaggle [Mehdinia.September2020.Concrete Compressive Strength].

Citation by PubMed Central ID [1].

Citation by PubMed ID [2].

Citation by Wikidata ID [3].

Citation by ISBN [4].

Citation by URL [5].

Citation by alias [6].

Multiple citations can be put inside the same set of brackets [4,6,7]. Manubot plugins provide easier, more convenient visualization of and navigation between citations [1,2,6,8].

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

## Referencing figures, tables, equations

Figure 1

Figure 2

Figure 3

```
Figure <u>4</u>

Table <u>1</u>

Equation <u>1</u>

Equation <u>2</u>
```

## **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:

```
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
е	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:

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

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

## **1** Blue Banner

useful for important information - manubot.org

**♦ Light Red Banner** useful for *warnings* - <u>manubot.org</u>

## References

### 1. Reproducibility of computational workflows is automated using continuous analysis

Brett K Beaulieu-Jones, Casey S Greene

Nature biotechnology (2017-04) <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6103790/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6103790/</a>

DOI: 10.1038/nbt.3780 · PMID: 28288103 · PMCID: PMC6103790

#### 2. Bitcoin for the biological literature.

Douglas Heaven

Nature (2019-02) https://www.ncbi.nlm.nih.gov/pubmed/30718888

DOI: <u>10.1038/d41586-019-00447-9</u> · PMID: <u>30718888</u>

## 3. 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

#### 4. Open access

Peter Suber

*MIT Press* (2012)

ISBN: 9780262517638

## 5. **Concrete Compressive Strength** <a href="https://www.kaggle.com/datasets/sinamhd9/concrete-comprehensive-strength">https://www.kaggle.com/datasets/sinamhd9/concrete-comprehensive-strength</a>

#### 6. 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) https://doi.org/gddkhn

DOI: 10.1098/rsif.2017.0387 · PMID: 29618526 · PMCID: PMC5938574

#### 7. 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/ckci

DOI: 10.7554/elife.32822 · PMID: 29424689 · PMCID: PMC5832410

#### 8. 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) <a href="https://doi.org/c7np">https://doi.org/c7np</a>

DOI: 10.1371/journal.pcbi.1007128 · PMID: 31233491 · PMCID: PMC6611653