Fractal Analysis as Method for studying Social Hierarchy in Prehistoric Settlement Plans

with case studies from the Linear Pottery and Trypillia cultures (5.500 - 3.500 cal. BCE)

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Contents

Preface

Thanks to everyone.

fdfasdf add citation Arponen et al. (2016).

This is a *sample* book written in **Markdown**. You can use anything that Pandoc's Markdown supports, e.g., a math equation $a^2 + b^2 = c^2$.

The **bookdown** package can be installed from CRAN or Github:

```
install.packages("bookdown")
# or the development version
# devtools::install_github("rstudio/bookdown")
```

Remember each Rmd file contains one and only one chapter, and a chapter is defined by the first-level heading `#`.

To compile this example to PDF, you need XeLaTeX. You are recommended to install TinyTeX (which includes XeLaTeX): https://yihui.name/tinytex/.

Part I

Frameworks

Chapter 1

Introduction

1.1 Background of the project

1.2 Research question and objectives

What are my goals for this project?

Two approaches: house-size distributions and settlement layouts

1.3 Some definitions

Hierarchy

Inequality

Scale

1.4 Main findings here?

1.5 Research ethics

- Open science and open-source scripts
- Terminology and spelling (British English for text. For geographical place names, Slovak special characters are kept as far as possible, even though it can be a pain in the xxx to render in Rmarkdown on Windows OS, and the 2010 Ukranian National transliteration system with only ASCII characters and no soft sign)
- Abstracts in Slovak and Ukranian (and not only in Norwegian)

1.6 Structure of the thesis

Interdisciplinary subject and no single history of research chapter.

Accessibility, non-specialised readers: technical details are, as far as possible, limited to the dedicated chapters (**??**).

Describe the parts (including this one).

Text

Here I skipped a line.
Here I added a backslash.

fdsasdfasdf You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter **??**. If you do not manually label them, there will be automatic labels anyway, e.g., Chapter **??**.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

```
par(mar = c(4, 4, .1, .1))
plot(pressure, type = 'b', pch = 19)
```

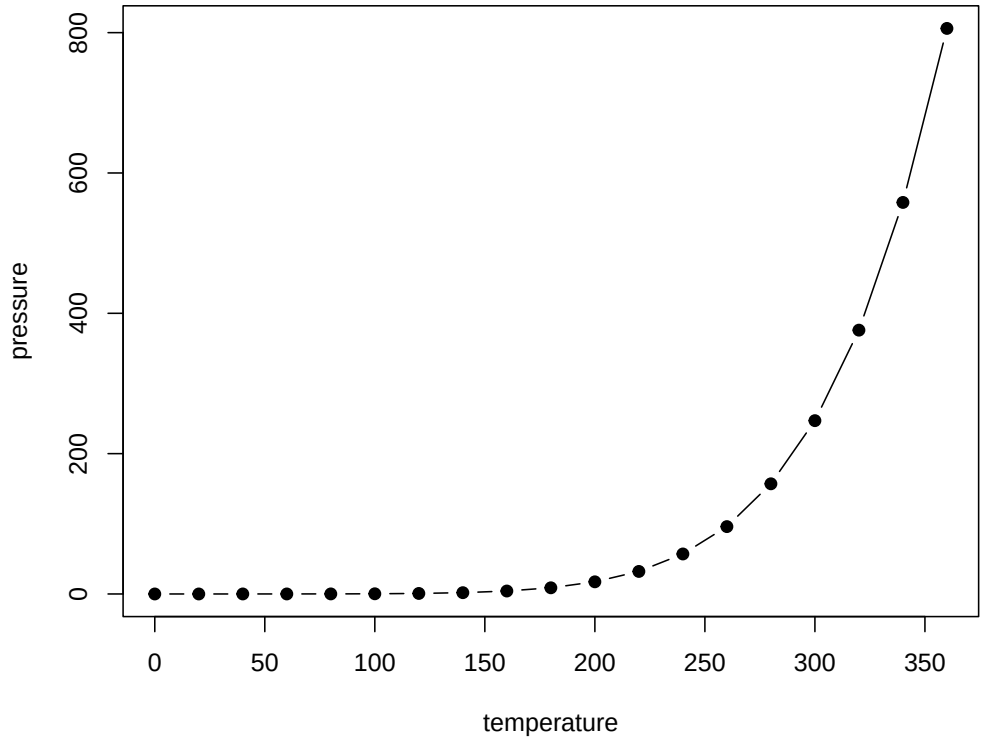

Figure 1.1: Here is a nice figure!

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 1.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 1.1.

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

You can write citations, too. For example, we are using the **bookdown** package (Xie, 2022) in this sample book, which was built on top of R Markdown and **knitr** (Xie, 2015).

Table 1.1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

Chapter 2

Material and data: social complexity in the European Neolithic

2.1 Studying social complexity in Archaeology and Prehistory.

- Grave goods
- Burial monuments
- The denominator problem
- The use of ethnography
- Other approaches (osteological, isotopes **refs**)
- This project: house-size distributions and settlement layouts (details in subsequent chapters), just very short argumentation

2.2 The Linear Pottery culture complex

- General intro to the culture
- The Žitava valley and research project

- Organisation of Linear Pottery society: egalitarian or hierarchic?

2.3 The Cucutení-Trypillia culture complex

- General intro to the culture
- The B2/C1 and the mega-sites of the Southern Bugh - Dnipro interfluve

2.4 Reading site plans from geomagnetic imagery

2.5 Synthetic data

- And why I'm not (yet) relying on ethnographic data.
- Don't go into technicalities here, just the reasoning.

Chapter 3

Theoretical framework: Complexity and Fractals

3.1 Very short introduction to Complexity Theory / Dynamical Systems Theory

Lit. use Daems (2021) and Bentley and Maschner (2007).

For Dynamical Systems, use Awrejcewicz and Grzelczyk (2020) and Devaney (2020), but don't go into detail.

Describe complexity, dynamical systems, chaos, feedback loops, criticality, emergence.

Mention the most common applications in Archaeology: ABMs, **and what**? check in literature.

3.2 Very short introduction to Fractals and Fractal Analysis

Lit. use Mandelbrot (1982), Falconer and Falconer (2013) (general), also Brown and Liebovitch (2010), Brown et al. (2005) and Diachenko (2018) (for Archaeology)

Two sentences on history of fractals? Mandelbrot. Maybe cut?

Fractals as irregular patterns/structures

Fractals as hierarchy

Self-similarity and scale invariance

Processes/mechanisms that produce fractals:

- Cascading bifurcations and confluences (splitting or merging - tree structure/arborescence/branching, and relation to size. Terminology borrowed from biology and fluid dynamics (including turbulence/turbulent flow)

The role of randomness - tidy and messy fractals (romanesco broccolis are not more fractal than regular broccolis, only more regular.

The relationship with criticality and chaos: deterministic *and* unpredictable

Fractals embedded in

- Space (hence "fractal geometry"): geomorphology, plants, ocean and wind currents, galaxies
- Time series: earthquakes, finance
- Networks: hierarchical organisations, income distributions, word counts, www. etc.
- Pure mathematics: Julia and Mandelbrot sets, strange attractors (don't go into details!)
- Other: 1/f or pink noise

No, not everything is fractal: e.g. Central Limit Theorem

Fractal analysis for studying irregular phenomena (methods described in more detail in **??** and **??**, and thus as a tool for quantitative empirical research.

3.3 Very short introduction to micro-macro approaches in social theory

- Lévi-Strauss and Structuralism
- Giddens and Structuration Theory
- Delanda and Assemblage Theory
- Latour and Actor-Network Theory

What these approaches all have in common, is that they are entirely qualitative (**check**).

- That's not a problem in itself.
- Quant approach is both possible for the stated purpose, and desirable for reasons of comparative analysis.
- Data deluge (refer to chap. on geomagn data). The goal here is to establish a quantitative framework for studying social complexity and hierarchy. Further articulating fractal analysis with existing theoretical approaches is not the primary goal here, as it could constitute a separate research project. In the present thesis, bla bla.

END chapter.

Math can be added in body using usual syntax like this

p is unknown but expected to be around 1/3. Standard error will be approximated

$$SE = \sqrt{(\frac{p(1-p)}{n})} \approx \sqrt{\frac{1/3(1-1/3)}{300}} = 0.027$$

You can also use math in footnotes like this[1].

We will approximate standard error to 0.027[2]

[1] where we mention $p = \frac{a}{b}$

[2] p is unknown but expected to be around 1/3. Standard error will be approximated

$$SE = \sqrt{(\frac{p(1-p)}{n})} \approx \sqrt{\frac{1/3(1-1/3)}{300}} = 0.027$$

Chapter 4

Applications

Some *significant* applications are demonstrated in this chapter.

4.1 Example one

4.2 Example two

Chapter 5

Final Words

We have finished a nice book.

References

Appendix A

This is my first appendix

Jada jada jada

Appendix B

This is my second one

Bla bla bla

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