begindocument/before

Evaluation of the performance of $\Delta\phi$ as a precipitation estimator

Author: Ignacio Cordova Pou
Facultat de Física, Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Spain.

Advisor: Dr. Ramon Padullès
(Dated: April 4, 2022)

Abstract:A Global Navigation Satellite System (GNSS) radio occultation (RO) experiment is taking place in the Spanish low Earth orbiter for Earth Observation PAZ. The RO payload provides globally distributed vertical thermodynamic profiles of the atmosphere suitable to be assimilated into weather numerical prediction models. Moreover, the mission runs, for the first time, a double-polarization GNSS RO experiment to assess the capabili- ties of polarimetric GNSS RO for sensing heavy rain events. This paper introduces introduces the application of statistical models to determine the performance of the measured variable $\Delta\phi$ as a precipitation estimator. Using Precision Recall curves, the study shows the optimal range of heights for transforming the vertical profiles of $\Delta\phi$ into a scalar average. The results show that Using NASA's IMERG precipitation data as our target with the 97th percentile mm/h as True, $\Delta\phi$ achievesan optimal F1 score of 0.54 when averaged between 0.1km and 8.5km.

I. INTRODUCTION

In this document you will find the structure as well as the length of what the *Treball Fi de Grau* (TFG) report is required to have. It uses LaTeX in a two-column format and provides an example of what the essay ought to look like, including lists, tables and figures.

The text has to be written in (good) English (compulsory). The length of the report should by no means exceed **five** pages in the present format, all figures, tables, etc..., included. It is important that the two requirements are precisely met. Otherwise the essay will not be considered for evaluation, and will automatically fail with a mark of *Suspès*.

The report must consist of the following parts:

1. Abstract.
2. Introduction.
3. Development sections.
4. Conclusions.
5. Appendix (Optional)
6. Bibliography.

The final score will combine both the advisor and the jury marks. The defense will consist of a 15 minute public presentation before a jury composed by two members. The deadlines as well as the dates for the presentations will be announced in due time. The students are encouraged to stick to the allowed allotted time (15 minutes), since no extra time will, in general, be conceded by the jury members. At any rate, it should be clear that a list of conclusions needs to be read before the presentation is over.

The evaluation will follow the *Rúbriques* (or *Taules d'avaluació*) provided by the TFG Advisory Commitee, which will be available to the students prior to the presentation date, well ahead of time. It is highly advisable for the students to read them thorough and carefully, in order to become aware of all the competences that need be assessed to comply with the guidelines of Bologna.

Make sure that the presentation will include:

1. Introduction.
2. Development sections.
3. Conclusions.

You can find all the information concerning the TFG process in,

`https://www.ub.edu/portal/web/fisica/tramit-tfg`

II. EQUATIONS: A FEW EXAMPLES

Let us write a few equations,

$$\Delta = \sum_{i=1}^{N} w_i (x_i - \bar{x})^2, \tag{1}$$

with a label so that we can refer to it later. For instance you can refer to it as Eq. (1). All equations must be numbered. If needed, you can also produce unnumbered equations.

$$T = 2\pi\sqrt{\frac{l}{g}}.$$

You can insert equations in the text, like $e^{i\pi} + 1 = 0$; $\frac{df(x)}{dx}$ or you may prefer $\dfrac{df(x)}{dx}$. You can also write aligned

equations,

$$\begin{aligned} \frac{du(x)}{dx} + Vu(x) + Wv(x) &= (\lambda + \alpha)\, u(x) \\ \frac{dv(x)}{dx} + Vv(x) + Wu(x) &= (\lambda - \alpha)\, v(x). \end{aligned} \tag{2}$$

Further examples are,

$$\begin{aligned} \nabla \cdot \vec{E} &= 4\pi\rho \\ \nabla \times \vec{B} - \frac{1}{c}\frac{\partial \vec{E}}{\partial t} &= \frac{4\pi}{c}\vec{J} \\ \nabla \times \vec{E} + \frac{1}{c}\frac{\partial \vec{B}}{\partial t} &= 0 \\ \nabla \cdot \vec{E} &= 0, \end{aligned} \tag{3}$$

as can be found in [3], pag. 14. Also,

$$E = -J \sum_{i=1}^{N} s_i s_{i+1}. \tag{4}$$

You can define your own macros to save typing [6]. For example, suppose that you introduce a macro as follows:

```
\newcommand{\El}{{\vec{E}(\vec{x},t)}}
```

Then, by simply typing,

```
$\El$
```

you get the electric field $\vec{E}(\vec{x},t)$ printed out (in math mode, of course).

You can write $\tilde{x}$, $\overline{A}$; %, accents: Schrödinger and é, à, À, Martí; calçotada, $A \equiv B$, $\vec{A} \cdot \vec{B}$, $\vec{A} \times \vec{B}$, $\vec{v}$, $\hat{n}$, $c \sim d$, $z \approx w$, $\langle x \rangle$, $\langle \psi | X | \psi \rangle$, $\hbar$, g_{ij}, δ^i_j, $R_{\mu\nu\alpha\beta;\xi}$.

You can also quote references easily, i.e., [4], [5].

A matrix

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}, \tag{5}$$

a vector (column)

$$\begin{pmatrix} 1 \\ \sqrt{3} \\ \pi \end{pmatrix}, \tag{6}$$

a row,

$$\begin{pmatrix} p & q & r \end{pmatrix}, \tag{7}$$

and a determinant,

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}. \tag{8}$$

Further examples:

$$\int_{-\infty}^{\infty} e^{-x^2}\, dx = \sqrt{\pi}, \tag{9}$$

also,

$$\int_a^b f'(x)\, dx = f(b) - f(a), \tag{10}$$

and so on.

A. Tables and figures

An example of a table is shown in Table I.

TABLE I: Force, area, and pressure data for an experiment with glass syringes.

	Piston 1	Piston 2
Force (N)	4.40	2.25
Area (cm^2)	6.16	3.14
Pressure (N/cm^2)	0.714 ± 0.002	0.716

Here we try to insert an ilustrating figure, Fig. 1. For that you need to have created the figure before, in this case the fig1.pdf file.

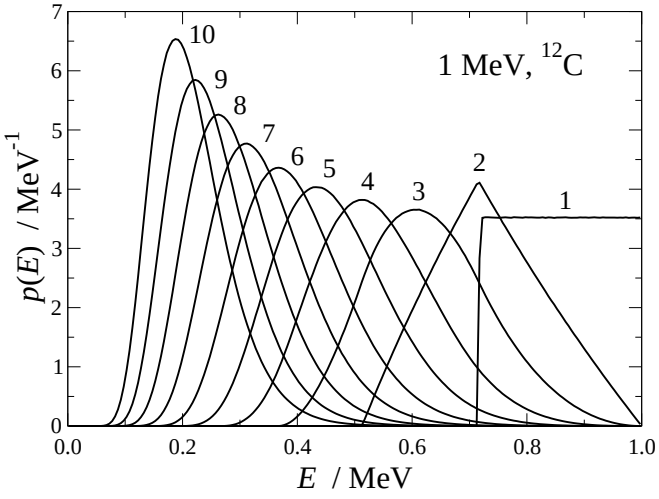

FIG. 1: A sample figure.

III. DEVELOPING SECTIONS

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

TABLE II: Another table.

M1	Teoria:	Galileo	A11G
(11:45)	Problemes:	Newton	A11G
	Problemes	Planck (M1A)	A11G
(12:45)	tutoritzats:	Fermi (M1B)	A23M
M2	Teoria:	Clausius	A12G
(8:30)	Problemes:	Goeppert Mayer	A12G
	Problemes	Boltzmann (M2A)	A12G
(9:30)	tutoritzats:	Maxwell (M2B)	A24M
T1	Teoria:	Gibbs	A12G
(18:00)	Problemes:	Helmholtz	A12G
	Problemes	Bohr (T1A)	A12G
(19:00)	tutoritzats:	Einstein (T1B)	A24M

A. Subsection 1

This is the first subsection.

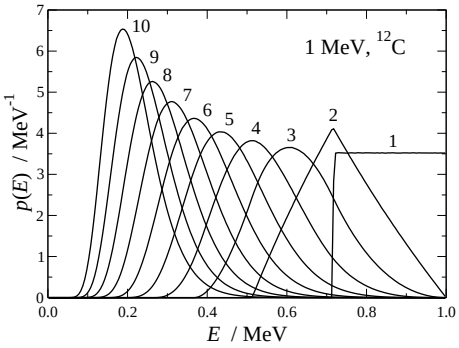

FIG. 2: A sample figure made smaller by changing the width parameter.

. . . . . .

B. Subsection 2

. . . . . .

IV. CONCLUSIONS

- . . . . . .
- . . . . . .

V. APPENDIX

You can add your appendix if needed, or you should like to do so. The following equation,

$$\vec{F} = m\vec{a}, \tag{11}$$

is important in Physics.

Acknowledgments

Be sure to thank your advisor, your colleagues, and granting agencies (e.g. parents, etc...) as well.

[1] Helmut Kopka and Patrick W. Daly, *A Guide to LaTeX: Document Preparation for Beginners and Advanced Users*, 3rd. ed. (Addison-Wesley, Reading, MA, 1999).
[2] It is necessary to process a file twice to get the counters correct.
[3] J.D. Jackson, *Classical Electrodynamics*, (John-Wiley & Sons, New York 1975, 2nd. ed.).
[4] Hinshaw, G. et al. (WMAP Collaboration). "Five-Year Wilkinson Microwave Anisotropy Probe Observations: Data Processing, Sky Maps, and Basic Results". The Astrophysical Journal Supplement **180**: 225–245 (2009).
[5] Weinberg, S.. "High-Energy Behavior in Quantum Field Theory". Phys. Rev. **118**: 838–849 (1960).
[6] This is a footnote.