

Heart Disease Prediction

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Abstract—This project aims to find the most efficient model to predict the presence of a heart disease on a patient based on 14 preconditions and exam results.

Index Terms—machine learning, dataset, heart disease, prediction, logistic regression, naive Bayes, k nearest neighbors, decision tree, random forest

I. INTRODUCTION

In this study, it was analyzed the data from the UCI Machine Learning Repository [5] regarding patient data used to ascertain the presence of a heart disease. In order to predict said disease were used five models of prediction: Logistic Regression, Naive Bayes, K Nearest Neighbors, Decision Tree and Random Forest.

II. DATASET

This dataset used for training contains the data of 303 patients from Cleveland [4] described by 14 attributes each; 5 of which are numerical values while the other 9 represent categories. The "goal" field is represented by a binary value representing the presence or absence of heart disease in the patient. The missing values were imputed as a median of the other values. There were other 3 other datasets from Hungary [1], Switzerland [2], [3] and Long Beach [4] in which the models obtained from the first set were tested after the training. Most of these datasets, however, had many missing values.

III. DATA ANALYSIS

IV. MODEL TRAINING AND TUNING

- A. *Logistic Regression*
- B. *Naive Bayes*
- C. *K Nearest Neighbors*
- D. *Decision Tree*
- E. *Random Forest*

V. RESULTS

VI. CONCLUSION

VII. EASE OF USE

A. *Maintaining the Integrity of the Specifications*

The IEEEtran class file is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin measures proportionately more than is customary. This measurement and

others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

VIII. PREPARE YOUR PAPER BEFORE STYLING

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections VIII-A–VIII-E below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads— \LaTeX will do that for you.

A. *Abbreviations and Acronyms*

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
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- Do not mix complete spellings and abbreviations of units: "Wb/m²" or "webers per square meter", not "webers/m²". Spell out units when they appear in text: ". . . a few henries", not ". . . a few H".
- Use a zero before decimal points: "0.25", not ".25". Use "cm³", not "cc".)

C. *Equations*

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a

long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \quad (1)$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is . . .”

D. *L^AT_EX-Specific Advice*

Please use “soft” (e.g., `\eqref{Eq}`) cross references instead of “hard” references (e.g., (1)). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don’t use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

Please note that the `{subequations}` environment in *L^AT_EX* will increment the main equation counter even when there are no equation numbers displayed. If you forget that, you might write an article in which the equation numbers skip from (17) to (20), causing the copy editors to wonder if you’ve discovered a new method of counting.

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L^AT_EX can’t read your mind. If you assign the same label to a subsection and a table, you might find that Table I has been cross referenced as Table IV-B3.

L^AT_EX does not have precognitive abilities. If you put a `\label` command before the command that updates the counter it’s supposed to be using, the label will pick up the last counter to be cross referenced instead. In particular, a `\label` command should not go before the caption of a figure or a table.

Do not use `\nonumber` inside the `{array}` environment. It will not stop equation numbers inside `{array}` (there won’t be any anyway) and it might stop a wanted equation number in the surrounding equation.

E. *Some Common Mistakes*

- The word “data” is plural, not singular.
- The subscript for the permeability of vacuum μ_0 , and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the

closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)

- A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
- Do not use the word “essentially” to mean “approximately” or “effectively”.
- In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
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- Do not confuse “imply” and “infer”.
- The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the “et” in the Latin abbreviation “et al.”.
- The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

F. *Authors and Affiliations*

The class file is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

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Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced.

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a) *Positioning Figures and Tables:* Place figures and tables at the top and bottom of columns. Avoid placing them

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TABLE I
TABLE TYPE STYLES

| Table Head | Table Column Head | | |
|------------|------------------------------|----------------|----------------|
| | <i>Table column subhead</i> | <i>Subhead</i> | <i>Subhead</i> |
| copy | More table copy ^a | | |

^aSample of a Table footnote.



Fig. 1. Example of a figure caption.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

REFERENCES

- [1] Hungarian Institute of Cardiology. Budapest: Andras Janosi, M.D.
- [2] University Hospital, Zurich, Switzerland: William Steinbrunn, M.D.
- [3] University Hospital, Basel, Switzerland: Matthias Pfisterer, M.D.
- [4] V.A. Medical Center, Long Beach and Cleveland Clinic Foundation: Robert Detrano, M.D., Ph.D.
- [5] Dua, D. and Graff, C. (2019). UCI Machine Learning Repository [http://archive.ics.uci.edu/ml]. Irvine, CA: University of California, School of Information and Computer Science.

TABLE II
DATA HEAD

| Age | Sex | ChestPainType | RestingBloodPressure | Cholesterol | FastingBloodSugar | RestingECG | MaxHeartRate | ExerciseInducedAngina | ST_depression | ST_slope | NumMajorVessels | ThalliumStressTest | Diagnosis |
|-----|------|---------------|----------------------|-------------|-------------------|------------|--------------|-----------------------|---------------|----------|-----------------|--------------------|-----------|
| 0 | 65.0 | 1.0 | 1.0 | 145.0 | 235.0 | 1.0 | 2.0 | 150.0 | 0.0 | 2.3 | 3.0 | 0.0 | 6.0 |
| 1 | 67.0 | 1.0 | 4.0 | 160.0 | 280.0 | 0.0 | 2.0 | 160.0 | 1.0 | 1.5 | 2.0 | 3.0 | 1.0 |
| 2 | 67.0 | 1.0 | 4.0 | 120.0 | 220.0 | 0.0 | 2.0 | 120.0 | 1.0 | 2.6 | 2.0 | 2.0 | 7.0 |
| 3 | 67.0 | 1.0 | 3.0 | 130.0 | 250.0 | 0.0 | 0.0 | 167.0 | 0.0 | 1.5 | 1.0 | 0.0 | 3.0 |
| 4 | 41.0 | 0.0 | 2.0 | 130.0 | 204.0 | 0.0 | 2.0 | 172.0 | 0.0 | 1.4 | 1.0 | 0.0 | 3.0 |
| 5 | 56.0 | 1.0 | 2.0 | 120.0 | 230.0 | 0.0 | 0.0 | 170.0 | 0.0 | 0.8 | 1.0 | 0.0 | 3.0 |
| 6 | 62.0 | 0.0 | 4.0 | 140.0 | 266.0 | 0.0 | 0.0 | 160.0 | 0.0 | 1.6 | 2.0 | 3.0 | 1.0 |
| 7 | 57.0 | 0.0 | 4.0 | 120.0 | 354.0 | 0.0 | 0.0 | 163.0 | 1.0 | 0.8 | 1.0 | 0.0 | 3.0 |
| 8 | 63.0 | 1.0 | 4.0 | 150.0 | 254.0 | 0.0 | 2.0 | 147.0 | 0.0 | 1.4 | 2.0 | 7.0 | 1.0 |
| 9 | 53.0 | 1.0 | 4.0 | 140.0 | 203.0 | 1.0 | 2.0 | 155.0 | 1.0 | 3.1 | 3.0 | 0.0 | 7.0 |

TABLE III
DATA DESCRIPTION

| Age | Sex | ChestPainType | RestingBloodPressure | Cholesterol | FastingBloodSugar | RestingECG | MaxHeartRate | ExerciseInducedAngina | ST_depression | ST_slope | NumMajorVessels | ThalliumStressTest | Diagnosis |
|-------|--------|---------------|----------------------|-------------|-------------------|------------|--------------|-----------------------|---------------|----------|-----------------|--------------------|-----------|
| count | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 | 303.00 |
| mean | 64.44 | 0.68 | 2.16 | 131.09 | 246.69 | 0.19 | 149.62 | 0.14 | 1.04 | 1.60 | 0.66 | 4.72 | 0.46 |
| std | 9.04 | 0.47 | 0.96 | 37.69 | 51.78 | 0.36 | 0.99 | 22.88 | 0.47 | 1.16 | 0.62 | 0.93 | 0.50 |
| min | 20.00 | 0.00 | 1.00 | 94.00 | 120.00 | 0.00 | 0.00 | 71.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| 25% | 46.00 | 0.00 | 1.00 | 120.00 | 211.00 | 0.00 | 0.00 | 133.00 | 0.00 | 0.00 | 1.00 | 0.00 | 3.00 |
| 50% | 56.00 | 1.00 | 1.00 | 130.00 | 241.00 | 0.00 | 1.00 | 153.00 | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| 75% | 61.00 | 1.00 | 4.00 | 140.00 | 275.00 | 0.00 | 2.00 | 160.00 | 1.00 | 1.00 | 2.00 | 1.00 | 1.00 |
| max | 77.00 | 1.00 | 4.00 | 200.00 | 364.00 | 1.00 | 2.00 | 202.00 | 1.00 | 6.20 | 3.00 | 7.00 | 7.00 |

TABLE IV
DATA CORRELATION

| | Diagnosis |
|-----------------------|-----------|
| Diagnosis | 1.000000 |
| ThalliumStressTest | 0.522057 |
| NumMajorVessels | 0.460033 |
| ExerciseInducedAngina | 0.431894 |
| ST_depression | 0.424510 |
| MaxHeartRate | 0.417167 |
| ChestPainType | 0.414446 |
| ST_slope | 0.339213 |
| Sex | 0.276816 |
| Age | 0.223120 |
| RestingECG | 0.169202 |
| RestingBloodPressure | 0.150825 |
| Cholesterol | 0.085164 |
| FastingBloodSugar | 0.025264 |

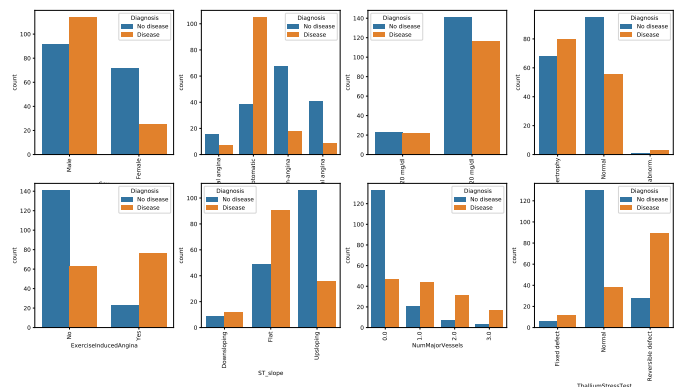


Fig. 2. Example of a figure caption.

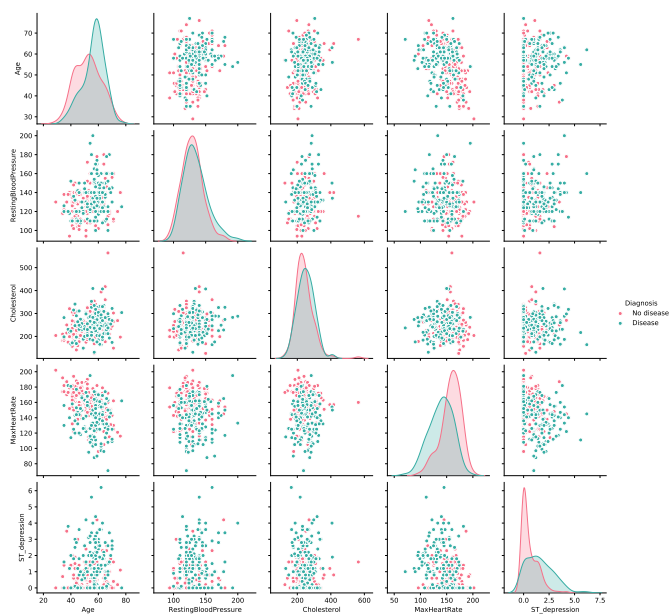


Fig. 3. Example of a figure caption.