

IS415 Report

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A clear and well-documented \LaTeX document is presented as an article formatted for publication by ACM in a conference proceedings or journal publication. Based on the “acmart” document class, this article presents and explains many of the common variations, as well as many of the formatting elements an author may use in the preparation of the documentation of their work.

Additional Key Words and Phrases: HDB Prices, Linear Regression, Geographically Weighted Regression, Exploratory Data Analysis

ACM Reference Format:

Chen Hao Xian, Tan Wen Yang, and Pierre Jean Michel. . IS415 Report. In . ACM, New York, NY, USA, 12 pages.

1 MOTIVATION

With the price of HDB resale flats seeing tremendous growth over the years, and news such as “**HDB resale prices accelerate in Jan as million-dollar deals surge by 42%: SRX, 99.co**” [36] or “**HDB resale prices rise 2.3% in Q4, slowest increase in 2022**” [24], Singaporeans face the ever-growing concern as to whether or not they are paying a fair price for their flats. Given the lack of accessibility to geographically weighted models, users may find it difficult to assess what factors impact the resale price of an HDB flat; indeed, current estimators often only consider linear relationships between dependent and independent variables and fail to include geographical predictors in their models, which may limit the ability of one regression to explain HDB resale prices; however, geographically weighted regressions provide a more sophisticated way to model spatial heterogeneity by accounting for the unique characteristics of different neighborhoods.

Despite the advantages of geographically weighted regressions, they can be difficult for casual users without specialized skills to use effectively. Thus, our research comes in handy to give the right tools to Singaporeans as we aim to:

1. Identify the most significant location-specific variables that affect the resale price of HDB flats in Singapore and quantify their impact on pricing using geographically weighted regression models. By analyzing the relationship between different amenities, such as rail stations, hawker centers, preschools, malls, and mosquito hotspots, we aim to determine which factors have the most significant explanatory power on HDB resale prices and which do not. It will provide valuable insights into the most important factors that homebuyers and sellers should consider when transacting in the HDB resale market.
2. Develop a user-friendly web application that leverages geographically weighted regression models to estimate the resale value of HDB flats in Singapore for a given area. By inputting location-specific variables such as

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Manuscript submitted to ACM

proximity to rail stations, hawker centers, preschools, malls, and mosquito hotspots, users can receive an estimated resale value for their property. It will provide users with a more accurate estimation of the value of their property, which can help them make better decisions when selling or buying an HDB flat.

3. Promote transparency and reduce information asymmetry in the HDB resale market by providing an accessible and user-friendly tool for estimating resale values. By making geographically weighted regression models more accessible to the public, we hope to empower homeowners, buyers, and policymakers to make more informed decisions about the HDB resale market. It could ultimately lead to better outcomes for buyers and sellers and help policymakers make more informed decisions about housing affordability, urban planning, and education policy.

2 RELEVANT RELATED WORK

We will now discuss past research in the fields of hedonic housing price models and the importance of geography in these models. We shall review three pieces of work in the following paragraphs.

Our [first article](#), “Spatial Heterogeneity in Hedonic House Price Models: The Case of Austria.” by M. Helbich, C. Leitner, and A. Kapusta, investigates the spatial heterogeneity of housing prices in Austria by using a hedonic pricing model. This statistical model estimates the value of a property based on its attributes, size, location, and other factors, such as proximity to different amenities (e.g., shopping malls and parks). In this paper, the writers apply geographically weighted regression (GWR) analysis to identify local spatial patterns of the housing market and examine the spatial variability of the hedonic price model coefficients. In their research, they deduce that the GWR approach provides more accurate predictions of housing prices than traditional regression methods, which assume spatial homogeneity of coefficients. Their study revealed that housing prices are significantly influenced by local characteristics of neighborhoods as accessibility, environment, and social amenities, to name a few. Their paper suggests that the spatial heterogeneity of housing prices is crucial to accurately model and analyze the housing market, especially in geographically diverse regions like Austria. In our case, we consider the paper’s methodology and insights valuable for our research as we plan to investigate the spatial heterogeneity of housing prices in Singapore and identify local factors that affect house prices.

The second work we will analyze is the [HDB Resale Flat Prices](#) web application developed by the Housing Development Board of Singapore. It provides a platform for users to access information on past resale transactions of Housing and Development Board (HDB) flats in Singapore. It allows users to search for resale transactions based on various criteria, such as location, flat type, and transaction period. This web application is the perfect example of what Singaporeans are missing, a model that explains the relevancy of locational factors on HDB resale price. Nonetheless, this web application still serves as a relevant solution that offers insights into the Singapore housing market and the attributes of HDB flats that may affect transaction prices. We believe there is room for improvement in the functionalities the platform offers. Through our research, we aim to explore ways to improve the current system, perhaps by incorporating additional data sources and applying advanced machine learning algorithms to provide an accurate and valuable explanatory model of housing prices.

The last piece of reading we shall discuss is the [Medium article](#) “Predict the Selling Price of HDB Resale Flats” by Jim Meng Kok. It uses machine learning to predict the selling price of HDB resale flats in Singapore. The author uses a dataset of HDB resale transactions and applies a random forest regression model to predict the resale price of HDB flats based on various features, including location, size, age, and nearby amenities. The model achieves a high accuracy rate, indicating that machine learning methods can effectively predict housing prices. The article is relevant to the current

research on housing prices in Singapore as it highlights the importance of utilizing machine learning techniques for predicting prices accurately. While the author uses Python in his analysis, we still consider that the insights provided in the article can be valuable for any researcher planning to use other programming languages, as R. The findings suggest that location and amenities play a significant role in determining housing prices, which is consistent with previous research on the topic.

In conclusion, this section has reviewed three pieces of research related to hedonic housing price models and the importance of geography in these models. Overall, these studies emphasize the need to account for location and amenities when modeling and analyzing housing prices and highlight the potential of advanced techniques like geographically weighted regression and machine learning to provide more accurate predictions.

3 DESIGN FRAMEWORK

The primary parameter given to the “acmart” document class is the *template style* which corresponds to the kind of publication or SIG publishing the work. This parameter is enclosed in square brackets and is a part of the “documentclass” command:

```
\documentclass[STYLE]{acmart}
```

Journals use one of three template styles. All but three ACM journals use the “acmsmall” template style:

- acmsmall: The default journal template style.
- acmlarge: Used by JOCCH and TAP.
- acmtog: Used by TOG.

The majority of conference proceedings documentation will use the “cmconf” template style.

- acmconf: The default proceedings template style.
- sigchi: Used for SIGCHI conference articles.
- sigchi-a: Used for SIGCHI “Extended Abstract” articles.
- sigplan: Used for SIGPLAN conference articles.

4 DEMONSTRATION - USE CASE

In addition to specifying the *template style* to be used in formatting your work, there are a number of *template parameters* which modify some part of the applied template style. A complete list of these parameters can be found in the \LaTeX User’s Guide.

Frequently-used parameters, or combinations of parameters, include:

- anonymous, review: Suitable for a “double-blind” conference submission. Anonymizes the work and includes line numbers. Use with the \acmSubmissionID command to print the submission’s unique ID on each page of the work.
- authorversion: Produces a version of the work suitable for posting by the author.
- screen: Produces colored hyperlinks.

This document uses the following string as the first command in the source file:

```
\documentclass[manuscript,screen,review]{acmart}
```

5 MODIFICATIONS

Modifying the template — including but not limited to: adjusting margins, typeface sizes, line spacing, paragraph and list definitions, and the use of the `\vspace` command to manually adjust the vertical spacing between elements of your work — is not allowed.

Your document will be returned to you for revision if modifications are discovered.

6 DISCUSSION/CONCLUSION

The “acmart” document class requires the use of the “Libertine” typeface family. Your \TeX installation should include this set of packages. Please do not substitute other typefaces. The “lmodern” and “ltimes” packages should not be used, as they will override the built-in typeface families.

7 TITLE INFORMATION

The title of your work should use capital letters appropriately - <https://capitalizemytitle.com/> has useful rules for capitalization. Use the “title” command to define the title of your work. If your work has a subtitle, define it with the “subtitle” command. Do not insert line breaks in your title.

If your title is lengthy, you must define a short version to be used in the page headers, to prevent overlapping text. The “title” command has a “short title” parameter:

```
\title[short title]{full title}
```

8 OPENING - POTENTIAL FUTURE WORK

Each author must be defined separately for accurate metadata identification. As an exception, multiple authors may share one affiliation. Authors’ names should not be abbreviated; use full first names wherever possible. Include authors’ e-mail addresses whenever possible.

Grouping authors’ names or e-mail addresses, or providing an “e-mail alias,” as shown below, is not acceptable:

```
\author{Brooke Aster, David Mehldau}
\email{dave,judy,steve@university.edu}
\email{firstname.lastname@phillips.org}
```

The `authornote` and `authornotemark` commands allow a note to apply to multiple authors — for example, if the first two authors of an article contributed equally to the work.

If your author list is lengthy, you must define a shortened version of the list of authors to be used in the page headers, to prevent overlapping text. The following command should be placed just after the last `\author{}` definition:

```
\renewcommand{\shortauthors}{McCartney, et al.}
```

Omitting this command will force the use of a concatenated list of all of the authors’ names, which may result in overlapping text in the page headers.

The article template’s documentation, available at <https://www.acm.org/publications/proceedings-template>, has a complete explanation of these commands and tips for their effective use.

Note that authors’ addresses are mandatory for journal articles.

9 RIGHTS INFORMATION

Authors of any work published by ACM will need to complete a rights form. Depending on the kind of work, and the rights management choice made by the author, this may be copyright transfer, permission, license, or an OA (open access) agreement.

Regardless of the rights management choice, the author will receive a copy of the completed rights form once it has been submitted. This form contains \LaTeX commands that must be copied into the source document. When the document source is compiled, these commands and their parameters add formatted text to several areas of the final document:

- the “ACM Reference Format” text on the first page.
- the “rights management” text on the first page.
- the conference information in the page header(s).

Rights information is unique to the work; if you are preparing several works for an event, make sure to use the correct set of commands with each of the works.

The ACM Reference Format text is required for all articles over one page in length, and is optional for one-page articles (abstracts).

10 CCS CONCEPTS AND USER-DEFINED KEYWORDS

Two elements of the “acmart” document class provide powerful taxonomic tools for you to help readers find your work in an online search.

The ACM Computing Classification System — <https://www.acm.org/publications/class-2012> — is a set of classifiers and concepts that describe the computing discipline. Authors can select entries from this classification system, via <https://dl.acm.org/ccs/ccs.cfm>, and generate the commands to be included in the \LaTeX source.

User-defined keywords are a comma-separated list of words and phrases of the authors’ choosing, providing a more flexible way of describing the research being presented.

CCS concepts and user-defined keywords are required for all articles over two pages in length, and are optional for one- and two-page articles (or abstracts).

11 SECTIONING COMMANDS

Your work should use standard \LaTeX sectioning commands: section, subsection, subsubsection, and paragraph. They should be numbered; do not remove the numbering from the commands.

Simulating a sectioning command by setting the first word or words of a paragraph in boldface or italicized text is **not allowed**.

12 TABLES

The “acmart” document class includes the “booktabs” package — <https://ctan.org/pkg/booktabs> — for preparing high-quality tables.

Table captions are placed *above* the table.

Because tables cannot be split across pages, the best placement for them is typically the top of the page nearest their initial cite. To ensure this proper “floating” placement of tables, use the environment **table** to enclose the table’s contents and the table caption. The contents of the table itself must go in the **tabular** environment, to be aligned

properly in rows and columns, with the desired horizontal and vertical rules. Again, detailed instructions on **tabular** material are found in the \LaTeX User’s Guide.

Immediately following this sentence is the point at which Table 1 is included in the input file; compare the placement of the table here with the table in the printed output of this document.

Table 1. Frequency of Special Characters

Non-English or Math	Frequency	Comments
\emptyset	1 in 1,000	For Swedish names
π	1 in 5	Common in math
\$	4 in 5	Used in business
Ψ_1^2	1 in 40,000	Unexplained usage

To set a wider table, which takes up the whole width of the page’s live area, use the environment **table*** to enclose the table’s contents and the table caption. As with a single-column table, this wide table will “float” to a location deemed more desirable. Immediately following this sentence is the point at which Table 2 is included in the input file; again, it is instructive to compare the placement of the table here with the table in the printed output of this document.

Table 2. Some Typical Commands

Command	A Number	Comments
<code>\author</code>	100	Author
<code>\table</code>	300	For tables
<code>\table*</code>	400	For wider tables

Always use `midrule` to separate table header rows from data rows, and use it only for this purpose. This enables assistive technologies to recognise table headers and support their users in navigating tables more easily.

13 MATH EQUATIONS

You may want to display math equations in three distinct styles: inline, numbered or non-numbered display. Each of the three are discussed in the next sections.

13.1 Inline (In-text) Equations

A formula that appears in the running text is called an inline or in-text formula. It is produced by the **math** environment, which can be invoked with the usual `\begin, . . . \end` construction or with the short form `\$. . . \$`. You can use any of the symbols and structures, from α to ω , available in \LaTeX [22]; this section will simply show a few examples of in-text equations in context. Notice how this equation: $\lim_{n \rightarrow \infty} x = 0$, set here in in-line math style, looks slightly different when set in display style. (See next section).

13.2 Display Equations

A numbered display equation—one set off by vertical space from the text and centered horizontally—is produced by the `equation` environment. An unnumbered display equation is produced by the `displaymath` environment.

Again, in either environment, you can use any of the symbols and structures available in \LaTeX ; this section will just give a couple of examples of display equations in context. First, consider Equation 1, shown as an inline equation above:

$$\lim_{n \rightarrow \infty} x = 0 \tag{1}$$

Notice how it is formatted somewhat differently in the `displaymath` environment. Now, we'll enter an unnumbered equation:

$$\sum_{i=0}^{\infty} x + 1$$

and follow it with Equation 2, another numbered equation:

$$\sum_{i=0}^{\infty} x_i = \int_0^{\pi+2} f \tag{2}$$

just to demonstrate \LaTeX 's able handling of numbering.

14 FIGURES

The “figure” environment should be used for figures. One or more images can be placed within a figure. If your figure contains third-party material, you must clearly identify it as such, as shown in the example below.

Your figures should contain a caption which describes the figure to the reader.

Figure captions are placed *below* the figure.

Every figure should also have a figure description unless it is purely decorative. These descriptions convey what's in the image to someone who cannot see it. They are also used by search engine crawlers for indexing images, and when images cannot be loaded.

A figure description must be unformatted plain text less than 2000 characters long (including spaces). **Figure descriptions should not repeat the figure caption – their purpose is to capture important information that is not already provided in the caption or the main text of the paper.** For figures that convey important and complex new information, a short text description may not be adequate. More complex alternative descriptions can be placed in an appendix and referenced in a short figure description. For example, provide a data table capturing the information in a bar chart, or a structured list representing a graph. For additional information regarding how best to write figure descriptions and why doing this is so important, please see <https://www.acm.org/publications/taps/describing-figures/>.

14.1 The “Teaser Figure”

A “teaser figure” is an image, or set of images in one figure, that are placed after all author and affiliation information, and before the body of the article, spanning the page. If you wish to have such a figure in your article, place the command immediately before the `\maketitle` command:

```
\begin{teaserfigure}
\includegraphics[width=\textwidth]{sampleteaser}
```



Fig. 1. 1907 Franklin Model D roadster. Photograph by Harris & Ewing, Inc. [Public domain], via Wikimedia Commons. (<https://goo.gl/VLCRBB>).

```
\caption{figure caption}
\Description{figure description}
\end{teaserfigure}
```

15 CITATIONS AND BIBLIOGRAPHIES

The use of Bib_T_EX for the preparation and formatting of one’s references is strongly recommended. Authors’ names should be complete – use full first names (“Donald E. Knuth”) not initials (“D. E. Knuth”) – and the salient identifying features of a reference should be included: title, year, volume, number, pages, article DOI, etc.

The bibliography is included in your source document with these two commands, placed just before the `\verb|\end{document}|` command:

```
\bibliographystyle{ACM-Reference-Format}
\bibliography{bibfile}
```

where “bibfile” is the name, without the “.bib” suffix, of the Bib_T_EX file.

Citations and references are numbered by default. A small number of ACM publications have citations and references formatted in the “author year” style; for these exceptions, please include this command in the **preamble** (before the command “`\begin{document}`”) of your \LaTeX source:

```
\citestyle{acmauthoryear}
```

Some examples. A paginated journal article [2], an enumerated journal article [10], a reference to an entire issue [9], a monograph (whole book) [21], a monograph/whole book in a series (see 2a in spec. document) [17], a divisible-book such as an anthology or compilation [12] followed by the same example, however we only output the series if the volume number is given [13] (so Editor00a’s series should NOT be present since it has no vol. no.), a chapter in a divisible book [34], a chapter in a divisible book in a series [11], a multi-volume work as book [20], a couple of articles in a proceedings (of a conference, symposium, workshop for example) (paginated proceedings article) [3, Hagerup et al. [15]], a proceedings article with all possible elements [33], an example of an enumerated proceedings article [14], an informally published work [16], a couple of preprints [7, Anzaroot et al. [6]], a doctoral dissertation [8], a master’s thesis: [4], an online document / world wide web resource [35, Ablamowicz and Fauser [1], Poker-Edge.Com [27]], a video game (Case 1) [26] and (Case 2)[25] and [23] and (Case 3) a patent [32], work accepted for publication [29], ‘YYYYb’-test for prolific author [30] and [31]. Other cites might contain ‘duplicate’ DOI and URLs (some SIAM articles) [?]. Boris / Barbara Beeton: multi-volume works as books [19] and [18]. A couple of citations with DOIs: [? , ?]. Online citations: [37, Thornburg [35], Veytsman [38]]. Artifacts: [28] and [5].

16 ACKNOWLEDGMENTS

Identification of funding sources and other support, and thanks to individuals and groups that assisted in the research and the preparation of the work should be included in an acknowledgment section, which is placed just before the reference section in your document.

This section has a special environment:

```
\begin{acks}
```

```
...
```

```
\end{acks}
```

so that the information contained therein can be more easily collected during the article metadata extraction phase, and to ensure consistency in the spelling of the section heading.

Authors should not prepare this section as a numbered or unnumbered `\section`; please the “acks” environment.

17 APPENDICES

If your work needs an appendix, add it before the “`\end{document}`” command at the conclusion of your source document.

Start the appendix with the “appendix” command:

```
\appendix
```

and note that in the appendix, sections are lettered, not numbered. This document has two appendices, demonstrating the section and subsection identification method.

18 MULTI-LANGUAGE PAPERS

Papers may be written in languages other than English or include titles, subtitles, keywords and abstracts in different languages (as a rule, a paper in a language other than English should include an English title and an English abstract).

Use `language=...` for every language used in the paper. The last language indicated is the main language of the paper. For example, a French paper with additional titles and abstracts in English and German may start with the following command

```
\documentclass[sigconf, language=english, language=german,
               language=french]{acmart}
```

The title, subtitle, keywords and abstract will be typeset in the main language of the paper. The commands `\translatedXXX`, `XXX` being title, subtitle and keywords, can be used to set these elements in the other languages. The environment `translatedabstract` is used to set the translation of the abstract. These commands and environment have a mandatory first argument: the language of the second argument. See `sample-sigconf-i13n.tex` file for examples of their usage.

19 SIGCHI EXTENDED ABSTRACTS

The “sigchi-a” template style (available only in \LaTeX and not in Word) produces a landscape-orientation formatted article, with a wide left margin. Three environments are available for use with the “sigchi-a” template style, and produce formatted output in the margin:

- **sidebar**: Place formatted text in the margin.
- **marginfigure**: Place a figure in the margin.
- **marginfigure**: Place a table in the margin.

ACKNOWLEDGMENTS

To Robert, for the bagels and explaining CMYK and color spaces.

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A RESEARCH METHODS

A.1 Part One

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A.2 Part Two

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B ONLINE RESOURCES

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