



A Tale of Two Crises: *The Housing Shortage and Homelessness*

For decades, the cost of housing in the U.S. and the U.K. has increased faster than incomes, putting economic pressure on families and individuals who may find it challenging to afford rent or a mortgage¹. This is often due to a shortage of available housing, an issue that has reached crisis levels^{2, 3}.

The housing crisis is closely linked with another crisis: homelessness*, a persistent issue even in the world's wealthiest societies^{4, 5}. While individual circumstances leading to homelessness are diverse, at a population level, the largest predictor is a lack of affordable housing^{6, 7}, which has been associated with a 38% increase in homelessness in the largest American cities in the past year⁸. The two crises are exacerbated by unforeseen circumstances such as natural disasters, humanitarian crises, and economic downturns⁹.

Unfortunately, there are few, if any, quick fixes for either of these ongoing crises¹⁰. Stable housing can ease homelessness and is often an important first step in helping individuals tackle other challenges like addiction, mental health issues, and unemployment¹¹, but increasing the housing supply is slow and requires significant financial investment. Land restrictions, population growth, financial constraints, and longevity of a housing structure are some of the complex factors surrounding the issue. Moreover, the impacts of decisions made about housing supply can last for decades.

In this problem, you are tasked with using mathematical modeling to understand these intertwined crises from a long-term perspective. In addressing the three questions below, your goal should be to help governments make plans not just for the next several years, but for the next several decades.

- **Q1: It Was the Best of Times**—Create a model that predicts changes in the housing supply in either the two U.S. or two U.K. regions below in the next 10, 20, and 50 years. Indicate your level of confidence in your predictions.
U.S.: Seattle, Washington Albuquerque, New Mexico
U.K.: Manchester Brighton and Hove
- **Q2: It Was the Worst of Times**—For the regions you chose in Q1, predict changes in the homeless population in the next 10, 20, and 50 years.
- **Q3: Rising from This Abyss**—Considering your results from the first two questions for at least one of the cities, create a model that would help a city determine a long-term plan to address homelessness. How adaptable is your model to unforeseen circumstances like natural disasters, economic recessions, or increased migrant populations?

The first page of your submission should be an executive summary of your findings, which may be written in the form of a brief to the Secretary of the U.S. Department of Housing and Urban Development or to the Minister of State for Housing and Planning. This should be followed by your solution paper, which we recommend not exceed 20 pages in length. **Remember to cite your sources**, including the provided data file, if you use it. If you choose to write code as part of your work to be eligible for the technical computing prize, please include it either in the body of your paper or in a separate appendix, and check the technical computing box when you upload. Appendices and references/citation pages do not count toward the recommended 20-page limit.

* Another common term for homeless is unhoused, which many feel lessens stigma and highlights that those lacking permanent roofs over their heads may still have communities or physical spaces they consider home. We have chosen to use "homeless" here because it is the term that appears in most resources on the topic.

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- 1 <https://www.npr.org/2024/01/25/1225957874/housing-unaffordable-for-record-half-all-u-s-renters-study-finds> (NPR)
 - 2 <https://www.npr.org/2022/07/14/1109345201/theres-a-massive-housing-shortage-across-the-u-s-heres-how-bad-it-is-where-you-l> (NPR)
 - 3 <https://commonslibrary.parliament.uk/research-briefings/cbp-7671/> (House of Commons Library)
 - 4 <https://www.huduser.gov/portal/datasets/ahar/2022-ahar-part-1-pit-estimates-of-homelessness-in-the-us.html>
(U.S. Office of Housing and Urban Development)
 - 5 https://england.shelter.org.uk/media/press_release/at_least_271000_people_are_homeless_in_england_today (Shelter England)
 - 6 <https://books.google.com/books?id=guxcEAAAQBAJ&printsec=frontcover#v=onepage&q&f=false> (University of California Press, 2022)
 - 7 https://www.usich.gov/sites/default/files/document/All_In.pdf (U.S. Interagency Council on Homelessness)
 - 8 <https://www.sciencedirect.com/science/article/pii/S0264275121001293> (Science Direct)
 - 9 <https://comptroller.nyc.gov/reports/accounting-for-asylum-seekers/> (New York City Comptroller)
 - 10 <https://www.npr.org/2024/02/17/1229867031/housing-shortage-zoning-reform-cities> (NPR)
 - 11 <https://nap.nationalacademies.org/catalog/25133/permanent-supportive-housing-evaluating-the-evidence-for-improving-health-outcomes>
(National Academies Press)

Data Statement:

Various organizations and agencies collect data that may be relevant to this problem. A small amount of data has been compiled and a link to an Excel spreadsheet with four worksheets of data is provided and summarized below. You are not required to use this data; that is, you may choose to use none, some, or all of this data and/or any additional data sources you may identify while working on this problem. Data sets in the real world are often incomplete or contain holes. Be sure to cite all resources used.

Data has been provided in a spreadsheet found here <https://m3challenge.siam.org/kdfrldh/> on availability and cost of housing, population size, homelessness rates, and income levels for each of the regions. If you use this data, please cite it as follows: A Tale of Two Crises, MathWorks Math Modeling Challenge 2024, curated data, <https://m3challenge.siam.org/kdfrldh/>.

MATLAB Users:

If you use Excel or any other spreadsheet data in MATLAB, you can import the data by double-clicking the files in MATLAB's "Current Folder" browser or use the [Import Data Button](https://www.mathworks.com/help/matlab/spreadsheets.html?ue) (<https://www.mathworks.com/help/matlab/spreadsheets.html?ue>) at the top of the Toolstrip.

Watch this quick MATLAB [video tutorial](https://www.youtube.com/watch?v=0hArv-UBKQQ&list=PLn8PRpmsu08oBSjfGe8WIMN-2_rwWFSgr&index=14) (https://www.youtube.com/watch?v=0hArv-UBKQQ&list=PLn8PRpmsu08oBSjfGe8WIMN-2_rwWFSgr&index=14) about importing spreadsheet data.

This problem was written by M3 Challenge Problem Development Committee members Dr. Jen Gorman, Lake Superior State University; Dr. Chris Musco, New York University; and Dr. Neil Nicholson, University of Notre Dame.