An Interactive Rent vs. Buy Calculator

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I. INTRODUCTION AND BACKGROUND

According to *USA Today*, over 40 million Americans move each year [1]. Our team aims to help Americans answer the question, *"Should I buy or rent?"* without hours of research.

Few ideals are as ingrained in the American mentality as the dream of homeownership [2]. Homeownership has been found to enhance civic pride and improve voter turnout [3]. It also contributes to less crime, better familial environments, and higher education outcomes [4]. Some research shows that homeowners are financially better off than renters in terms of overall wealth [3]. The wealth gap is attributable to wealth being built over time through home appreciation and generous tax breaks [5]. That homeownership is viewed as a smart investment has even contributed to the stigmatization of renters as young, uninformed, or less financially capable [6].

Recent research, however, is mixed. Homeowners, especially in older households, are less likely to relocate in response to difficult labor markets [7]. Statistical studies suggest that homeownership has a causal effect (at least Granger causal) on unemployment [8]. Millennials are more likely to seek rapid professional advancement, leading to higher relocation rates [9]. Societal changes and the increased cost of homeownership have made millennials a generation of renters [10].

Financially, homeownership is not always a better investment than renting [11]–[14]. Increases in holding periods, inflation, and the spread between imputed rent and the opportunity cost of household savings favor ownership. However, renters save on mortgage payments, maintenance, and improvement costs. Whether buying or renting is more favorable depends, in part, on interest rates [12].

Various frameworks have been proposed to determine the optimal housing decision. Beracha and Johnson [15] presented the first "horse race" between renting or buying and compared both scenarios using the internal rate of return. Taubner proposed the use of the net present value (NPV) and found that households often need a holding period of between 5 and 10 years to achieve a breakeven NPV [11]. The rent or buy decision problem is noted as equivalent to a disk spindown problem [16]. Krishnan, Long, and Vitter [16] have optimally solved that problem, but only using probability distributions under the assumption that resource use times are a priori unknown. Since our product will make recommendations based on specified anticipated durations at a property, this solution is not applicable.

II. CURRENT SOLUTIONS

The number of frequent movers has inspired the development of web applications that help inform housing decisions. *The New York Times* [17] published an interactive web application that keeps a running tally of the most common expenses and takes into account initial costs, recurring costs, and opportunity costs but requires users to enter home price, holding period, mortgage details, tax rates, closing costs, and estimated interest rates. The app does not use any market data to help users estimate prices or interest rates. Real estate applications, such as Zillow.com [18] and Realtor.com [19], provide similar services and also rely on users to estimate interest and equity appreciation rates. Realtor.com provides initial estimates for costs and rates, but those values reflect a nationwide average, despite the fact that they vary significantly by state, city, and neighborhood [15]. Li et al [20] and [21] have produced visualizations that could be utilized to enhance our project but are currently beyond the scope of this project due to data availability and range of locations.

III. OUR SOLUTION

The advantage of our product is that users are spared extensive data research. Our tool's back end utilizes publicly available data (from Kaggle [22]) of historical housing prices in the U.S. from 1996 to 2017 to perform regression and machine learning estimation of key parameters (location-dependent

sales price, rental price, and equity appreciation rate) and to compare rent versus buy scenarios using NPV, similar to the approach of Tabner [11]. We will use Python to build the predictive model, Python's Django framework for the web application, and d3.js for the user interface (see Figure 1). The project will not cost anything as we plan to use Heroku to serve the application.
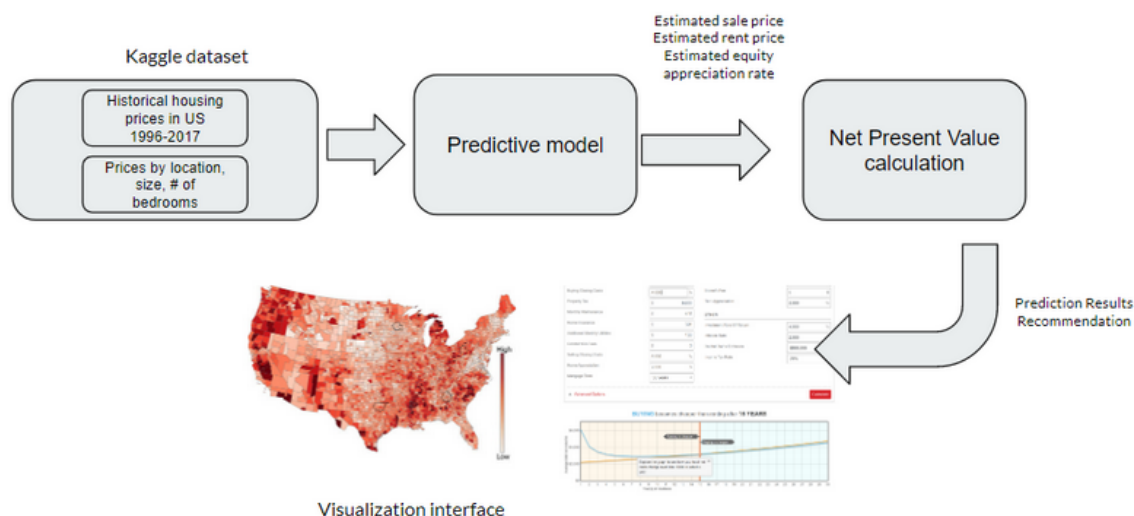

Fig. 1: Block diagram of the proposed solution

IV. SOLUTION IMPACT AND BENCHMARKING

Our tool will have a societal impact for anyone moving, and particularly for frequent movers and financially motivated buyers. Furthermore, our tool will not require our users to have strong financial literacy or knowledge of real estate market dynamics. No financial impact is expected as the tool will not be commercialized. If we commercialize this product, or given more time, we would conduct A/B tests and customer surveys. As a preliminary (midterm) check, we will test our product's recommendations against those of standard calculators with inputs limited to average responses. As a final check, tests and comparisons will be conducted using a wider range of inputs.

V. RISKS AND PAYOFFS

Product risks include changing tax regulations, real estate regulations, and rental requirements. The ability to provide accurate recommendations will be limited by timeliness of our tool's ability to capture such changes. We will disclose that our recommendations are dependent on tax rates, closing fees, varying apartment fees, and other uncontrolled variables. By utilizing broader datasets and more generalizable back-end models, our recommendations should be an improvement over what less sophisticated users might otherwise obtain. At the same time, they should take less time and effort to generate.

VI. WORK DISTRIBUTION TO DATE AND PLAN OF ACTION

Dataset: Felipe. Competitor Research: Skye. Slide Deck: Skye, Sylvia. Architecture Design and Diagram: Omer, Felipe. Survey Research: Felipe, Richard. Project Write-Up: Skye, Felipe. All team members have contributed a similar amount of effort.

Moving forward, Felipe and Omer will be in charge of front end development, and Skye, Sylvia, and Richard will be in charge of the back end development; however, all team members will contribute to both sides of the project. We plan to use the next four weeks to build the project, with the last 3 weeks before the final project due date used for testing, code cleanup, and documentation.

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