Predicting Homelessness in Vancouver

When I first arrived in Canada in the summer of 2023, the homeless people in Vancouver China Town astonished me in terms of the sheer scale: when I was walking down one of the main streets, I had to pay attention so as not to step upon them, many of whom were sitting or lying there in groups or alone. Later I learned that homelessness is becoming a problem, if not a crisis yet, of increasing concern in North America because the people experiencing homelessness are getting more and more, especially in the post-COVID era where economic recovery is still on the way. According to a CBC report this October citing newly released data, The number of homeless people in Vancouver and its suburbs has risen substantially since the COVID-19 pandemic began: 4,821 people were counted, up 32% from 2020 (CBC, 2023). To highlight the possible factors and potential consequences of homelessness, I would create a Python simulation to predict the possible number of homeless people in Vancouver in the next 10 years based on the "2023 Homeless Count: Vancouver" as data from the Metro Vancouver Homeless Count Report (Official site of the City of Vancouver, 2023).

As is the case with most social problems, the reasons are myriad and interwoven. Over decades, there are usually two levels of theory on the causes of homelessness, one being structural such as unemployment rate and housing, and the other being individual such as mental health and substance abuse (Rukmana, 2014). I doubt this dichotomy in analyzing the causes of homelessness because in reality those causes are often connected in dynamic and complicated ways. An individual would become homeless due to structural factors and individual factors at the same time, such as unemployment and mental illness or substance abuse. As Brendan O'Flaherty's observation goes upon the individual-level studies on homelessness and those on the city-level that

draw systematically different conclusions: “The findings are consistent with a model of homelessness as a condition requiring a conjunction of unfortunate circumstances … Different kinds of variables tend to be important in these two different kinds of studies. In the city-level studies, researchers generally find that housing market parameters, broadly understood, determine the volume of homelessness, and that indicators of personal characteristics have little or no influence (O’Flaherty, 2004)”. Therefore, I intend to assign structural and individual factors together as the variables determining the number of homeless people in Vancouver in a given year. In accordance with the top drivers of homeless data provided by the PiT census on homeless people in Vancouver (City of Vancouver, 2023), the factors as variables in my script for predicting the future homeless people are unemployment (Not enough income), addiction, mental health issue, housing (landlord conflict and unfit housing), domestic abuse (conflict with spouse/partner), physical health issue.

The primary logic of the simulation is to calculate the probability of an individual in a certain status such as unemployment to become homeless in Vancouver based on the data for “Top Reason for Housing Loss” from the census report, and multiply this probability by the total population to get the total number of homeless people as the result of the particular driver. For example, the population in Metro Vancouver in 2023 is 2,657,000 (macrotrends.net, 2023), and the unemployment rate is 4.7%(Statistics Canada) while the number of people who became homeless mainly because of unemployment is 503(according to the survey's “Top Reasons for Housing Loss” section, in which “Not enough income” take up 28%); this means that among the unemployed people, 3.36%（round to 2 decimal places） became homeless. Then apply this logic to other variants(factors), then the probability of becoming homeless for other reasons will be

calculated. At last, with those probabilities and the average population growth rate, the number and percentage of homeless people in the Metro Vancouver area can be calculated.

To conclude, the default data for the script include the following: population of Metro Vancouver and its average annual population growth over the past decade, which is 2,657,000 and 0.91%; the number of homeless people (2023), 2420; unemployment rate, which is 4.7%(average rate from Apr 2022 to March 2023); addiction rate 0.49%, round to 2 decimal points (addictionhelp.com, 2023); mental illness rate, 21.6% (vancouver-fraser.cmha.bc.ca, 2023); eviction rate of the whole population(as a simplified reason for unaffordable housing), which is 0.40% as calculated by multiplying the renter eviction rate 10.5% (terracestandard.com, 2023) with renter percentage 37.8% in the Metro Vancouver area; domestic abuse rate is 33.6%(Statistic Canada, 2021); physical illness rate 41.0% (Statistic Canada, 2021). As a way to simplify the complicated dynamic between housing price and homelessness, here the eviction is taken as the only reason, against the background that homeownership in Vancouver is 62.1% and the renter rate is 37.8% according to the census (Statistics Canada, 2021), and house owners are comparatively less likely to become homeless.

First, use the function “zip” to pair up the relevant rates list and factors list, such as the unemployment rate with the percentage of people who become homeless mainly because of unemployment:

```
rate_list = [0.047, 0.0049, 0.004, 0.216, 0.336, 0.41]
factor_list = [0.28, 0.19, 0.27, 0.12, 0.12, 0.10]
a_list_for_fator_and_rate = list(zip(factor_list, rate_list))
```

Then create the function for calculating the probability of an individual that has been affected by any of the factors mentioned above becoming homeless, and pass the factor/rate pair as parallel arguments to the function to calculate relevant probabilities and turn them into a list of probabilities:

```
def calculating_probability(factor, rate):
    probability = HOMELESS_PEOPLE_2023*factor/(population*rate)
    return probability
probability_list = []
for x in a_list_for_fator_and_rate:
    probability = calculating_probability(x[0], x[1])
    probability_list.append(probability)
```

After that, the two crucial probabilities in calculating the homeless people in the population are both available now, and they are turned into a list of tuples:

```
crucial_index = list(zip(rate_list, probability_list))
```

Now the function to count the possible homeless people in a group of people affected by one factor. The population is represented by a "for loop" where the loop time equals to population, and whenever the random floating numbers, each of which can be seen as the representation of a human, turn out not bigger than the default rate and the calculated probability at the same time in one loop, the individual become homeless.

```
#homeless people number in different groups
def census(rate, probability, population_x):
   homeless_people = 0
   for x in range(population_x):
     if random.random() <= rate:
           if random.random() <= probability:
                 homeless_people += 1
return homeless people
```

To calculate the homeless people in the future from 2024 to 2033, those homeless people in different groups affected by different factors need to be added up each year, and the annual population growth also needs to be taken into account as it will affect the loop times and the calculation of the percentages of homeless people, while the year as a variable whose initial value is 2023 as is now will be added with 1 in each loop to represent the passing of time:

```
homeless_over_years = []
```

```
percentage_list = []
years = []
for year in range(2024, 2034):  # predict homeless people amount in 10 years
        homeless_people_list = []
        population *= 1 + ANNUAL_POPULAITON_GROWTH
        population = int(population)
        years.append(year)
# to count the homeless people vunerable to different factors and store the numbers into
#the same list
        for x in crucial_index:
                homeless_people = census(x[0], x[1], population)
                homeless_people_list.append(homeless_people)
        # count the homeless people in a year, which should be the elements in the
        #homeless_people_list added up
        homeless_people = sum(homeless_people_list)
# data from PiT census for Vancouver, where there were 1815 sheltered homeless people
#and 605 unsheltered for a total of 2420 homeless people
        homeless_over_years.append(homeless_people)
        percentage_homeless = f"{(homeless_people / population):.4%}"
        percentage_list.append(percentage_homeless)
# pair them up so as to present the data as group that contain crucial information such as
#time and number of homeless people without a shelter
        census_list = list(zip(percentage_list, homeless_people_list, years))
        year += 1
```

At last, the simulation above for calculating the homeless people in any given year from 2024 to 2033 will be run 10 times to yield a maximum and a minimum value for the percentage of homeless people in the population. This will be realized by a for loop, and a few empty lists to store the max and the min value in each loop for the course of ten years, and some of the empty lists are there to store parallel information such as the year, the number of homeless people, and the unsheltered homeless people according to the ratio from the census report where among the 2420 homeless people there are 605 unsheltered and 1815 sheltered.

```
max_list = []
min_list = []
max_year_list = []
min_year_list = []
max_homeless_simulation = []
min_homeless_simulation = []
```

```
# run the simulation 100 times, which can also be changed to larger number
for i in range(50):
…
for x in census_list:
        if x[0] >= max(percentage_list):
            max_list.append(x[0])
            max_homeless_simulation.append(x[1])
            max_year_list.append(x[2])

        elif x[0] <= min(percentage_list):
            min_list.append(x[0])
            min_homeless_simulation.append(x[1])
            min_year_list.append(x[2])

max_final = list(zip(max_list, max_homeless_simulation, max_year_list))
min_final = list(zip(min_list, min_homeless_simulation, min_year_list))
for x in max_final:
    if x[0] == max(max_list):
        print(
            "The maximum homeless people percentage is in ",
            x[2],
            "and is",
            x[0],
            " as ",
            x[1],
            "are homeless and ",
            int(x[1] * 605 / 2420),
            " unsheltered.",
        )

for x in min_final:
    if x[0] == min(min_list):
        print(
            "The minimum homeless people percentage is in ",
            x[2],
            "and is",
            x[0],
            " as ",
            x[1],
            "are homeless and ",
           int( x[1] * 605 / 2420),
            " unsheltered.",
        )
```

One of the outputs reads “The maximum homeless people percentage is in 2029 and is 0.1024% as 3445 are homeless and 861 unsheltered. The minimum homeless people percentage is in 2032 and is 0.0947% as 4702 are homeless and 1175 unsheltered.” With this case, one can presume the worst and the best scenario for homelessness to happen in Vancouver in ten years, and have a glimpse of the seriousness of this matter from a quantitative perspective. As can be seen here, compared to 2023, the number of unsheltered homeless people which is 1175 theoretically could nearly double from the then 605 in 2032, and the percentage 0.1024% is a rise of more than 10% compared to the then 0.091% (2420/2657000) in just 2029.

The limitation in the homeless simulation is obvious: besides the fact that I have made compromises in preparing some of the default data by using national-level ones, the factors such as unemployment, housing price, mental health, addiction, and domestic abuse here are hypothetically affecting individual independently, and the interconnection between these factors are not considered, while in reality they are certainly relevant to each other and their relation can be expressed in sophisticated mathematic equations. In the future study, I will try to simulate the homelessness census with that knowledge and relevant tools, to yield more persuasive results and to provide insights for tackling the problem.

NOTES:

Unemployment rates are calculated by averaging the unemployment rates from April 2022 to March 2023, which is the time of the PiT census. Domestic abuse rate, addiction rate, and physical illness rate are data on a national level. The physical illness rate is calculated as 100% minus 59.0%, the latter of which is the percentage of people who perceive their physical health condition as being very good or excellent. Mental illness rate is provincial-level data.

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