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4.3.2 Problem Set: Introduction

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In this problem set, we will consider the optimization of cell tower locations to provide the best possible coverage of a collection of user locations. The final application of the algorithm you will implement will be to help determine optimal placement of cell towers on the MIT campus to improve cell signal strength at MIT undergraduate residences.

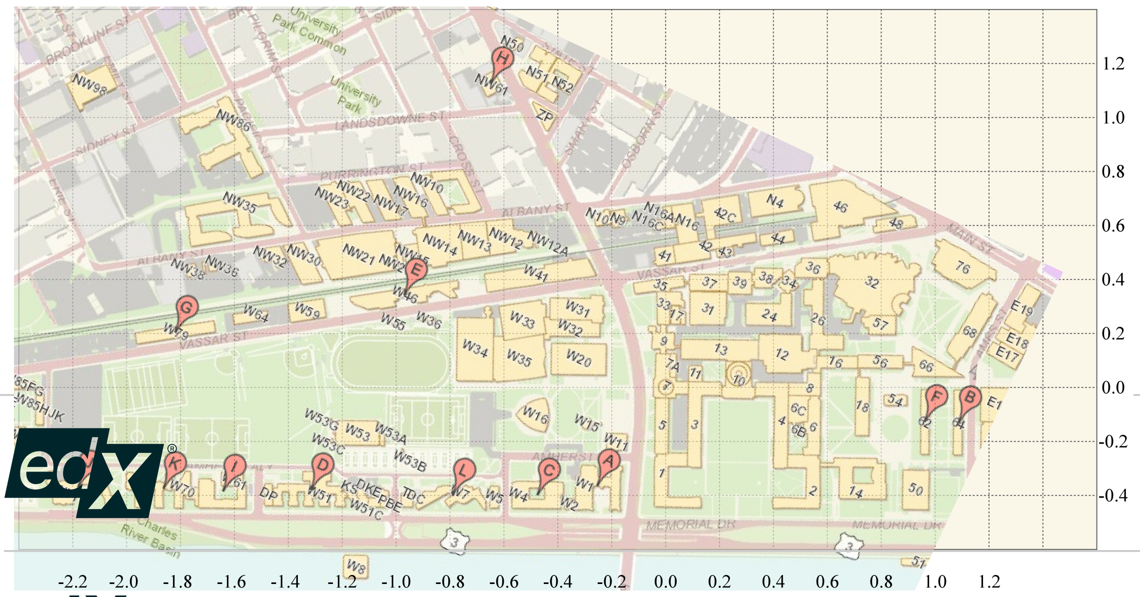

Figure 4.11: Map of MIT undergraduate residences showing the undergraduate residences labelled with letters A through L.

Cell towers are refered to as base stations. Suppose we have N^b base stations and N^u users. Let the location of base station i be (x_i^b, y_i^b) and the location of user j be (x_j^u, y_j^u). The distance (squared) between this base station and user is,

$$d_{ij}^2 = (x_i^b - x_j^u)^2 + (y_i^b - y_j^u)^2 \tag{4.43}$$

The power of the signal between the base station and user is a function of distance and decays as $1/d_{ij}^2$ for large distances. We will use the following model for the power between base station i and user j,

$$P_{ij} = \frac{1}{r_0^2 + d_{ij}^2} \tag{4.44}$$

where r_0 is a constant that we will set to 1 throughout this problem set. Please don't overly interpret this power-distance relation as being precise.

We would like to maximize the power that is available to all users by optimizing the base station locations. In principle, we could consider using the following as our objective function which we would then minimize,

$$J_{\text{minmax}} = -\min_j P_j^{\max}, \qquad P_j^{\max} = \max_i P_{ij} \tag{4.45}$$

where $P_j^{\max}$ is the maximum power available to user j (which will be from the nearest cell tower in our model). The minus sign is

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