Estimating Parking Spot Occupancy

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Stochastic Processes Project
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Outline

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Everybody Parks

Figure: Google Earth. BYU Parking Lot 1A. 40°15′4.49″N and 111°38′58.37″W. Image Taken: Jun 17, 2010. Accessed: Nov 11, 2013.

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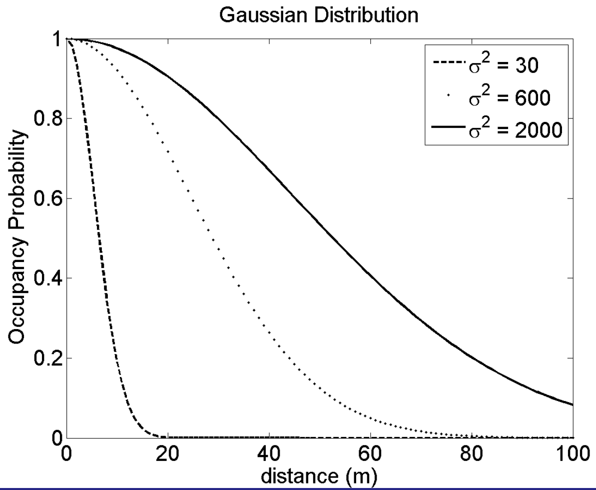
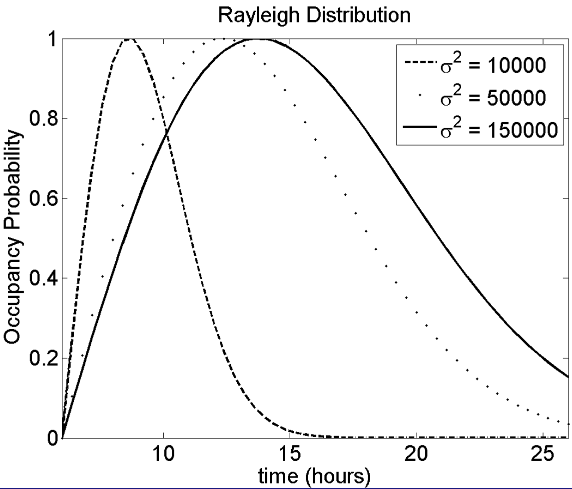
Bernoulli Process

- Each parking space is a Bernoulli random variable
- The probability of occupancy, p, changes with
    - **distance** from the point of interest
    - **time** of day

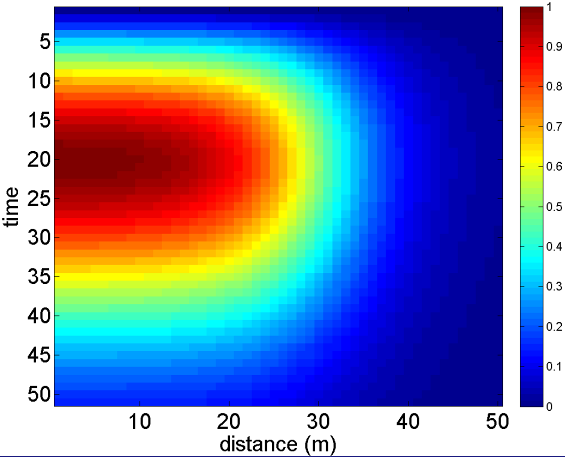
Distance


Gaussian Distribution
Occupancy Probability
distance (m)
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
σ^2 = 30
σ^2 = 600
σ^2 = 2000

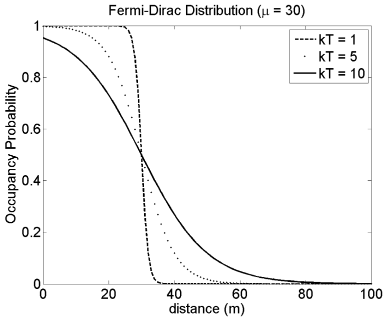
Time of Day

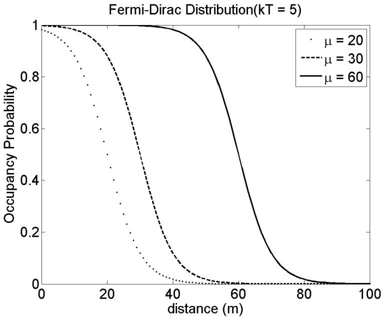

Rayleigh Distribution
Occupancy Probability
time (hours)
0
0.2
0.4
0.6
0.8
1
10
15
20
25
σ² = 10000
σ² = 50000
σ² = 150000

Joint Distribution



Fermi-Dirac - An Alernate Distribution





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Total Time

$$T_{total} = pT_o + (1 - p)T_u \quad (1)$$

T_o

T_o is the wait time for a space to open up plus the walking time to reach the point of interest

T_o

$$Y = min(X_1, X_2..., X_N) \tag{2}$$

T_o - Derived pdf for Wait Time

$$f_Y(x) = N f_X(x)(1 - F_X(x))^{N-1} \tag{3}$$

T_o - Expected Wait Time

$$E[Y] = \int_{-\infty}^{\infty} x N f_X(x)(1 - F_X(x))^{N-1} dx \quad (4)$$

T_o - Expected Distance

$$d_o = \frac{1}{N}\sum_{i}^{N} d_i \tag{5}$$

T_o - Total

$$T_o = E[Y] + \frac{d_o}{v} \tag{6}$$

T_u - Which Spot?

$$p_u = (1 - p_n) \prod_{i=1}^{n-1} p_i, n > 1 \tag{7}$$

T_u - Expected Distance

$$E[d_u] = \sum_{j=1}^{N} d_j p_{u,j} \tag{8}$$

T_u

$$T_u = \frac{E[d]}{v} \tag{9}$$

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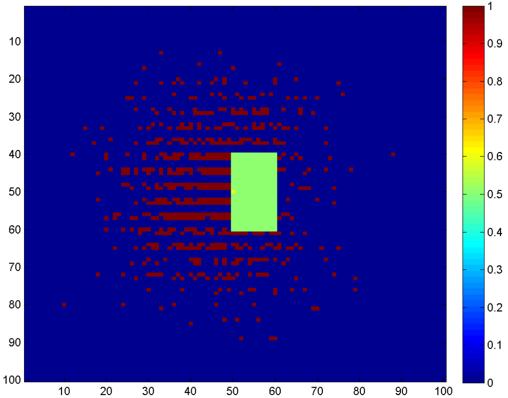
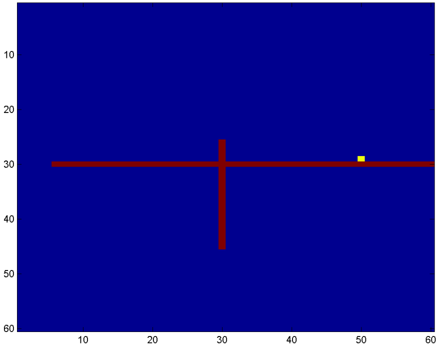
Retail Parking Example



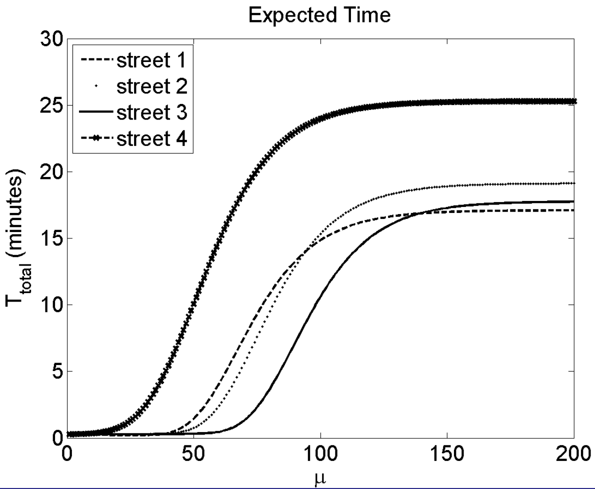
- $\mu = 20$
- $kT = 5$

Street Parking - Time to Point of Interest



- $kT = 30$
- $\mu_1 = 30$
- $\mu_2 = 100$

So which street should I park on?



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Conclusion

Who knew you could have so much fun with parking lots?

And Have Fun Parking

Figure: Munroe, Randall. “Parking”. xkcd. Licensed under CC BY-NC 2.5