ANLY 515-50-2017: Midterm

Due on Tuesday, August 29, 2017

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Problem #1

The US Federal Motor Carrier Safety Administration planned in 2013 to issue rules that would limit the number of hours per week that truck drivers can work. The rules would reduce driver workweeks (fewer hours), restrict the number of nights that truckers can work, and require rest breaks during the day. The impacts could include keeping sleep deprived drivers off the road, reducing crashes, preventing fatigue-related crashes, improving working conditions, reducing driver turnover, improving driver safety, saving lives, reducing injuries, and reducing fatigue-related health problems.

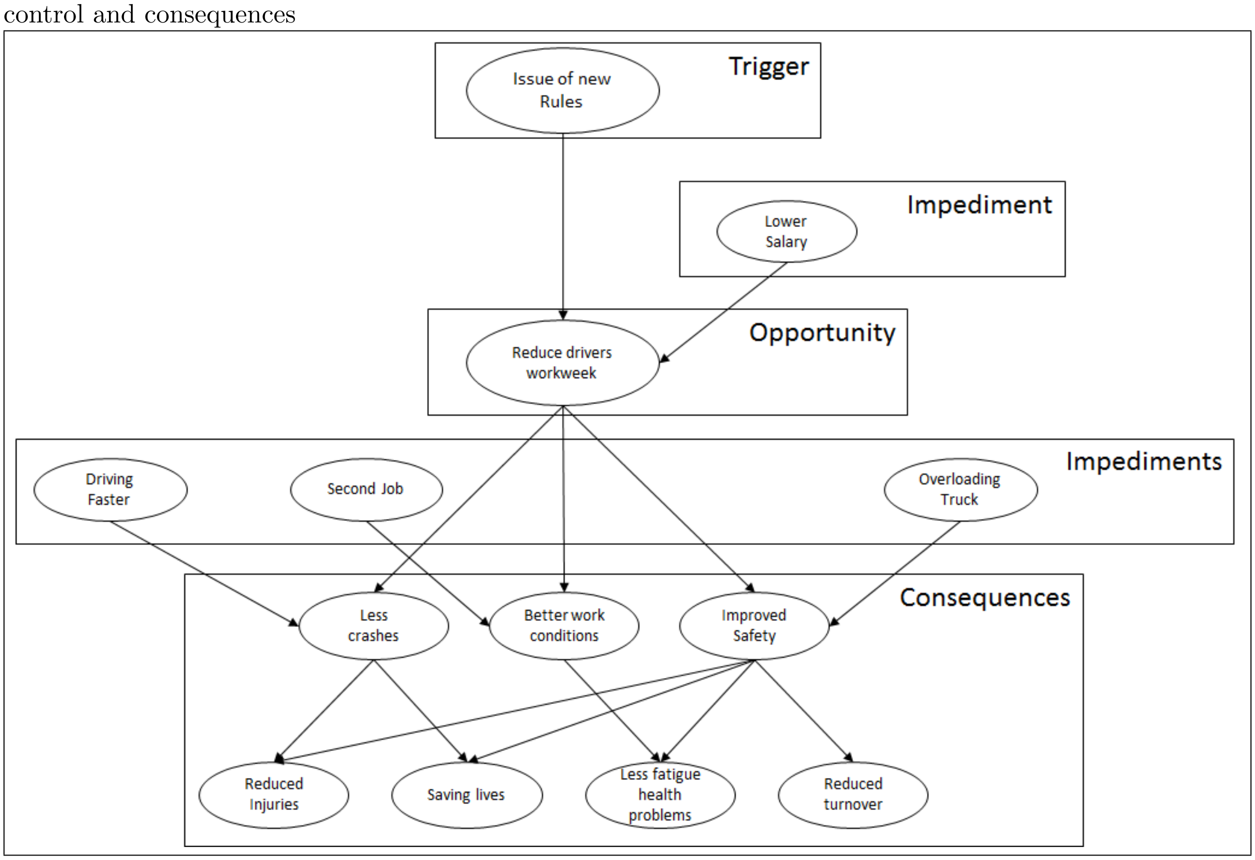
(a)

Identify 3 risks associated with this information

- To compensate for less hours and lower salary, drivers could start a second job, decreasing some of the benefits like fatigue-related health problems and crashes.
- To compensate for less hours and lower salary, drivers may try to drive faster, which would decrease safety and increase crashes.
- To compensate for less hours and lower salary, drivers may overload the truck to carry more cargo, decreasing safety and increasing crashes.

(b)

Using the risk/opportunity approach, develop a conceptual model including events, triggers, mitigation, control and consequences



Problem #2

There are three identical and independent temperature sensors that will trigger in:

- 90% of the cases where the temperature is high.
- 5% of the cases where the temperature is nominal.
- 1% of the cases where the temperature is low.

(T)emperature	L	N	H
True	0.01	0.05	0.9
False	0.99	0.95	0.1

The probability of high temperature is 20%, nominal temperature is 70%, and low temperature is 10%. Describe a Bayesian network and corresponding queries for computing the following:

(T)emperature	True	False
H	0.2	0.8
N	0.7	0.3
L	0.1	0.9

Below the tabular version for calculating the marginal probabilities of the Sensors

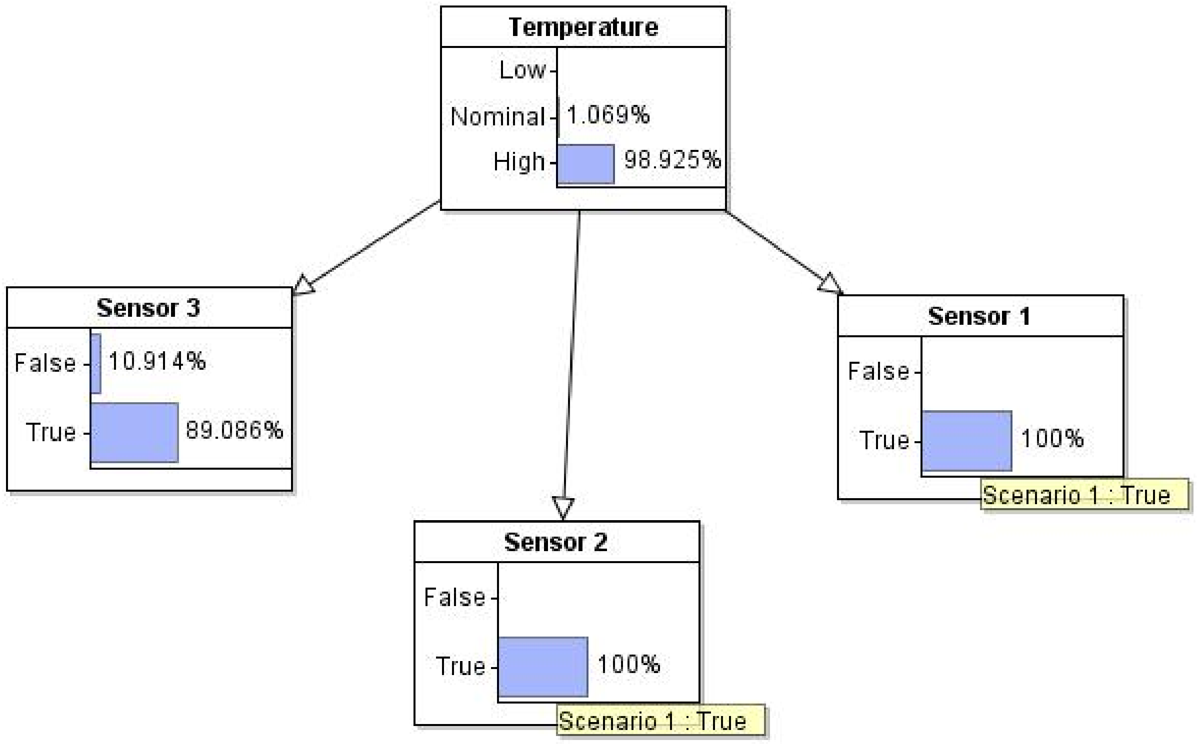
	H	N	L	P(S)
True	0.18	0.035	0.001	0.216
False	0.02	0.665	0.099	0.784
P(T)	0.2	0.7	0.1	1

The Bayes networks equations to calculate the probabilities can be long and error prone when done manually. Since the book and slides recommends using AgenaRisk for representations and calculations, this is method I decided to use here.

Problem #2 continued on next page. . .

(a)

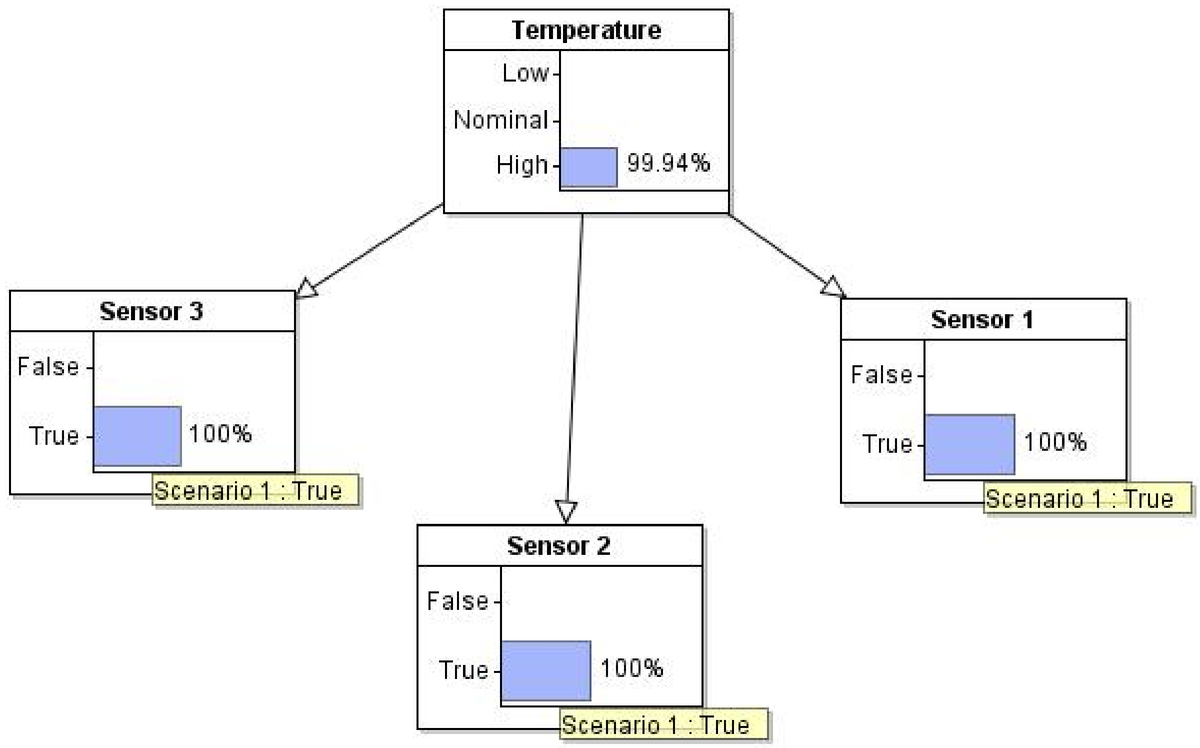
Probability that the first sensor will trigger given that the other two sensors have also triggered.



Thus, the probability is **89.1%**

(b)

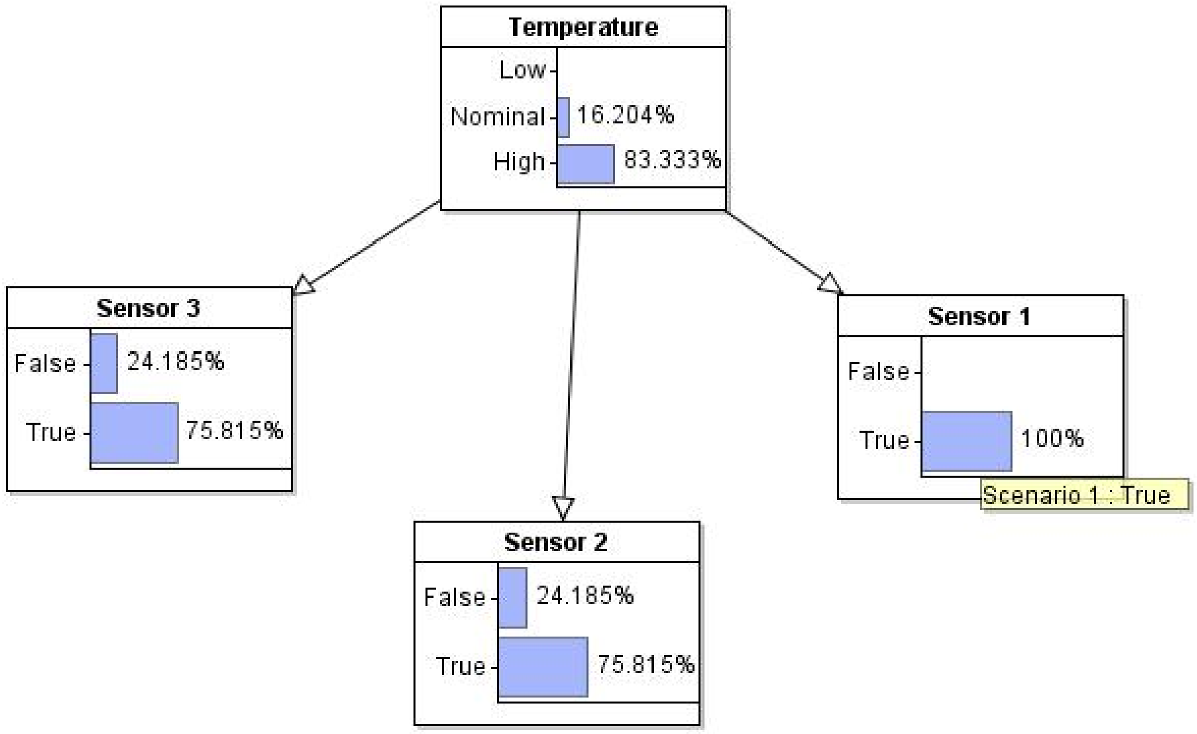
Probability that the temperature is high given that all three sensors have triggered.



Thus, the probability is **99.94%**

(c)

Probability that the temperature is high given that at least one sensor has triggered.

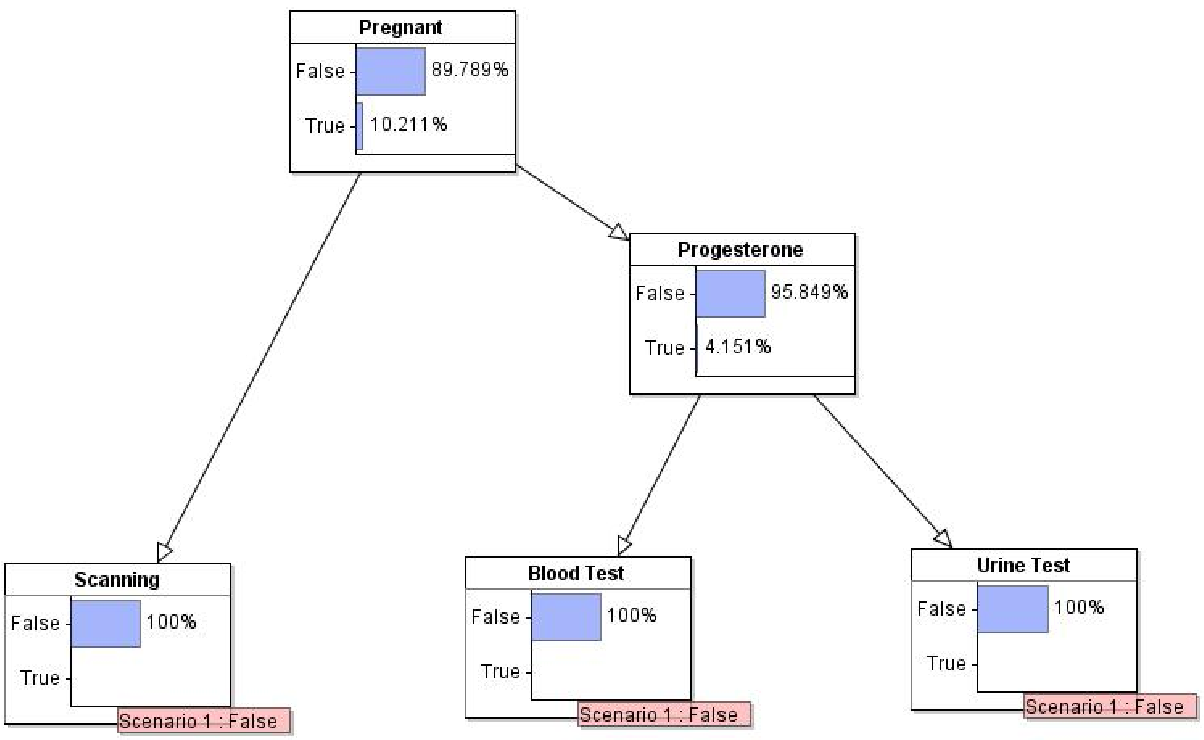


Thus, the probability is **83.33%**

Problem #3

A few weeks after inseminating a cow, we have three possible tests to confirm pregnancy. The first is a scanning test (S) that has a false positive of 1% and a false negative of 10%. The second is a blood test (B) that detects progesterone with a false positive of 10% and a false negative of 30%. The third test is a urine test (U) that also detects progesterone with a false positive of 10% and a false negative of 20%. The probability of a detectable progesterone level is 90% given pregnancy and 1% given no pregnancy. The probability that insemination will impregnate a cow is 87%. Suppose now that we inseminate a cow, wait for a few weeks, and then perform the three tests, which all come out negative. Using a Bayesian model determine the probability that the cow is pregnant?

The model for the exercise was designed using AgenaRisk and is shown in the image below.



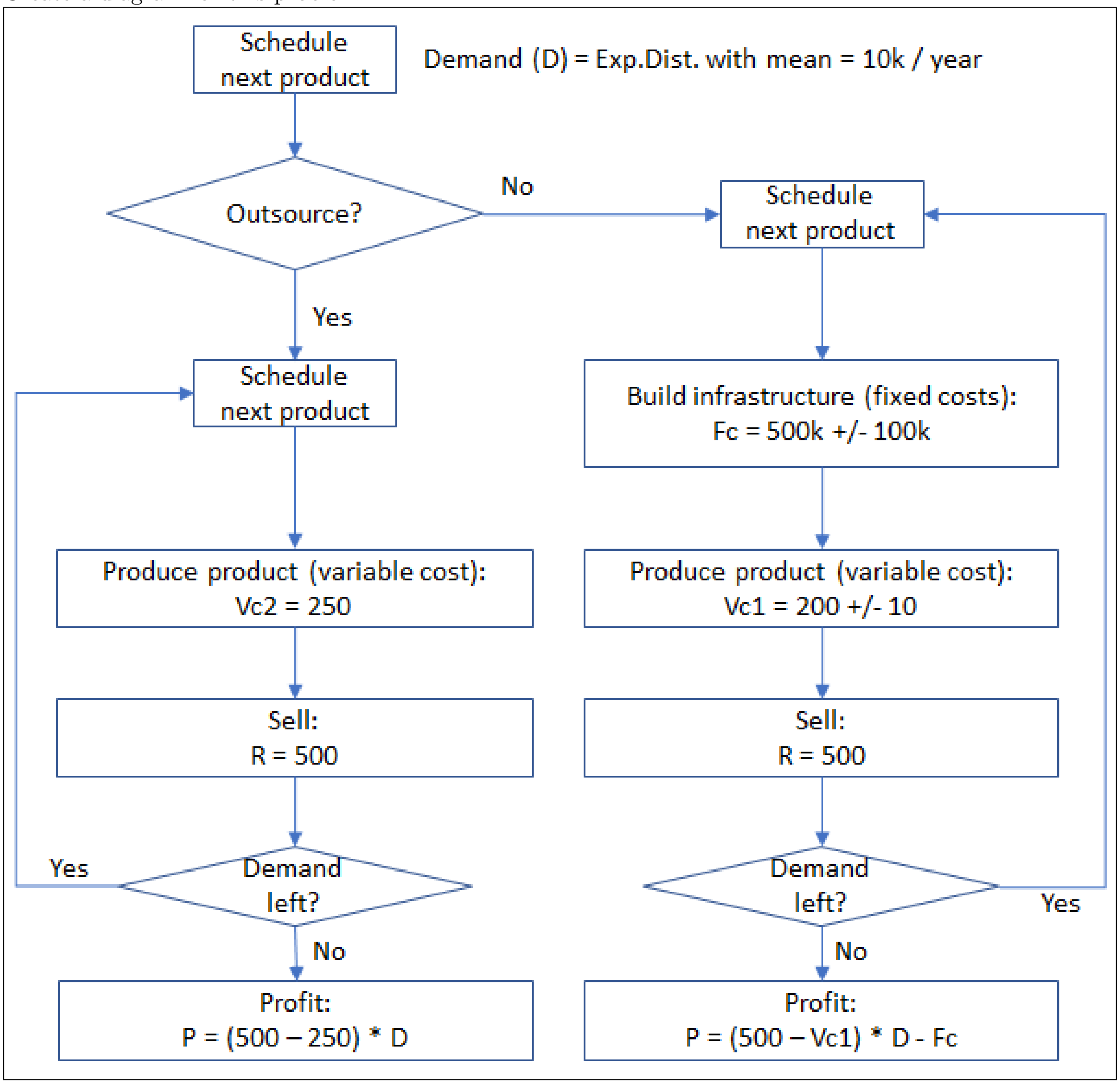
Thus, the probability of the cow being pregnant after the three tests returned negative is **10.21%**

Problem #4

A manufacturing firm has signed a contract to produce a product to demand, receiving \$500 per unit. The firm could either produce the product itself or outsource the production. Demand is exponentially distributed with a mean of 10,000 units per year. In-house production has normally-distributed fixed costs with mean of \$500,000 and a standard deviation of \$100,000 and normally-distributed variable costs with mean \$200 and standard deviation of \$10. Outsourcing has no fixed cost, but variable costs are \$250.

(a)

Create a diagram for this problem.



(b)

Forecast the profit for each alternative.

Analytically, we have two models: Producing in-house (Model 1) and outsourcing (Model 2). Calculating the profit for each of the equations from (a).
Model 1:

$$\begin{aligned} P1 &= (Revenue - Cost) * D - FC1 \\ &= (500 - VC1) * D - FC1 \\ &= (500 - 200) * 10000 - 500000 \\ &= 2,500,000 \end{aligned}$$

Model 2:

$$\begin{aligned} P2 &= (Revenue - Cost) * D \\ &= (500 - 250) * 10000 \\ &= 2,500,000 \end{aligned}$$

(c)

Determine the difference in profit.

Analytically speaking, on average, the profit for both models is the same and thus, the difference between them is zero. For demand(D) less lower than 10,000, outsourcing (Model 2) provides greater profits and above the 10,000 it becomes more profitable to produce in-house.

Problem #4 continued on next page. . .

(d)

Determine the probability that each alternative achieves at least \$0, \$100,000 and \$200,000 profit.

For Model 2, the probability can be calculated by solving the equation for demand when the profits are \$0, \$100,000 and \$200,000. The demand (D) required for these values is, respectively, 0, 200 and 400. This can be easily calculate by getting the cumulative probability of these values in a exponential distribution. In Excel, this is simply done by using **= 1 - EXPON.DIST('D',1/10000,1)** with D being equal to the values above. Using the exponential distribution, we get the probabilities of 100%, 98.02% and 96.08%.

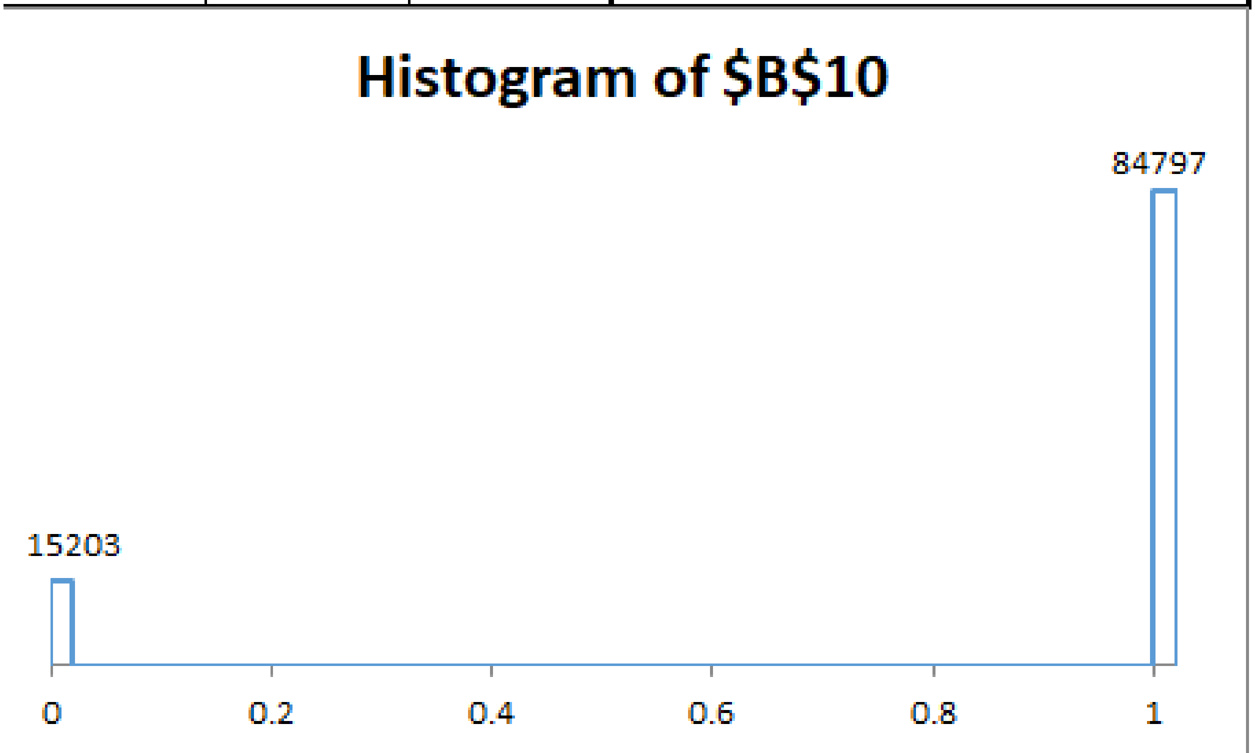
For Model 1, the calculation become more complicated because the probability distribution now is a combination of two normal distributions, one for each cost, and an exponential distribution, for the demand. The approach used to calculate this distribution is to use Monte Carlo simulation in Excel (MCSim addin, available at `http://www3.wabash.edu/econometrics/EconometricsBook/Basic%20Tools/ExcelAddIns/MCSim.htm`).

Assuming a confidence interval of 95%:

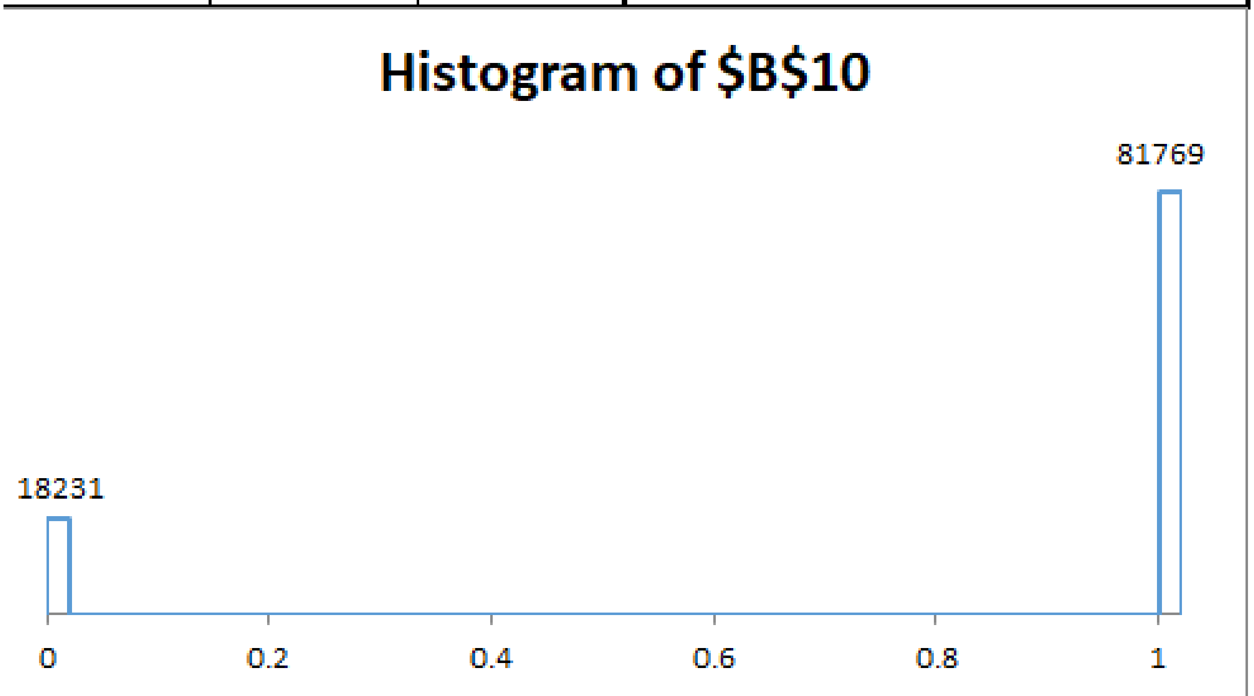
For profit >= 0, P(profit >= 0) = 84.80 +/- 0.22%
For profit >= 100,000, P(profit >= 100,000) = 81.77 +/- 0.24%
For profit >= 200,000, P(profit >= 200,000) = 79.41 +/- 0.25%

One important note is that in opposite of Model 2, the profit in Model 1 will be negative (loss) in about 15% of the time.

Summary Statistics			Notes	
Average	84.80%		SE =	0.001135
SD	0.3591		C.I. 95% =	1.96
Max	1.000		+/- =	0.22%
Min	0.000			



Summary Statistics		Notes	
Average	81.77%	SE =	0.001221
SD	0.3861	C.I. 95% =	1.96
Max	1.000	+/- =	0.24%
Min	0.000		



Summary Statistics		Notes	
Average	79.41%	SE =	0.001279
SD	0.4044	C.I. 95%=	1.96
Max	1.000	+/- =	0.25%
Min	0.000