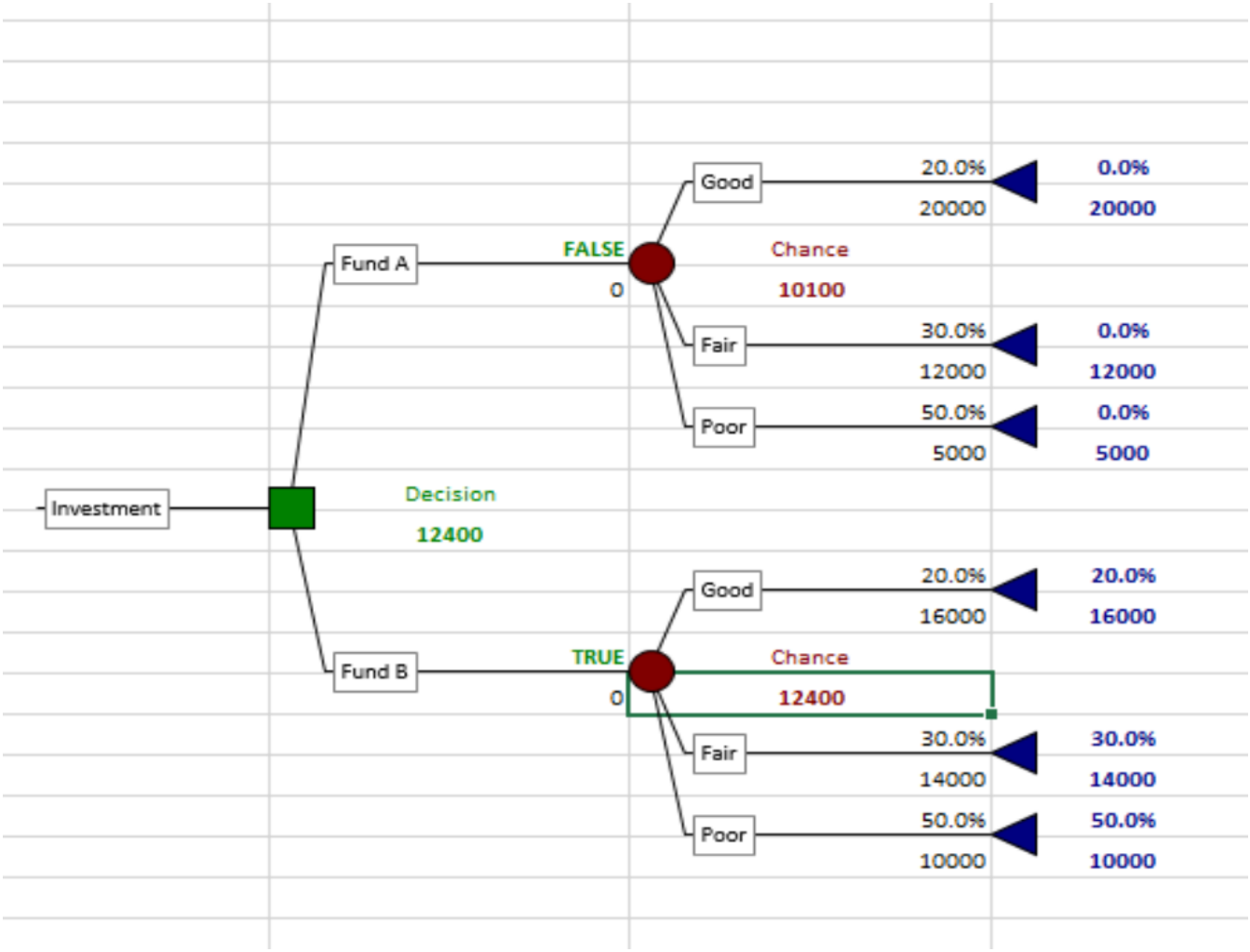
Home Work #7

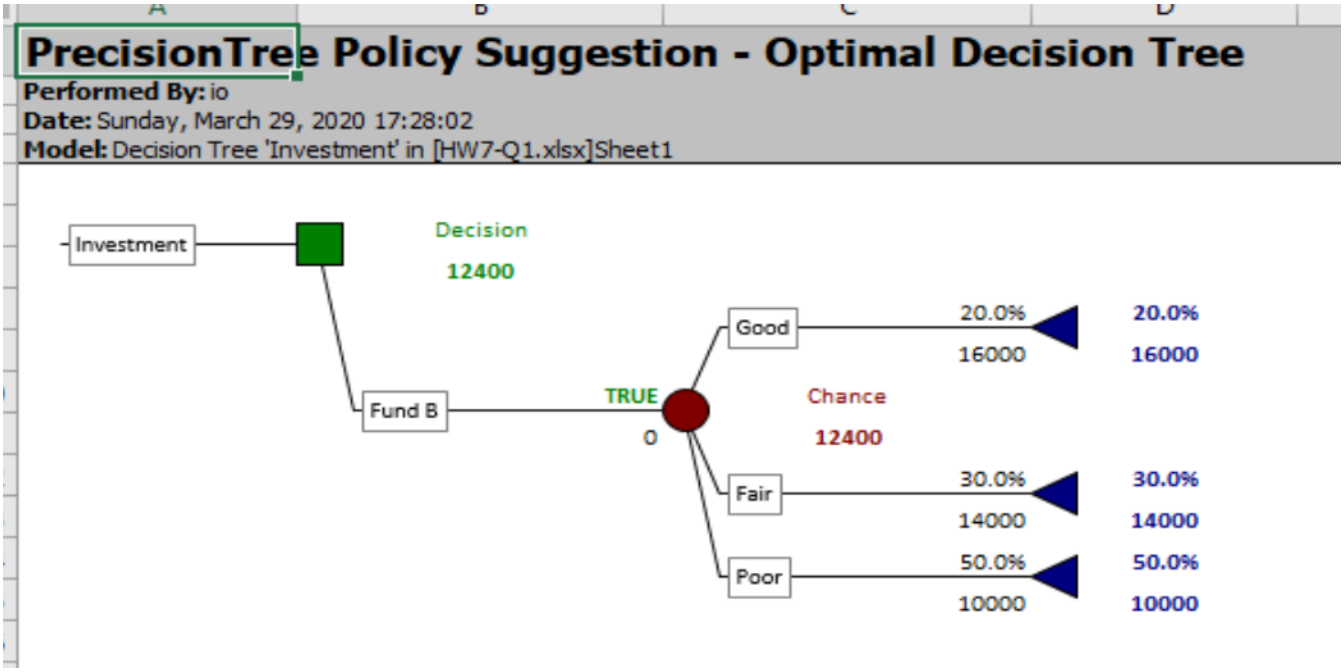
Chapter 10 Computer Analysis of Decision Trees and Sensitivity Analysis – Small Problems Using Precision Tree Software

Q1

The Tree



The Optimal Path



Sensitivity

The analysis is: until the value of the portfolio is `31.5K` , it is when the return must be at least `21.5K` the `Fund B` is still the best option.

Strategy Region Data

	Input		Fund A		Fund B	
	Value	Change (%)	Value	Change (%)	Value	Change (%)
#1	20000	0.00%	10100	-18.55%	12400	0.00%
#2	22272.7273	11.36%	10554.5455	-14.88%	12400	0.00%
#3	24545.4545	22.73%	11009.0909	-11.22%	12400	0.00%
#4	26818.1818	34.09%	11463.6364	-7.55%	12400	0.00%
#5	29090.9091	45.45%	11918.1818	-3.89%	12400	0.00%
#6	31363.6364	56.82%	12372.7273	-0.22%	12400	0.00%
#7	33636.3636	68.18%	12827.2727	3.45%	12400	0.00%
#8	35909.0909	79.55%	13281.8182	7.11%	12400	0.00%
#9	38181.8182	90.91%	13736.3636	10.78%	12400	0.00%
#10	40454.5455	102.27%	14190.9091	14.44%	12400	0.00%
#11	42727.2727	113.64%	14645.4545	18.11%	12400	0.00%
#12	45000	125.00%	15100	21.77%	12400	0.00%

Cumulative Probability

PrecisionTree RiskProfile - Cumulative Chart

Performed By: io
Date: Sunday, March 29, 2020 17:50:19
Model: Decision Tree 'Investment' in [HW7-Q1.xlsx]Sheet1
Analysis: Choice Comparison for Node 'Decision' (B29)

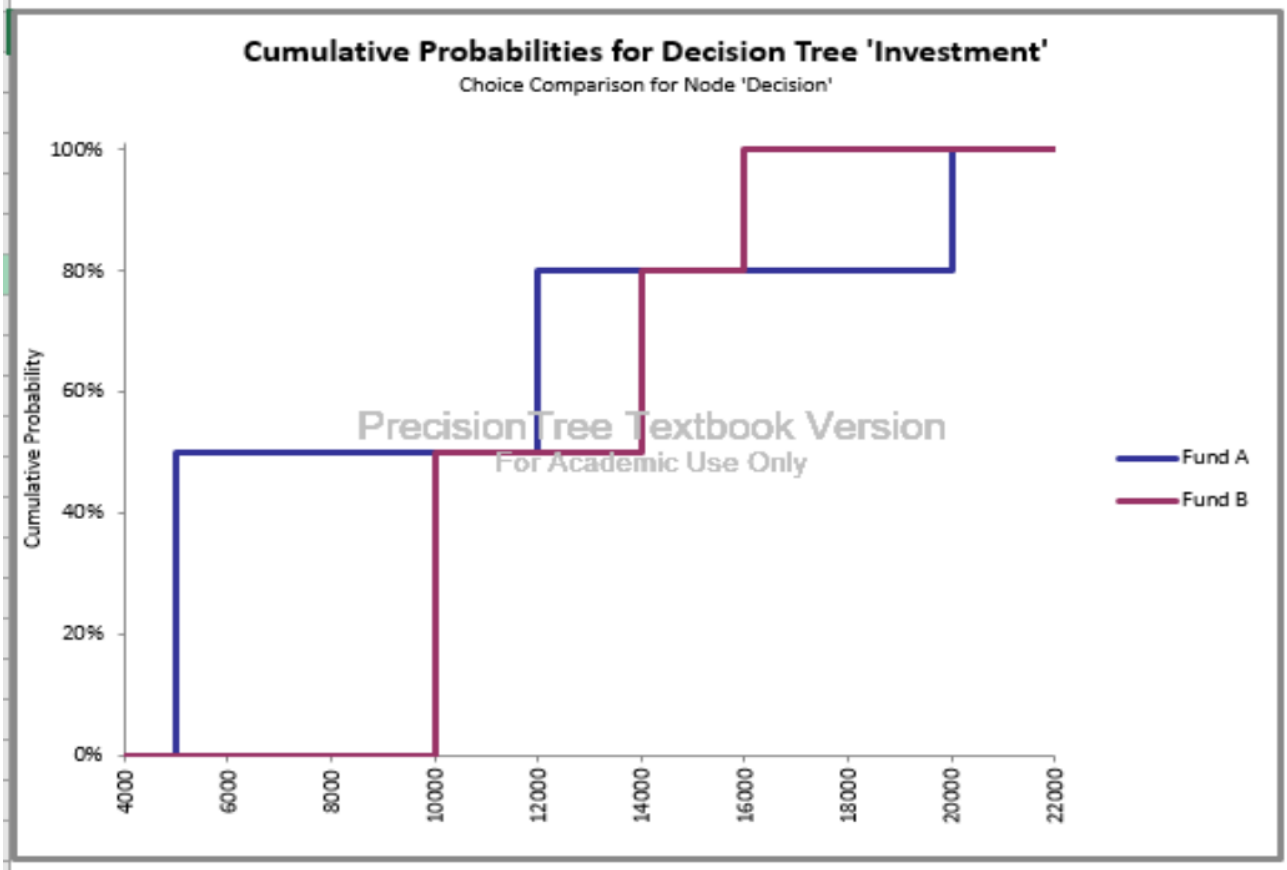


Chart Data

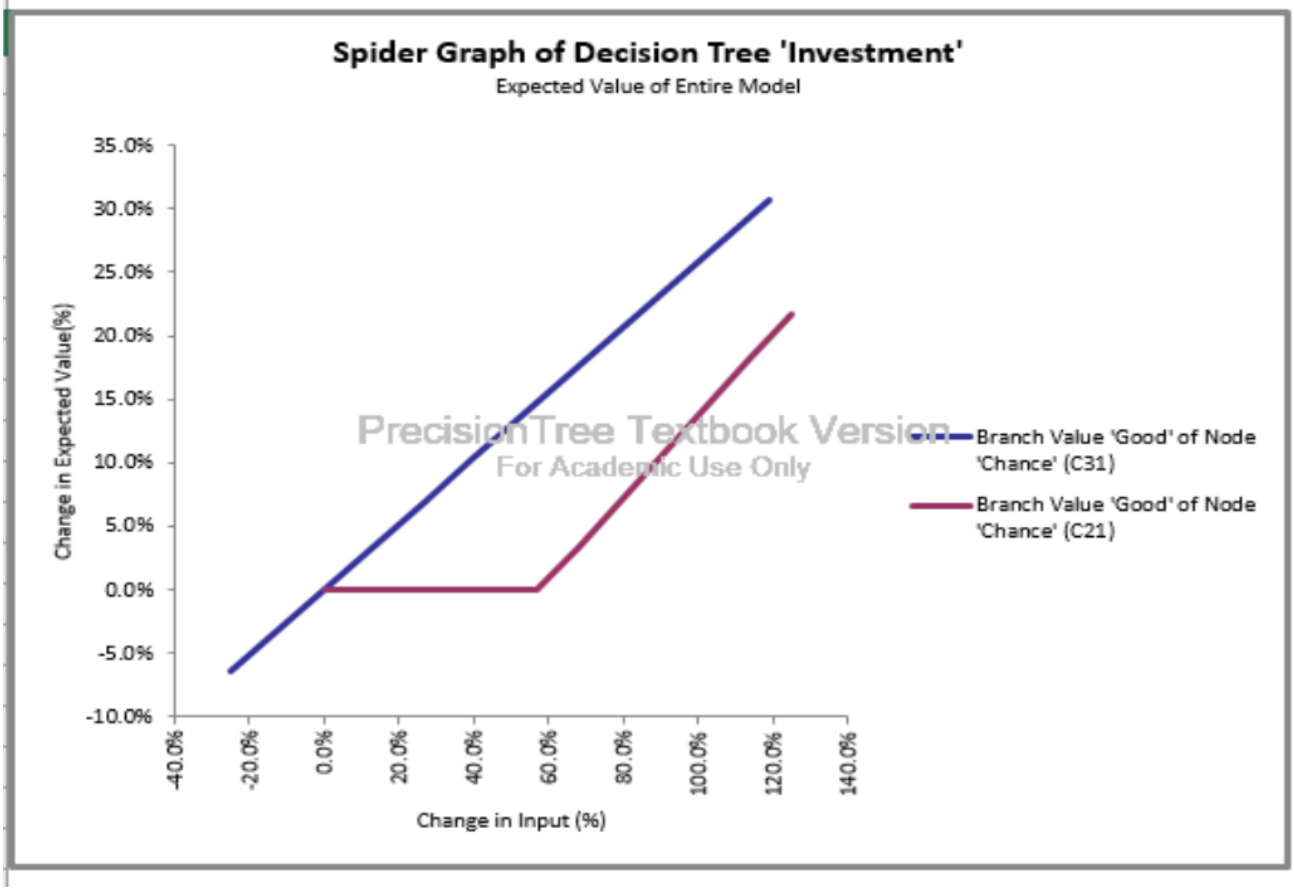
	Fund A		Fund B	
	Value	Probability	Value	Probability
#1	-Infinity	0.0000%	-Infinity	0.0000%
#2	5000	0.0000%	10000	0.0000%
#3	5000	50.0000%	10000	50.0000%
#4	12000	50.0000%	14000	50.0000%
#5	12000	80.0000%	14000	80.0000%
#6	20000	80.0000%	16000	80.0000%
#7	20000	100.0000%	16000	100.0000%
#8	Infinity	100.0000%	Infinity	100.0000%

- There is a `%50` risk to end up loosing `5000K` using `Fund A` strategy
- There is a `%50` risk to end up with initial `10000K` using `Fund B` strategy

Spider

PrecisionTree Sensitivity Analysis - Spider Graph

Performed By: io
Date: Sunday, March 29, 2020 17:58:46
Output: Decision Tree 'Investment' (Expected Value of Entire Model)



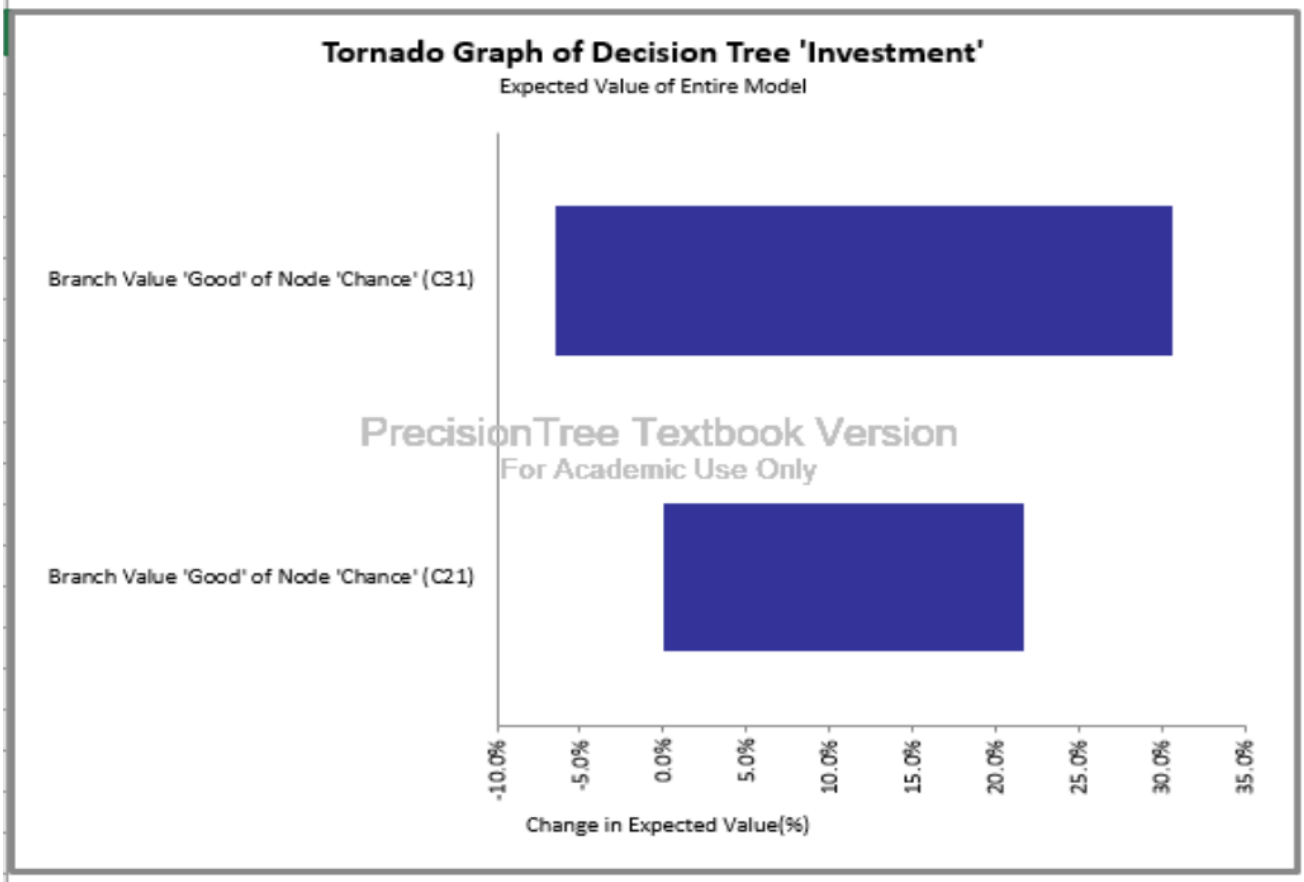
Spider Graph Data

Decision Tree 'Investment' (Expected Value of Entire Model)

			Input Variation			Output Variation		
Input Name	Cell	Step	Value	Change	Change (%)	Value	Change	Change (%)
Branch Value 'Good' of Node 'Chance' (C31)	C31	1	12000	-4000	-25.00%	11600	-800	-6.45%
		2	14090.90909	-1909.090909	-11.93%	12018.18182	-381.8181818	-3.08%
		3	16181.81818	181.8181818	1.14%	12436.36364	36.36363636	0.29%
		4	18272.72727	2272.727273	14.20%	12854.54545	454.5454545	3.67%
		5	20363.63636	4363.636364	27.27%	13272.72727	872.7272727	7.04%
		6	22454.54545	6454.545455	40.34%	13690.90909	1290.909091	10.41%
		7	24545.45455	8545.454545	53.41%	14109.09091	1709.090909	13.78%
		8	26636.36364	10636.36364	66.48%	14527.27273	2127.272727	17.16%
		9	28727.27273	12727.27273	79.55%	14945.45455	2545.454545	20.53%
		10	30818.18182	14818.18182	92.61%	15363.63636	2963.636364	23.90%
		11	32909.09091	16909.09091	105.68%	15781.81818	3381.818182	27.27%
		12	35000	19000	118.75%	16200	3800	30.65%
Branch Value 'Good' of Node 'Chance' (C21)	C21	1	20000	0	0.00%	12400	0	0.00%
		2	22272.72727	2272.727273	11.36%	12400	0	0.00%
		3	24545.45455	4545.454545	22.73%	12400	0	0.00%
		4	26818.18182	6818.181818	34.09%	12400	0	0.00%
		5	29090.90909	9090.909091	45.45%	12400	0	0.00%
		6	31363.63636	11363.63636	56.82%	12400	0	0.00%
		7	33636.36364	13636.36364	68.18%	12827.27273	427.2727273	3.45%
		8	35909.09091	15909.09091	79.55%	13281.81818	881.8181818	7.11%
		9	38181.81818	18181.81818	90.91%	13736.36364	1336.363636	10.78%
		10	40454.54545	20454.54545	102.27%	14190.90909	1790.909091	14.44%
		11	42727.27273	22727.27273	113.64%	14645.45455	2245.454545	18.11%
		12	45000	25000	125.00%	15100	2700	21.77%

Tornado

PrecisionTree Sensitivity Analysis - Tornado Graph
Performed By: io
Date: Sunday, March 29, 2020 17:58:45
Output: Decision Tree 'Investment' (Expected Value of Entire Model)



Tornado Graph Data
Decision Tree 'Investment' (Expected Value of Entire Model)

			Minimum			Maximum		
			Output		Input	Output		Input
Rank	Input Name	Cell	Value	Change (%)	Value	Value	Change (%)	Value
1	Branch Value 'Good' of Node 'Chance' (C31)	C31	11600	-6.45%	12000	16200	30.65%	35000
2	Branch Value 'Good' of Node 'Chance' (C21)	C21	12400	0.00%	20000	15100	21.77%	45000

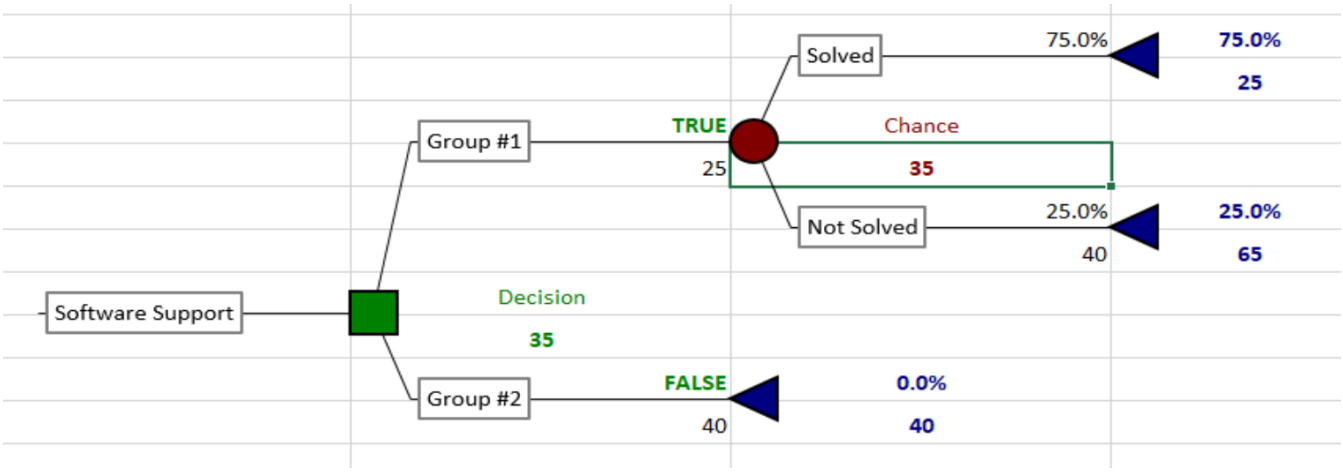
Conclusions

- For the `Fund A` investment to become more valuable in the `Good Economy` scenario the return must be at least `21.5K`
- There is an equal risk of ending up with `5000K` less trusting the `Fund A` as wel as keeping the initial `10000K` with investing in the `Fund B`

Q2

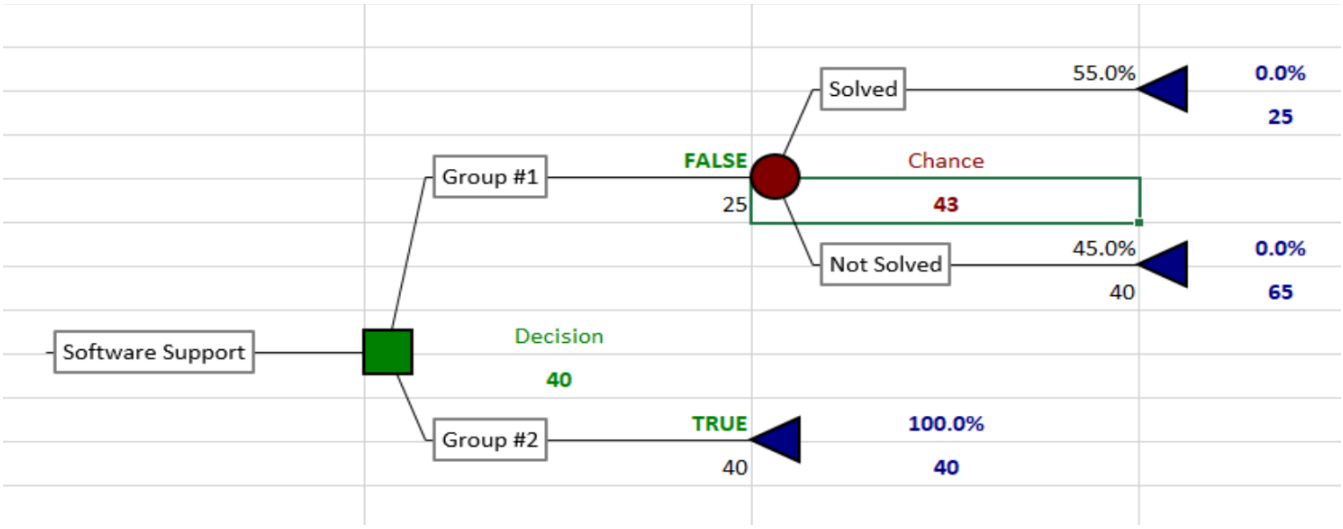
The goal is to minmize the EMV of `Support cost per episode`

a)



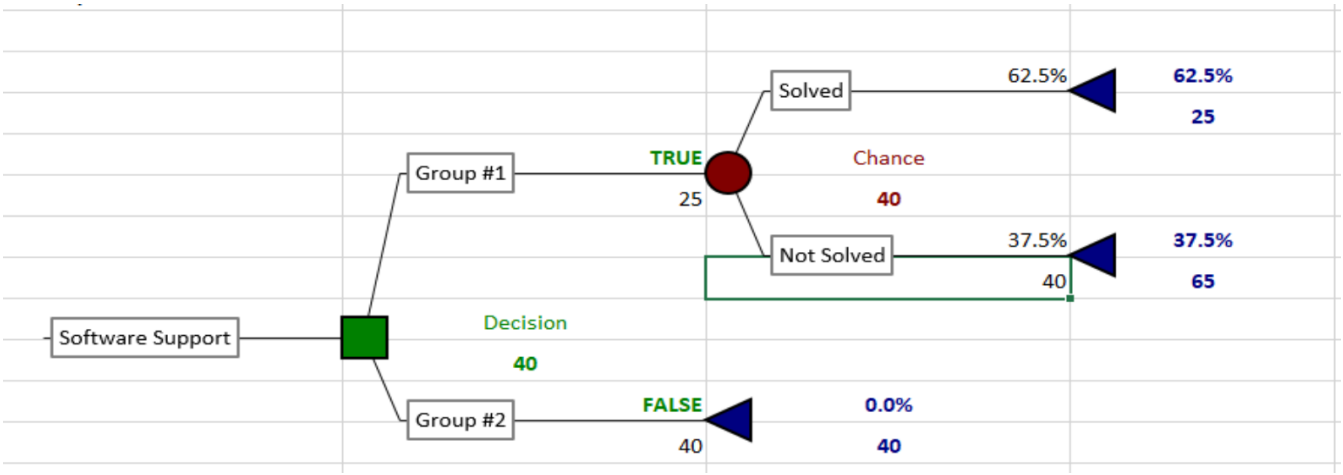
b) The assigment of `Group 1` specialist in the case where probability of him solving the problem is `75%` have EMV of `$35` vs `$40` if the `Group 1` takes it first. The `Group 1` has to handle this request.

c)



d) The assigment of `Group 2` specialist in the case where probability of the `Group 1` specialist solving the problem is `55%` gives EMV of `$40` vs `$43` if done the other way. The `Group 2` has to handle this request.

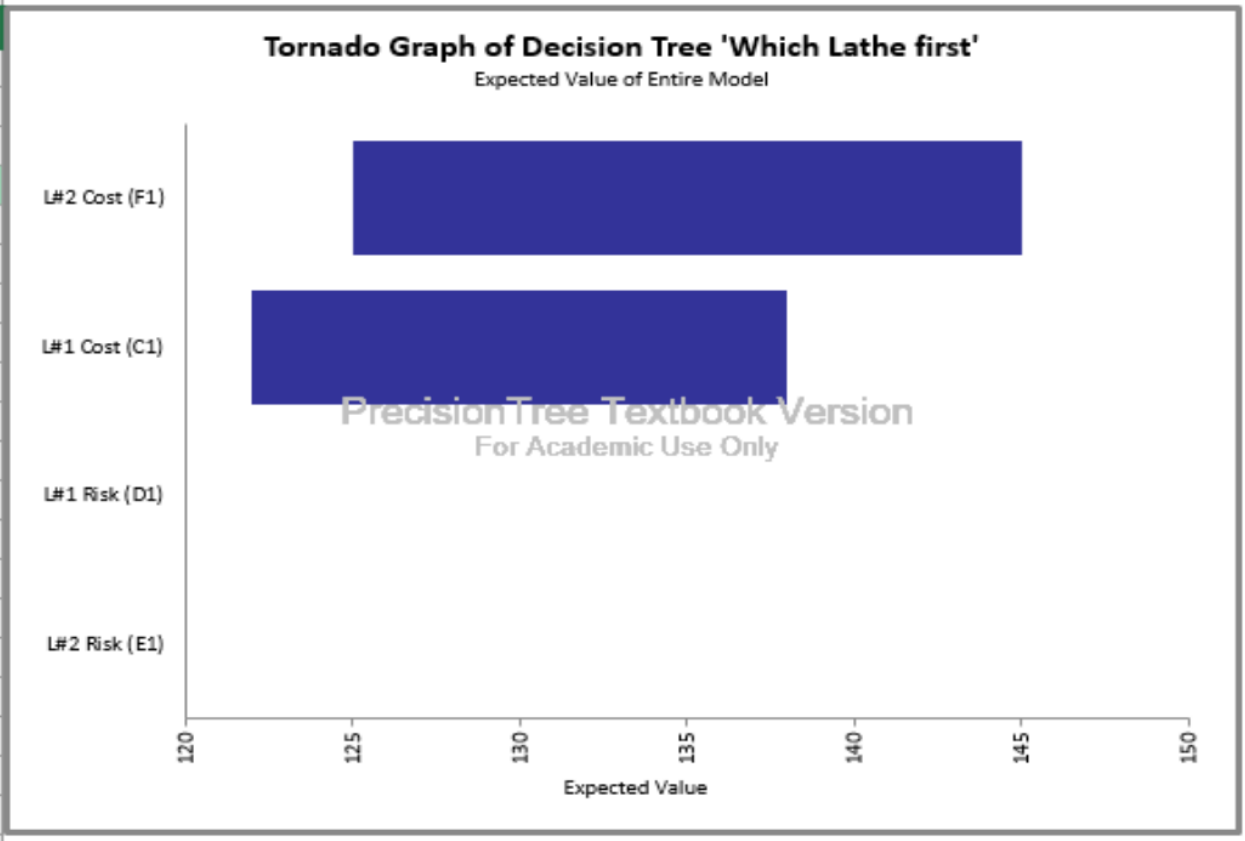
e) If Probability of solving assigment by `Group 1` specialist is bellow `62.5%` the problem has to be assigned to `Group 2`



11.6.a)

PrecisionTree Sensitivity Analysis - Tornado Graph

Performed By: io
Date: Sunday, April 5, 2020 20:05:57
Output: Decision Tree 'Which Lathe first' (Expected Value of Entire Model)



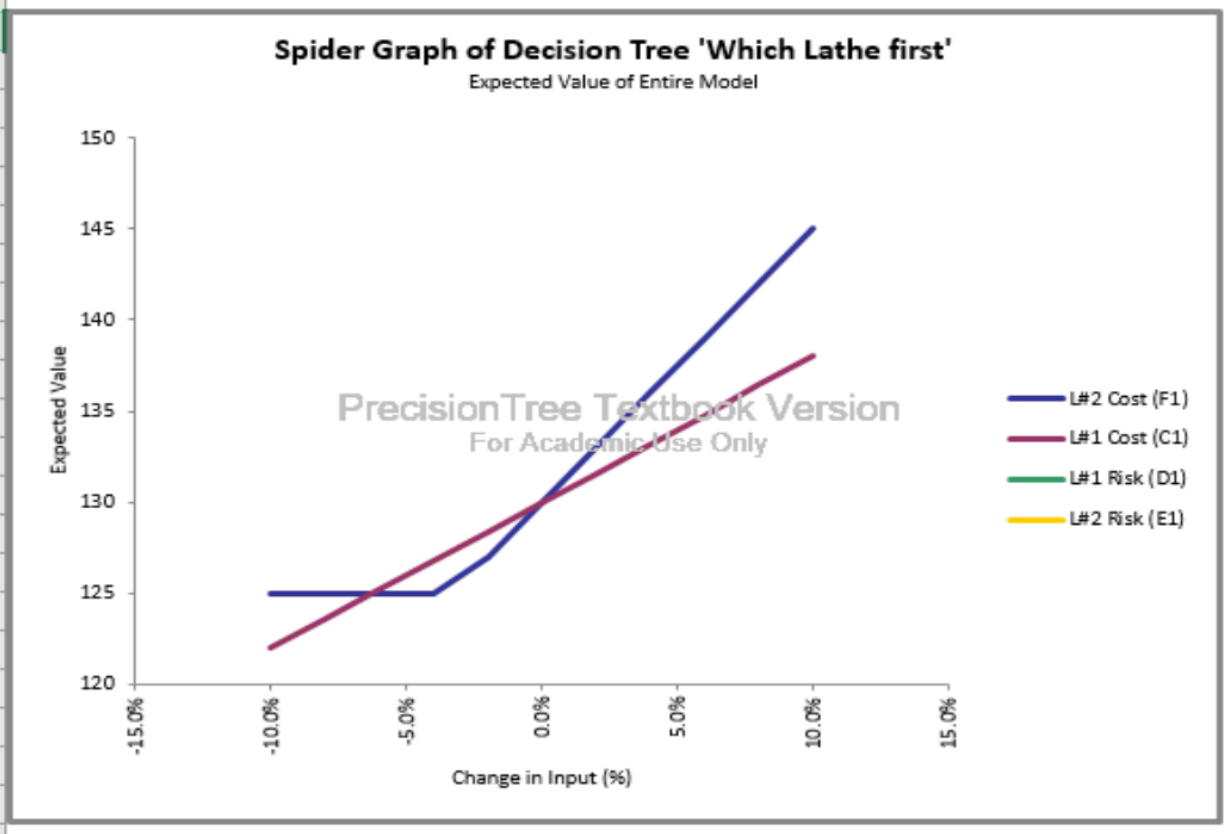
Tornado Graph Data

Decision Tree 'Which Lathe first' (Expected Value of Entire Model)

			Minimum			Maximum		
			Output		Input	Output		Input
Rank	Input Name	Cell	Value	Change (%)	Value	Value	Change (%)	Value
1	L#2 Cost (F1)	F1	125	-3.85%	-165	145	11.54%	-135
2	L#1 Cost (C1)	C1	122	-6.15%	-110	138	6.15%	-90
3	L#1 Risk (D1)	D1	130	0.00%	0.1	130	0.00%	0.1
4	L#2 Risk (E1)	E1	130	0.00%	0.2	130	0.00%	0.2

PrecisionTree Sensitivity Analysis - Spider Graph

Performed By: io
Date: Sunday, April 5, 2020 20:05:57
Output: Decision Tree 'Which Lathe first' (Expected Value of Entire Model)



Spider Graph Data

Decision Tree 'Which Lathe first' (Expected Value of Entire Model)

			Input Variation			Output Variation		
Input Name	Cell	Step	Value	Change	Change (%)	Value	Change	Change (%)
L#2 Cost (F1)	F1	1	-165	-15	-10.00%	125	-5	-3.85%
		2	-162	-12	-8.00%	125	-5	-3.85%
		3	-159	-9	-6.00%	125	-5	-3.85%
		4	-156	-6	-4.00%	125	-5	-3.85%
		5	-153	-3	-2.00%	127	-3	-2.31%
		6	-150	0	0.00%	130	0	0.00%
		7	-147	3	2.00%	133	3	2.31%
		8	-144	6	4.00%	136	6	4.62%
		9	-141	9	6.00%	139	9	6.92%
		10	-138	12	8.00%	142	12	9.23%
		11	-135	15	10.00%	145	15	11.54%
L#1 Cost (C1)	C1	1	-110	-10	-10.00%	122	-8	-6.15%
		2	-108	-8	-8.00%	124	-6.4	-4.92%
		3	-106	-6	-6.00%	125	-4.8	-3.69%
		4	-104	-4	-4.00%	127	-3.2	-2.46%
		5	-102	-2	-2.00%	128	-1.6	-1.23%
		6	-100	0	0.00%	130	0	0.00%
		7	-98	2	2.00%	132	1.6	1.23%
		8	-96	4	4.00%	133	3.2	2.46%
		9	-94	6	6.00%	135	4.8	3.69%
		10	-92	8	8.00%	136	6.4	4.92%
		11	-90	10	10.00%	138	8	6.15%
L#1 Risk (D1)	D1	1	0.1	0	0.00%	130	0	0.00%
		2	0.1	0.001	1.00%			
		3	0.1	0.002	2.00%			
		4	0.1	0.003	3.00%			
		5	0.1	0.004	4.00%			
		6	0.11	0.005	5.00%			
		7	0.11	0.006	6.00%			
		8	0.11	0.007	7.00%			
L#2 Risk (E1)	E1	1	0.2	0	0.00%	130	0	0.00%
		2	0.2	0.002	1.00%			
		3	0.2	0.004	2.00%			
		4	0.21	0.006	3.00%			
		5	0.21	0.008	4.00%			
		6	0.21	0.01	5.00%			
		7	0.21	0.012	6.00%			
		8	0.21	0.014	7.00%			

11.6.b)

- The *highes impact* is from `L#2 Cost`
- No impact from *Both* `Risks`

11.6.c)

- The highes *Rate of Change* is the `L#2 Cost`

11.6.d and 11.6.e)

The *Expected Value of Perfect Information* is calculated by taking the pessimistic value and subtracting the optimistic value.

For given range of changes:

Variable	Pessimistic Value	Optimistic Value
Lathe 1 Cost	10% of base	Neg 10% base
Lathe 2 Cost	10% of base	Neg 10% base
Risk of Lathe 1 Cost	7% of base	Base
Risk of Lathe 2 Cost	7% of base	Base

The *EVPI*s for both are as follows:

	Cost	Pessimistice Value	Optimistic Value	EVPI
Lathe 1	100	110	90	20
Lathe 2	150	165	135	30

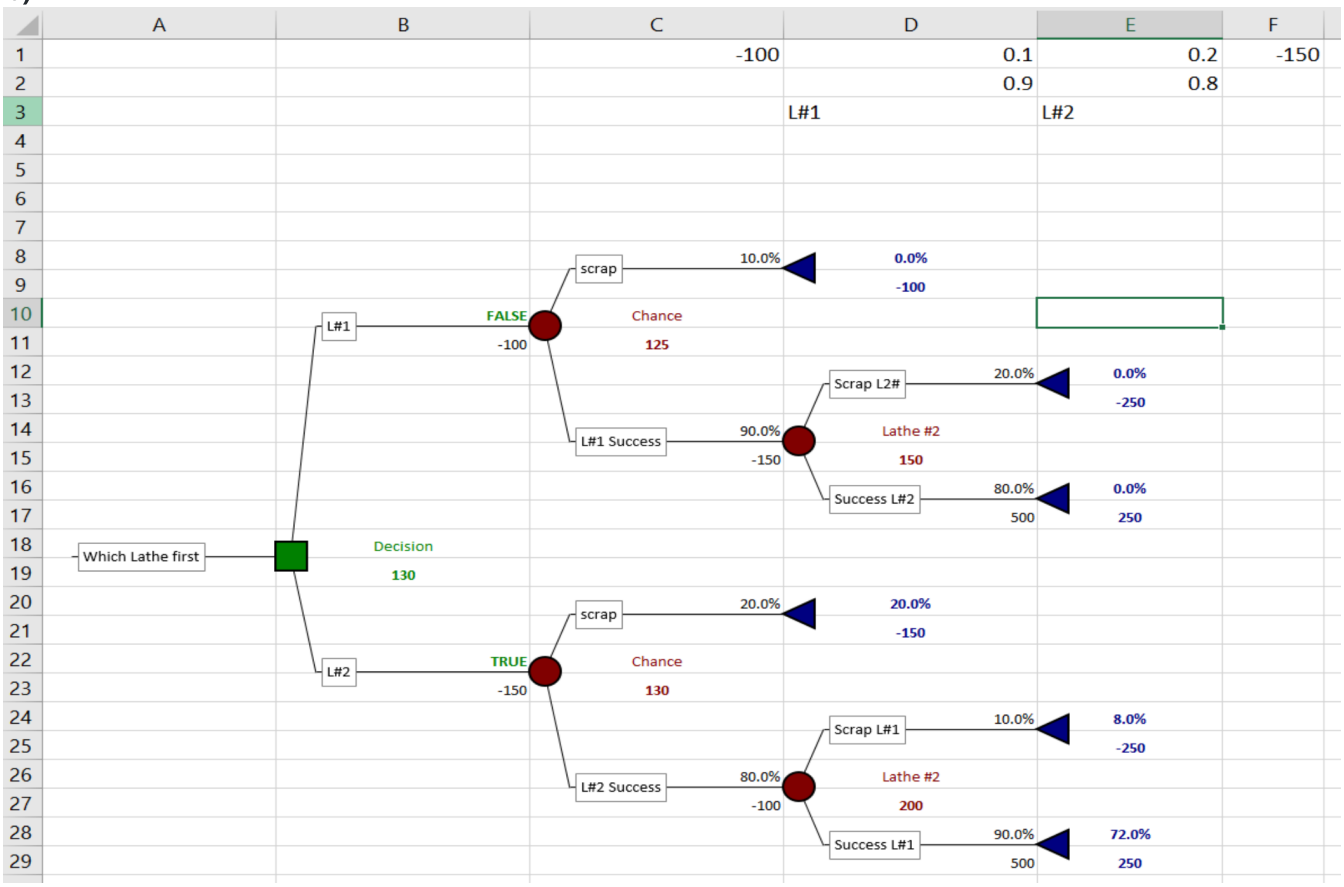
Q3

a)

The Probability of part to be scrapped is the *same no matter what order the operations are performed*.

- What is the probability of the part being ruined?
  - Probability of Success (1 – 0.1)(1 – 0.2) = %72
  - Probability of Failure %100 - %72 = %28

b)

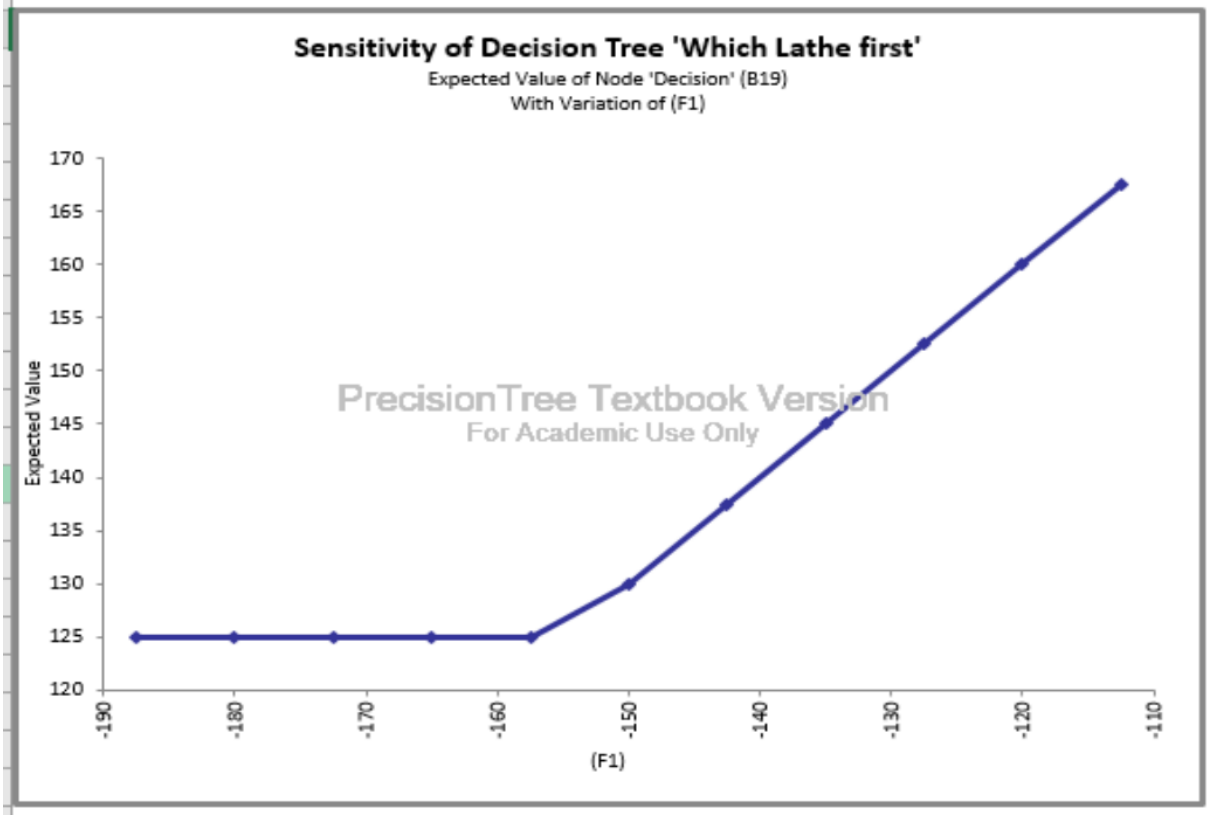


c) Conclusion: `Lathe #2` has to start first.

d) The Total value encreases linearly with coefficient ~1 when cost of `L#2` operation drops

PrecisionTree Sensitivity Analysis - Sensitivity Graph

Performed By: io
Date: Sunday, April 5, 2020 17:52:32
Output: Decision Tree 'Which Lathe first' (Expected Value of Entire Model)
Input: (F1)



Sensitivity Data

	Input		Output	
	Value	Change (%)	Value	Change (%)
#1	-187.5	-25.00%	125	-3.85%
#2	-180	-20.00%	125	-3.85%
#3	-172.5	-15.00%	125	-3.85%
#4	-165	-10.00%	125	-3.85%
#5	-157.5	-5.00%	125	-3.85%
#6	-150	0.00%	130	0.00%
#7	-142.5	5.00%	137.5	5.77%
#8	-135	10.00%	145	11.54%
#9	-127.5	15.00%	152.5	17.31%
#10	-120	20.00%	160	23.08%
#11	-112.5	25.00%	167.5	28.85%

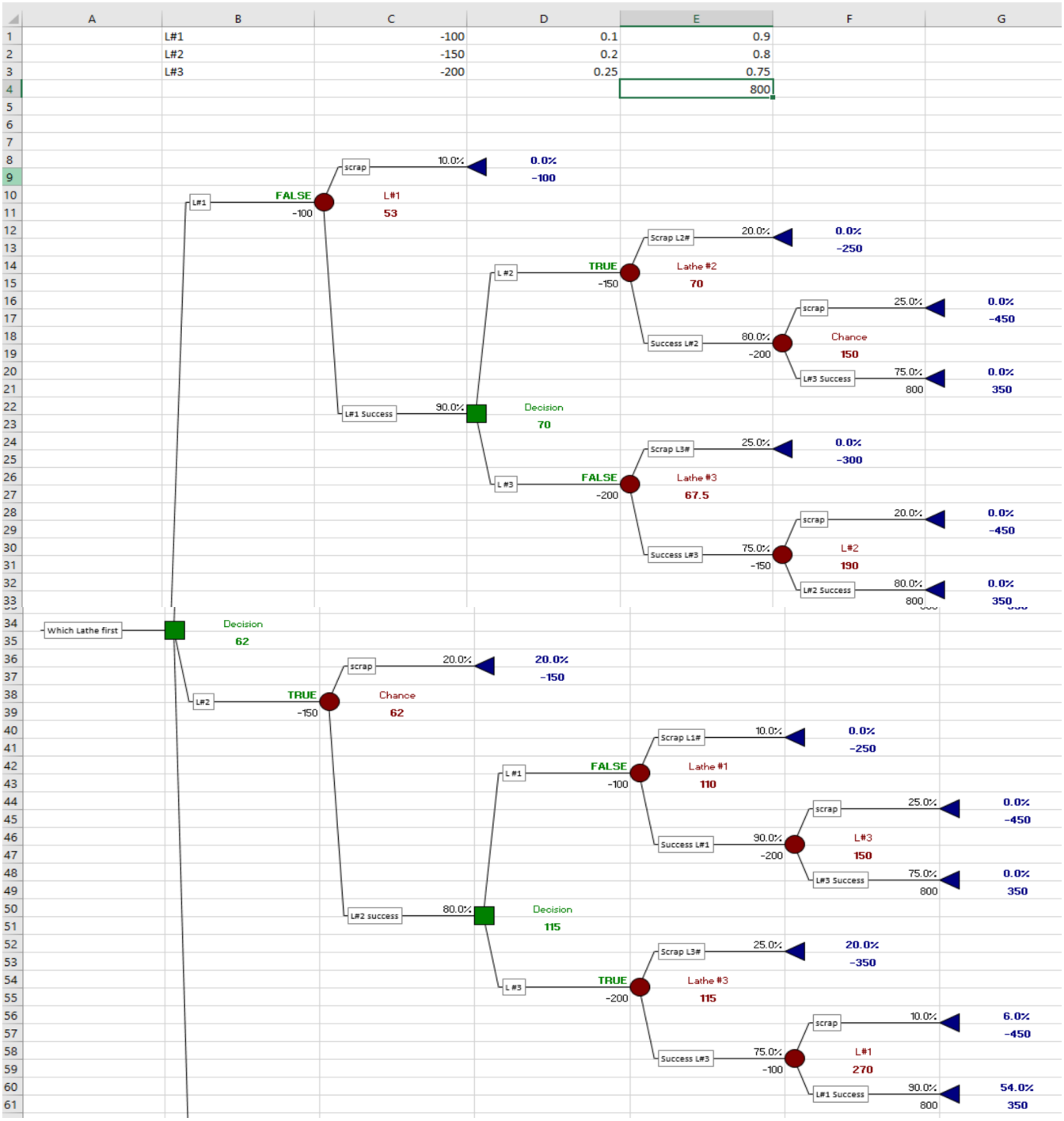
10.14.a) There is `3! = 3*2*1` or `six` possible permutations for the three machines.

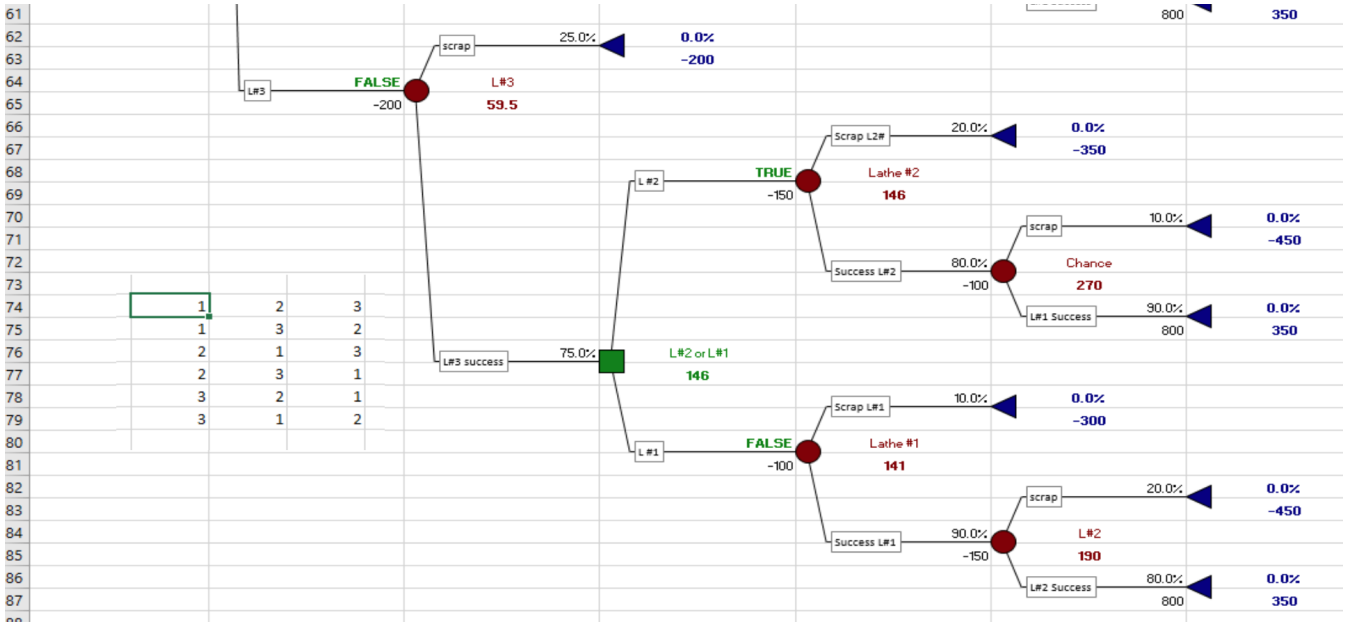
1	2	3
1	3	2
2	1	3
2	3	1
3	2	1
3	1	2

10.14.b)

* Probability of Success (1 – 0.1) * (1 – 0.2) * (1 – 0.25) = %54
* Probability of Failure %100 – %54 = %46

10.14.c)


L#1 -100 0.1 0.9
L#2 -150 0.2 0.8
L#3 -200 0.25 0.75
800
L#1
FALSE
-100
scrap
10.0%
0.0%
-100
L#1
53
L#1 Success
90.0%
Decision
70
L#2
TRUE
-150
Scrap L2#
20.0%
0.0%
-250
Lathe #2
70
Success L#2
80.0%
-200
scrap
25.0%
0.0%
-450
Chance
150
L#3 Success
75.0%
800
0.0%
350
L#3
FALSE
-200
Scrap L3#
25.0%
0.0%
-300
Lathe #3
67.5
Success L#3
75.0%
-150
scrap
20.0%
0.0%
-450
L#2
190
L#2 Success
80.0%
800
0.0%
350
Which Lathe first
Decision
62
L#2
TRUE
-150
scrap
20.0%
20.0%
-150
Chance
62
L#2 success
80.0%
Decision
115
L#1
FALSE
-100
Scrap L1#
10.0%
0.0%
-250
Lathe #1
110
Success L#1
90.0%
-200
scrap
25.0%
0.0%
-450
L#3
150
L#3 Success
75.0%
800
0.0%
350
L#3
TRUE
-200
Scrap L3#
25.0%
20.0%
-350
Lathe #3
115
Success L#3
75.0%
-100
scrap
10.0%
6.0%
-450
L#1
270
L#1 Success
90.0%
800
54.0%
350



1	2	3
1	3	2
2	1	3
2	3	1
3	2	1
3	1	2

10.14.d)

The winning branch is `L#2 -> L#3 -> L#1` . The Value obtained is `62` . The second choice in the `L#3 -> L#1 -> L#2 =:= 59.5` . It is possible to schedule the processing this way too if needed for the situation.

10.14.e)

For the pair-wise comparison one would build a table with 6 rows and calculate the value and select the maximum - the same calculations done during the Tree RollUp. Unfortunately the complexity grows very fast: it the function of `n!` !

10.14.f)

There is `4! = 4*3*2*1` or 24 permutations for the four machines.

Conclusions

- There impact of the processing cost for step performed by `Lathe#2` is the most significant for two-machines configuratiuon.
- Only two decisions needed for three-machines configuration.
- In some industries, like `Aviation/Space` , the loss of the part being scraped may significantly impact the Value: the complicated machining with high tolerances may bring the part costs to 100K range - this is most defenetely need to be taken into account in `real life` problems.
- The probability of `scrap` grows wth adding more steps to the processing.
- The fast increasing the number of possible permutations per added process impose some limit on the `tree` based models.