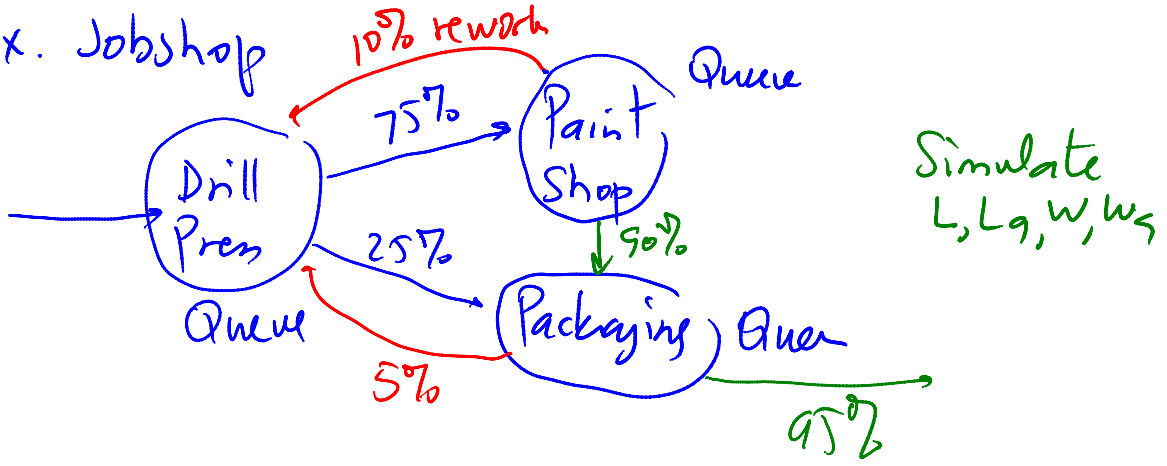
Monday, October 31, 2011
6:15 PM

Ch. 20 Simulation

"Simulare" (latin): to copy, to imitate

In Ch. 17, formulas for everything

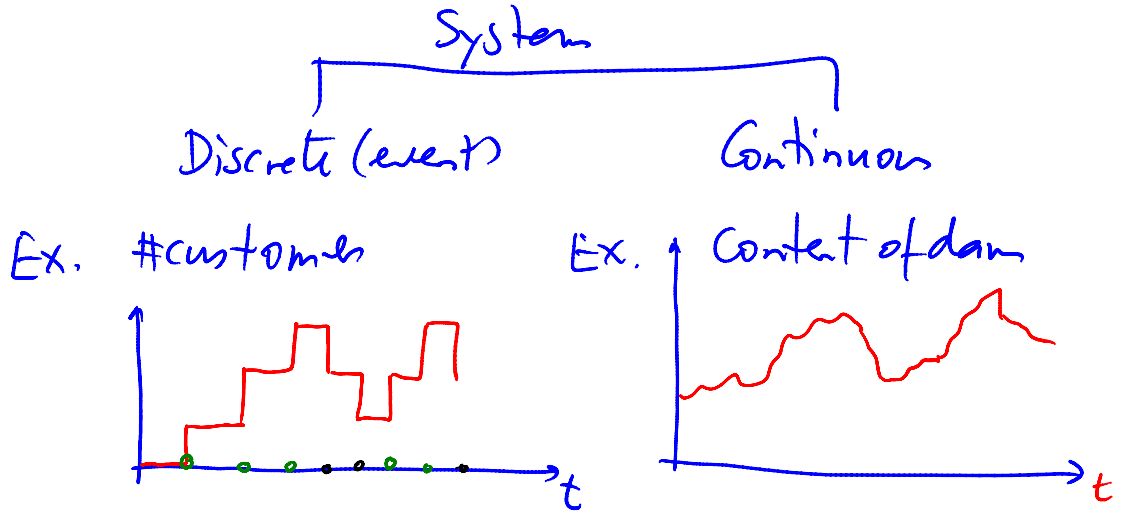
Ex. Jobshop



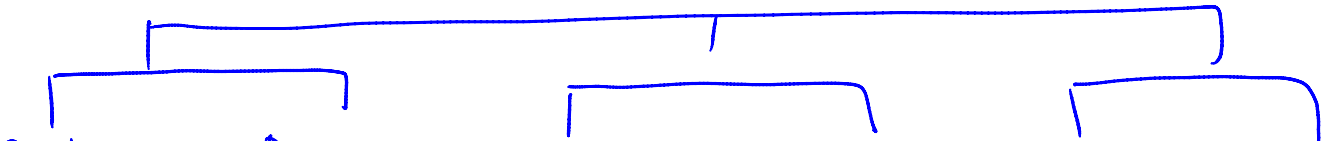
Simulate L, L_q, W, W_q

System: Facility or process of interest

State: Current status (# customers)



Simulation Models



Static (One period) · Monte Carlo	Dynamic (Over time) · Queue
(a) ✓	(b) ✓

Deterministic (No r.v.'s)	Stochastic (Has random elements)
(c)	(d) ✓

Discrete event (as above)	Cont
(e) –	(f)

(i) Monte Carlo simulation

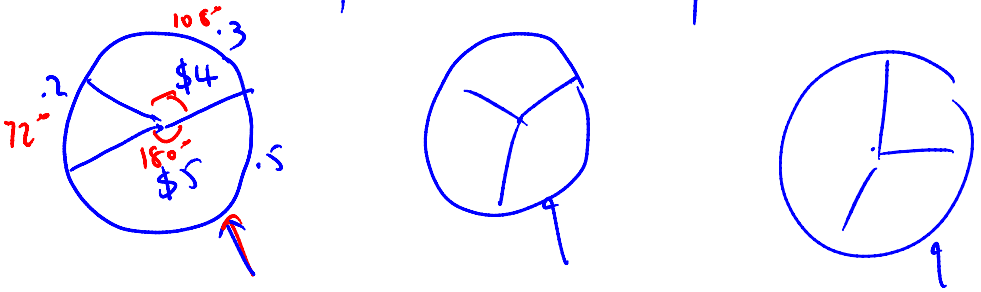
Ex. New product marketing (a)+(d) Monte Carlo

- Investment: $5M
- Uncertain factors
  - price (P)
  - var. cost (C)
  - Sales volume (annual) (millions) Q
- Life of 1 yr

P	Prob
$4	.3
5	.5
6	.2

C	Prob
$2	.1
3	.6
4	.3

Q (mill)	Prob
3	.2
4	.4
5	.4



Profit = (Price − Cost) · Vol − 5

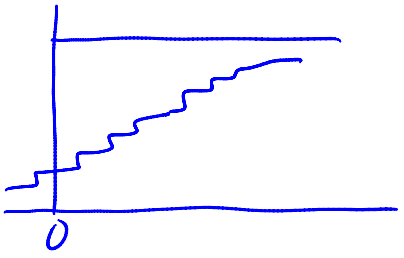
Trial	Price	Cost	Vol	Profit

1	5	3	4	$(5-3)\times 4-5 = 3$
2	4	4	4	$= -5$
3	5	4	5	$= 0$
4	4	3	3	$= -2$
5	5	3	4	$= 3$

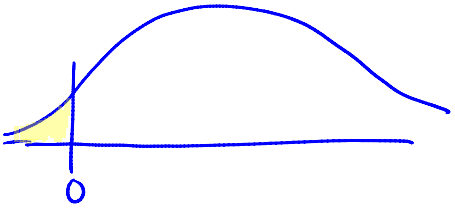
Total = -1

Avg = $-\frac{1}{5} = -.2$

- Run length (RL) = 5
- # runs = 1



Risk profile



Exact soln

$$\text{Profit} = (\text{Price} - \text{Cost}) \cdot \text{Vol} - 5$$

$$E(\text{Profit}) = [E(\text{Price}) - E(\text{Cost})] \cdot E(\text{Vol}) - 5$$

$E(\text{Price}) = 4(.3) + 5(.5) + 6(.2) = 4.9$

$E(\text{Cost}) = 3.2$

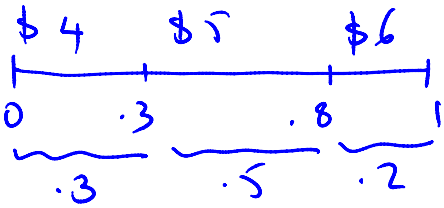
$E(\text{Vol}) = 4.2$

$$E(\text{Profit}) = [4.9 - 3.2] \cdot (4.2) - 5$$

$$= 2.14$$

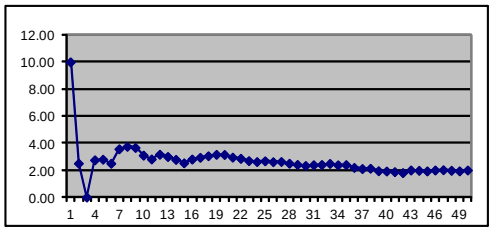
Simulation w/Excel

Price	Prob	Rnd
$4	.3	[0, .3)
5	.5	[.3, .8)
6	.2	[.8, 1)



RAND() : [0,1)

=IF(B4<0.3, 4, IF(B4<0.8, 5, IF(B4<1, 6)))



Sample averages from 10 runs	
Run #	Xi
1	3.16
2	2.32
3	1.86
4	1.36
5	2.6
6	2.02
7	1.48
8	1.08
9	1.14
10	3.8

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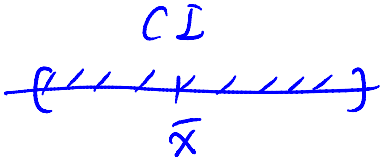
$\sum x_i = 20.82$

$\bar{x} = \frac{1}{10}\sum x_i = 2.08$

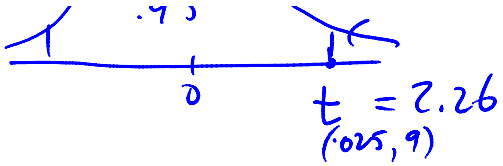
Can we find a $100(1-\alpha)\%$ conf. int. for true mean

$\bar{x} \pm t_{(\alpha/2, n-1)} \frac{s}{\sqrt{n}}$



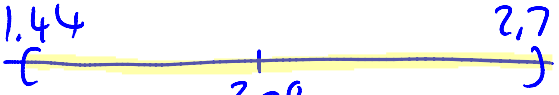
$s^2 = \frac{1}{n-1}\sum (x_i - \bar{x})^2 = .8072$, $s/\sqrt{n} = .28$

Excel: α, $n-1$



TINV(.05, 9) = 2.26

95% CI:



2.08 − 2.26(.28)

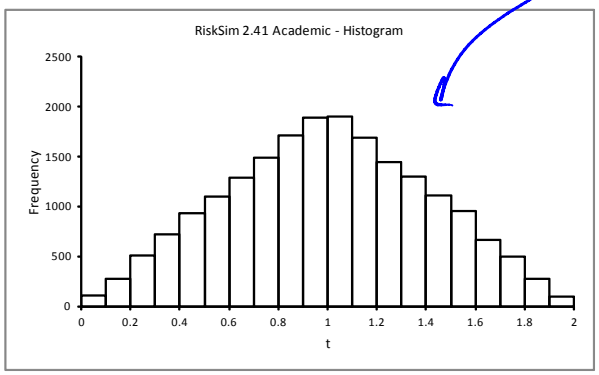
2.08 + 2.26(.28)

RiskSim

(0,1) (0,1)

Sum = $U_1 + U_2$

Ex.



Ex. New Product

Price: P	Prob		Cost: C	Prob		Sales: Q	Prob
4	0.3		2	0.1		3	0.2
5	0.5		3	0.6		4	0.4
6	0.2		4	0.3		5	0.4

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Mean	2.0746
St. Dev.	4.128721288
Mean St. Error	0.041287213
Minimum	-5
First Quartile	-1
Median	1
Third Quartile	5
Maximum	15
Skewness	0.3328

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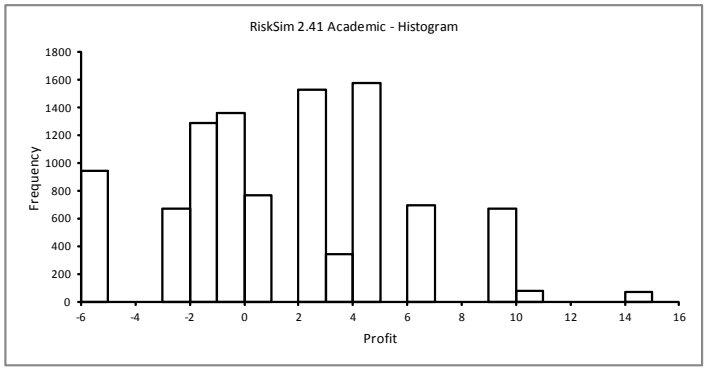

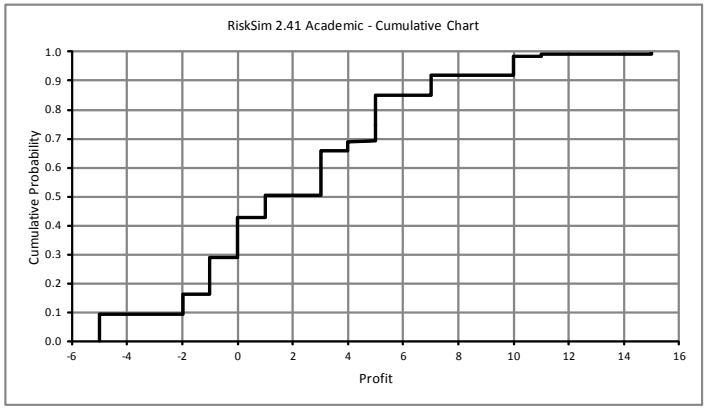

Ex. Inventory problem (Freddie's problem)

Sale price $r = \$2.50$/unit
Order cost $c = \$1.50$ / "
Salvage value $s = \$0.50$ / "

D: discrete uniform 40, 41, .. , 69, 70

Q: order quant to max. E(profit)

Sales revenue: $r \cdot \min(Q, D)$
Purch. cost $c \cdot Q$
Salvage value. $s \cdot \max(Q-D, 0)$