Chapter 6: Simulation Using Spread-Sheets (Excel)

Refer to Reading Assignments

Simulation Using Spread-Sheets (Excel)

Excel User-Defined Inverse functions:

- The User should define the inverse function for given CDF
- Define Excel cells by the defined inverse function using RAND().
- For fixable simulation use separate cells for parameters

Simulation Using Spread-Sheets (Excel)

Excel User-Defined Inverse functions:

- Continuous Uniform (a,b)

$$= a + (b - a) * \text{RAND}()$$

- Discrete Uniform (a,b)

$$= a + \text{INT}((b - a + 1) * \text{RAND}())$$

- Bernoulli(p)

$$= \text{IF}(\text{RAND}() <= p, 1, 0)$$

- Geometric (p)

$$= 1 + \text{INT}(\text{LN}\,(1 - \text{RAND}())/\text{L}$$

- Exponential (λ)

$$= -\,(1/\lambda)\ \text{LN}\,(1 - \text{RAND}())$$

Simulation Using Spread-Sheets (Excel)

Excel Built-In Inverse functions:

- Excel has a number of important Built-In inverse functions.
- Usually, the name of inverse in Excel ends with .INV
- The user must be careful when in using any of the Built-In inverse:
  - Read help of the function
  - Understand the definition of the parameters
- User can apply RAND() in the inverse function .INV directly

Simulation Using Spread-Sheets (Excel)

Excel Built-In Inverse functions:

Examples

- NORM.INV(U, mean, standard deviation)
  - NORM.INV(RAND(), 3, 1) ~ N(3,1)
- BINOM.INV(#trials, p , U)
  - BINOM.INV(6, 0.5, RAND()) ~ Binomial(n=6,p=0.5)
- U(*a*,*b*) ~ a + (b-a)*RAND()
  - U(3,8) ~ 3 + (5) RAND()
- EXPO(mean) ~ -mean*LN(1-RAND())
  - Exp(λ=10) ~ -0.1*LN(1-RAND())

Simulation Using Spread-Sheets (Excel)

	A	B	C	D	E
1					Formula
2	Uniform(0,1)			0.845009617	=RAND()
3		min	max		
4	Discrete Uniform(min,max)	3	10	8	=RANDBETWEEN(B5,C5)
5		min	max		
6	Uniform(min,max)	4	20	18.66724518	=B7+(C7-B7)*RAND()
7			p		
8	Bernoulli(p)		0.7	1	=IF(RAND()<=C9,1,0)
9			p		
10	Geometric(p)		0.3	2	=1+INT(LN(1-RAND())/LN(1-C11))
11			mean		
12	Exponential(mean)		5	4.359013352	=-C13*LN(1-RAND())
13		scale	shape		
14	Weibull(scale, shape)	5	3	3.975532185	=B15*POWER(-LN(1-RAND()),1/C15)
15		alpha1	alpha2		
16	Beta(alpha1, alpha2)	5	1.5	0.807041407	=BETAINV(RAND(),B17,C17)
17			DF		
18	ChiSquare		5	14.12091438	=CHIINV(RAND(),C19)
19		scale	shape		
20	Gamma(scale,shape)	2	10	19.06188666	=GAMMAINV(RAND(),C21,B21)
21		mean	std dev		
22		5	3		
23	Lognormal(mean, std dev)	1.455695563	0.554513	5.012218975	=LOGINV(RAND(),B24,C24)
24		mean	std dev		
25	Normal(mean, std dev)	10	2	10.50135199	=NORMINV(RAND(),B25,C25)

Simulation Using Spread-Sheets (Excel)

Simulation from Discrete Distributions

- Given a random variable X with P{X=x} and CDF P{X≤x}

x_i	1	2	3	4
$f(x_i)$	0.4	0.3	0.2	0.1
$F(x_i)$	0.4	0.7	0.9	1.0

- Direct simulation way: use the IF statement In each cell
- Do it now…

Simulation Using Spread-Sheets (Excel)

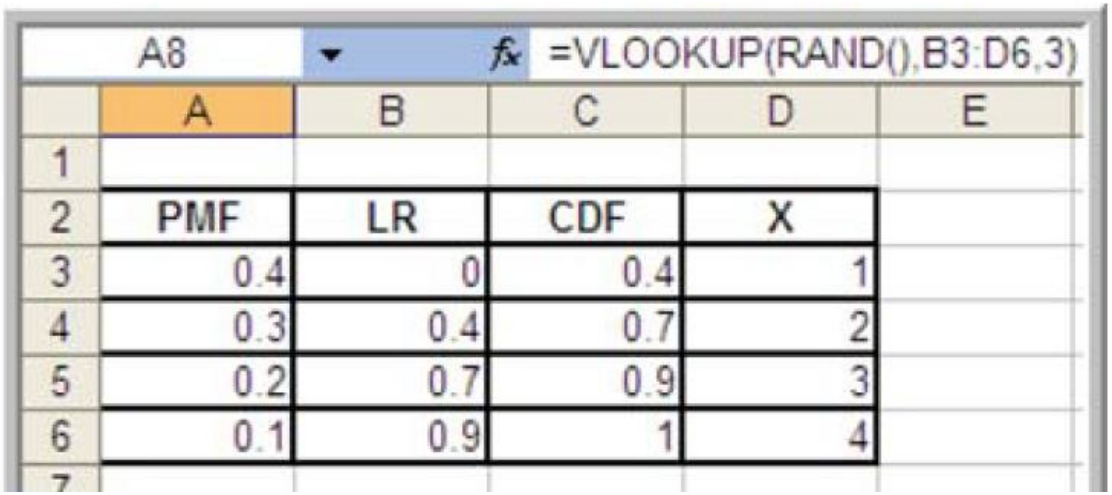
Simulation from Discrete Distributions

- Better way: use the VLOOKUP function
- The VLOOKUP cell function provides an easy way to implement the inverse transform method for discrete distributions.
- Organize data associated with distribution in a special way to take advantage of VLOOKUP functionality

Simulation Using Spread-Sheets (Excel)

Simulation from Discrete Distributions

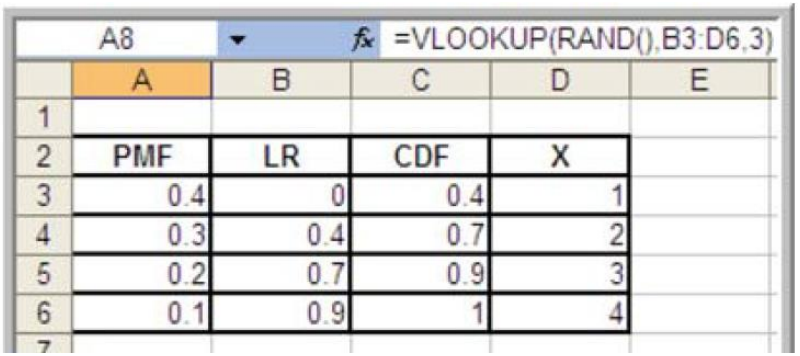
- Form the following table in Excel



	A	B	C	D	E
1					
2	PMF	LR	CDF	X	
3	0.4	0	0.4	1	
4	0.3	0.4	0.7	2	
5	0.2	0.7	0.9	3	
6	0.1	0.9	1	4	

Simulation Using Spread-Sheets (Excel)

Simulation from Discrete Distributions



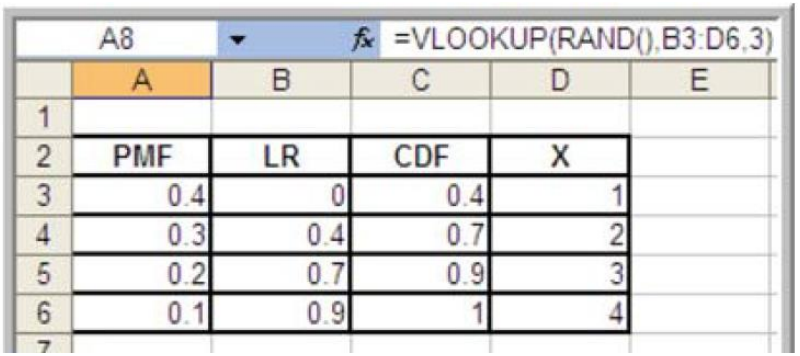
A8 =VLOOKUP(RAND(),B3:D6,3)

	A	B	C	D	E
1					
2	PMF	LR	CDF	X	
3	0.4	0	0.4	1	
4	0.3	0.4	0.7	2	
5	0.2	0.7	0.9	3	
6	0.1	0.9	1	4	

- The column LR is the lower limit on the range for the value.
- The column CDF specifies the upper range
- For example, if the random number U falls between (0, 0.4), then the X is set to 1.
- The column X should contain the possible values for the random variable.

Simulation Using Spread-Sheets (Excel)

Simulation from Discrete Distributions



A8 =VLOOKUP(RAND(),B3:D6,3)

	A	B	C	D	E
1					
2	PMF	LR	CDF	X	
3	0.4	0	0.4	1	
4	0.3	0.4	0.7	2	
5	0.2	0.7	0.9	3	
6	0.1	0.9	1	4	

- Use the following:

  = VLOOKUP(RAND()), Cell-Range, 3)
- Cell Range is the range for the LR-X columns. In the example, Cell Range is B3:D6.
- The function will looked up RAND() in the table's first column (of Cell Range) and the corresponding value from the third column (the 3 in the formula) is returned.
- VLOOKUP works event when the X column doesn't have to have numbers

Using Data Table (Excel)

- A data table is a range of cells that shows how changing one or two variables in your formula will affect the results of those formulas.
- Data tables provide a shortcut for calculating multiple results in one operation and a way to view and compare the results of all the different variations together on your sheet.
- Search on Data Tables in Help to see detailed overview of their setup and use.

Using Data Table (Excel)

Example:

1. Make a column to count the replications.
   - Column F is used in this example.

2. Make a cell that you want repeated.
   - Cell A8 is used in this example.

3. Tie the data table to the cell that needs repeating by setting the cell above and to the right of the 1st replication equal to the cell to be repeated.
   - In this example Cell G4 is set equal to cell A8.

4. Select the cells that are to form the data table.
   - In this example, the cells in the range F4:G24 are the required cells.

Using Data Table (Excel)

Example:

5. From the spreadsheet menu invoke the data table functionality. This is Data ⇒ What- IF ⇒ Data Table.
   - A confusing dialog box will appear asking for a row input cell and a column input cell. Since the table is column oriented, we only need the column input cell.

6. Enter any blank cell in for the Column input cell.
   - Cell F4 was chosen as the input cell in this example.
   - Leave the Row input cell blank. Select the OK button.

Using Data Table (Excel)

Example:

5. From the spreadsheet menu invoke the data table functionality. This is Data ⇒ What- IF ⇒ Data Table.
   - A dialog box will appear asking for a row input cell and a column input cell. Since the table is column oriented, we only need the column input cell.

6. Enter any blank cell in for the Column input cell.
   - Cell F4 was chosen as the input cell in this example.
   - Leave the Row input cell blank. Select the OK button.