A Study in Generation Functions for Monte Carlo Reservoir Estimations

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Outline

- Introduction
- Generation Functions
- Testing
- Results
- Recommendations

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Introduction

1. What is a Monte Carlo Reserve Estimation?

2. How can we use it to generate these distributions and confidences?

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Introduction

1. The Monte Carlo Reserve Estimation is an iterative, random process used to generate the probability distribution function for a specific scenario.

2. Utilizing the Volumetric OOIP Equation

$$OOIP = c\ A\ h\ \varphi\ (1-Sw) / Bo$$

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Introduction

1. Random Process – generates random values, within a specified range, for each of the variables in the OOIP equation
2. With the random values the OOIP is calculated
3. Iterative – this process is repeated many times to give a range of possible values

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Generation Functions

This study looks at the way the program will pick these random values

- Discrete Random Variable
- Beta ($\alpha = \beta = 1.5$; $\alpha = \beta = 2$)
- Chi Squared
- Gamma ($\alpha = \beta = 1$; $\alpha = \beta = 2$; $\alpha = 2$, $\beta = 1$)

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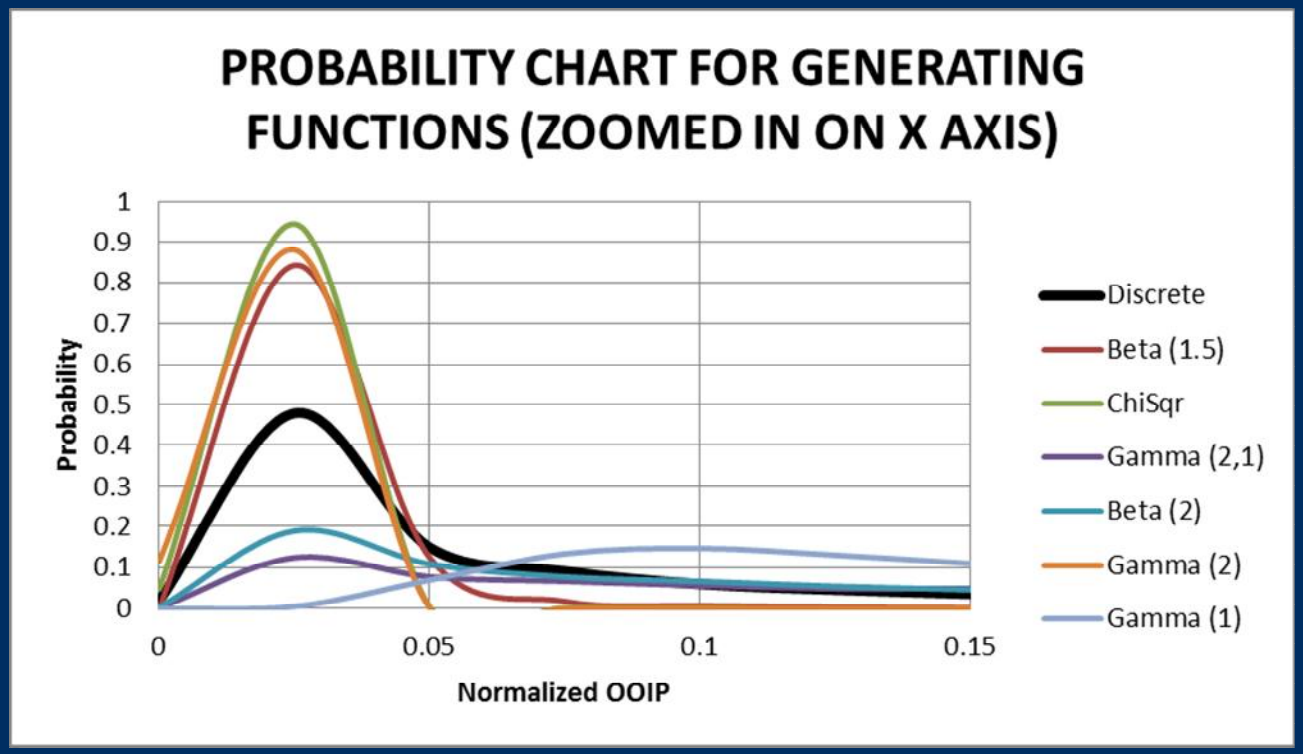
Generation Functions



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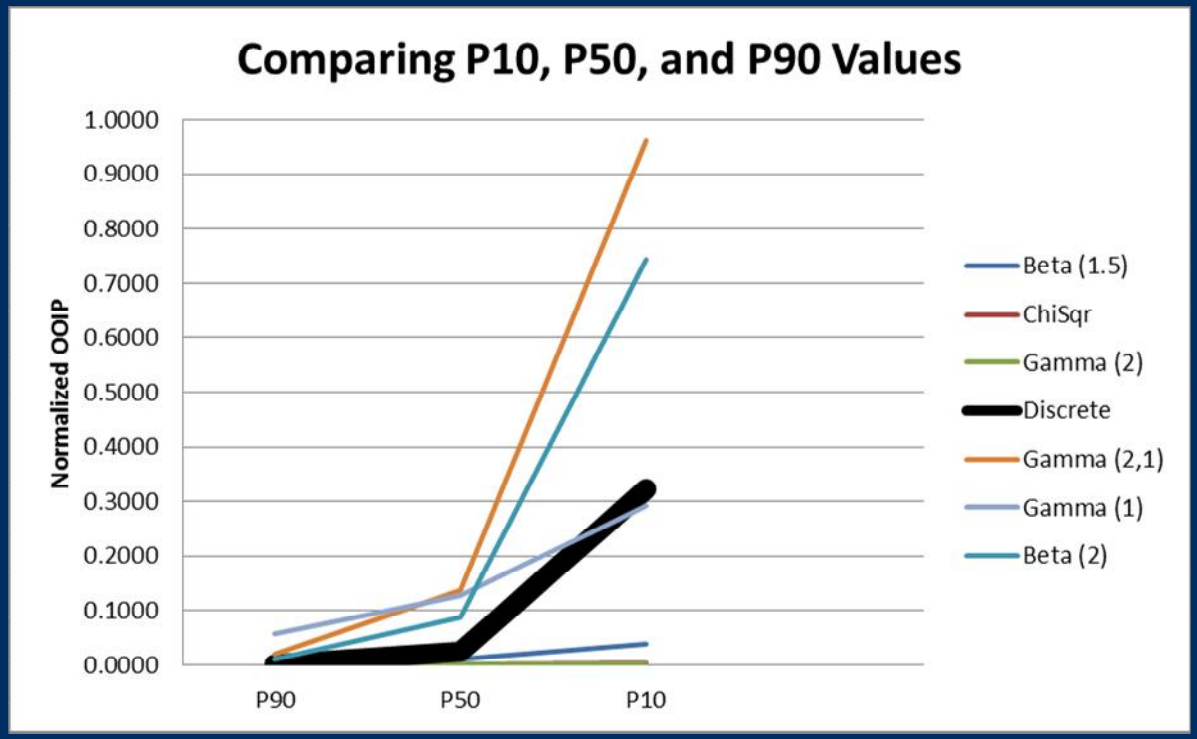
Generation Functions



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Testing

- 2 real fields
  - 1 “well” across each range
- 10 theoretical fields
  - 3 of each range and 1 random
  - 50 random “wells” in each field

Properties	Narrow Range	Medium Range	Wide Range
Porosity	.1 >	.2 > Phi > .1	.3+
Thickness (ft)	30 >	40 > t > 30	50+
Area (acres)	300 >	500 > A > 325	600+
Oil Saturation	.2 >	.3 > So >.25	.35+
Bo (rb/STB)	.15 >	.25 > Bo > .15	.25+

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Testing

Monte Carlo Probability Densities

- 10k iterations
- P50 demonstrates best values
- Change < 0.01 % → constant

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Results

Mean Percent Error for the Theoretical Fields

Test	Discrete	Beta (1.5)	Beta (2)	ChiSqr	Gamma (2,1)	Gamma (2)	Gamma (1)
2W	191.3%	74.4%	59.6%	94.4%	555.4%	2610.9%	53.7%
3W	225.7%	70.9%	56.0%	109.1%	625.2%	2945.8%	56.0%
4W	472.7%	69.8%	68.3%	194.8%	1491.2%	11400.3%	82.6%
W Mean	**297%**	**72%**	**61%**	**133%**	**891%**	**5652%**	**64%**
5M	47.9%	76.4%	73.2%	41.8%	160.6%	538.1%	46.3%
6M	119.0%	57.7%	47.3%	77.7%	269.4%	685.0%	43.9%
7M	67.1%	52.3%	41.8%	46.8%	141.1%	294.4%	29.5%
M Mean	**78%**	**62%**	**54%**	**55%**	**190%**	**506%**	**40%**
8N	84.7%	66.0%	54.6%	54.4%	207.9%	551.9%	41.8%
9N	61.6%	46.2%	36.1%	44.8%	123.9%	239.2%	30.1%
10N	36.3%	47.3%	38.7%	30.0%	68.1%	130.2%	26.8%
N Mean	**61%**	**53%**	**43%**	**43%**	**133%**	**307%**	**33%**
Total Mean	**145%**	**62%**	**53%**	**77%**	**405%**	**2155%**	**46%**
Total Std Dev	**131%**	**11%**	**12%**	**48%**	**426%**	**3414%**	**16%**

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Results

Mean Percent Error for the Two Real Fields and Random Field							
Test	Discrete	Beta (1.5)	Beta (2)	ChiSqr	Gamma (2,1)	Gamma (2)	Gamma (1)
T11:W	25%	80%	70%	16%	136%	553%	52%
T12:W	79%	72%	58%	21%	237%	819%	33%
Avg W	**52%**	**76%**	**64%**	**18%**	**186%**	**686%**	**43%**
T11:M	49%	60%	46%	16%	124%	307%	22%
T12:M	91%	36%	21%	61%	170%	322%	16%
Avg M	**70%**	**48%**	**33%**	**39%**	**147%**	**314%**	**19%**
T11:N	29%	53%	42%	5%	69%	162%	23%
T12:N	66%	14%	2%	53%	102%	154%	25%
Avg N	**47%**	**34%**	**22%**	**29%**	**85%**	**158%**	**24%**
Total Avg	**57%**	**53%**	**40%**	**29%**	**140%**	**386%**	**29%**
T1:Rand	**95%**	**69%**	**55%**	**60%**	**243%**	**683%**	**44%**

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Results

Total Place Scoring							
Fxn	Discrete	Beta (1.5)	Beta (2)	ChiSqr	Gamma (2,1)	Gamma (2)	Gamma (1)
Wid	5	3	1	4	6	7	2
Med	5	4	2	3	6	7	1
Nar	5	4	3	2	6	7	1
Ran	5	4	2	3	6	7	1
Tot	5	3	2	4	6	7	1
SUM	25	18	10	16	30	35	6

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Conclusions

- 4 generation functions less % change than discrete

1. Gamma ($\alpha = \beta = 1$)
2. Beta ($\alpha = \beta = 2$)
3. Beta ($\alpha = \beta = 1.5$) and Chi-Squared

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Recommendations

- This demonstrates need for further investigation
- Wider number of generation functions
- More data (theoretical and real)

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Thank You

1. Paul Fulton Research Grant
2. Triad Hunter

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Questions?

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