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# Operations Analysis in Iraq: Helping the Command Grapple with Uncertainty and Complexity

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- My Background
- Operations Analysis
- Intelligence Analysis
- Data Collection & Management
- Final Thoughts

*All data randomly generated*

- **Military**

- **Infantry Officer**

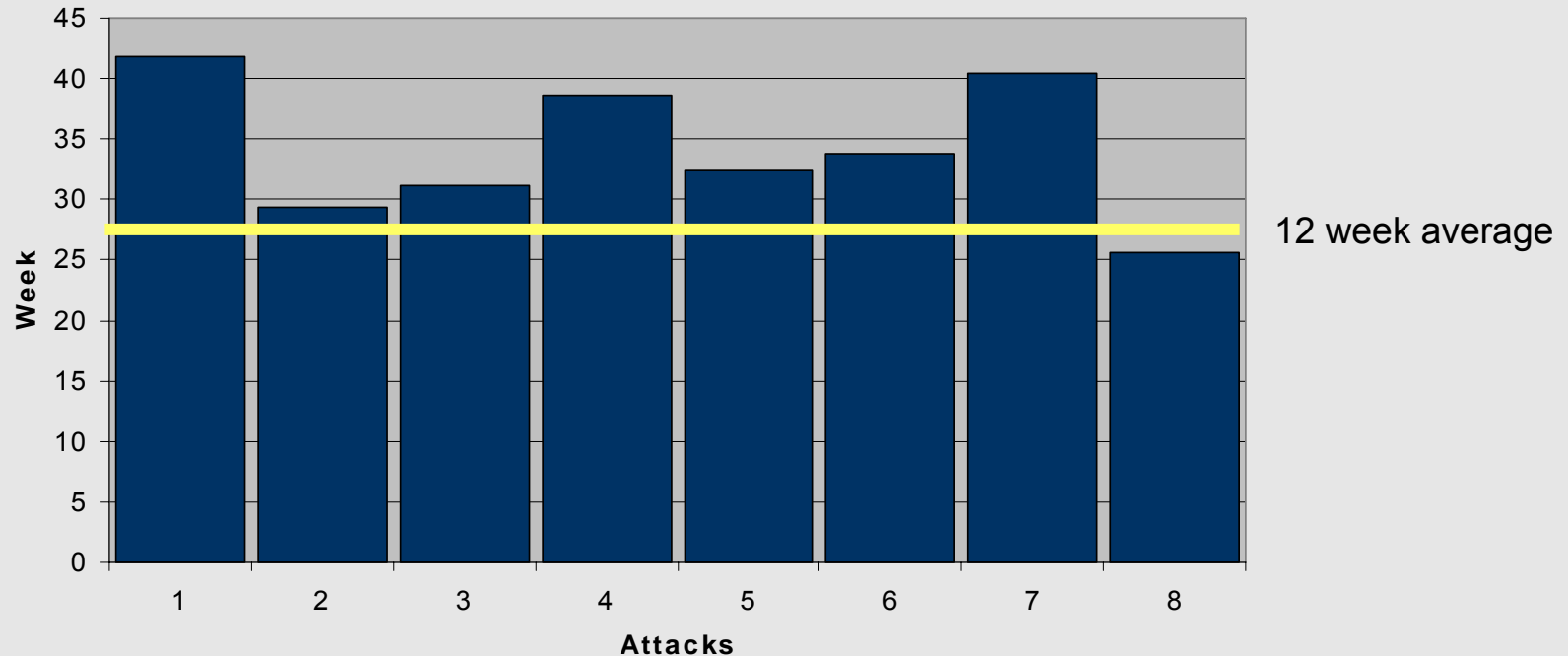
- 1990-1994 82d Airborne Division (Platoon Leader, Co XO, S3 Air)
    - 1995-1997 Republic of Korea (Company Commander)

- **Operations Research Analyst**

- 1999-2002 Center for Army Analysis (CAA)
    - 2005 Defense Advanced Research Projects Agency (DARPA)
    - 2005-2007 Center for Army Analysis

- Operations Research Analyst (continued)
  - 2008 Multi-National Corps - Iraq
  - 2008 Naval Postgraduate School
- Academic
  - 1990 BS Engineering Management, United States Military Academy
  - 1999 MS Industrial Engineering, Georgia Institute of Technology
  - 2005 DSc Operations Research, The George Washington University

Attacks - Last Eight Weeks



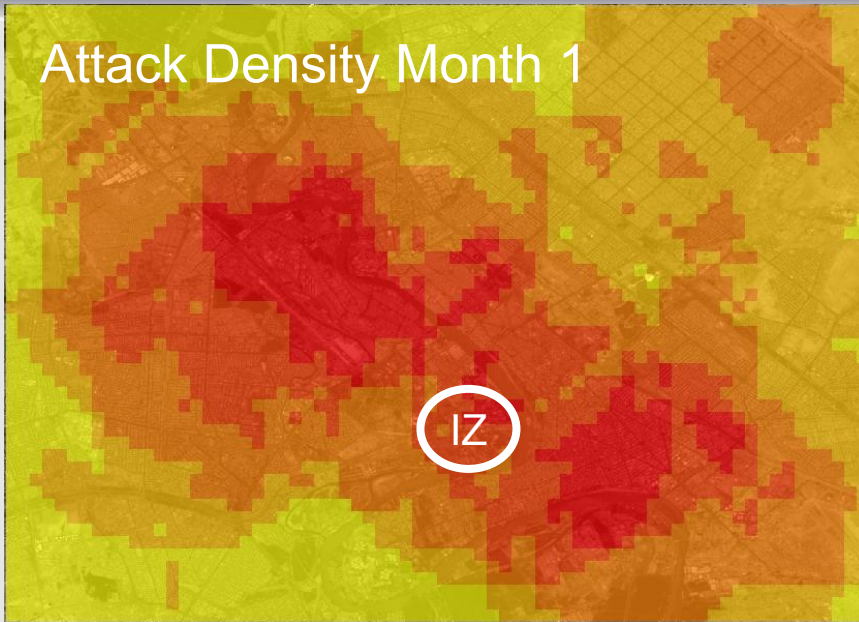
“Attacks fell below the twelve week average for the first time in 2008. Woop dee doo! You OA types need to provide me with some analysis beyond bar charts.”

- MND-SE Chief of Staff

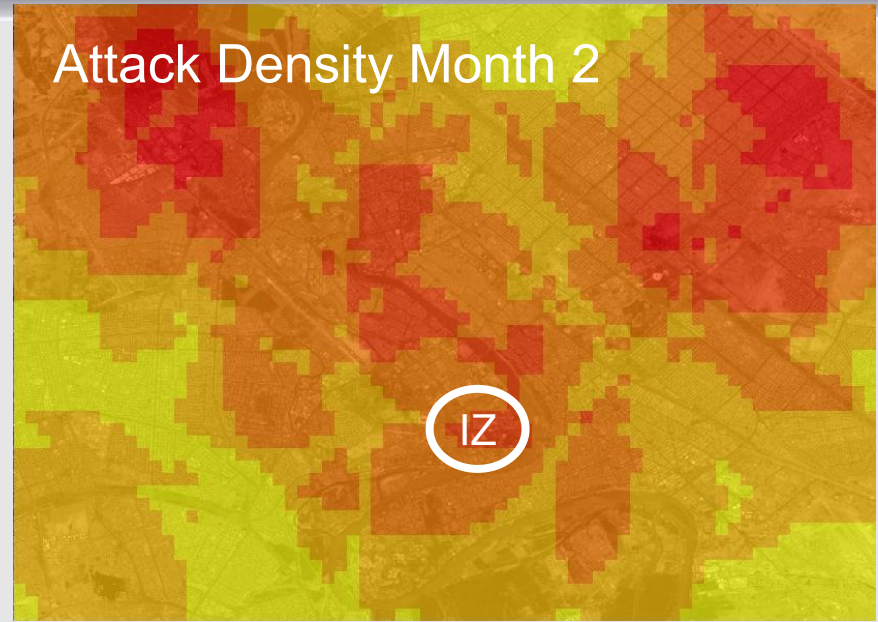
# Operations Analysis

## Geo-spatial Analysis: *Attack Velocity*

Attack Density Month 1



Attack Density Month 2

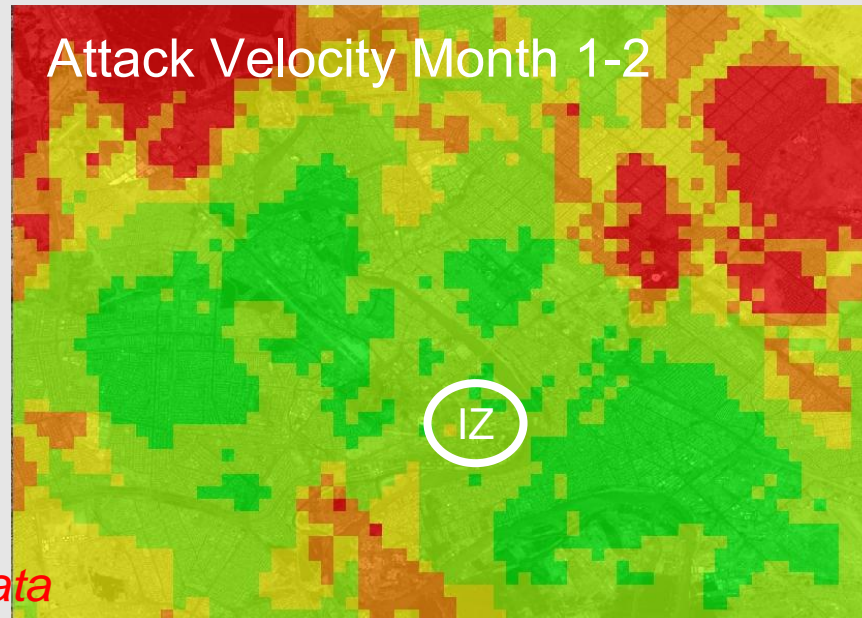


### Attack Density

#### Value

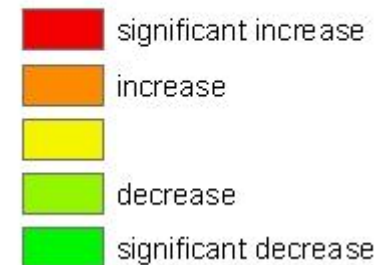


Attack Velocity Month 1-2



### Attack Velocity

#### Value

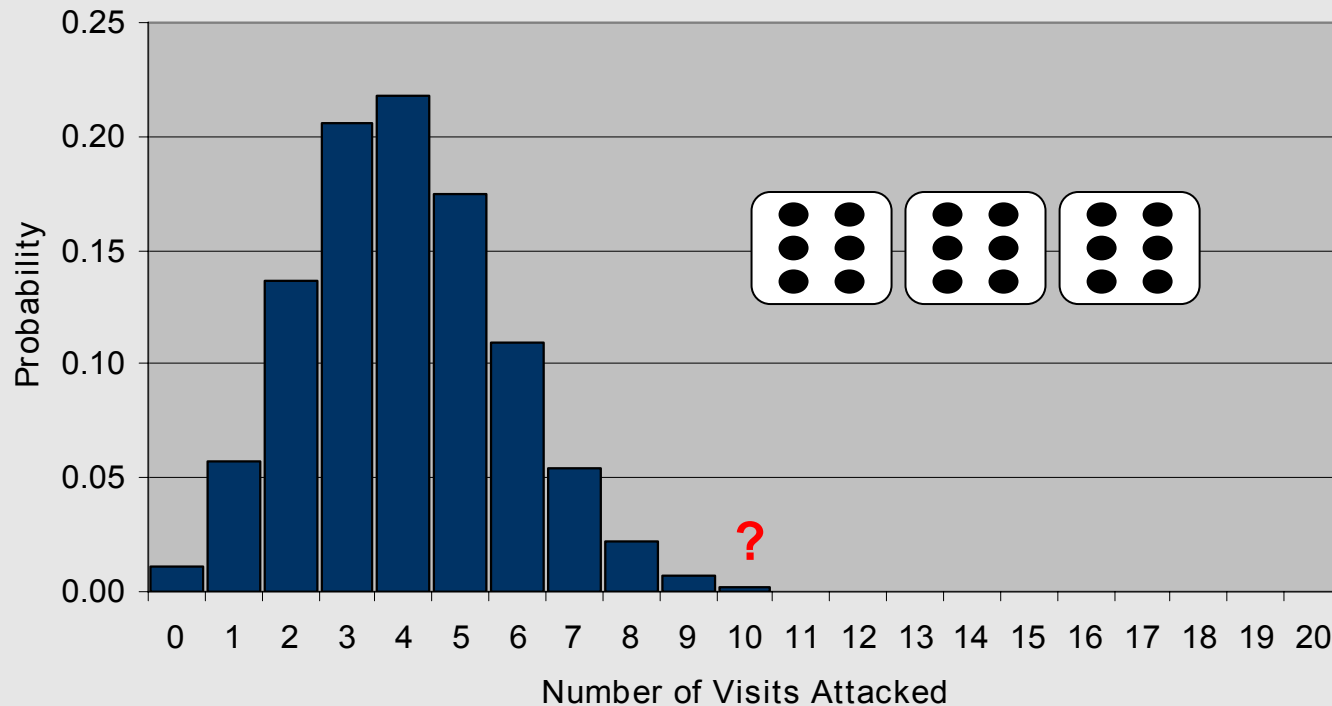


*Randomly generated data*

MNC-I requested assistance in evaluating the likelihood that insurgents were targeting a Coalition general officer during his visits to various FOBs.

$$H_0: X \sim \text{BN} (n=20, p=0.20) \quad P(X \geq 10) < 0.3\%$$

Binomial (n=20, p=0.2) Probability Mass Function

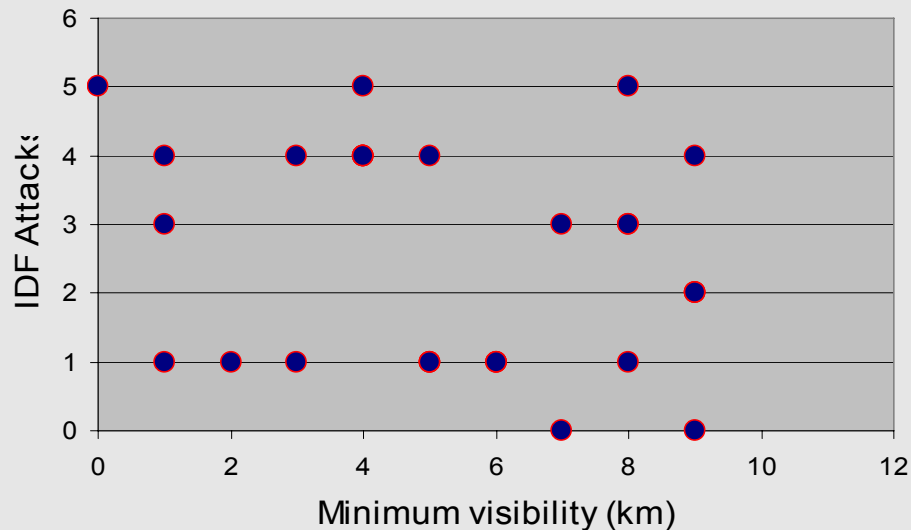


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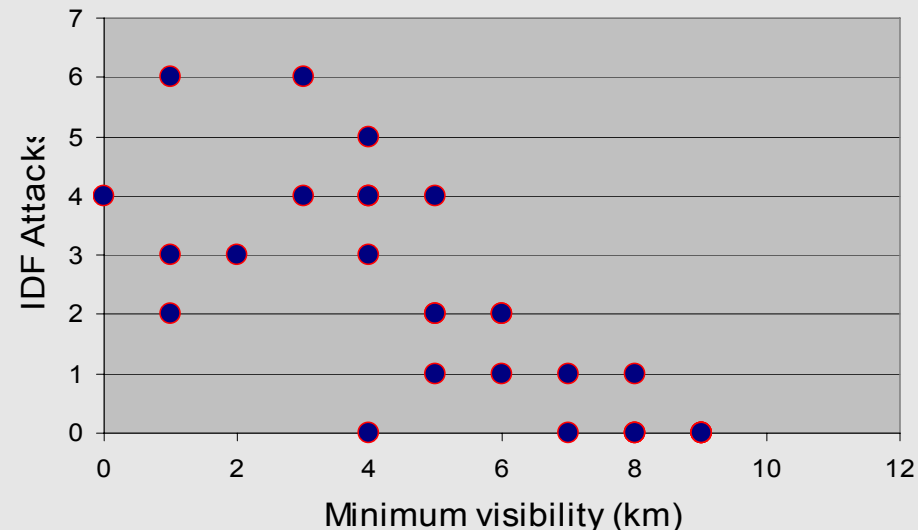
The MNF-I and MNC-I commanders frequently expressed their opinions on all sorts of matters during staff meetings.

“The enemy will conduct more mortar and rocket attacks against the IZ when visibility is limited.”

These opinions were not always correct.



But some became correct over time.



If you correct a general officer, you had best be correct ... and remain correct.



# Operations Analysis

## Statistical Analysis: *Casualty Undercounting*

The press frequently accused MNC-I with undercounting the number of civilian murders in Baghdad. The command believed that not all murders were reported and needed an estimate for the number not in the count.

Assume  $X \sim \text{BN}(n, p)$

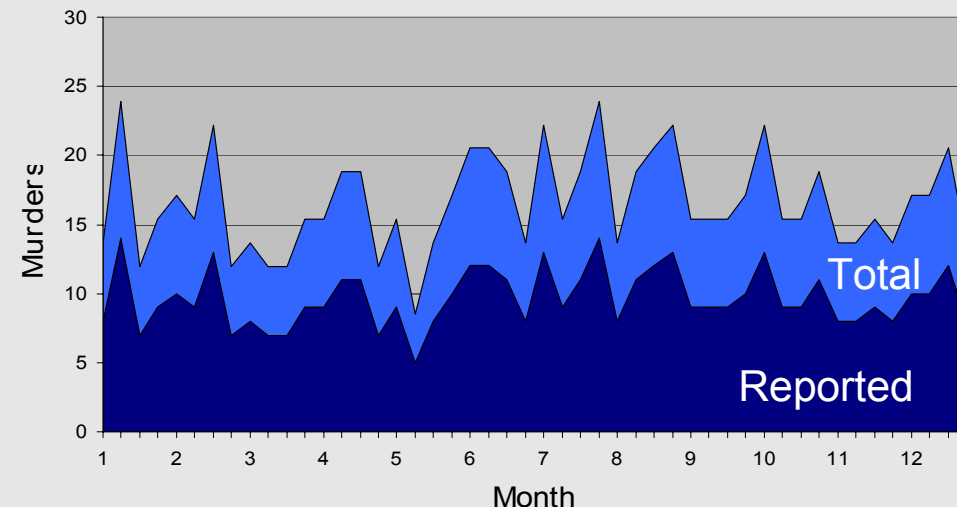
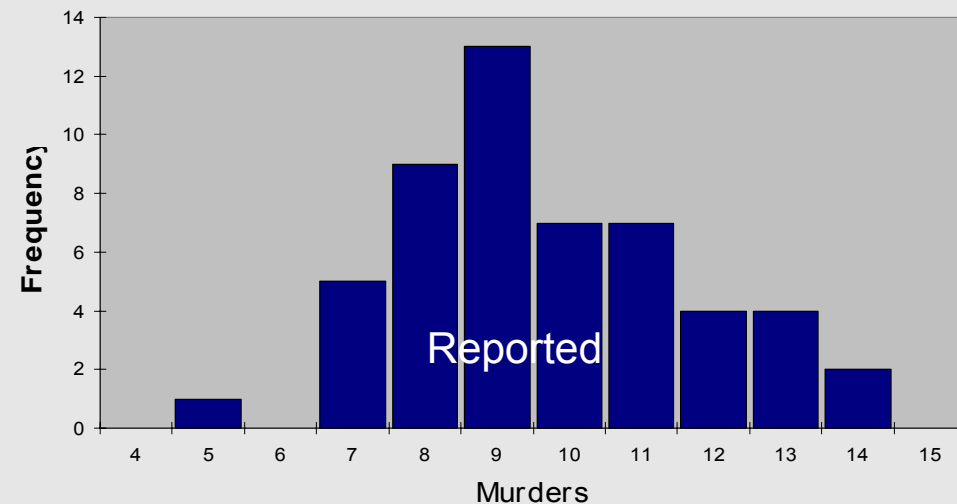
$n$  = number of murders in Baghdad

$p$  = probability that a murder is reported

$X$  = number of murders reported

Estimate  $n$  and  $p$  using method of moments

- $np$  = sample mean
- $npq$  = sample variance
- 2 equations, 2 unknowns



*Randomly generated data*

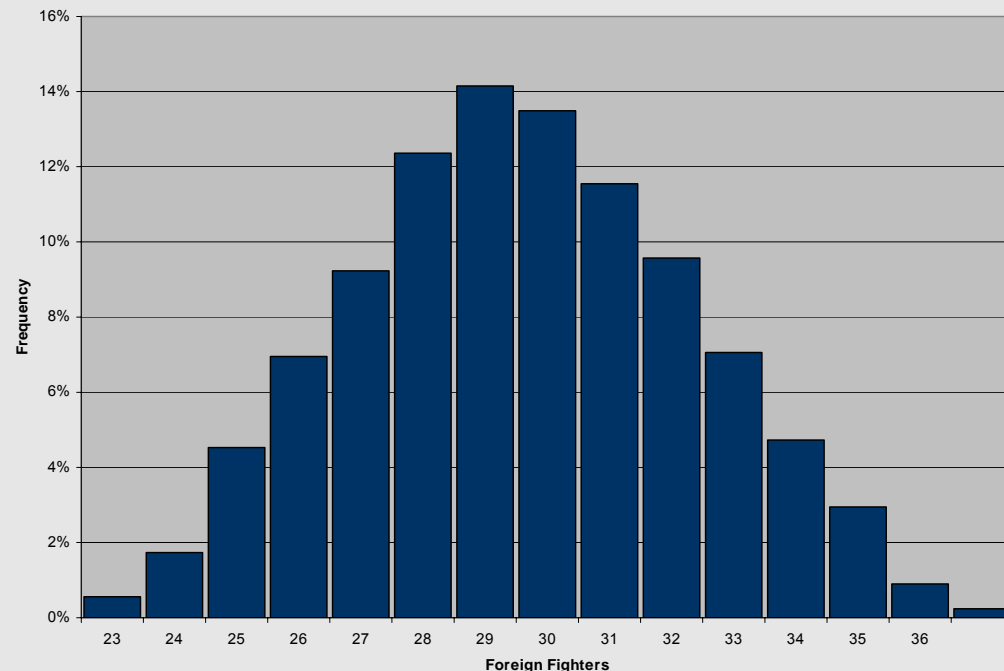
# Intelligence Analysis

## Monte Carlo Simulation: *Foreign Fighter Flow*

MNF-I C2 requested assistance in estimating the flow of foreign fighters into Iraq for the quarterly report to Congress and operational uses.



- Number of suicide attacks modeled with empirical distributions obtained from unit data.
- Cell-Days / Attack and Fighters / Cell modeled with triangular distributions, parameters obtained from intelligence community.



*Randomly generated data*

# Intelligence Analysis

## Monte Carlo Simulation: *Size of the Insurgency*

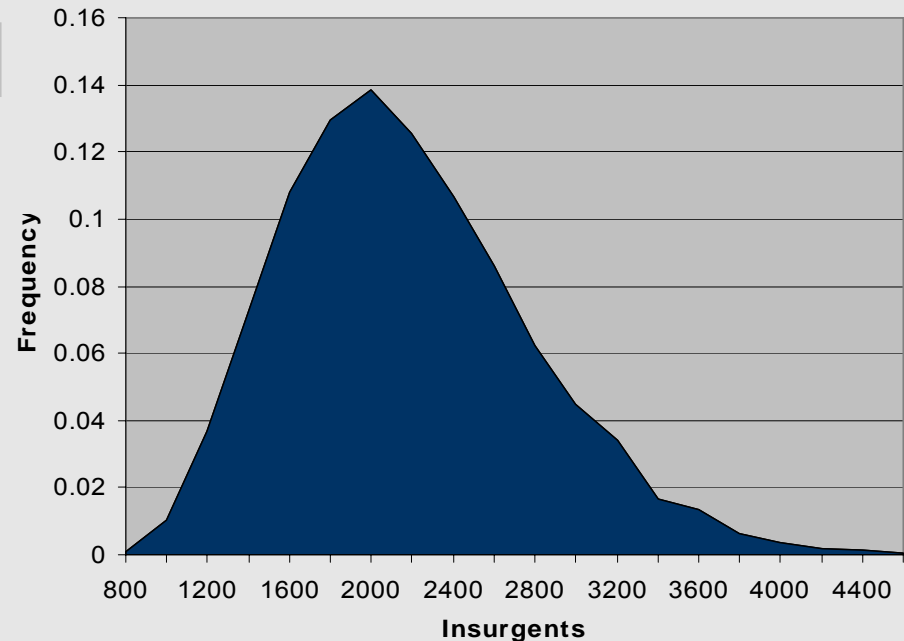
MNF-I C2 requested assistance in estimating the size of the insurgency for the quarterly report to Congress and operational uses.

$$\begin{array}{c}
 40 \\
 \text{Attacks / Day}
 \end{array}
 \times
 \begin{array}{c}
 6 \\
 \text{Cell-Days / Attack}
 \end{array}
 \times
 \begin{array}{c}
 5 \\
 \text{Fighters / Cell}
 \end{array}
 =
 \begin{array}{c}
 1200 \\
 \text{Insurgent Manpower Equivalent (MPE)}
 \end{array}$$

$$\begin{array}{c}
 1200 \\
 \text{Insurgent MPE}
 \end{array}
 \times
 \begin{array}{c}
 50\% \\
 1 / ((1 - \% \text{ Part-time}) + \text{Effectiveness} * \% \text{ Part-time})
 \end{array}
 =$$

$$\begin{array}{c}
 1600 \quad 800 \quad 800 \\
 \text{Insurgents (Part and Full-time)}
 \end{array}$$

- Attacks / Day modeled with empirical distributions obtained from unit data.
- Cell-Days / Attack and Fighters / Cell modeled with triangular distributions, parameters obtained from intelligence community.



*Randomly generated data*

# Intelligence Analysis

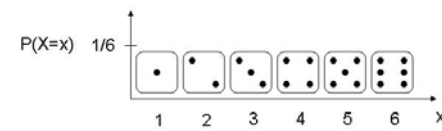
## Monte Carlo Simulation: *Primer*

The use of Monte Carlo simulation required (1) a simple, brief primer on the method and (2) a general with 15 minutes to spend on the topic.

### Monte Carlo Simulation

**Example 1**

Let  $X$  = Number observed on one die  
 Distribution of  $X$ :  $P(X=x)$  or probability of observing an "x"



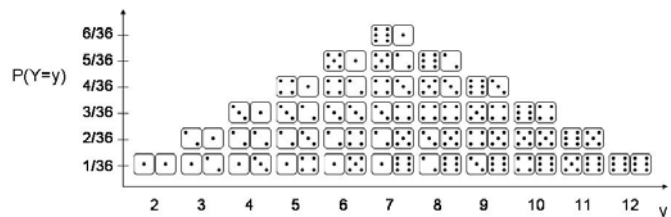
**Example 2**

Let  $Y$  = Sum of the numbers observed on two dice  
 Distribution of  $Y$ :  $P(Y=y)$  or probability of observing a "y"

What is the shape of the distribution of  $Y$ ?

1

### Monte Carlo Simulation



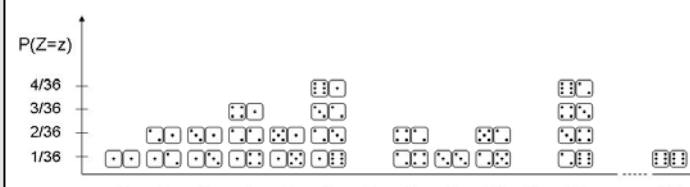
**Example 3**

Let  $Z$  = Product of the numbers observed on two dice  
 Distribution of  $Z$ :  $P(Z=z)$  or probability of observing a "z"

What is the shape of the distribution of  $Z$ ?

2

### Monte Carlo Simulation



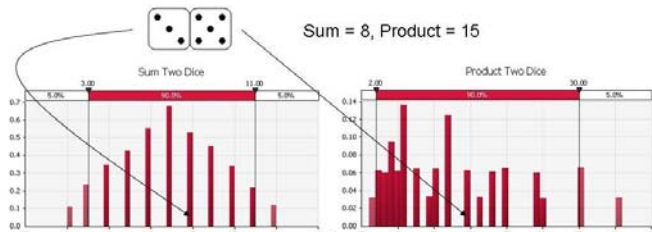
Our intuition fails us when it comes to understanding how uncertainties interact

3

### Monte Carlo Simulation

**Estimating the output distribution**

- Monte Carlo simulation
  - 10,000 runs
  - Each run, randomly select a value from each of input variables and calculate a value for the output variable
  - Calculate the probability of each event in the 10,000 runs

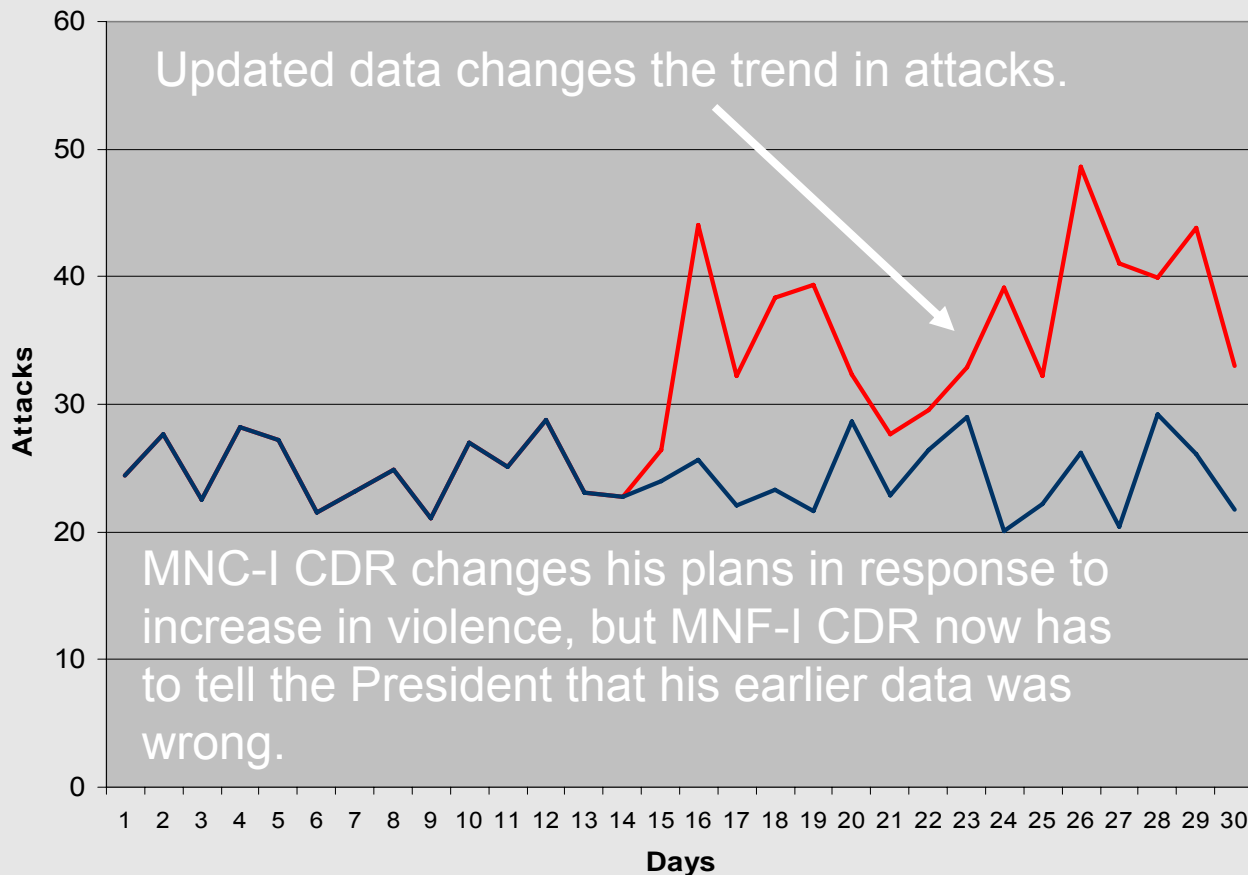


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# Data Collection & Management

## Strategic v. Operational Requirements

MNC-I CDR requires accurate data to make operational decisions in order to secure the Iraqi populace;  
 MNF-I CDR requires consistent data for strategic communications to the President, the Congress and the American people.



*Randomly generated data*

— Updated — Original

- Proximity to decision makers is essential.
  - III Corps v. XVIII Airborne Corps
- The intelligence community desperately needs quantitative support ... and a few will even acknowledge this fact.
- Operations Analysis – that provides the warfighter with information that he can use – is a challenge.
- The basics matter - too much analytical work done in theater is poor in quality
  - Correlation = Causality
  - Spurious correlations (data mining will always find something)
  - Linear models for non-linear relationships



- The quality of your analysis is inversely proportional to the amount of time that you spend in the palace.

