

# AAPA's 14<sup>th</sup> International Flexible Pavements Conference

Sydney  
25–28 September 2011

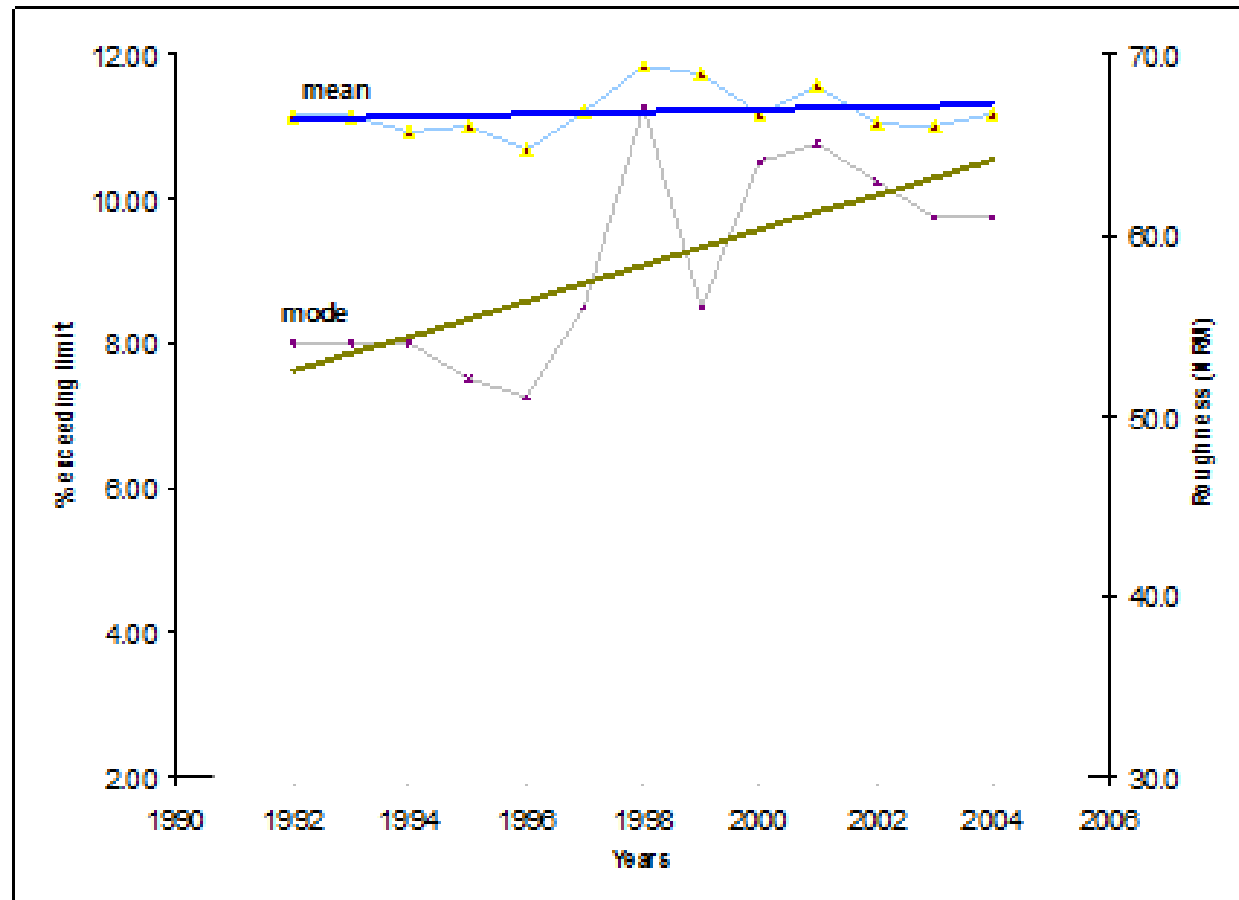
**Dr Peter Kadar**  
Principal Consultant  
ARRB Group Pty Ltd

# Expect the unexpected





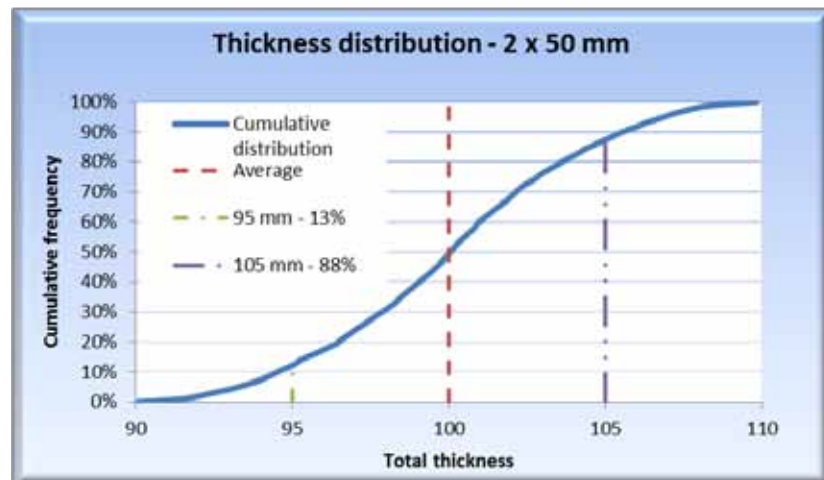
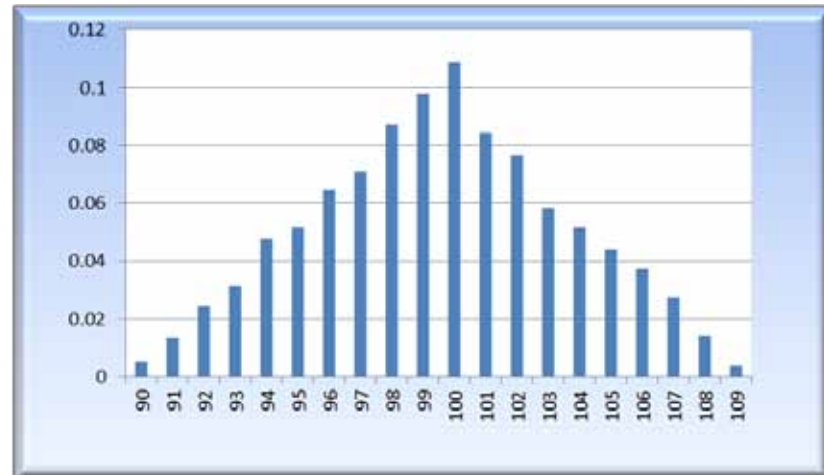
# Average – the convenient untruth



# 2 + 2 does not always equal 4

2 layers each 50 mm

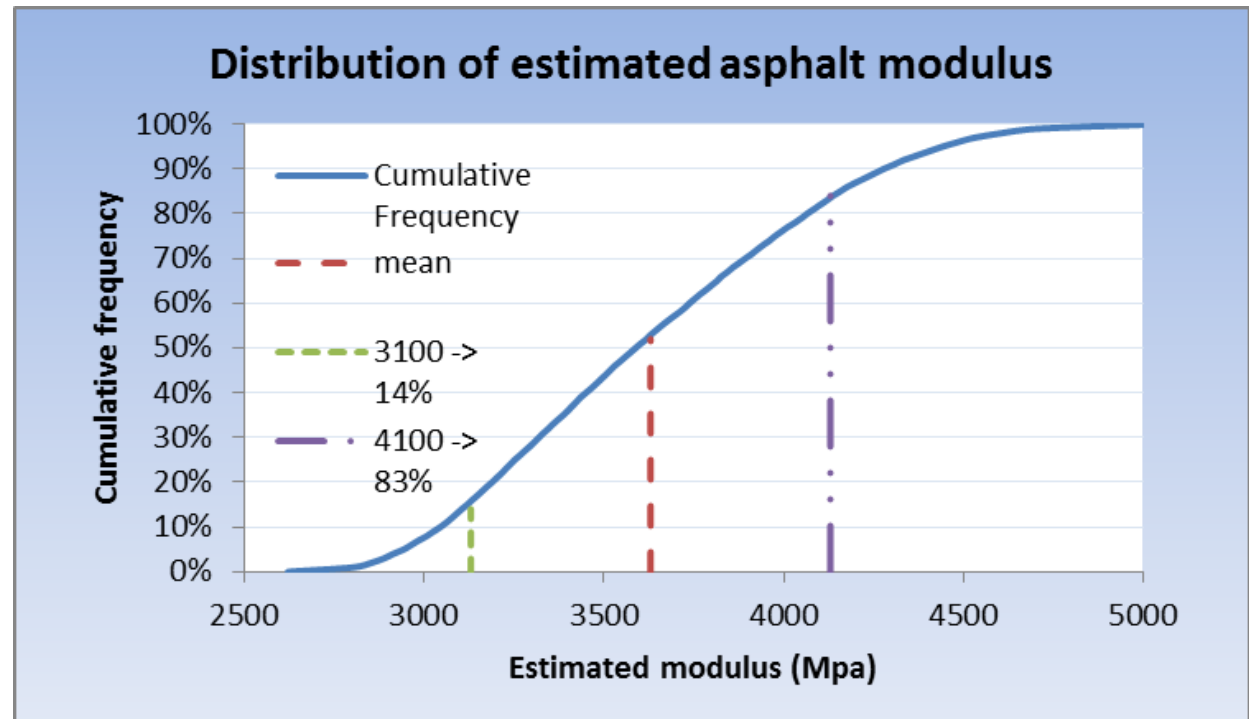
Tolerance +/- 5 mm



# Estimated asphalt modulus

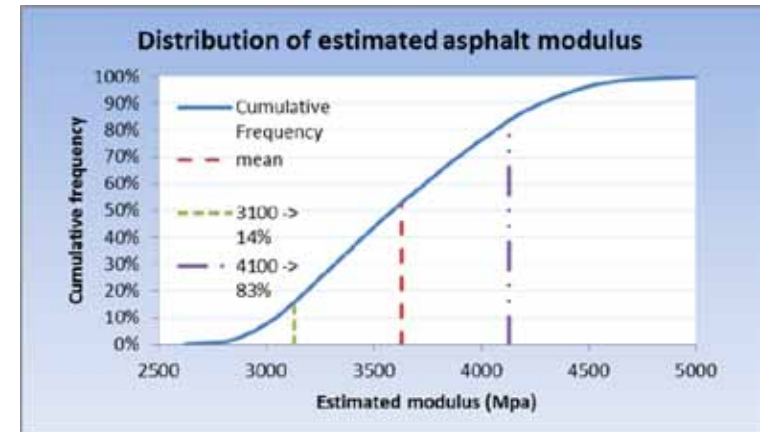
## Variables:

- Bitumen content
- Compaction
- Viscosity
- Specific gravity of aggregate
- **All within specification**



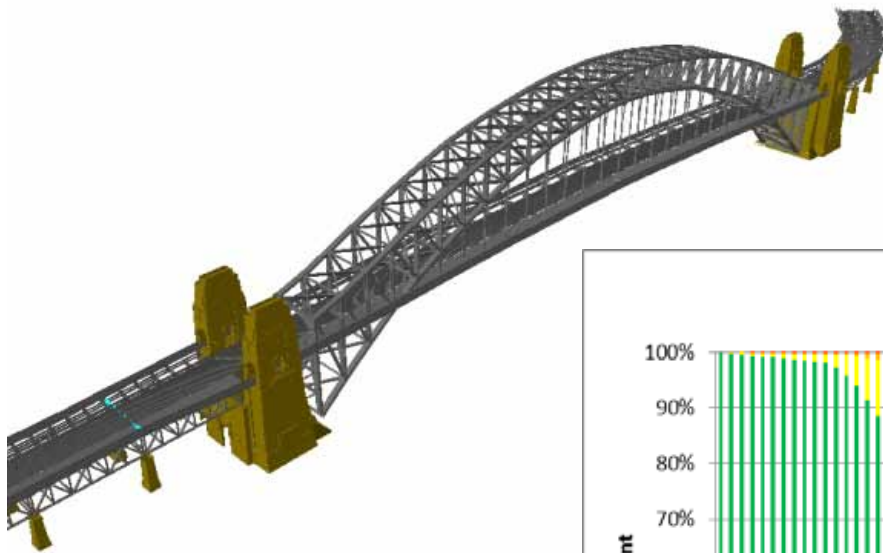
# The false positive

- 10,000,000 travellers
- 1000 terrorists
- 99% detection rate = 990 terrorists identified
- 1% false identification;  $0.01 \times (10,000,000 - 990) = 99,990$
- **99,990 ~ 100,000 unhappy travellers!**

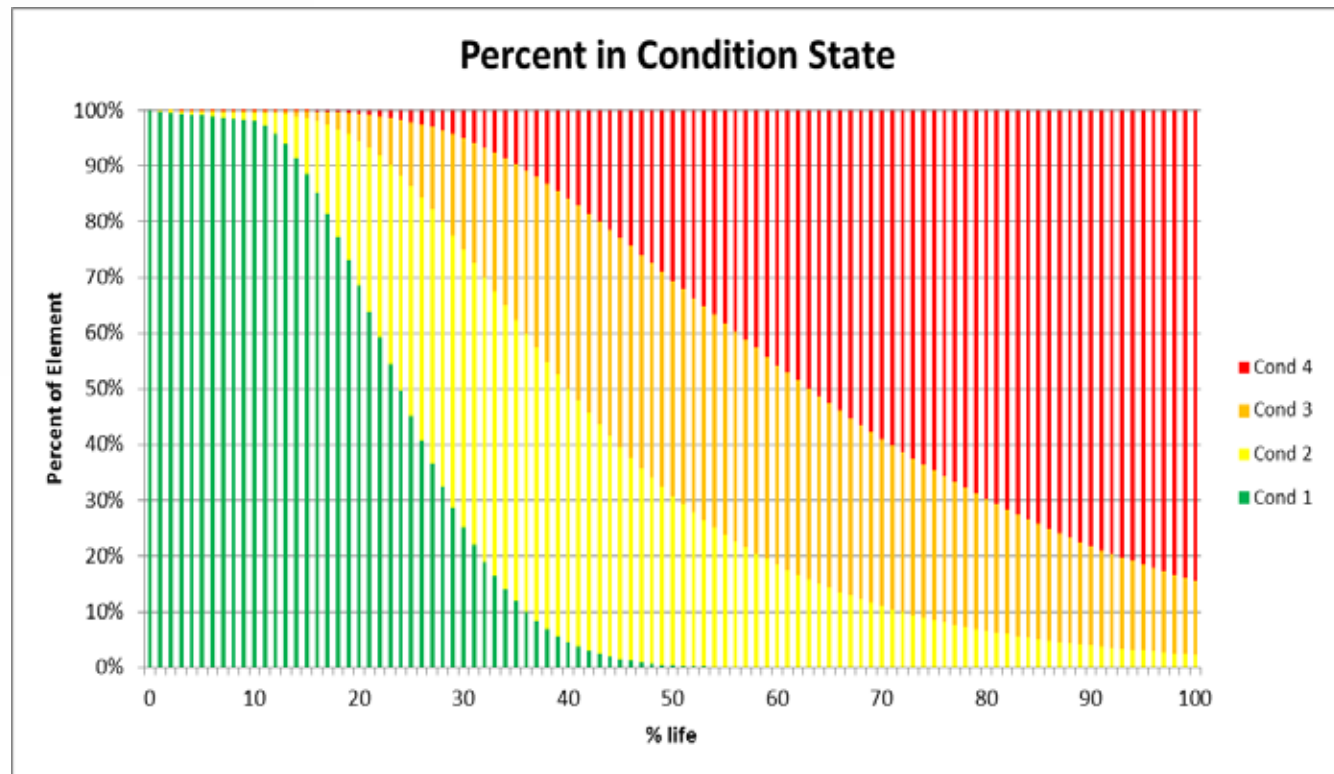




# SHB modified Markov Chain model

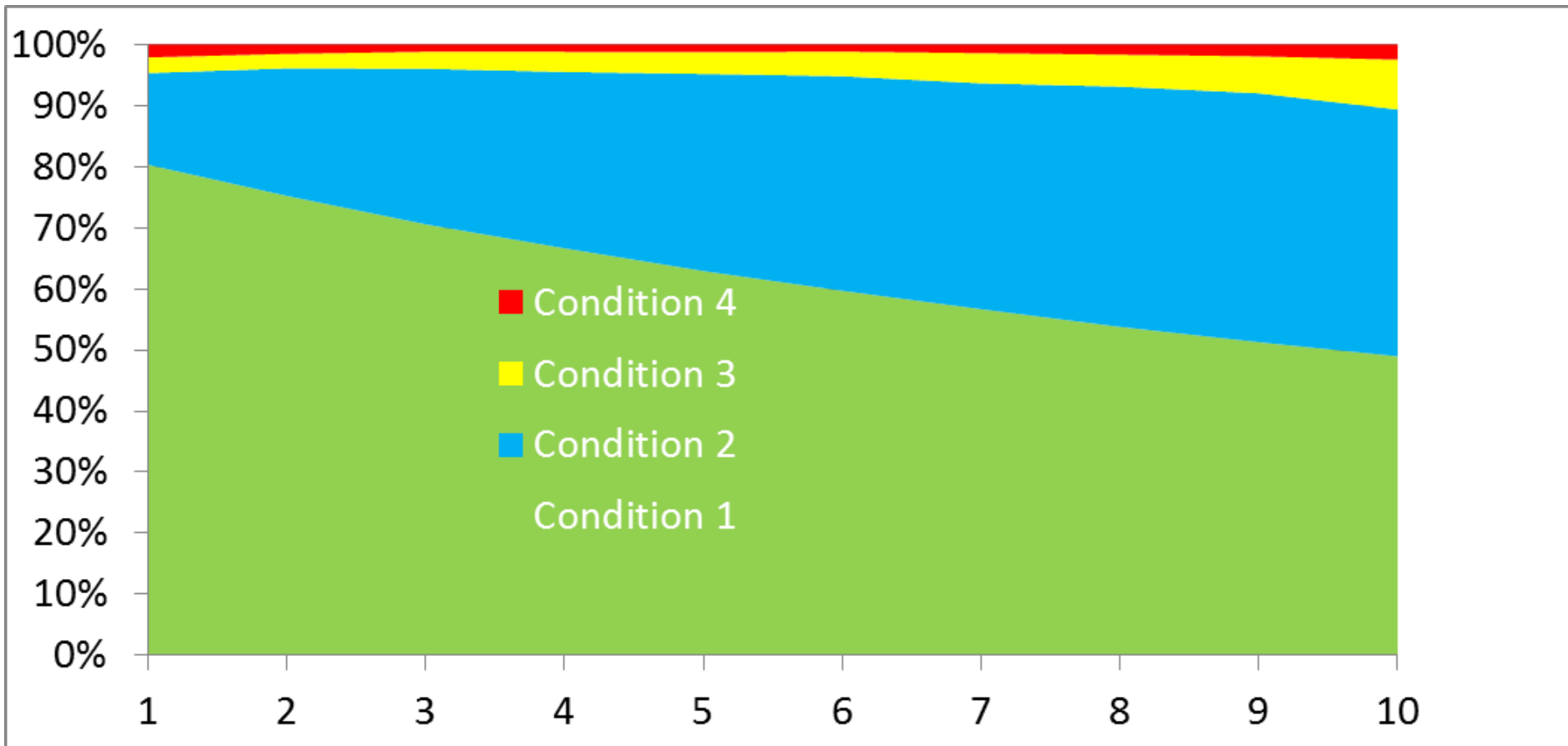


delayed deterioration





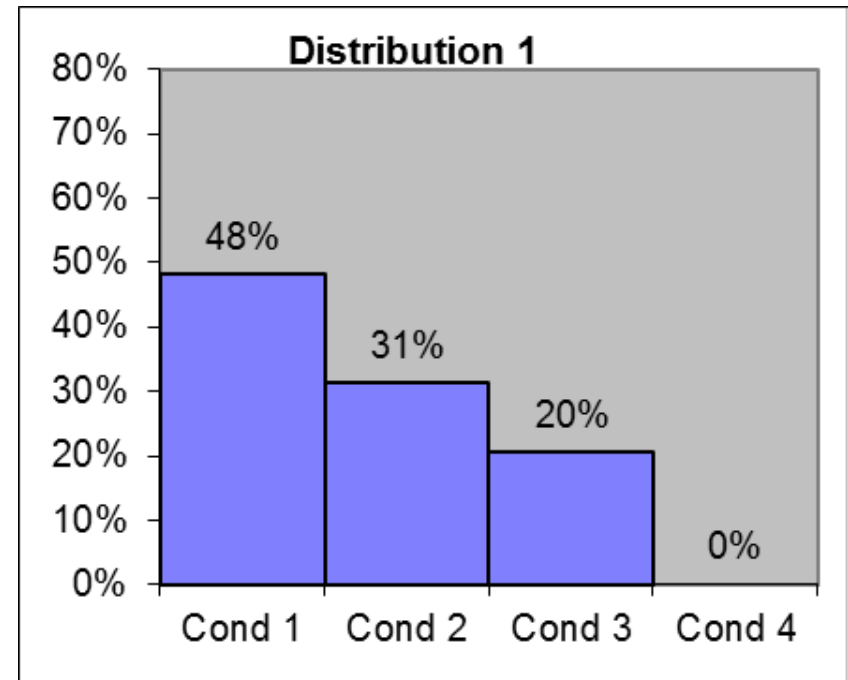
# SHB 10 year paint condition



# Markov Chain model

State	Today
Condition 1	48%
Condition 2	31%
Condition 3	20%
Condition 4	0%

	Cond1	Cond2	Cond3	Cond4
Cond 1	82%	10%	0.0%	0%
Cond 2	15%	65%	5.0%	0%
Cond 3	2%	24%	94.0%	0%
Cond 4	1%	1%	1.0%	100%

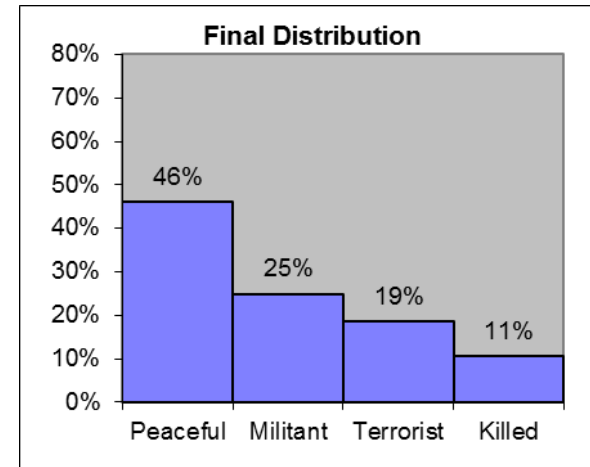


Condition after 10 years

# Early intervention

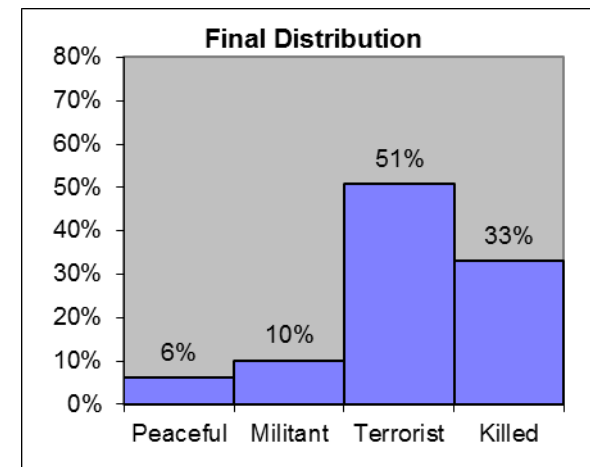
	P	M	T	K
Peaceful	90%	18%	0.0%	0%
Militant	10%	70%	15.0%	0%
Terrorist	0%	11%	85.0%	0%
Killed	0%	1%	0.0%	100%

## Condition after 10 years



Changing the transition matrix changes the outcome

	P	M	T	K
Peaceful	82%	10%	0.0%	0%
Militant	15%	65%	5.0%	0%
Terrorist	2%	24%	94.0%	0%
Killed	1%	1%	1.0%	100%



# Conclusions



- Expect the unexpected – the black swan
- Represent data in its fullness – beware of the average
- Forecast future with a given probability
- Computational statistical methods are our friends – forget about steam age statistics











# Forecasting

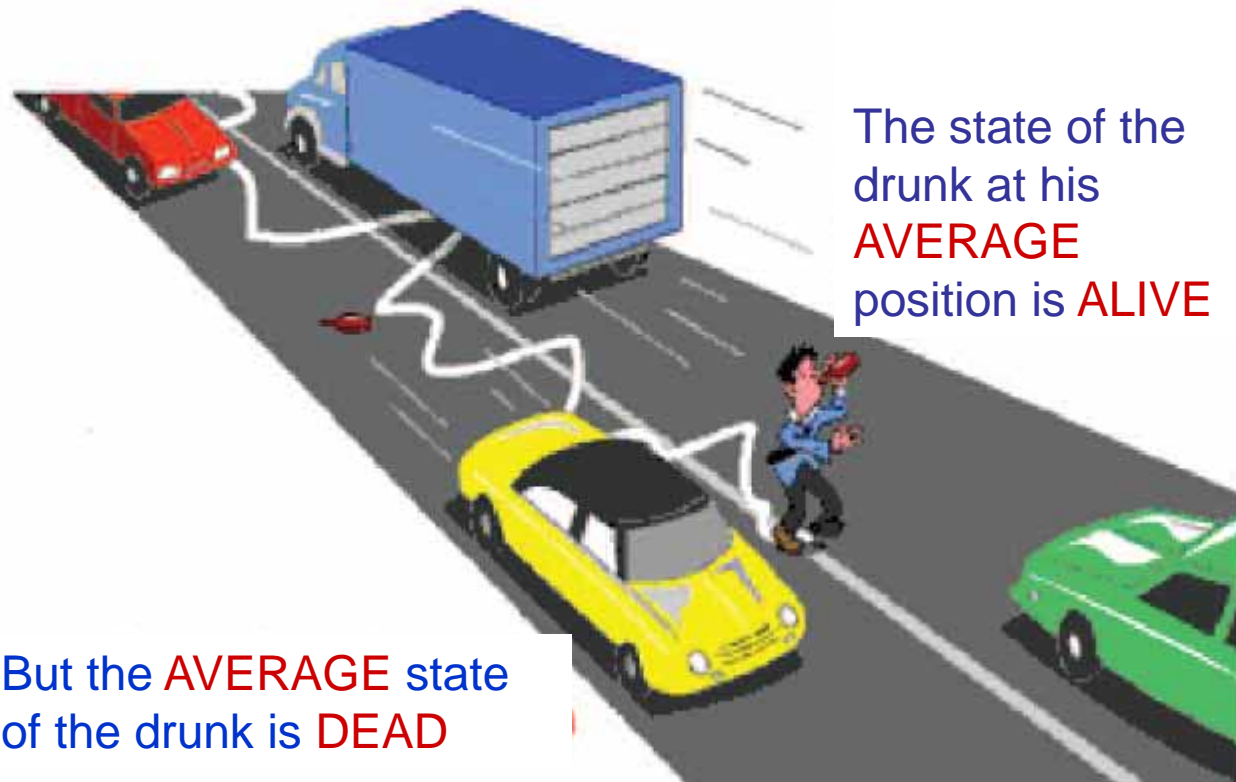




# Working with uncertainty

- What is wrong with the average
- Working with uncertain numbers
- Beware of false positives

# Average – a convenient fiction





# Chasing terrorists

- 10,000,000 travellers
- 1000 terrorists
- 99% detection rate = 990 terrorists identified
- 1% false identification;  $0.01 \times (10,000,000 - 990) = \mathbf{99,990}$
- **99,990 ~ 100,000 unhappy travellers!**