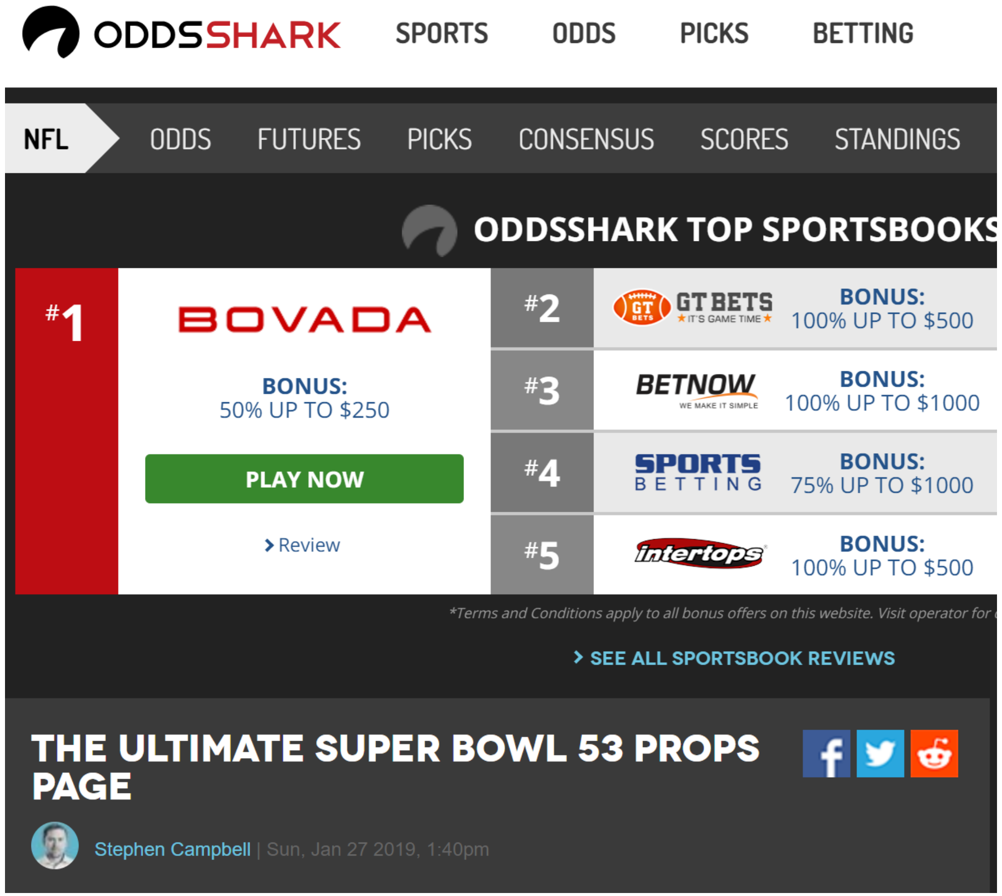
Assignments

- Assignment 5: extra credit. Due Thursday
    - https://www.meted.ucar.edu/training_module.php?id=500#.VMpjz2jF-Sp
- Assignment 7: Super Bowl. Due Friday
- Assignment 8: Due at beginning of class next Tuesday
- Read Chapter 3 notes
- Read text: Text Chapter 3.1-3.3

SuperBowl!! https://www.oddsshark.com/super-bowl/props

- bet 115 on NE to win get 100 (go home with 225 if NE wins; lose 115 if NE loses)
- Patriots favored by 1: bet 101 on Patriots to win by at least 1 point (go home with 201 if Patriots win by 1; go home with 101 if Patriots win by 1- push; lose 101 if Patriots tie or lose)



Probability Definitions

- Event- possible uncertain outcomes
- Null event- can’t happen
- Elementary event- can’t be decomposed into other events
- Compound event- decomposable into 2 or more elementary events
- S- sample or event space- all possible elementary events
- Mutually exclusive- two events that can’t occur at same time
- MECE- Mutually exclusive and collectively exhaustive- no more than 1 event can occur and at least one event will occur

the probability of each event
on the situation and location.

ity Concepts

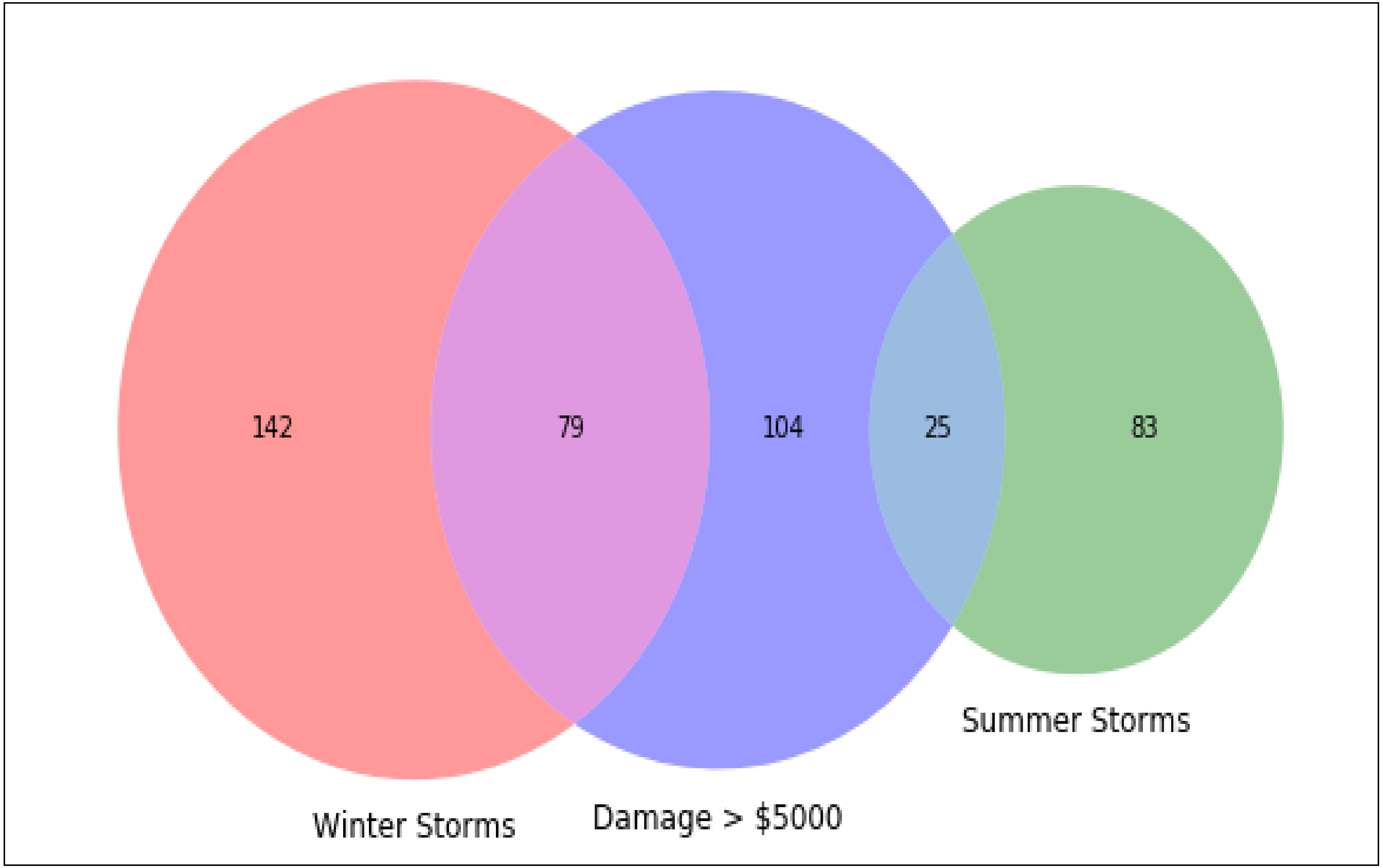
ng are pretty obvious, but
et mathematicians involved,
have "axioms", lemmas, etc.
ability of any event is
negative. In English: an event
to happen or else it is not an
nt
ability of the compound event
1 or 100%. The probability
all events will happen is 1.
ability that one or the other of two mutually exclusive events is the sum of their

Temperature below Precipitation below	Temperature above Precipitation below
Temperature below Precipitation above	Temperature above Precipitation above

Figure 4.2. MECE possibilities for seasonal forecasts temperature and precpitation anomalies for a specific location.

More Definitions

- E- Event
- Pr{E}- probability of Event E; $0 \leq Pr\{E\} \leq 1$
- Pr{E} = 0, event does not occur
- Pr{E} = 1 event occurs



Number of Opportunities: 2340 (180 days * 13 years)

Two Statistical Frameworks: Frequency vs. Bayesian

- Frequency- probability of an event is its relative frequency after many trials
- a- number of occurrences of E
- n- number of opportunities for E to take place
- a/n- relative frequency of E occurring
- $\Pr\{E\} \rightarrow a/n$ as $n \rightarrow \infty$

Two Statistical Frameworks: Frequency vs. Bayesian

- Bayesian- probability represents the degree of belief of an individual about an outcome of an uncertain event
- Some events occur so rarely that there is no long-term relevant probability
- Two individuals can have different probabilities for same outcome
- Bookies are Bayesian
  - **Super Bowl odds 2019: Heavy Patriots money has sportsbooks rooting for Rams**

More concepts

- $\{E\}^c$- complement of $\{E\}$, event does not occur
- $Pr\{E\}^c = 1-\{E\}$
- $Pr\{E_1 \cap E_2\}$- joint probability that E_1 & E_2 occur
- $Pr\{E_1 \cap E_2\} = 0$ if E_1 & E_2 are mutually exclusive
- $Pr\{E_1 \text{ U } E_2\}$- probability that E_1 OR E_2 occur
- $Pr\{E_1 \text{ U } E_2\} = Pr\{E_1\} + Pr\{E_2\} - Pr\{E_1 \cap E_2\}$

Conditional Probability

- Conditional probability: probability of $\{E_2\}$ given that $\{E_1\}$ has occurred
- $Pr\{E_2 \mid E_1\} = Pr\{E_1 \cap E_2\} / Pr\{E_1\}$
- E_1 is the conditioning event
- If E_1 and E_2 are independent of each other, then $Pr\{E_2 \mid E_1\} = Pr\{E_2\}$ and $Pr\{E_1 \mid E_2\} = Pr\{E_1\}$
- Fair coin- $Pr\{heads\} = 0.5$
  - chance of getting heads on second toss is independent of the first

    $Pr\{heads \mid heads\} = 0.5$

    $Pr\{heads\}$ twice $= 0.5 * 0.5 = .25$

Deck of Cards

- If don't look at cards, then the odds of getting any specific card when dealt cards is the same as if you only were dealt one card: they are independent events

Pr{ace}	Pr{10-K}	Pr{2-9}	Pr{21}
7.7	30.8	61.5	4.8

	Tally of occurrences	Total number of occurrences (a)	Tally of opportunities (2 x number of hands)	Total # of opportunities (n)	Observed probability a/n *100 (%)	Expected Probability from Part 1 (%)	Expected number of outcomes if n opportunities
ace				20		7.7	1.5
10-K				20		30.8	6
2-9				20		61.5	12
21				10		4.8	.5

Bayes Theorem

- $Pr\{E_2 \mid E_1\} = Pr\{E_1 \cap E_2\} / Pr\{E_1\}$
- E_1 is the conditioning event
- What is the advantage? Probability of conditioning event E_1 only computed once

- $Pr\{E_1 \mid E_2\} = Pr\{E_2 \mid E_1\} * Pr\{E_1\} / Pr\{E_2\}$

- $Pr\{E_1 \cap E_2\} = Pr\{E_2 \mid E_1\} * Pr\{E_1\}$
- $Pr\{E_1 \cap E_2\} = Pr\{E_1 \mid E_2\} * Pr\{E_2\}$ then

Bayesian Application: how you should respond to “evidence”

	Pos Test	Neg Test	TOTAL
DRUG USER	0.495%	0.005%	0.5%
NOT DRUG USER	.995%	98.505%	99.5%
TOTAL	1.49%	98.51%	1

How many drug users test positive? 99%
*Out of a ten thousand people, how many drug users do they catch? .00495*10000=~50*

What are odds of falsely accusing non drug user?
E_1 – not drug user
E_2 - positive test
$Pr\{E_1\}$ – 99.5%
$Pr\{E_2\}$ – 1.49%
$Pr\{E_2 \mid E_1\}$ – .995%
$Pr\{E_1 \mid E_2\} = Pr\{E_2 \mid E_1\} * Pr\{E_1\} / Pr\{E_2\}$ = 0.995 * 99.5 / 1.49 = 68%

- If you are a non drug user, you have a 68% chance of getting a “false positive”
- *How many non-drug users get falsely accused?.00995*10000=~100*

Conclusion: always always ask for second opinion if clean and test positive

Application of Bayes theorem: how to be rational responding to probabilities

	Pos Test	Neg Test	TOTAL
DRUG USER	0.495%	0.005%	0.5%
NOT DRUG USER	.995%	98.505%	99.5%
TOTAL	1.49%	98.51%	1

What are odds of a drug user skating?

E_4 – drug user

E_3 - negative test

$Pr\{E_3\}$ – 98.51%

$Pr\{E_4\}$ – 0.5%

$Pr\{E_3 \cap E_4\}$ – .005%

$Pr\{E_4 \mid E_3\} = Pr\{E_4 \cap E_3\} / Pr\{E_3\} =$

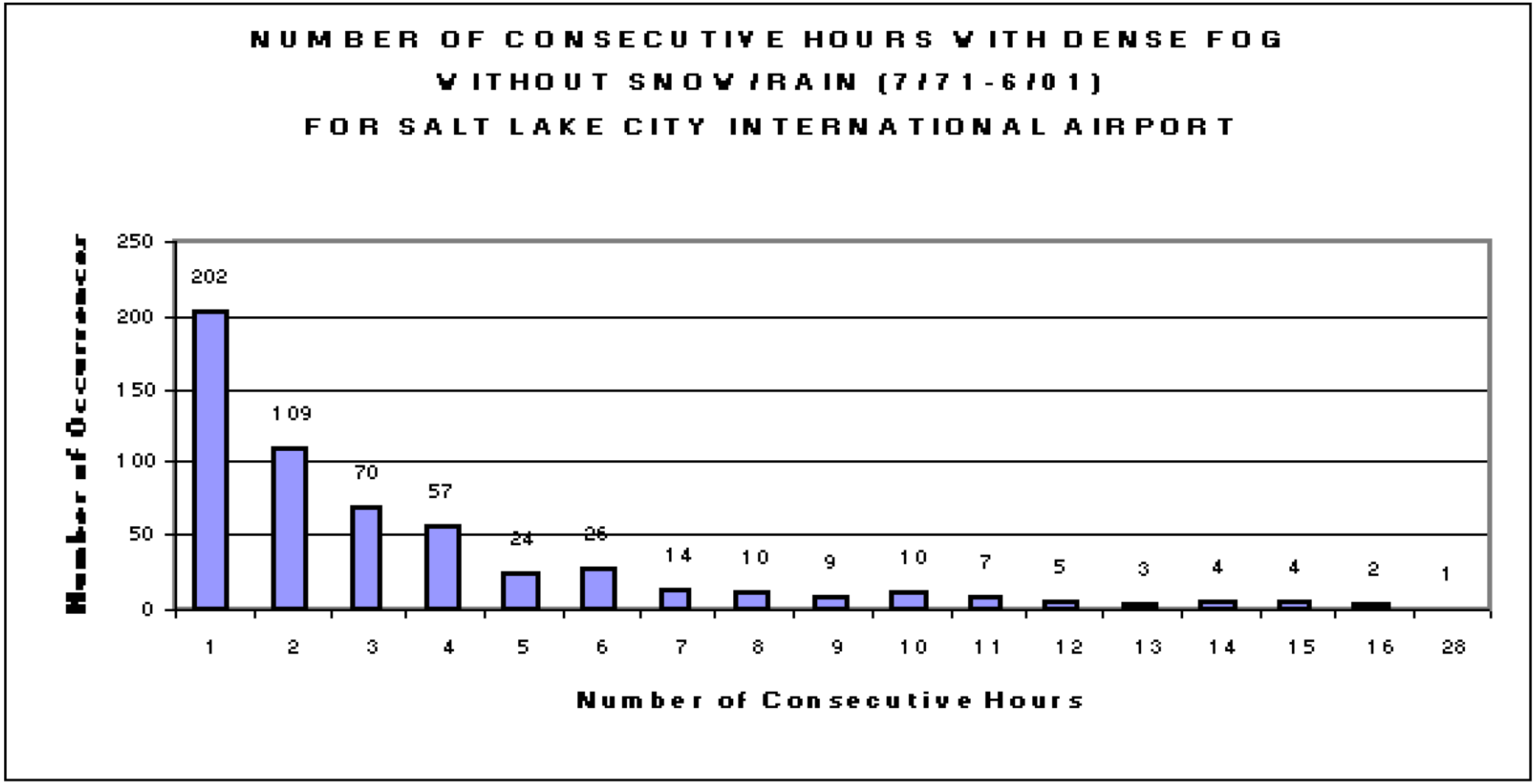
$= 0.005 / 98.51 = .0051\%$

Out of 10000 people, maybe 1 drug user will test negative

Conclusion: people who give drug tests are more interested in making sure drug users are caught than worrying about innocent people being falsely accussed

Olympic Fog Climatology

When phenomena are persistent, then "odds" are higher once an event is underway



Forecast Verification

- What is your reason for doing it?
- (Brier and Allen 1951; Compendium of Meteorology)
  - Administrative: who's blowing the forecasts?
  - Scientific: why do errors happen?
  - Economic: what's the impact of forecast errors?

Measures oriented: "give me a number!"

- Distill set of forecasts and observations into small # of metrics

		Observed	Observed	Forecast marginal totals
		Yes	No	
Forecast	Yes	a	b	a+b
Forecast	No	c	d	c+d
	Observed marginal totals	a+c	b+d	n=a+b+c+d sample size

- PC = percent correct = $\frac{a+d}{n}$
- FAR = false alarm ratio = $\frac{b}{a+b}$
- TS = CSI = $\frac{a}{a+b+c}$
- POD = HR = $\frac{a}{a+c}$

What if it just happened by chance?

		Observed	Observed	Forecast marginal totals
		Yes	No	
Forecast	Yes	a	b	a+b
Forecast	No	c	d	c+d
	Observed marginal totals	a+c	b+d	n=a+b+c+d sample size

- Random correct yes forecast by chance = $\frac{(a+b)}{n}\frac{(a+c)}{n}$
- Random correct no forecast by chance = $\frac{(b+d)}{n}\frac{(c+d)}{n}$
- $SS = \frac{(correct\ forecasts - random\ correct\ forecasts)}{(total\ forecasts - random\ correct\ forecasts)}$
- $HSS = \frac{2(ad-bc)}{(a+c)(b+d)+(a+b)(b+d)}$