Forecasting using Data

Introduction to probabilistic forecasting
Using data rather than estimates

Every spreadsheet and exercise worksheet is here:

Bit.ly/SimResources (gitHub)

PRAIRIE DEV CON PRESENTS
DELIVER
EXPLORING BETTER WAYS TO DELIVER SOFTWARE

FocusedObjective.com (see “free stuff”)
@t_magennis
troy.magennis@focusedobjective.com

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(in the Exercises folder or the Spreadsheets Folder)

or **FocusedObjective.com** (free stuff)
or **@t_magennis** (I've post links here)

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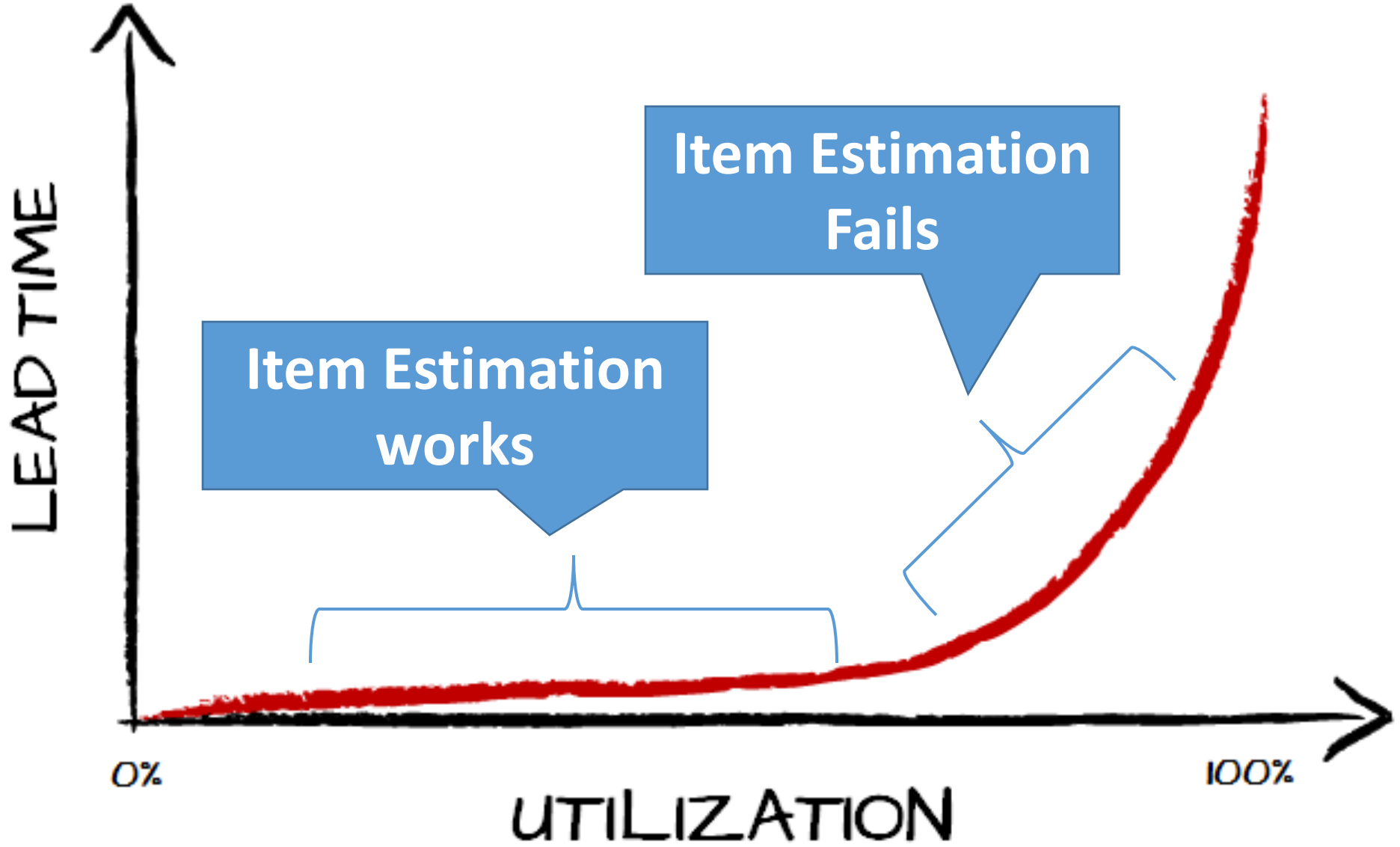
heapsoffun.com



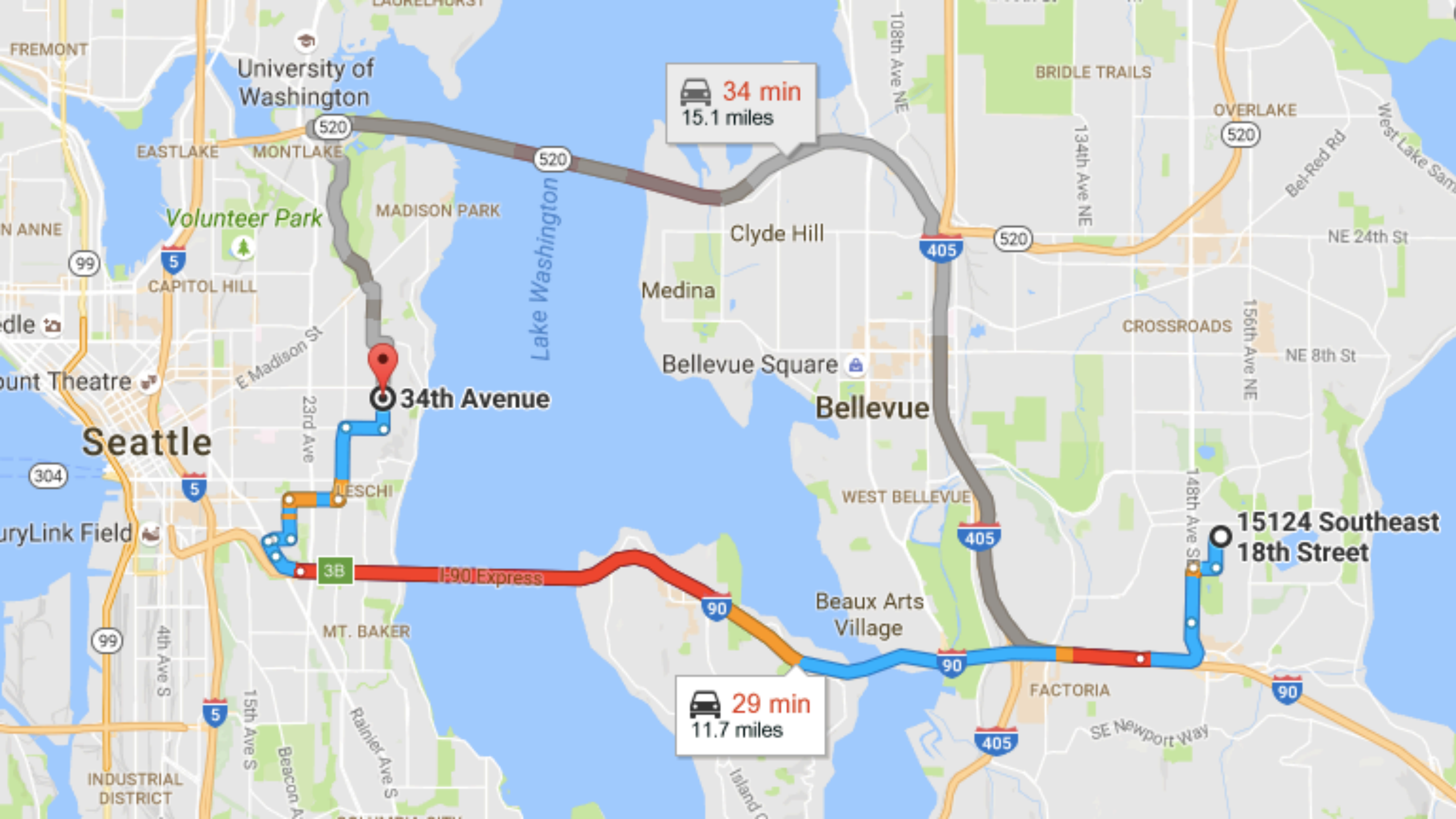
See full story at http://brodzinski.com/2015/01/slack-time-value.html

Can’t forecast high utilization systems using item size

Trucks move at same speed as cars

Can’t forecast white sheep events (random impediments)

(Things happen unforeseeable in advance)


34 min
15.1 miles
29 min
11.7 miles
34th Avenue
15124 Southeast
18th Street
Seattle
Bellevue
Medina
Clyde Hill
Bellevue Square
Lake Washington
University of
Washington
Volunteer Park
MADISON PARK
CAPITOL HILL
EASTLAKE
MONTLAKE
FREMONT
BRIDLE TRAILS
OVERLAKE
CROSSROADS
WEST BELLEVUE
Beaux Arts
Village
FACTORIA
MT. BAKER
INDUSTRIAL
DISTRICT
I-90 Express
3B
JESCHI
E Madison St
23rd Ave
108th Ave NE
134th Ave NE
156th Ave NE
148th Ave SE
NE 24th St
NE 8th St
Bel-Red Rd
SE Newport Way
4th Ave S
15th Ave S
Rainier Ave S
5
90
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304
405
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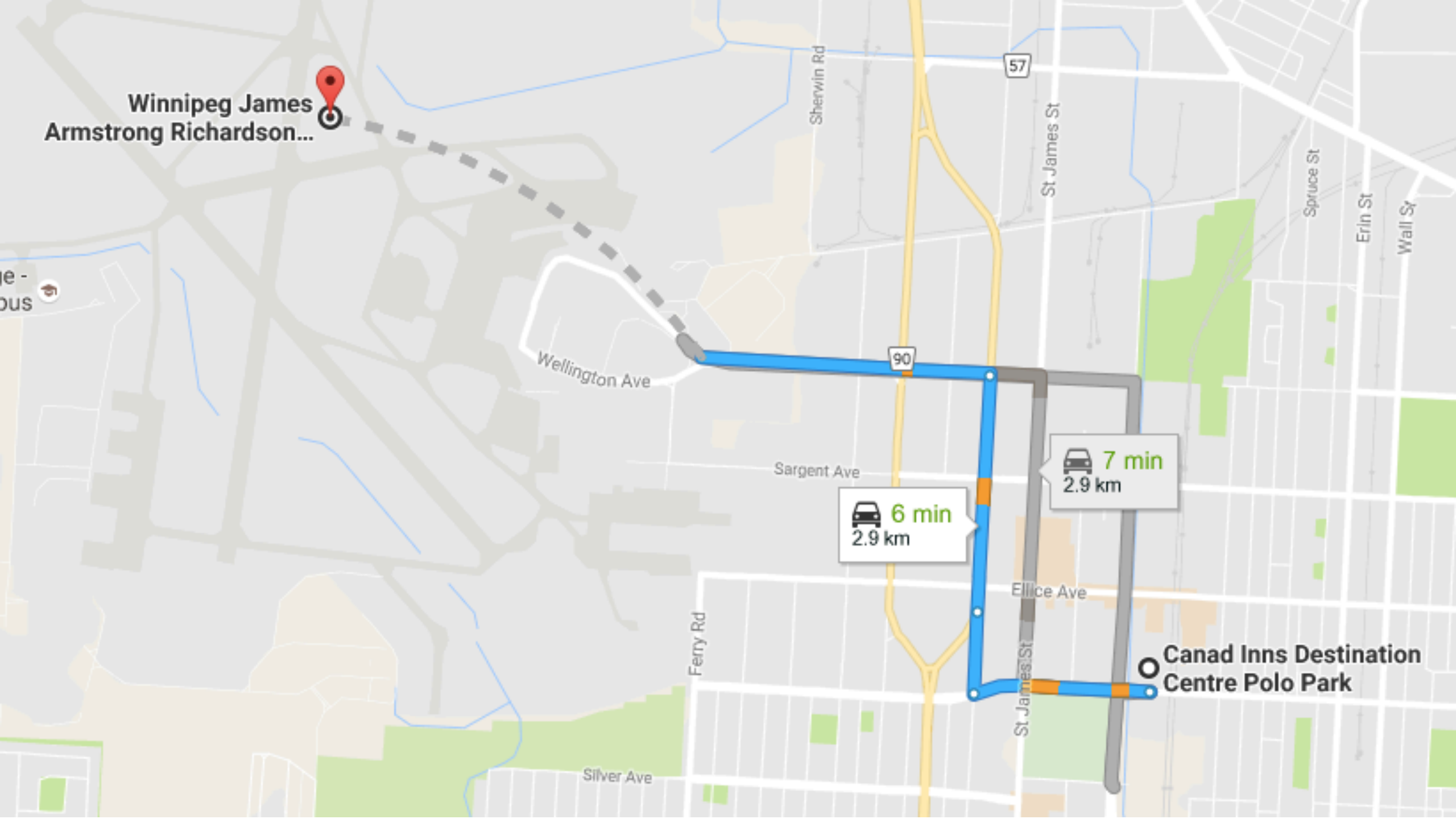

Winnipeg James Armstrong Richardson...
Sherwin Rd
57
St James St
Spruce St
Erin St
Wall St
Wellington Ave
90
Sargent Ave
7 min
2.9 km
6 min
2.9 km
Ellice Ave
Ferry Rd
St James St
Canad Inns Destination Centre Polo Park
Silver Ave

If you have data, use it to forecast.

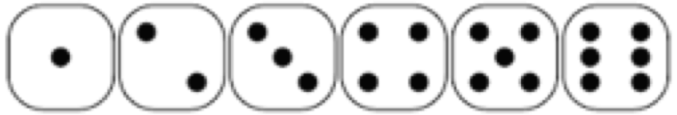
If you have no data, then use range estimates,

If you can’t get a range estimate, no process will help you.

Probability Refresher	Undo all of the statistics you learnt in school
Sampling	Learn how much data we need to forecast
Getting Data	Learn how to get historical data and estimates
Forecasting with Data	Practice using historical data to forecast

Understanding probability - Exercises

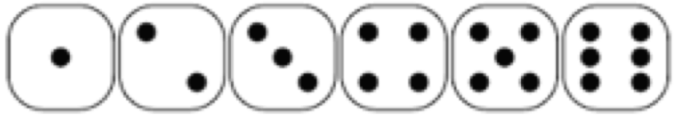
Q1. How many different possible values are there for a standard six-sided dice?



A:

Q2. How many values of a six sided dice are less than 4?

Tip: Circle the values that are less than 4.



A:

Q3. What is the probability of rolling a value less than 4 on a standard six side dice?

Tip: Count the number of "right" values and divide by the total number.

$$p = \frac{Number\ of\ "right"\ values}{Total\ possible\ values}$$ A:

$$p = \frac{Number\ of\ "right"\ values}{Total\ possible\ values}$$

$$p = \frac{Number\ of\ "right"\ values}{6}$$

$$p = \frac{3}{6} \qquad p = \frac{1}{2} \qquad p = 0.5$$

Finish the rest of the probability questions

3 minutes

Probability Refresher	Undo all of the statistics you learnt in school
Sampling	Learn how much data we need to forecast
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Sampling

A way to use the data we do have to make predictions & forecasts

It helps discover the **range** of possible values fast and *reliably*

Q. How quickly do we discover a range of values by sampling?

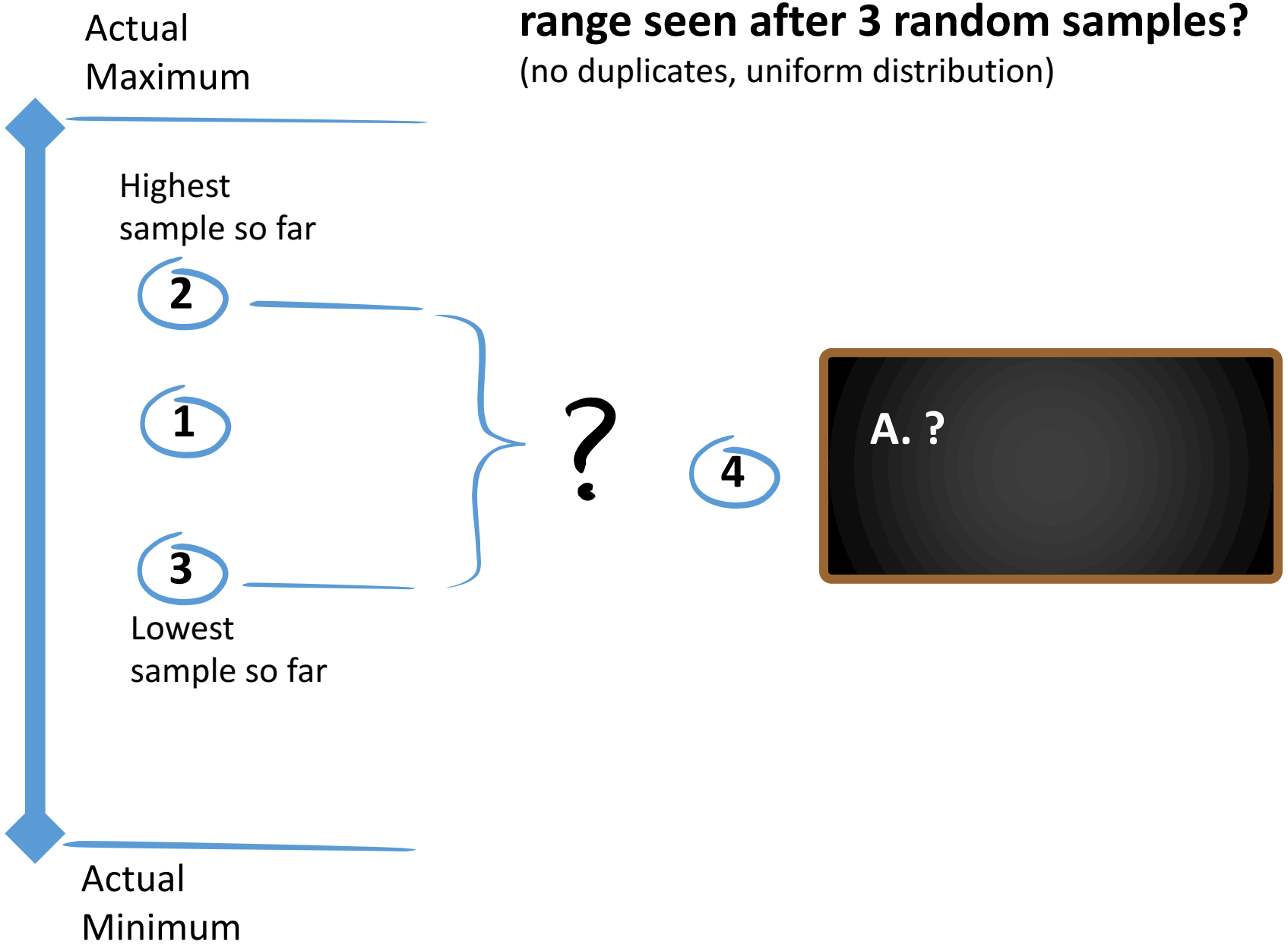
Why? Because as we get story count, story size, velocity, Throughput, cycle-time. How confident should we be of having found the full range values.

Month	Intelligence estimate	Sampling estimate	Post war (actual)
June 1940	1,000	169	122
June 1941	1,550	244	271
August 1942	1,550	327	342

2 tanks. Each Panther tank had eight axles,
and each axle had six bogie wheels,
making 48 wheels per tank. 96 samples total

Intelligence estimate versus sampling estimate compared with actual post war records . Source: (Wikipedia, 2016)

Q. On average, what is the chance of the 4th sample being between the range seen after 3 random samples?
(no duplicates, uniform distribution)



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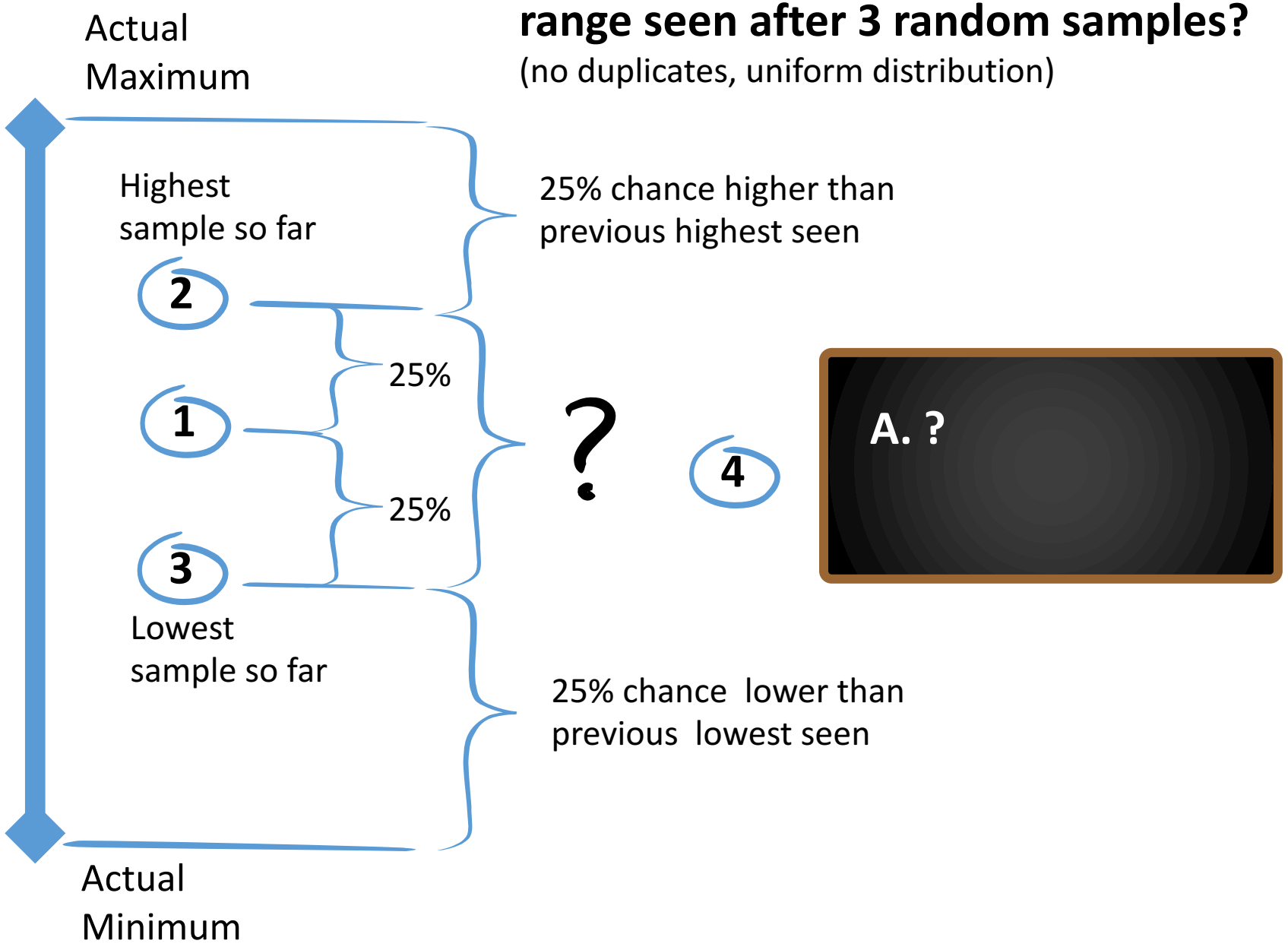
(no duplicates, uniform distribution)



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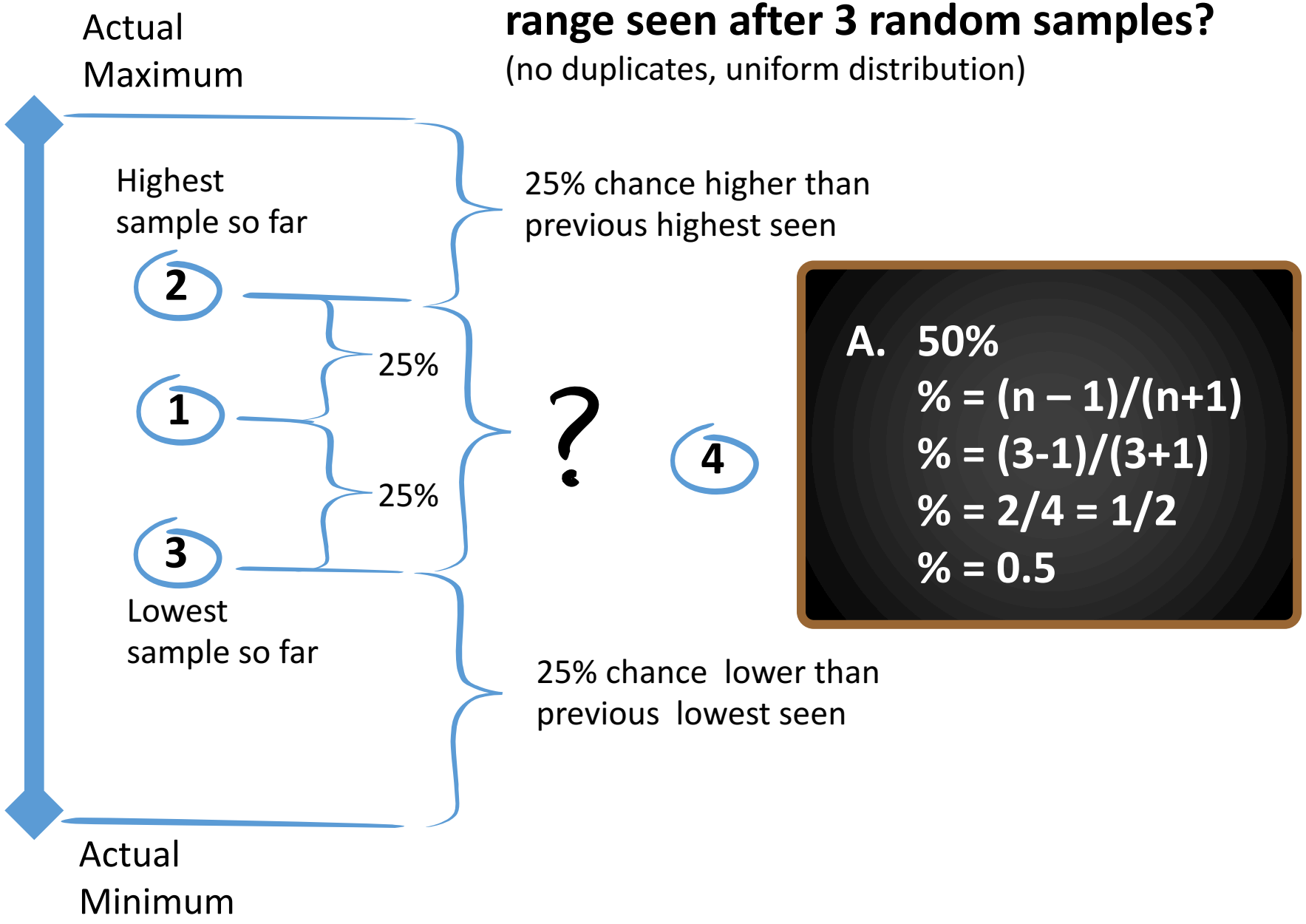
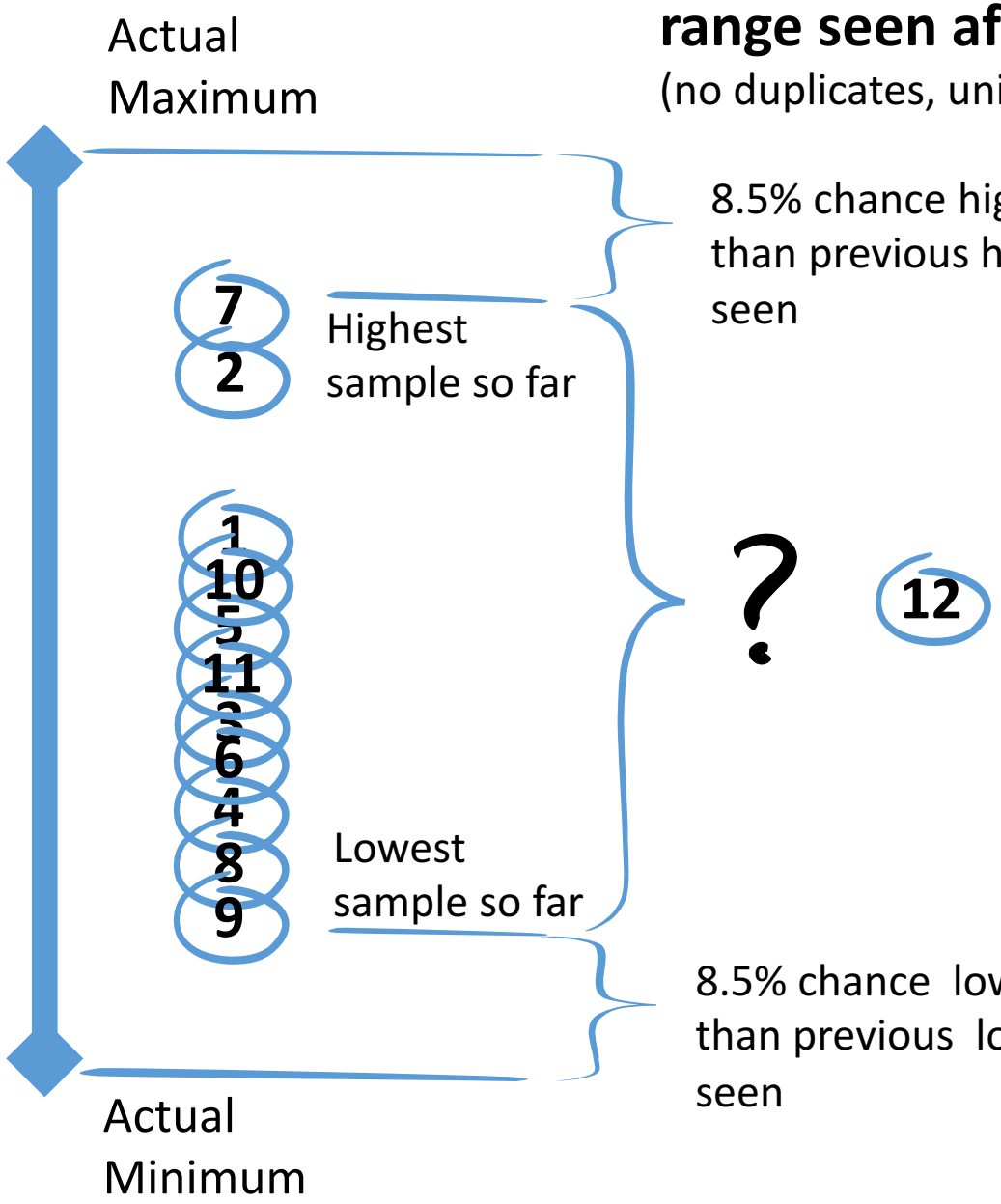
(no duplicates, uniform distribution)



A. 50%
% = (n – 1)/(n+1)
% = (3-1)/(3+1)
% = 2/4 = 1/2
% = 0.5

Q. On average, what is the chance of the 12th sample being between the range seen after 11 random samples?
(no duplicates, uniform distribution)



A. 83%
% = (n-1)/(n+1)
% = (11-1)/(11+1)
% = 0.833

Prediction Intervals

- “n” = number of prior samples
- % chance next sample in previous range for prior sample count

n	(n-1)/(n+1)	n	(n-1)/(n+1)
2	33%	16	88%
3	50%	17	89%
4	60%	18	89%
5	67%	19	90%
6	71%	20	90%
7	75%	21	91%
8	78%	22	91%
9	80%	23	92%
10	82%	24	92%
11	83%	25	92%
12	85%	26	93%
13	86%	27	93%
14	87%	28	93%
15	88%	29	93%
		30	94%

Experiment

From a *known* range of values, take samples at random and see how fast we can determine what the full range *might* be.

Prediction Intervals Exercise

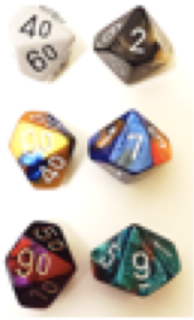
To find how many samples it takes to find the lower and upper bounds of a sample set on average? This exercise simulates finding the upper and lower boundary of a sequential range by sampling the result of dice rolls.

The process

1. **Roll Dice**: Create a random number with a range of 1 to 100. Options:
    a. A random number generator app on your phone (Randomizers)
    b. Use three rolls of a six-sided dice (see next page for chart)
    c. Sum two 10 sided dice (00 – 90 by 10's) and a traditional (0-9)
2. **Repeat**: Repeat 20 times and record the results in the table below.
3. **Examine Results**: Look at the range between the lowest rolled and highest rolled. Compare against expected.

3 x 6 Sided Dice

2 x 10 Sided Dice



42

7

99

Note: Rolling a 00 and 0 = 100

Questions and discussion topics

1. **What probability distribution is a single roll?**
2. **What guarantee do I have that I have found the range expected?**
3. **What happens if the data is a Normal (bell curve) distribution?**
4. **What happens if the data is left or right skewed?**

Results table

Record each roll and calculate the ranges seen so far after each roll. Are you ahead or behind expected?

n	This Roll	Lowest So Far	Highest So Far	Range So Far = Highest-Lowest	Expected Range $\frac{(n-1)}{(n+1)} \times 100$	Average So Far (expected 50)
1					0	
2					33.3	

IGNORE FOR NOW

Record each roll and calculate the ranges seen so far after each roll. Are you ahead or behind expected?

n	This Roll	Lowest So Far	Highest So Far	Range So Far = Highest-Lowest	Expected Range $\frac{(n-1)}{(n+1)} \times 100$	Average So Far (expected 50)
1					0	
2					33.3	
3					50	
4					60	
5					66.6	
6					71.4	
7					75	
8					77.8	
9					80	
10					81.2	
11					83.3	
12					84.6	
13					85.7	
14					86.7	
15					87.5	
16					88.2	
17						
18						
19						
20					90.5	

42

7

99

00 & 0 = 100

https://www.random.org

IGNORE FOR NOW

10 minutes

Come to the front when completed. Compare with expected.
How close to 9 samples is range of 80 found? (80% range, 10% above?)

Group	# samples > range > 80	# samples until 2 x avg > 80
1		
2		
3		
4		
5		
6		
7		

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Format

A2

http://bit.ly/Throughput

	A		
1	Completed Date	Start Date (optional)	Type (optional)
2	1/21/15	1/14/15	
3	1/26/15	1/14/15	Story
4	1/26/15	1/14/15	Defect
5	1/26/15	1/21/15	Story
6	1/26/15	1/22/15	Story
7	1/29/15	1/23/15	Story
8	2/2/15	1/23/15	Story
9	2/2/15	1/20/15	Defect
10	2/2/15	1/20/15	Defect
11	2/4/15	1/20/15	
12	2/4/15	1/26/15	
13	2/4/15	1/23/15	
14	2/4/15	1/22/15	

17 charts so far…

Throughput (planned & un-planned)

Throughput Histogram(s)

Cycle Time (planned & un-planed)

Cycle Time Histogram(s)

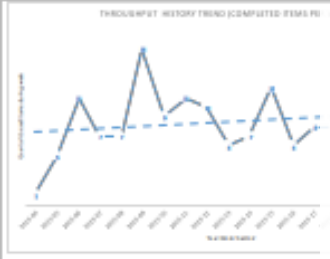
Work In Process

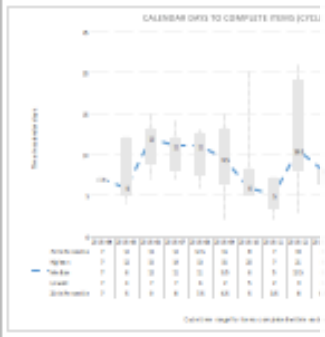
Cumulative Flow

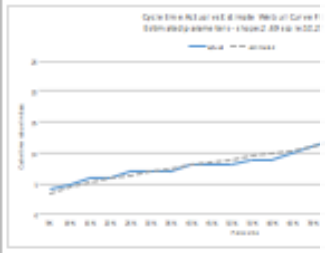
Arrival vs Departure Rate

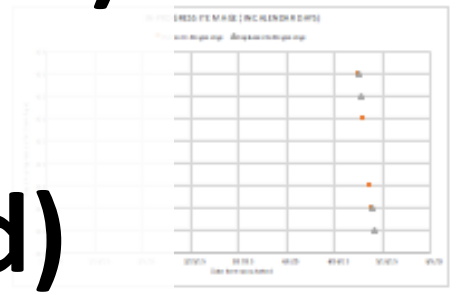
Un-planned work Percentage

Cycle Time Distribution Fitting









http://bit.ly/Throughput

Demo the throughput data spreadsheet

1. What data do you need
2. See how to get that data

Probability Refresher	Undo all of the statistics you learnt in school
Sampling	Learn how much data we need to forecast
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On average (or median), Arithmetic fails….

1 to 6 days + 1 to 6 + 1 to 6 + 1 to 6 + 1 to 6
= 5 to 30 days

3.5 days + 3.5 + 3.5 + 3.5 + 3.5 = 17.5 days

Siri, Add 1 to 6 five times.

Cortana, Add 1 to 6 five times.

(sometime later)

Alexa, Buy me some Vodka….

Q. Could I make a simple forecast tool that worked?

Without macros or add-ins!

http://bit.ly/ThroughputForecast

http://bit.ly/ThroughputForecast

Forecast Completion Date

1. Start Date 4/1/15

2. How many stories are remaining to be completed?

(enter the range estimate of stories. Tip: start wide and narrow as certainty increases)

Low guess 20 Highest guess 30

3. Stories are often split before and whilst being worked on. Estimate the split rate low and high bounds.

(often the throughput in the backlog is pre-split, but captured throughput post-split. Adjust for this here)

Low guess 1.00 Highest guess 1.00

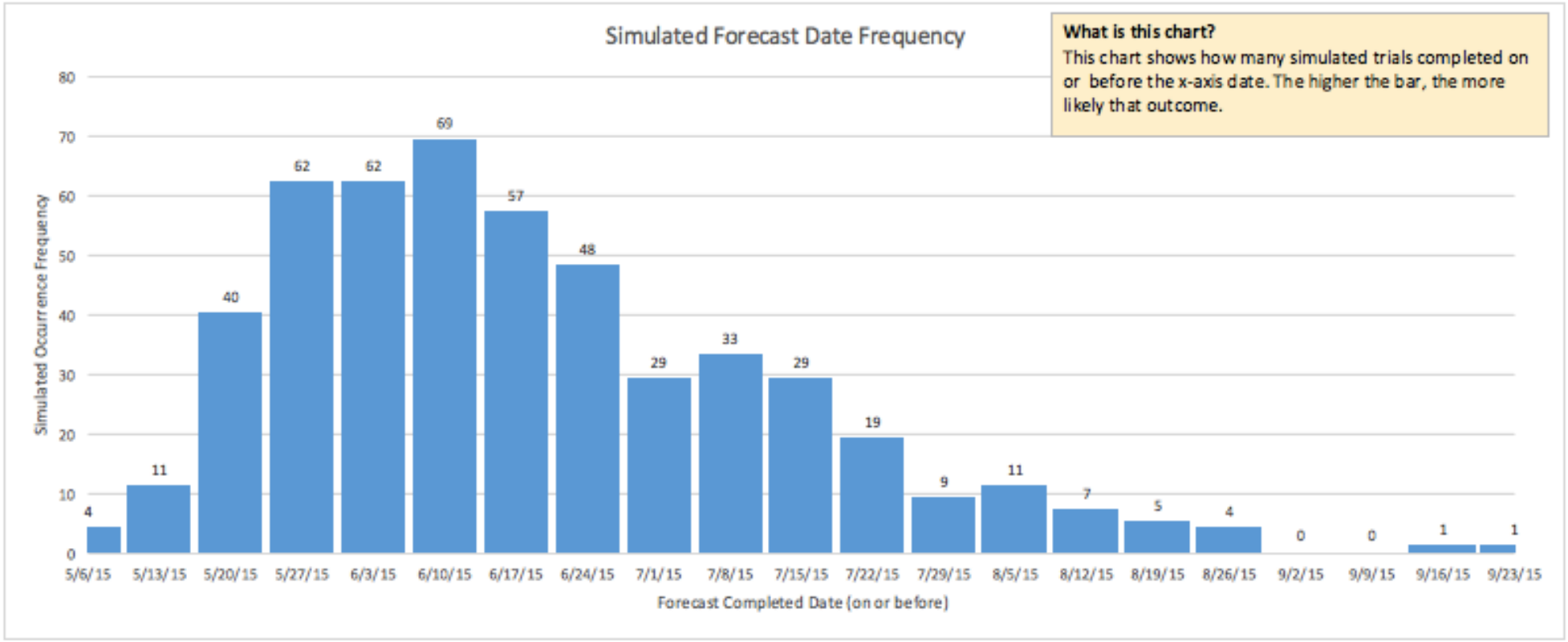
4. Throughput. How many completed stories per week or sprint do you estimate low and high bounds?

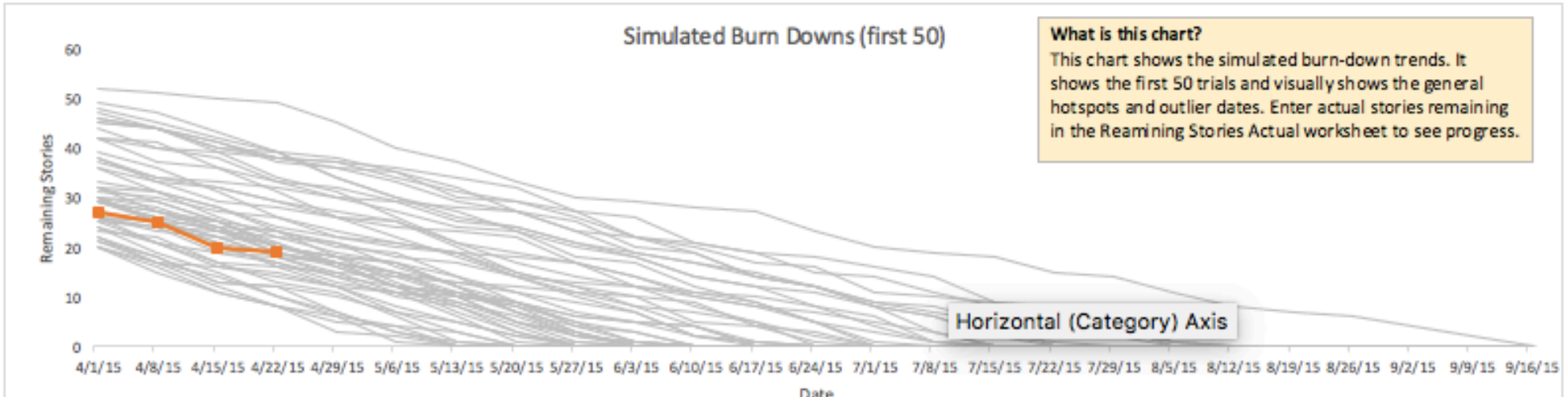
Throughput estimate/samples are per Week 7 days

Use historical throughput data **OR** enter a low and high estimate below. Use: Estimate

Low guess 1 Highest guess 5

http://bit.ly/ThroughputForecast





http://bit.ly/ThroughputForecast

Results

Likelihood	Duration in Week's	Date
100%	25	9/23/15
95%	18	8/5/15
90%	16	7/22/15
85%	15	7/15/15
80%	14	7/8/15
75%	13	7/1/15
70%	12	6/24/15
65%	12	6/24/15
60%	11	6/17/15
55%	11	6/17/15
50%	11	6/17/15
45%	10	6/10/15
40%	10	6/10/15

Almost certain

Somewhat certain

Experiment

From a set of *prior* throughput samples, compute the completion rate(s) for the next 6 (six) weeks.

Process –

1. Repetitively sample prior throughput in sets of 6
2. Compute how many trials complete at least 10, 20, 30, 40, 50, 60 items in 6 weeks

Exercise – Throughput Forecast Monte Carlo Worksheet

Aim: To estimate the number of stories that will be completed by a team for a six (6) week timespan using historical weekly throughput samples for that team. To understand the probability of achieving those estimates.

Process:

1. Shuffle the 24 throughput cards or dice (whichever method you choose)
2. Pick a card at random or throw dice and record sample in the table below
3. Return the card to the deck and reshuffle ("sample with replacement")
4. Repeat until all squares are filled

We randomly sampled trials 4 to 11 for you to save time.

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11
			7	11	7	5	17	5	10	16
			19	7	10	5	13	13	5	7
			6	5	5	3	5	16	6	5
			6	19	5	3	5	3	6	3
			5	7	10	5	6	8	8	6
			5	7	19	10	16	8	10	16

5. **Sum of all samples for each trial by column (upper) / Nearest "tens" grouping rounded down (lower)**

			48	**56**	**56**	**31**	**62**	**53**	**45**	**53**
			40+	50+	50+	30+	60+	50+	40+	50+

6. **Sum all trials (a):** **Average all trials (a/11):**

Actual data average 6 week throughput = **57.75**. How close was your average?

7. **Probabilities of achieving at least n stories for a six-week timespan**

Six Week Throughput	Count trial sum groups at least 30,40, 50, etc. stories	(Count / 11) Likelihood
At least **30** stories		
At least **40** stories		

This value is 0 to 1

Multiply it by 100 to get a percentage. 0% = no chance,

First dice throw

	⚀	⚁	⚂	⚃	⚄	⚅
⚀	16	3	10	6	19	11
⚁	17	17	15	9	11	8
⚂	5	13	5	7	8	6
⚃	10	10	8	5	5	7
⚄	Roll again	Roll again	Roll again	Roll again	Roll again	Roll again
⚅	Roll again	Roll again	Roll again	Roll again	Roll again	Roll again

Second dice throw

24 Throughput (or velocity) Samples Randomly picked by throwing a dice

1. Throw a 6-sided dice. Pick the column.
2. Throw a six-sided dice and pick the row
3. If it doesn't say "Roll again" this is your throughput sample.

Fill in the numbers for Trials 1, 2 and 3. I've done Trials 4 to 11 so you don't want to kill me!

4. Repeat until all squares are filled

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	T
			7	11	7	
			19	7	10	
			6	5	5	
			6	19	5	
			5	7	10	
			5	7	19	

Come to the front and give me your Likelihood of 40, 50 and 60 stories

Group	% >= 40 stories	% >= 50 stories	% > 60 stories
1			
2			
3			
4			
5			
6			
7			

Forecast Completion Date

1. Start Date 7/25/16

2. How many stories are remaining to be completed?

(enter the range estimate of stories. Tip: start wide and narrow as certainty increases)

Low guess 20 Highest guess 30

3. Stories are often split before and whilst being worked on. Estimate the split rate low and high bounds.

(often the throughput in the backlog is pre-split, but captured throughput post-split. Adjust for this here)

Low guess 1.00 Highest guess 1.00

4. Throughput. How many completed stories per week or sprint do you estimate low and high bounds?

Throughput estimate/samples are per Week 7 days

Use historical throughput data **OR** enter a low and high estimate below. Use: Data

Low guess 6 Highest guess 17

Can I use velocity rather than throughput?
Yes. If you do have estimates in story points, then you can sume all of the estimates and use that for input 2 and estimate or use historical team velocity for input 4. The benefit of using throughput (count of completed stories per week/sprint) is that the individual stories don't require estimation in story points.

Enter data in Orange cells

Read forecast from this table.

Results

Likelihood	Duration in Week's	Date
100%	6	9/5/16
95%	5	8/29/16
90%	4	8/22/16
85%	4	8/22/16
80%	4	8/22/16
75%	4	8/22/16
70%	4	8/22/16
65%	3	8/15/16
60%	3	8/15/16
55%	3	8/15/16
50%	3	8/15/16
45%	3	8/15/16
40%	3	8/15/16
35%	3	8/15/16
30%	3	8/15/16
25%	3	8/15/16
20%	2	8/8/16
15%	2	8/8/16
10%	2	8/8/16
5%	2	8/8/16
0%	2	8/8/16

Forecast Story Count Completion by Time Period

5. How long? 6 Weeks

(To forecast story counts, enter the how long.
To change unit, change input 4. above.)

Result: Total Pre-split Stories in 6 Weeks

(Pre-split means, splitting IS accounted for)

85%	46
50%	58
15%	69

<--- Tip: This is your forecasted # storiess for this period at 50% confidence

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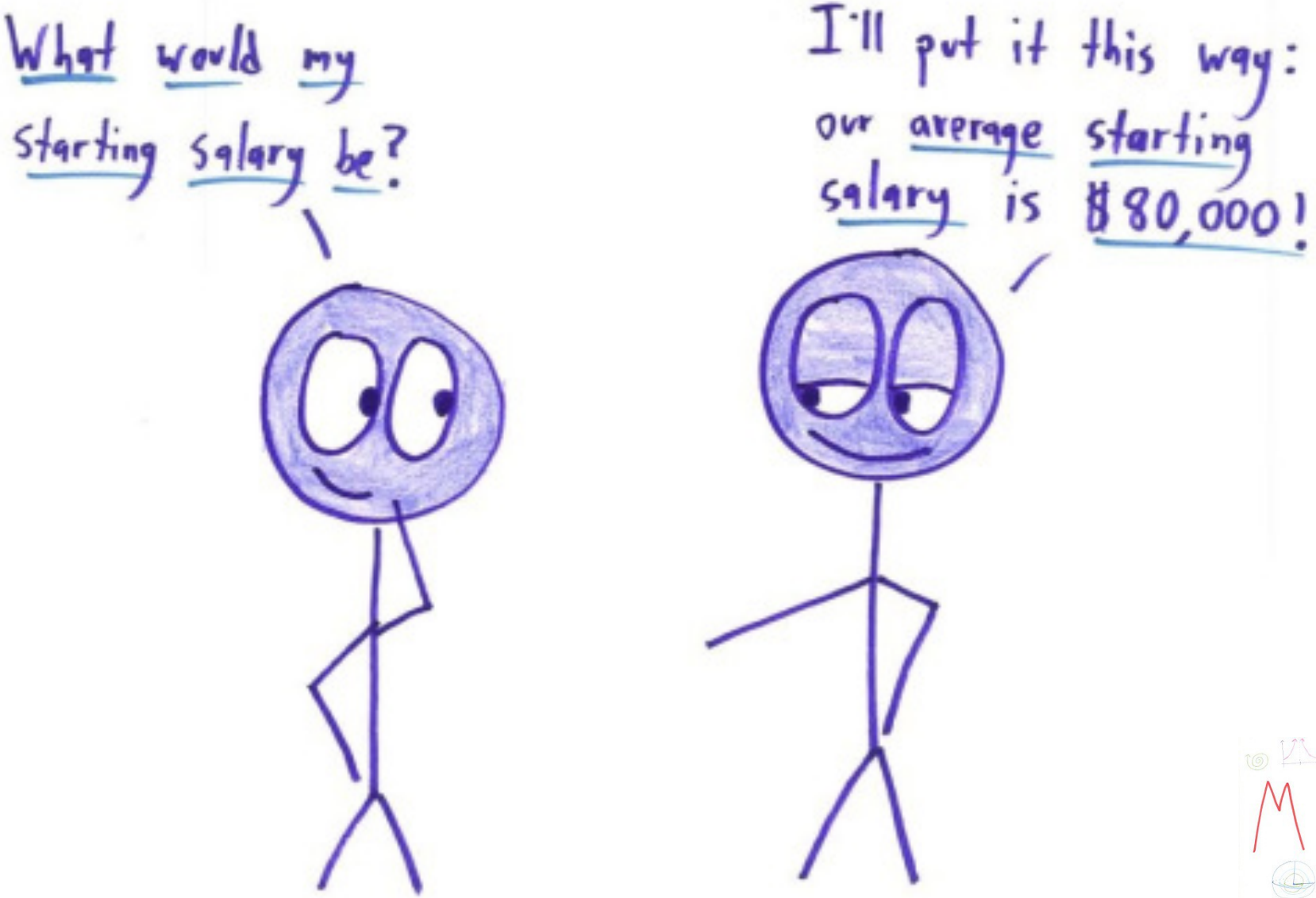
or **@t_magennis** (I've post links here)

Mean



MATH with BAD DRAWINGS

you → $30,000

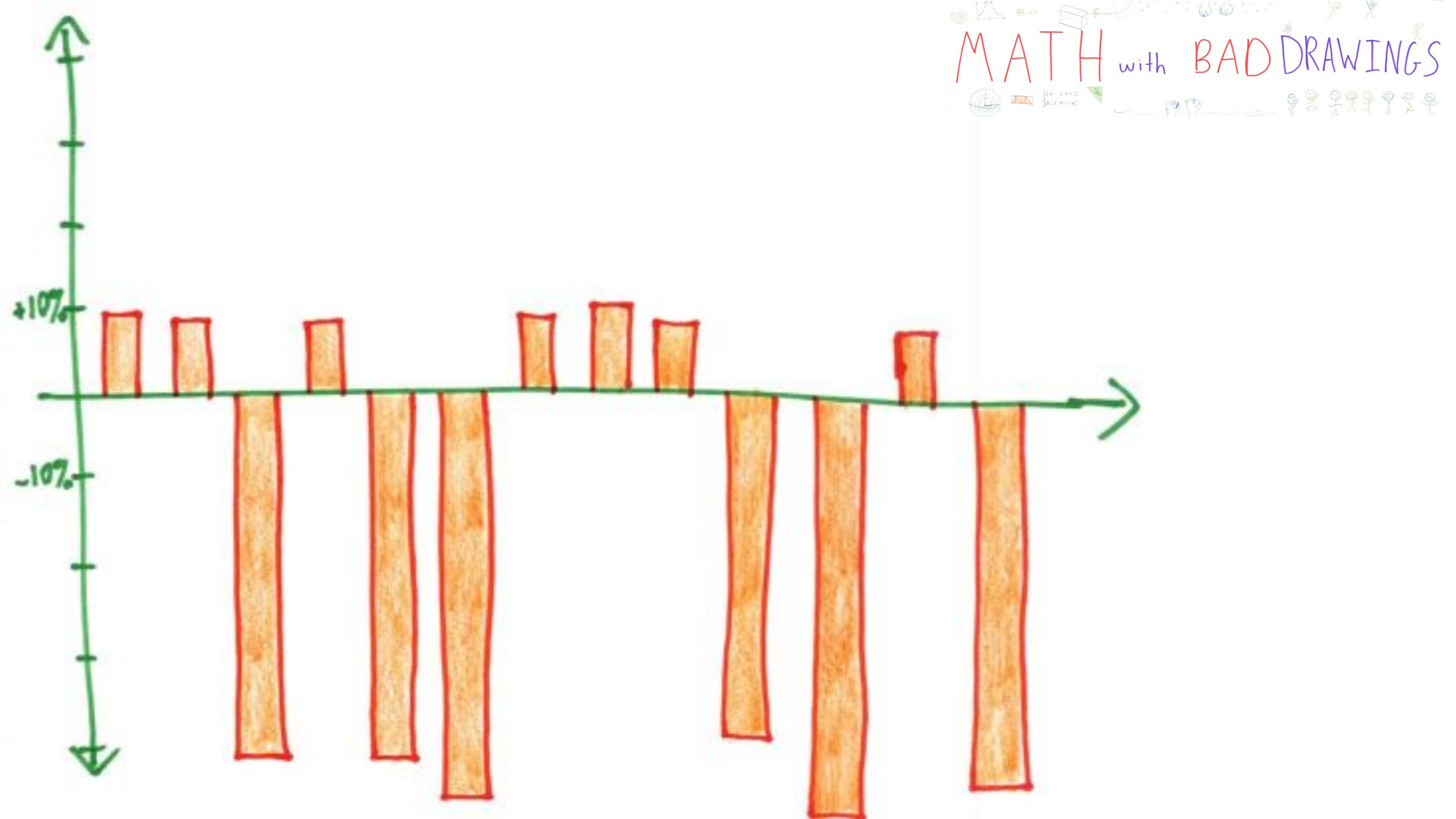
all your coworkers
- $30,000
- $30,000
- $30,000
- $30,000
- $30,000
- $30,000

CEO's son → $430,000

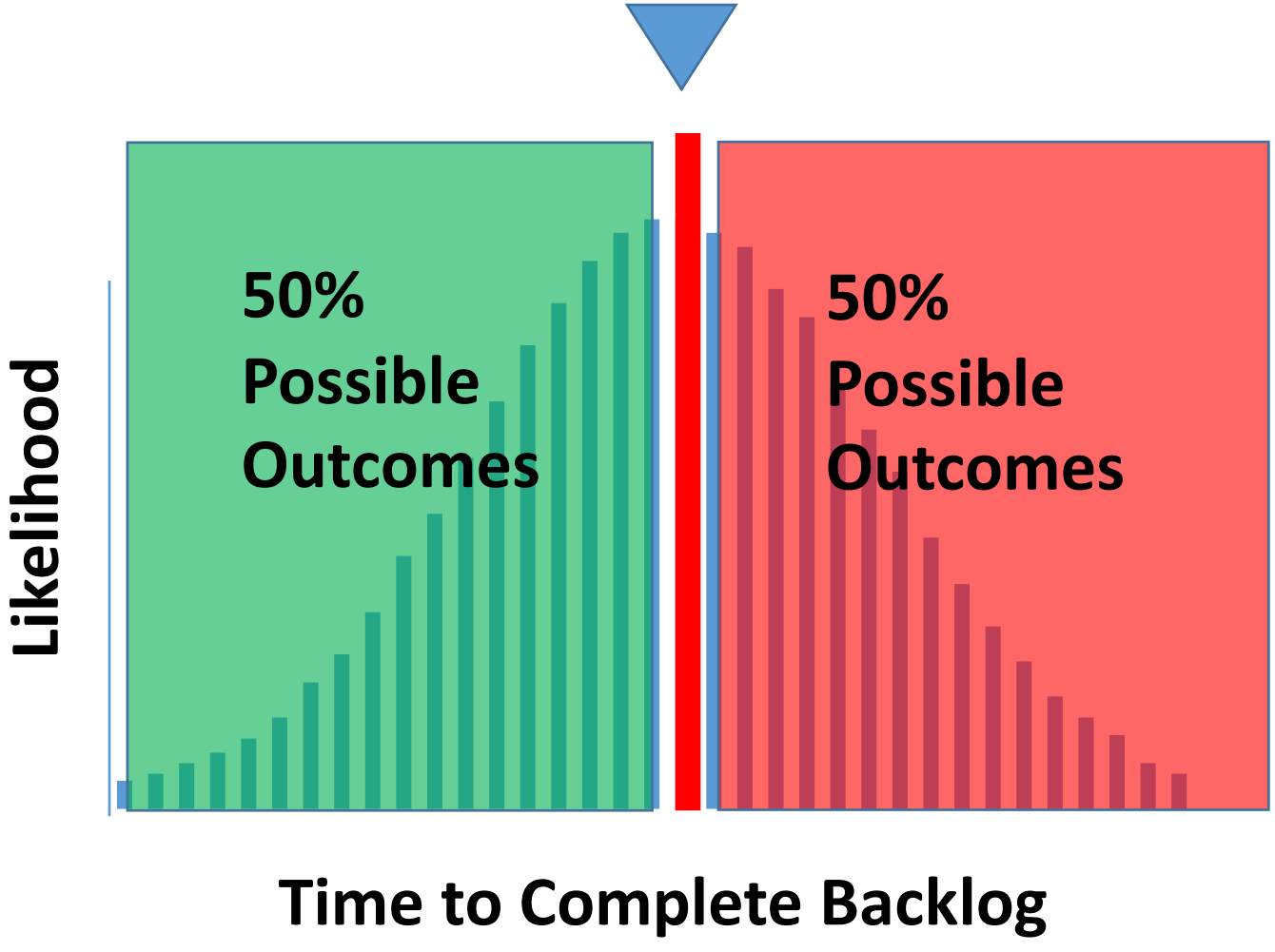
Average: $80,000.

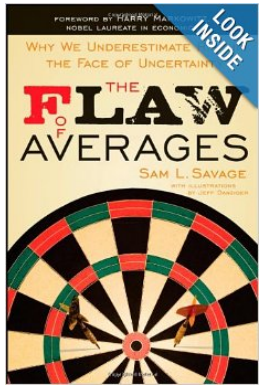
MATH with BAD DRAWINGS

Median


+10%
-10%

Probabilistic Forecasting combines many uncertain inputs to find many possible outcomes, and what outcomes are more likely than others





Seeing “How Likely”