

Predictive Model for Traffic Control in Underground Mines

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June 3, 2019



Mine Conditions



- ▶ Lots of people and vehicles
- ▶ Deep below ground
- ▶ No radio penetration
- ▶ WiFi





Narrow Roads



Problem Breakdown

- ▶ Identify oncoming vehicles
- ▶ Identify nearby meeting slots or places to give way
- ▶ Predict difference in arrival time to a meeting slot
- ▶ Manage inaccurate positioning
- ▶ Manage loss of connection and old data



Available Resources

- ▶ A graph representation of the map.
- ▶ Positioning for every vehicle in the mine.
- ▶ History of previous travel in form of logs.

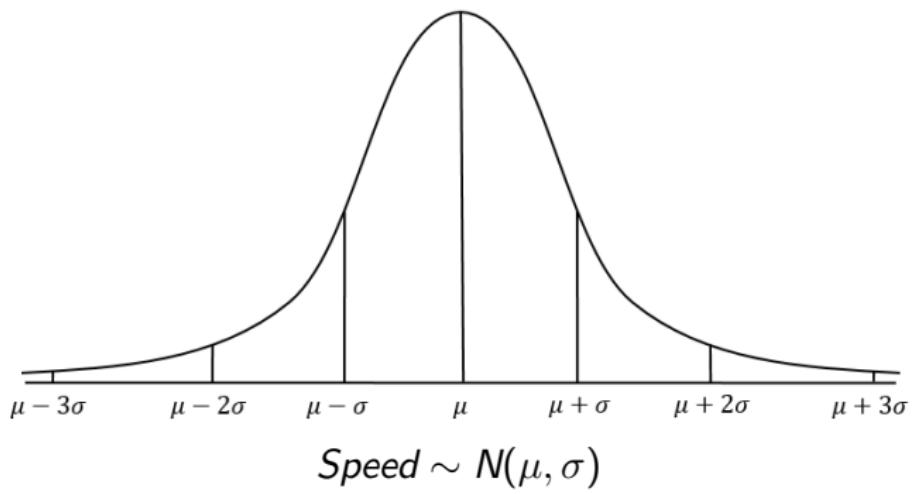


Log Structure

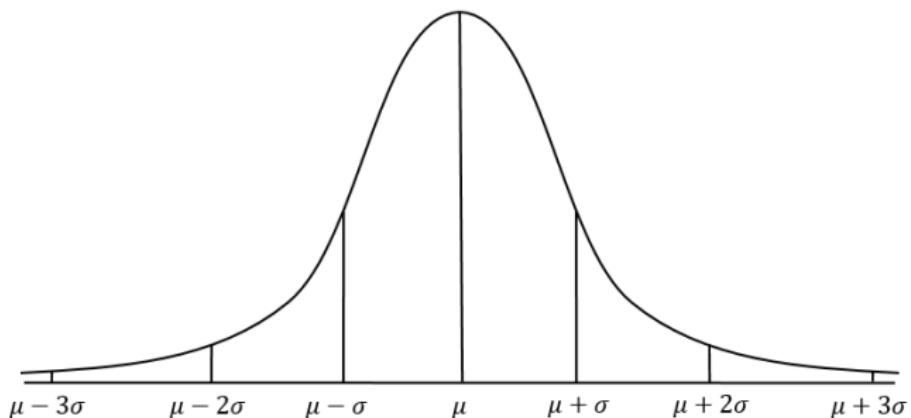
time	speed	x	y	z	.	.	.
553	22	1340	543	-430	.	.	.
554	20	1338	547	-431	.	.	.
555	18	1336	550	-431	.	.	.
556	20	1335	556	-432	.	.	.
557	21	1335	556	-432	.	.	.
558	23	1333	560	-434	.	.	.
559	24	1333	563	-435	.	.	.
560	24	1330	563	-436	.	.	.
561	26	1330	560	-436	.	.	.
562	25	1328	557	-437	.	.	.
563	25	1330	555	-438	.	.	.
.
.
.



Gaussian Assumption of Speed over Edge



Gaussian Assumption of Speed over Edge

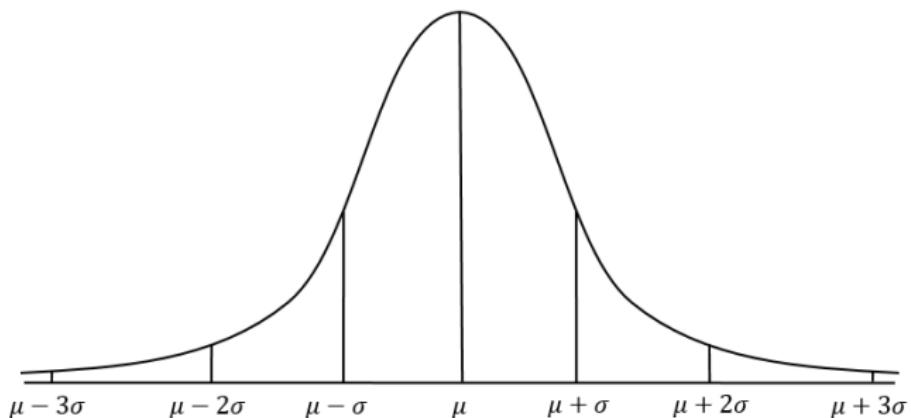


$$\text{Speed} \sim N(\mu, \sigma)$$

Dependent or independent?



Gaussian Assumption of Speed over Edge



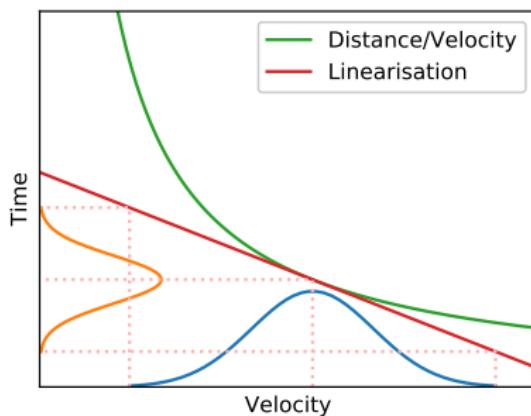
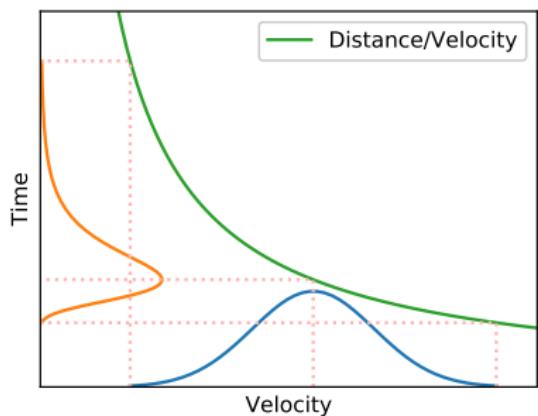
$$Speed \sim N(\mu, \sigma)$$

Dependent or independent?

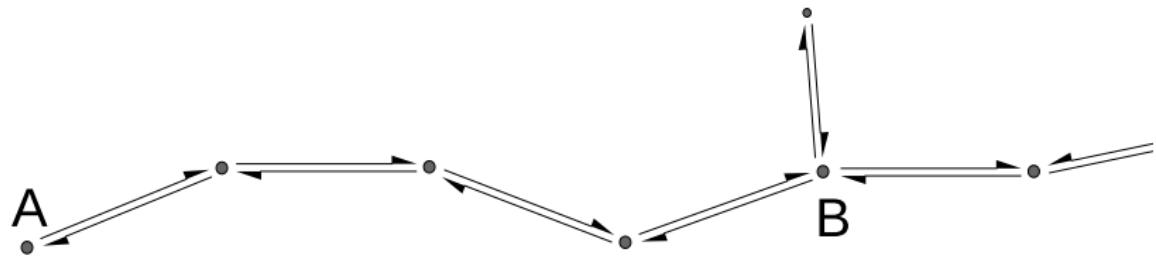
$$\text{Time over edge} = \frac{\text{Distance}}{\text{Speed}}$$



Linarising Distance over Speed



Adding time of Path



$$time = \frac{Distance_1}{Speed_1} + \frac{Distance_2}{Speed_2} + \dots + \frac{Distance_n}{Speed_n}$$



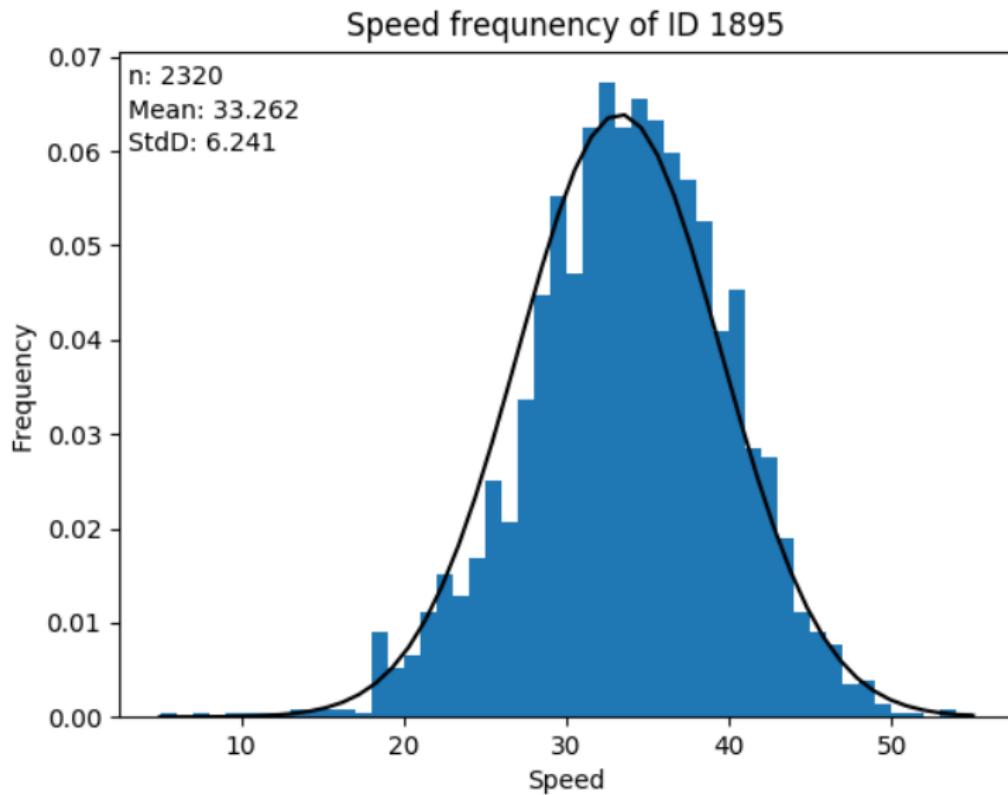
Result Layout

Results:

- ▶ Edge speed distributions
How well do they reflect reality?
- ▶ Linearisation and dependence
How much do they distort the results?
- ▶ Predicting time difference to a point
How well does it work?

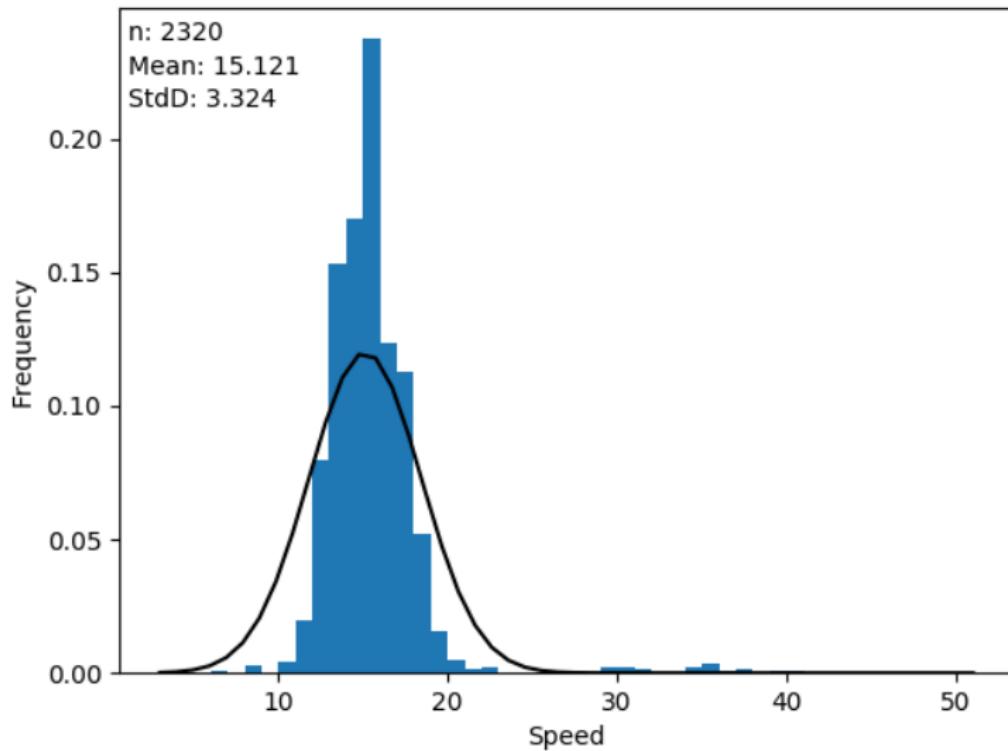


Edge Speed Distribution Results

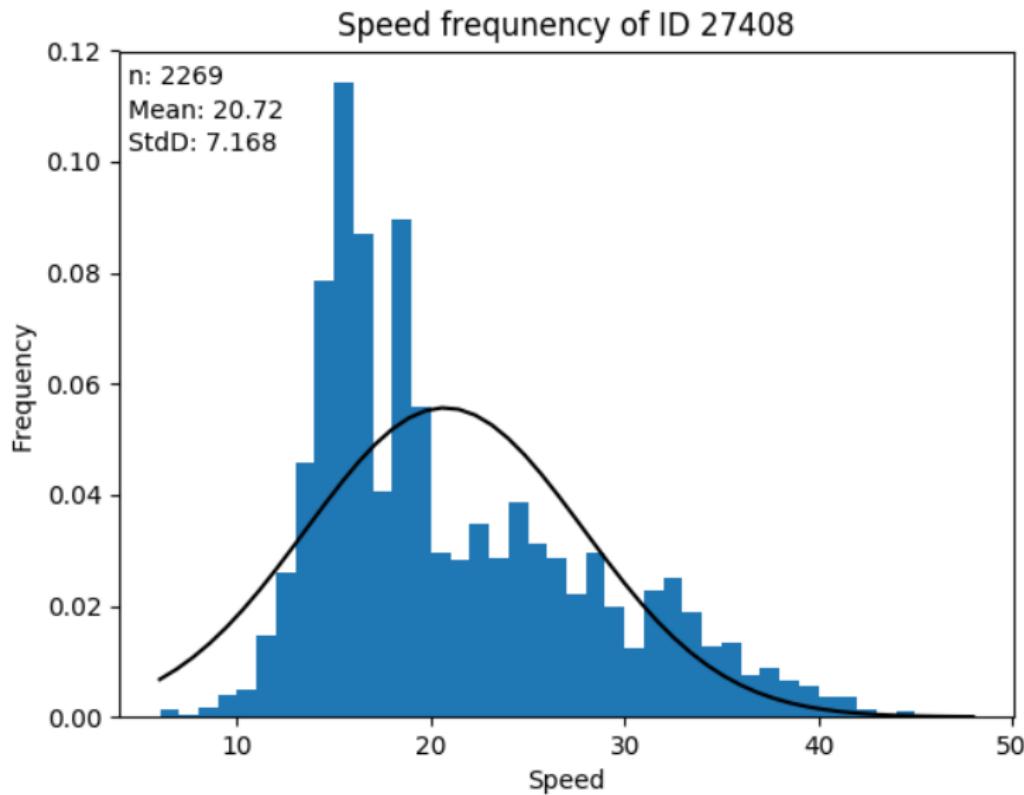


Edge Speed Distribution Results

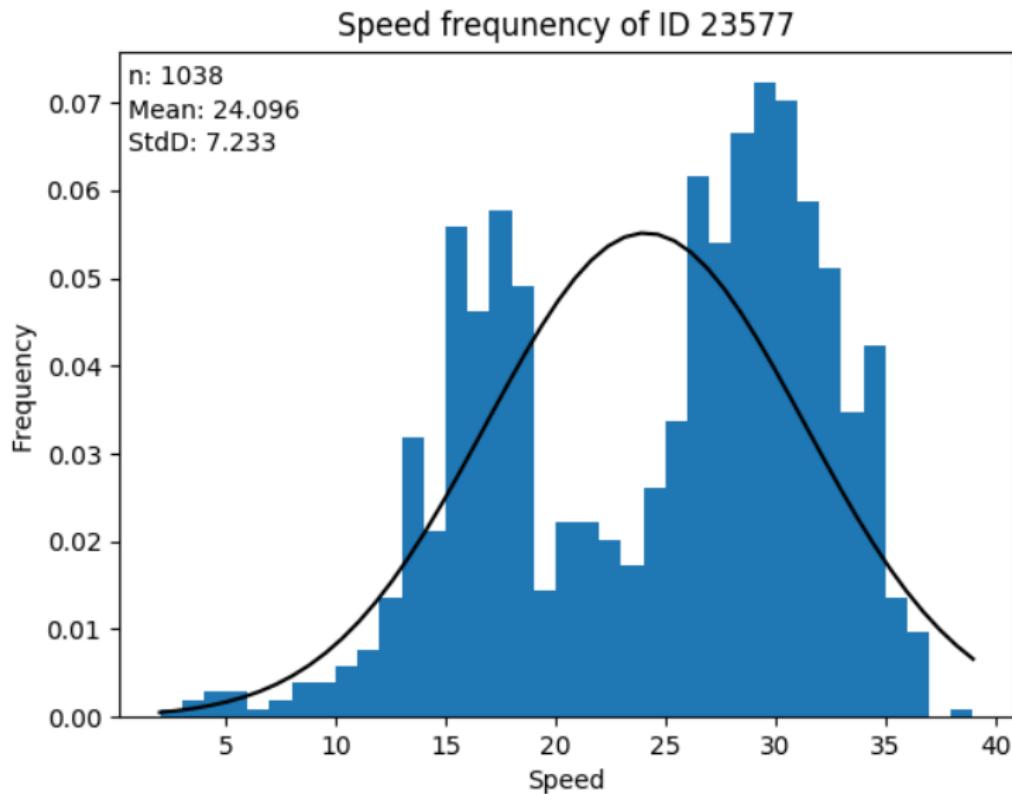
Speed frequency of ID 4484



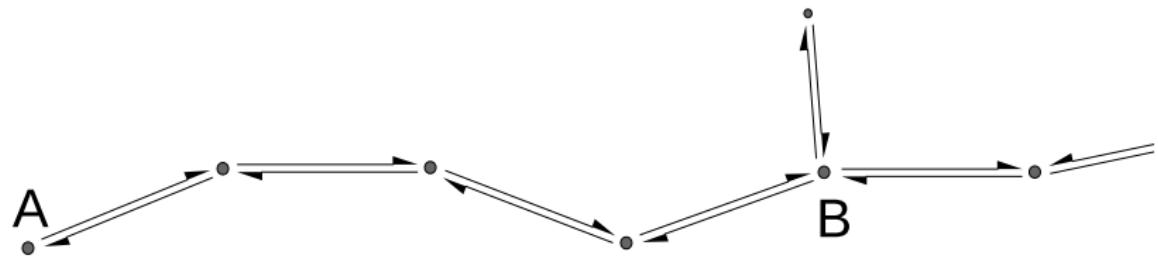
Edge Speed Distribution Results



Edge Speed Distribution Results



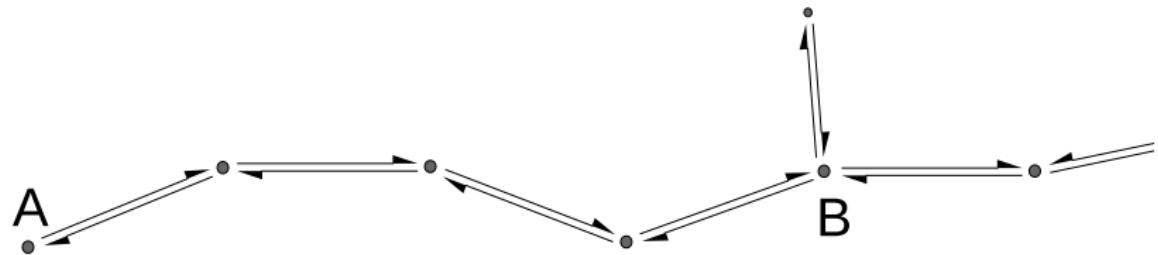
Comparing against logs



Set of logs from A to B vs Prediction



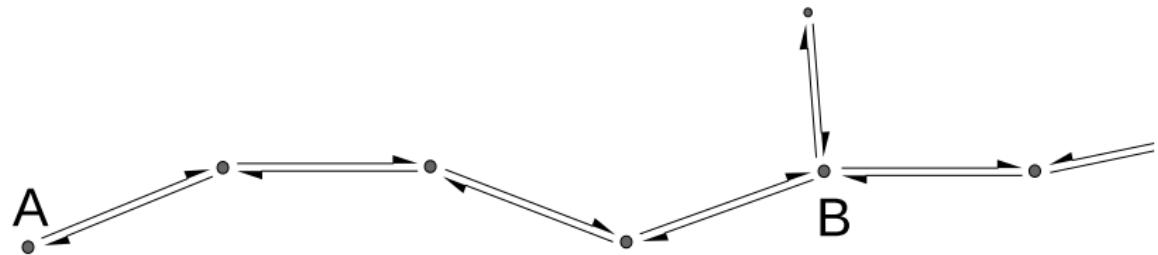
Comparing against logs



Set of logs from A to B vs Prediction
Log Time



Comparing against logs



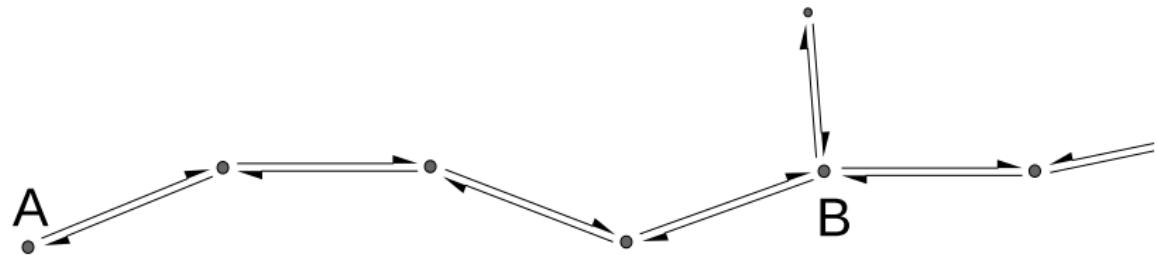
Set of logs from A to B vs Prediction

Log Time

Log Speed



Comparing against logs



Set of logs from A to B vs Prediction

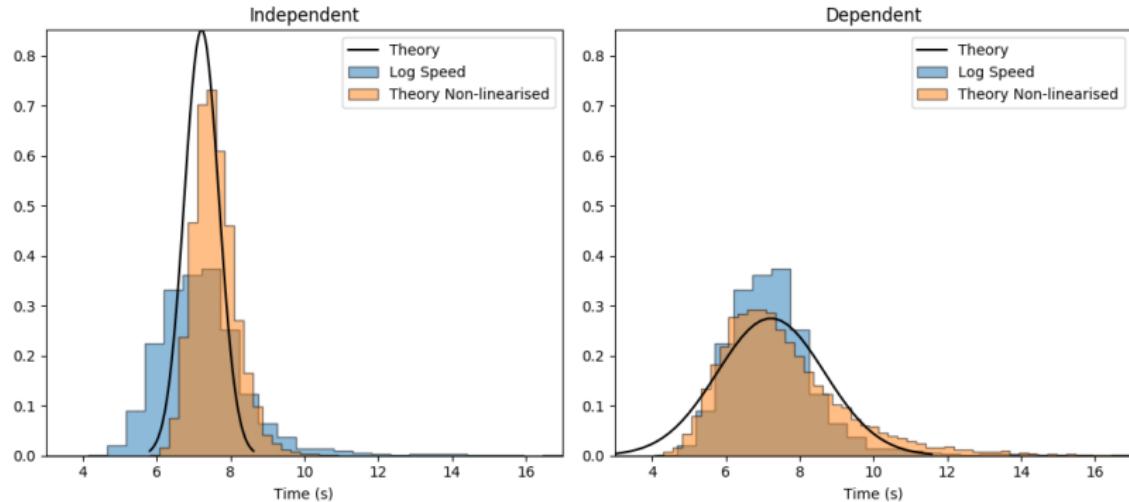
Log Time

Log Speed

Theory



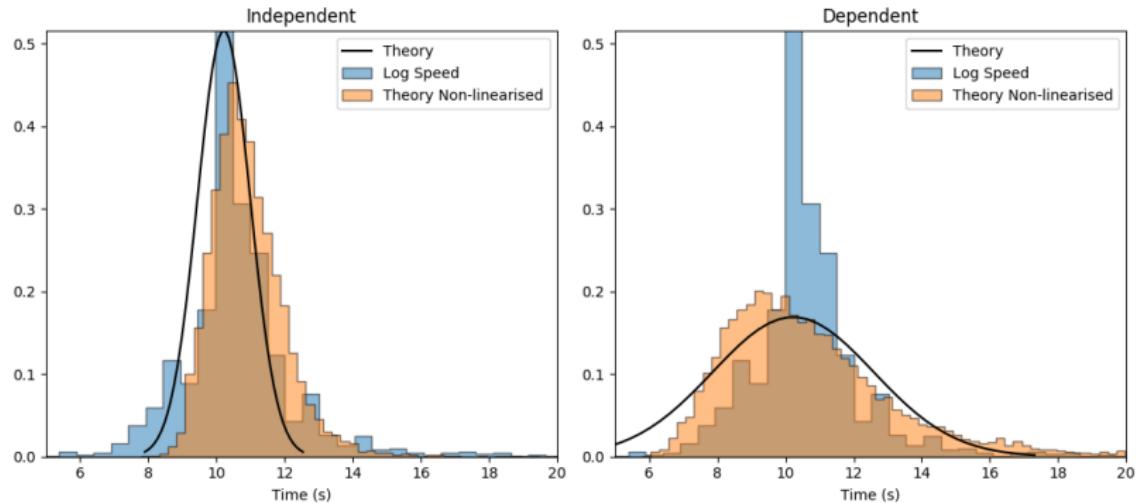
Linearisation and Dependence, Short



Path 10 edges long



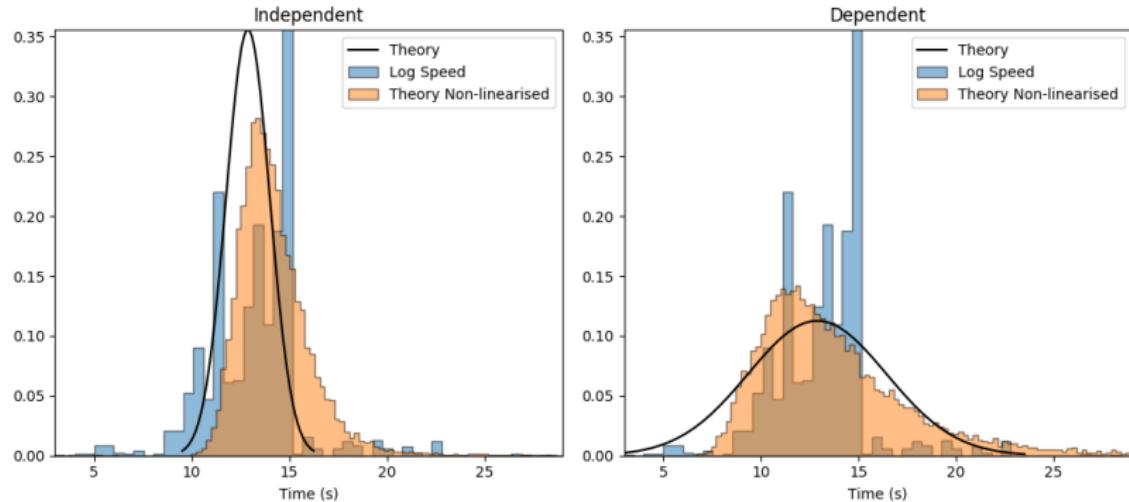
Linearisation and Dependence, Short



Path 10 edges long



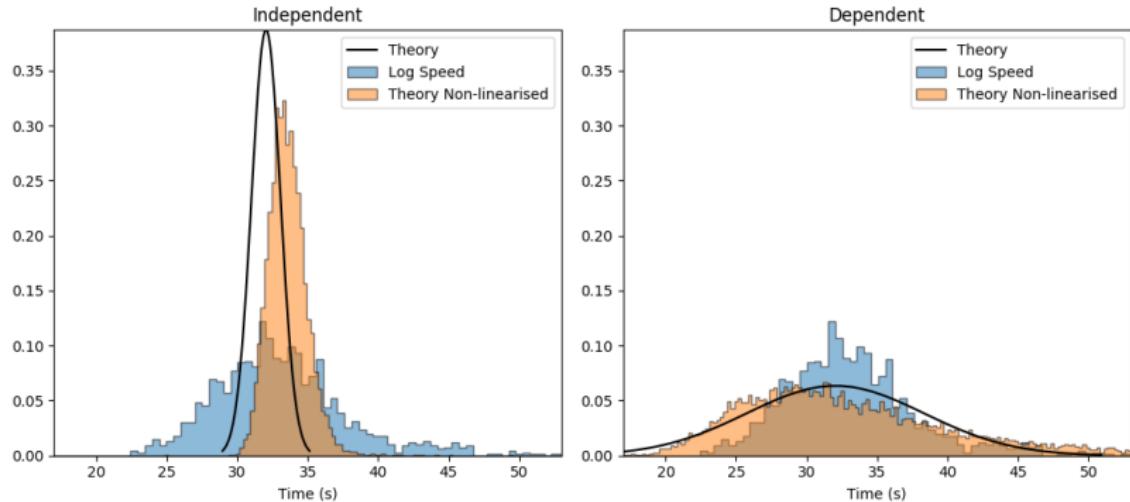
Linearisation and Dependence, Short



Path 10 edges long



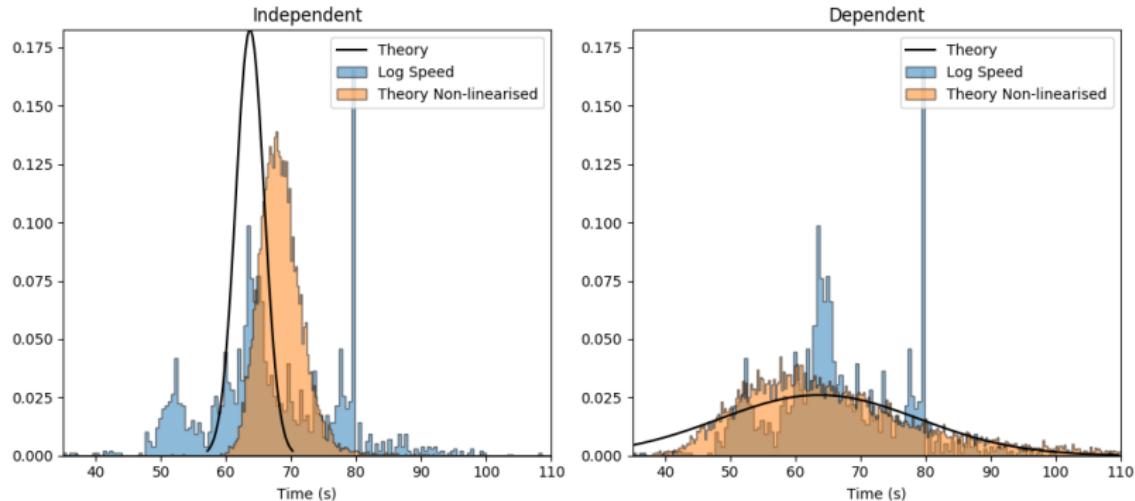
Linearisation and Dependence, Long



Same path that had good independent fit, now 40 edges long



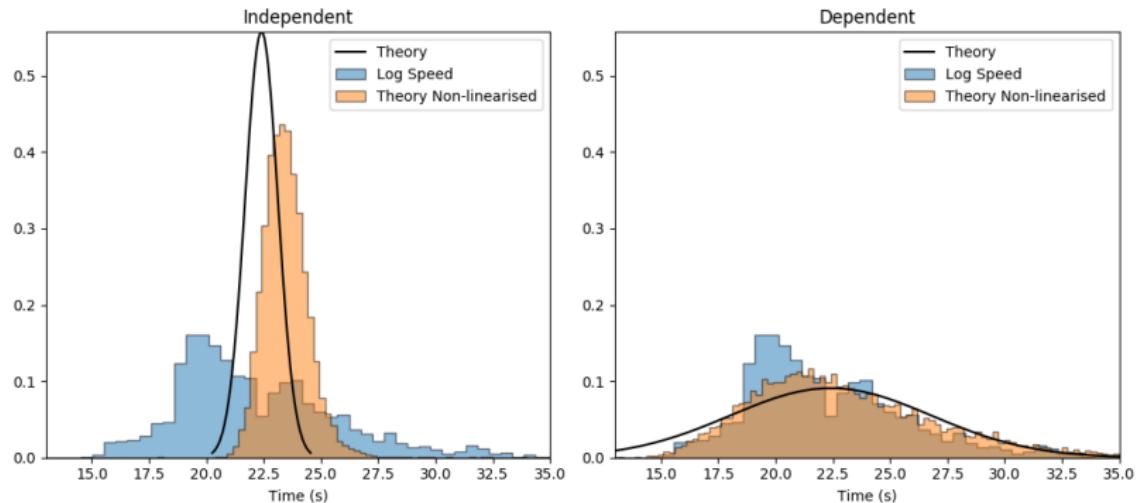
Linearisation and Dependence, Long



Same path that didn't have a good gaussian fit, now 50 edges long



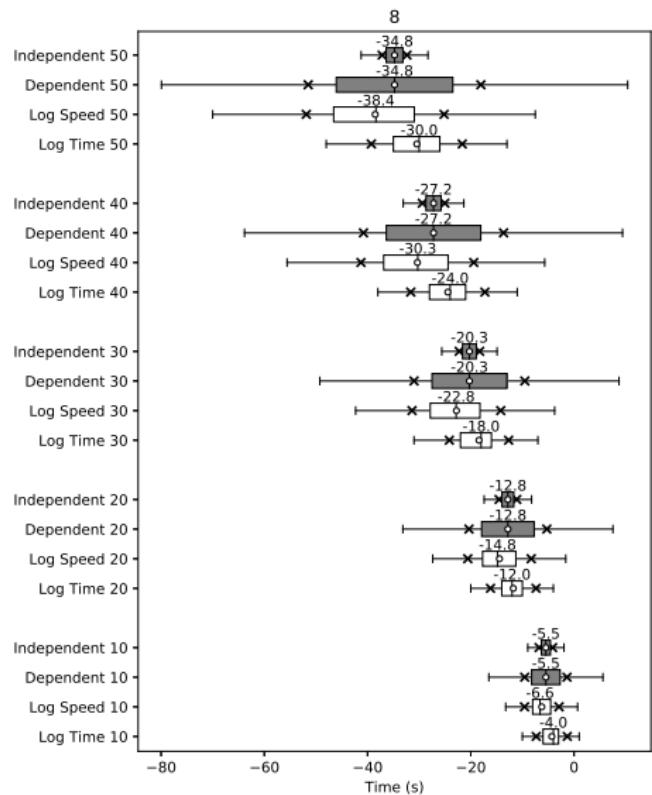
Linearisation and Dependence, Long



40 edges long path. Slanted Log Speed.



Time Difference of Two Paths



Conclusion

- ▶ The good
- ▶ The bad
- ▶ The ugly



Appendix - Data

Number of nodes: 16433
Number of edges: 32956
Files processed: 836
Total points of data: 8627650
Biggest single dataset: 3341

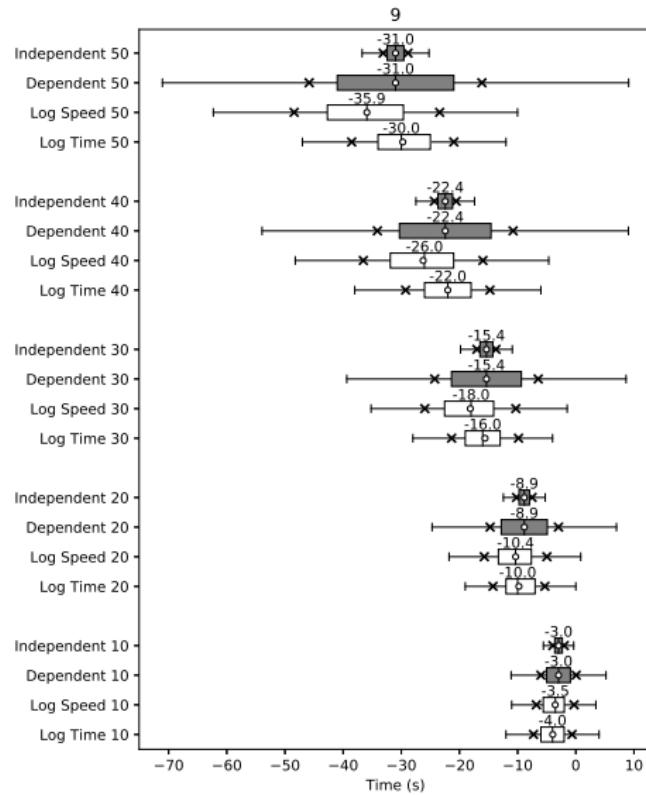


Appendix - Code

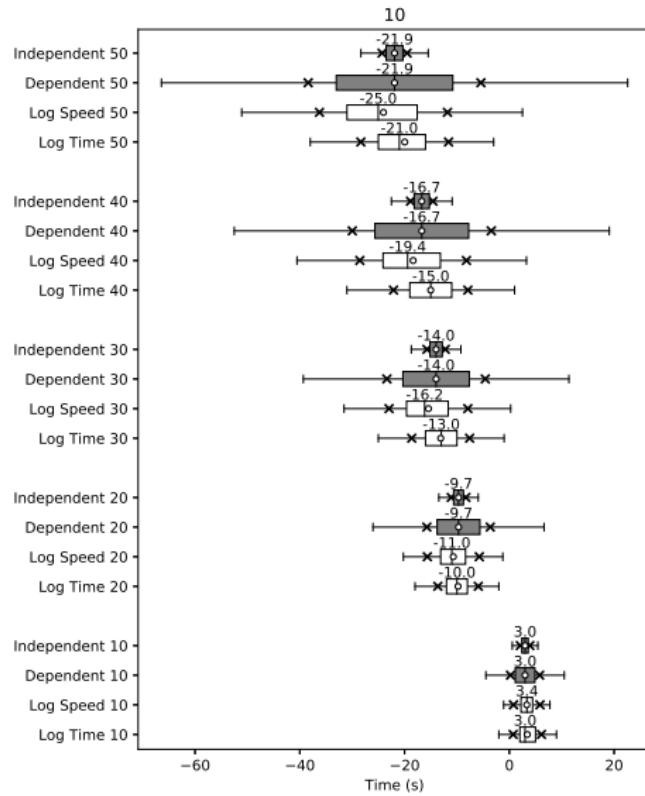
Language	files	blank	comment	code
C++	42	1836	1111	12454
C/C++ Header	25	456	1204	1168
TeX	7	311	17	838
Python	7	172	78	554
CMake	4	101	64	360
Bourne Shell	7	40	18	264
GLSL	8	40	42	163
Markdown	3	86	0	155
Protocol Buffers	2	13	13	77
SUM:	105	3055	2547	16033



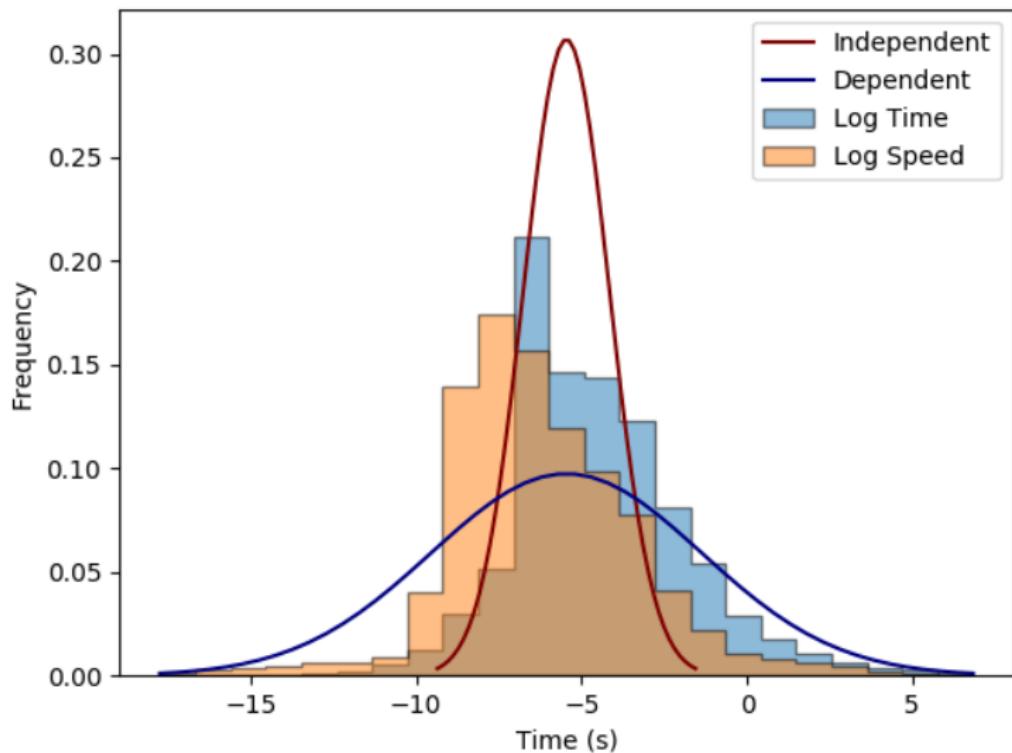
Appendix - More Time Differences



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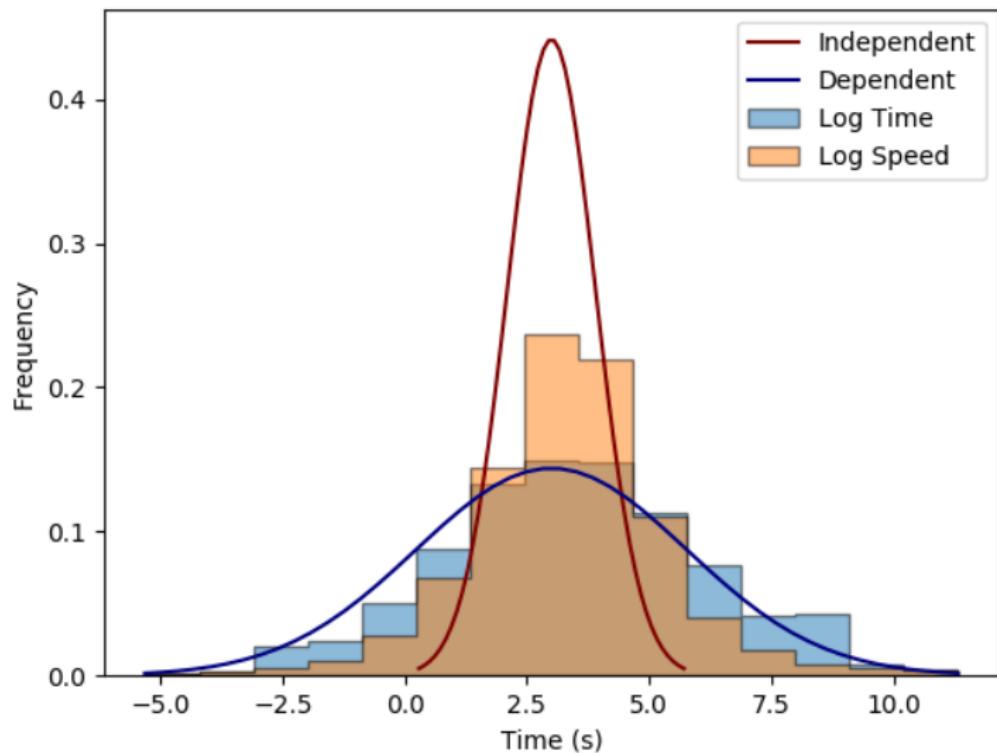
Appendix - Time Difference Distribution



10 Edges



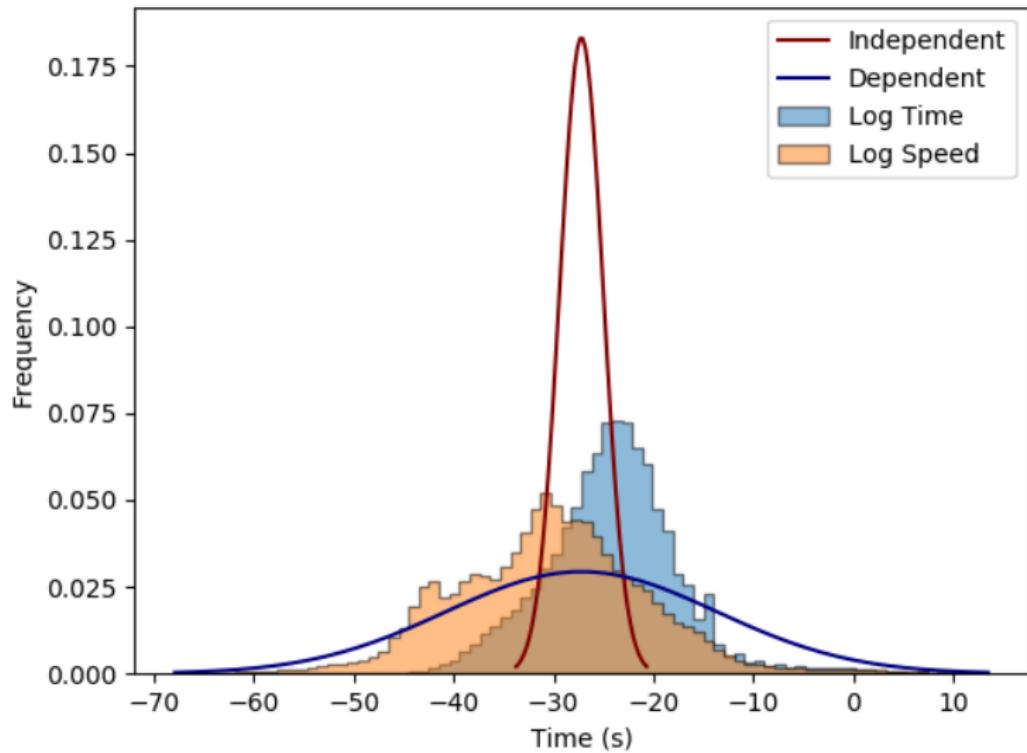
Appendix - Time Difference Distribution



10 Edges



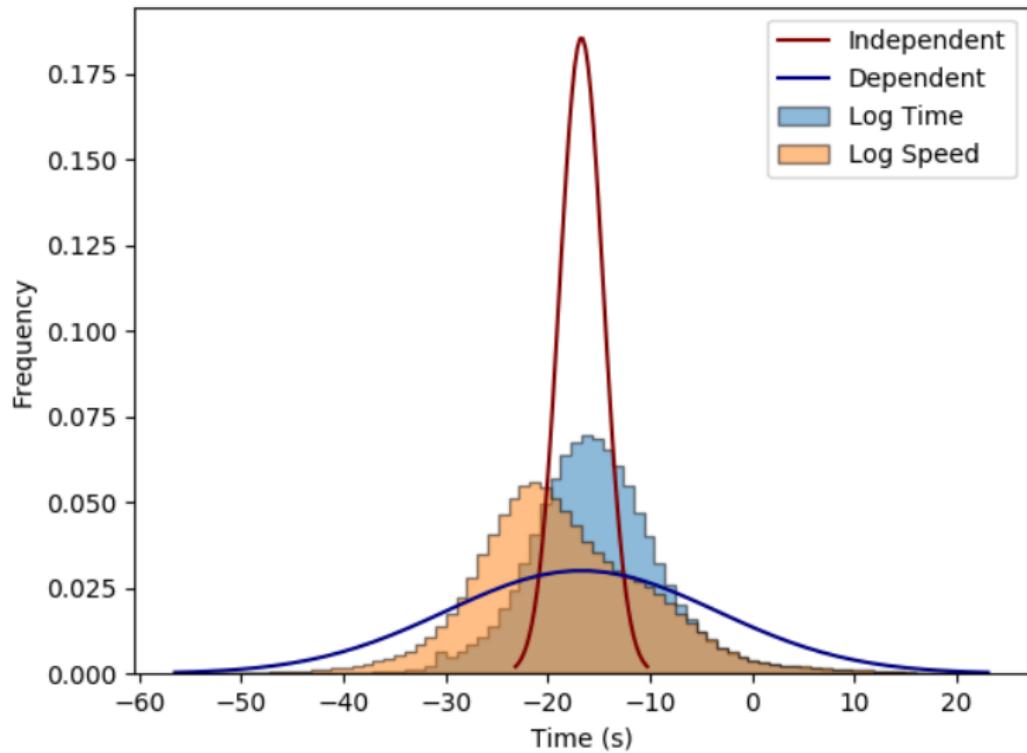
Appendix - Time Difference Distribution



40 Edges



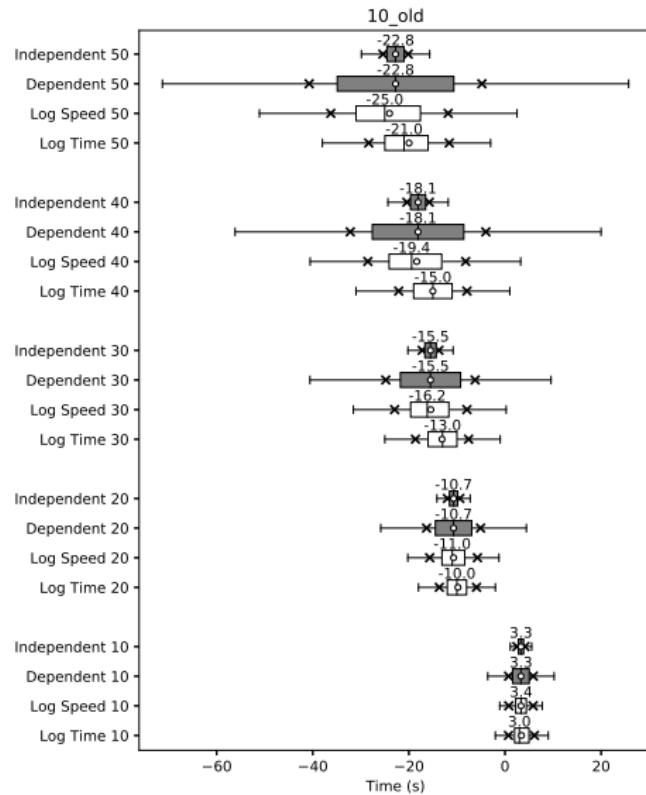
Appendix - Time Difference Distribution



50 Edges



Appendix - Old Data Time Differences



Appendix - Low Data Time Differences

