Appendix-D part-II Reasonably Foreseeable Derivation process

Data collection

- List of parameters of each extracted scenario case

No	Ve0 [km/h]	Ve0−Vo0 [km/h	dx0 [m]	Vy [m/s]	Source	Vo [km/h]	Ln_Vy
1	73.94195058	0.076543453	39.86989117	0.722375597	運転行動DB	73.86540713	−0.325210057
2	69.12369401	6.671261743	24.662357	0.525639364	運転行動DB	62.45243226	−0.643139922
4	76.02277677	10.28962887	61.65827267	1.159814593	運転行動DB	65.73314789	0.148260158
5	71.83478436	8.38325387	51.84807743	0.646180721	運転行動DB	63.45153049	−0.436676061
10	97.11933777	7.214960372	25.84377515	1.07760732	運転行動DB	89.9043774	0.074743139
13	107.2869937	8.734622608	44.74003453	0.883929215	運転行動DB	98.55237105	−0.123378293
14	110.1099683	19.0385493	51.44914049	0.794345413	運転行動DB	91.07141903	−0.230236883
15	111.2521719	19.060008	65.67190248	0.955970266	運転行動DB	92.19216393	−0.045028469
19	135.057244	46.75962862	58.01302004	0.645867884	運転行動DB	88.29761536	−0.43716031
20	120.9274444	38.62615688	62.54615224	0.642712704	運転行動DB	82.30128752	−0.442057461
21	112.9997476	5.847105951	68.23909864	0.777992597	運転行動DB	107.1526416	−0.251038271
22	110.5909616	14.93450174	49.84227	1.097332927	運転行動DB	95.65645985	0.092882624
23	110.0059829	7.138630302	32.44346305	0.719621564	運転行動DB	102.8673526	−0.32902981
25	94.06872371	5.594222416	34.92580038	1.042823204	運転行動DB	88.47450129	0.041931655
26	105.3044746	6.771244302	43.85559937	1.000192104	運転行動DB	98.53323034	0.000192085
27	116.5374488	17.1626345	57.70009957	0.840430168	運転行動DB	99.37481433	−0.173841413
28	101.8691015	3.456335893	13.25711529	1.080926726	運転行動DB	98.41276561	0.077818752
31	111.1008665	16.17386648	69.07009146	0.731766421	運転行動DB	94.92700005	−0.312293914
33	107.9245157	9.558769517	67.5490264	0.76605478	運転行動DB	98.36574622	−0.266501597
38	113.4019073	5.134379787	29.43814938	0.973761695	運転行動DB	108.2675275	−0.026588672
46	114.9551234	23.6386218	62.40172351	0.868859059	運転行動DB	91.31650161	−0.140574354
47	115.2674119	10.411981	53.52039565	0.702620932	運転行動DB	104.8554309	−0.352937747
48	94.54254106	19.67508446	47.33117536	0.939149219	運転行動DB	74.86745659	−0.0627809
51	118.3540901	10.92132309	49.01896342	1.01513744	運転行動DB	107.432767	0.015024012
53	122.3336629	7.400155629	59.53778429	0.721951227	運転行動DB	114.9335072	−0.325797695
54	105.2906745	9.60784822	66.53202225	0.59814032	運転行動DB	95.68282631	−0.513929904
55	92.61274609	5.667487883	53.01894171	1.254481752	運転行動DB	86.94525821	0.22672254
56	83.97834948	6.265520605	56.65619803	1.013335451	運転行動DB	77.71282887	0.013247316
58	88.79398219	16.07598179	37.66952565	0.944492507	運転行動DB	72.7180004	−0.057107525
59	101.387955	4.984469001	8.532740228	1.256266381	運転行動DB	96.403486	0.228144132
60	94.35351858	20.0341912	40.21886307	0.719190815	運転行動DB	74.31932739	−0.329628567
62	101.135928	10.68074865	51.95954654	0.737454769	運転行動DB	90.45517934	−0.304550522
63	107.1281566	19.33925676	57.67525856	1.482762037	運転行動DB	87.78889979	0.39390659
64	116.811267	11.79296333	68.67381812	1.025096627	運転行動DB	105.0183037	0.024786878
65	125.0423504	11.81033468	65.2823193	0.925673011	運転行動DB	113.2320157	−0.077234226
66	121.0442489	16.34194915	55.83999259	0.863163337	運転行動DB	104.7022998	−0.147151339
69	104.2592484	15.89334041	57.57016227	0.770256203	運転行動DB	88.36590803	−0.261032089
70	69.03137596	3.316806604	17.21218568	0.91844422	運転行動DB	65.71456936	−0.085074106
77	65.77800201	2.693199969	20.11219503	0.798562213	運転行動DB	63.08480204	−0.224942402
85	83.49332513	9.267547361	59.73796584	1.132164304	運転行動DB	74.22577777	0.124131114
99	118.5634244	16.90986822	56.83561594	0.766115305	運転行動DB	101.6535562	−0.266422592
100	93.37439709	9.672423574	27.29214906	0.761114571	運転行動DB	83.70197351	−0.272971379
101	104.8097393	19.22995447	44.77439647	1.456330554	運転行動DB	85.57978483	0.375919953
102	106.9647351	13.38278003	68.35698466	0.712320318	運転行動DB	93.58195506	−0.339227583
103	109.2732545	23.01443241	65.29312827	1.015311804	運転行動DB	86.25882208	0.015195762
106	89.16872307	4.122781889	54.05397603	0.991174397	運転行動DB	85.04594118	−0.008864779
107	103.8872716	24.33591365	45.1563654	0.96661907	運転行動DB	79.55135796	−0.033950791
111	90.18905211	0.947278433	31.48475926	1.332206245	運転行動DB	89.24177368	0.286836399
114	94.46119312	7.640049551	22.19237728	0.638979623	運転行動DB	86.82114356	−0.447882713
115	72.99401612	4.047902534	16.98447772	0.659387101	運転行動DB	68.94611359	−0.41644451
124	69.87936362	8.112895935	21.72936489	0.933099093	運転行動DB	61.76646769	−0.069243875
125	84.01088313	30.64588146	64.27868195	0.832914638	運転行動DB	53.36500167	−0.182824117
130	63.30433833	6.819966725	30.16491233	0.814202035	運転行動DB	56.4843716	−0.205546743
131	84.06641964	8.38782385	52.77143375	1.645333541	運転行動DB	75.67859579	0.497943124

Select arbitrary group of data

- **Ex. extract only high(low) speed range**

No	Ve0 [km/h]	Ve0−Vo0 [km/h	dx0 [m]	Vy [m/s]	Source	Vo [km/h]	Ln_Vy
1	73.94195058	0.076543453	39.86989117	0.722375597	運転行動DB	73.86540713	−0.325210057
2	69.12369401	6.671261743	24.662357	0.525639364	運転行動DB	62.45243226	−0.643139922
4	76.02277677	10.28962887	61.65827267	1.159814593	運転行動DB	65.73314789	0.148260158
5	71.83478436	8.38325387	51.84807743	0.646180721	運転行動DB	63.45153049	−0.436676061
10	97.11933777	7.214960372	25.84377515	1.07760732	運転行動DB	89.9043774	0.074743139
13	107.2869937	8.734622608	44.74003453	0.883929215	運転行動DB	98.55237105	−0.123378293
14	110.1099683	19.0385493	51.44914049	0.794345413	運転行動DB	91.07141903	−0.230236883
15	111.2521719	19.060008	65.67190248	0.955970266	運転行動DB	92.19216393	−0.045028469
19	135.057244	46.75962862	58.01302004	0.645867884	運転行動DB	88.29761536	−0.43716031
20	120.9274444	38.62615688	62.54615224	0.642712704	運転行動DB	82.30128752	−0.442057461
21	112.9997476	5.847105951	68.23909864	0.777992597	運転行動DB	107.1526416	−0.251038271
22	110.5909616	14.93450174	49.84227	1.097332927	運転行動DB	95.65645985	0.092882624
23	110.0059829	7.138630302	32.44346305	0.719621564	運転行動DB	102.8673526	−0.32902981
25	94.06872371	5.594222416	34.92580038	1.042823204	運転行動DB	88.47450129	0.041931655
26	105.3044746	6.771244302	43.85559937	1.000192104	運転行動DB	98.53323034	0.000192085
27	116.5374488	17.1626345	57.70009957	0.840430168	運転行動DB	99.37481433	−0.173841413
28	101.8691015	3.456335893	13.25711529	1.080926726	運転行動DB	98.41276561	0.077818752
31	111.1008665	16.17386648	69.07009146	0.731766421	運転行動DB	94.92700005	−0.312293914
33	107.9245157	9.558769517	67.5490264	0.76605478	運転行動DB	98.36574622	−0.266501597
38	113.4019073	5.134379787	29.43814938	0.973761695	運転行動DB	108.2675275	−0.026588672
46	114.9551234	23.6386218	62.40172351	0.868859059	運転行動DB	91.31650161	−0.140574354
47	115.2674119	10.411981	53.52039565	0.702620932	運転行動DB	104.8554309	−0.352937747
48	94.54254106	19.67508446	47.33117536	0.939149219	運転行動DB	74.86745659	−0.0627809
51	118.3540901	10.92132309	49.01896342	1.01513744	運転行動DB	107.432767	0.015024012
53	122.3336629	7.400155629	59.53778429	0.721951227	運転行動DB	114.9335072	−0.325797695
54	105.2906745	9.60784822	66.53202225	0.59814032	運転行動DB	95.68282631	−0.513929904
55	92.61274609	5.667487883	53.01894171	1.254481752	運転行動DB	86.94525821	0.22672254
56	83.97834948	6.265520605	56.65619803	1.013335451	運転行動DB	77.71282887	0.013247316
58	88.79398219	16.07598179	37.66952565	0.944492507	運転行動DB	72.7180004	−0.057107525
59	101.387955	4.984469001	8.532740228	1.256266381	運転行動DB	96.403486	0.228144132
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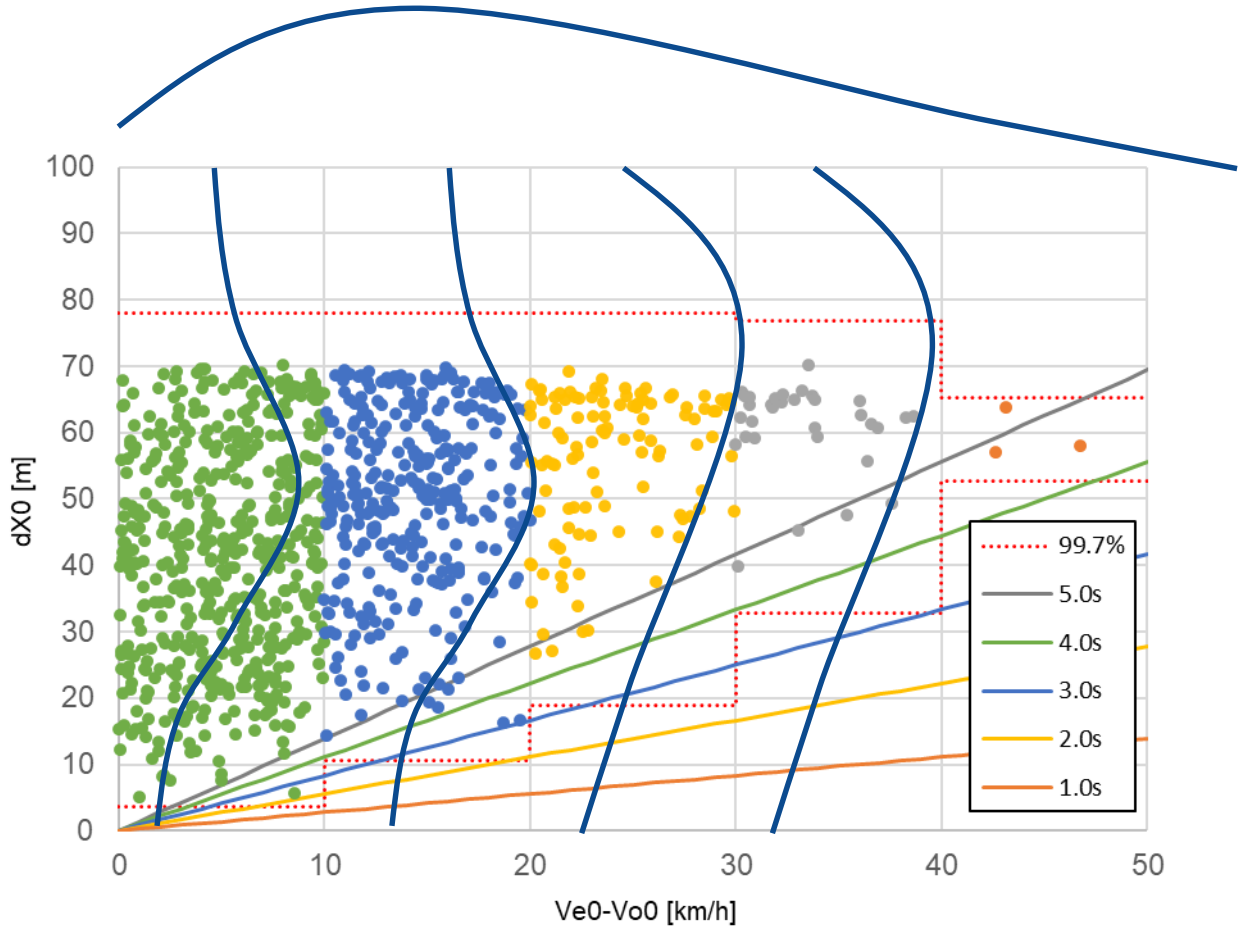
62	101.135928	10.68074865	51.95954654	0.737454769	運転行動DB	90.45517934	−0.304550522
63	107.1281566	19.33925676	57.67525856	1.482762037	運転行動DB	87.78889979	0.39390659
64	116.811267	11.79296333	68.67381812	1.025096627	運転行動DB	105.0183037	0.024786878

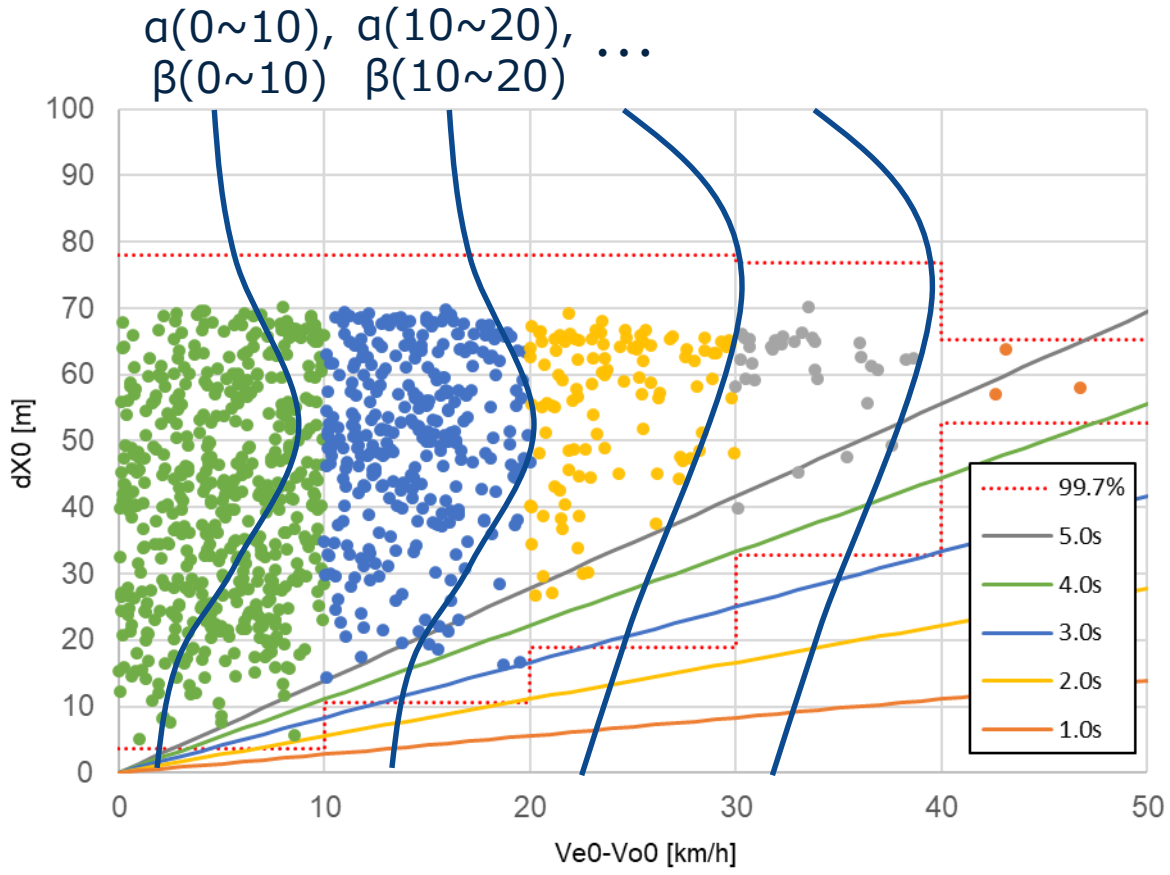
Estimate distribution

- Estimate β distribution by classes



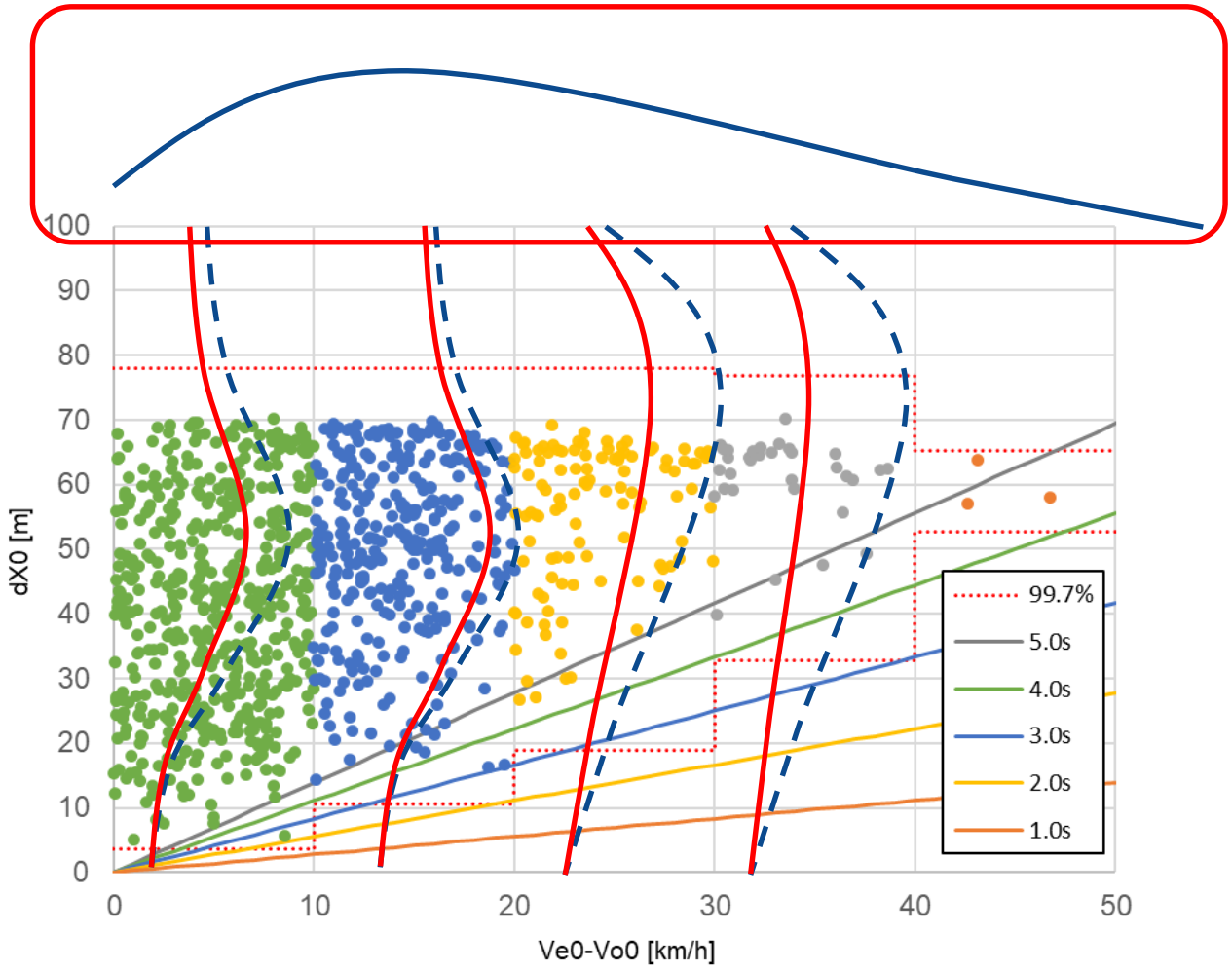
Regression of β distribution parameters

- **Estimate continuous α(Vrel), β(Vrel) by descrete α_n, β_n**



Weight function of each class

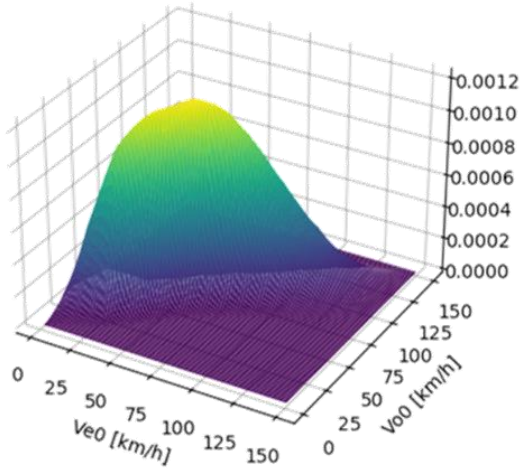
- estimate weight function from distribution of Vrel

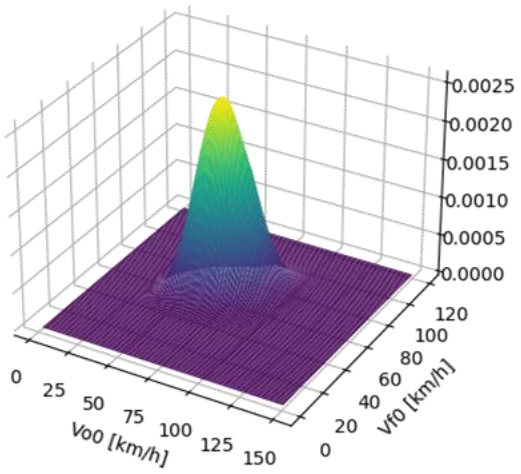


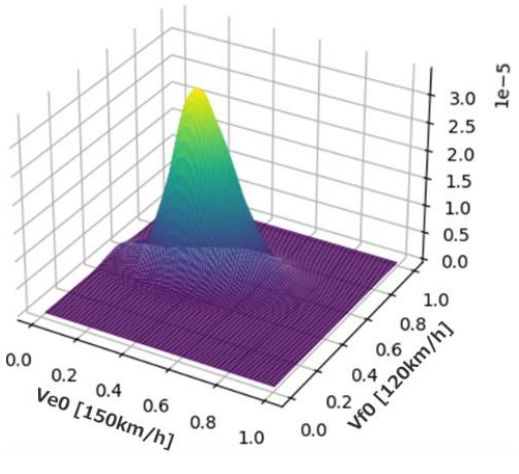
Calculate multi-dimentional distribution

- Input: α(Vrel), β(Vrel), weight function
- Discretization: Frequency to probability
- Non-correlated parameter's distribution is calculated indemendently

absolute value changes

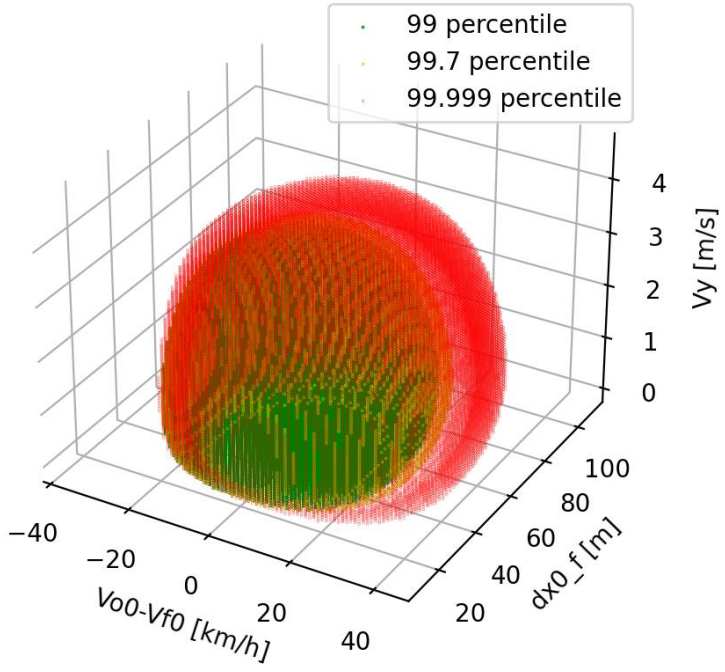






Conversion to Annual Encounter Probability

- $P = 1 - (1 - p)^n$
- $E = \sum_{k=1}^{n} k\, p^k (1-p)^{n-k} = \boldsymbol{np}$
  - *P is the probability of encountering a scenario with a certain parameter*
  - *p is the probability of encountering a scenario with that parameter one or more times*
  - *n is the number of encounters*
  - *E is the expected number of encounters in a year*



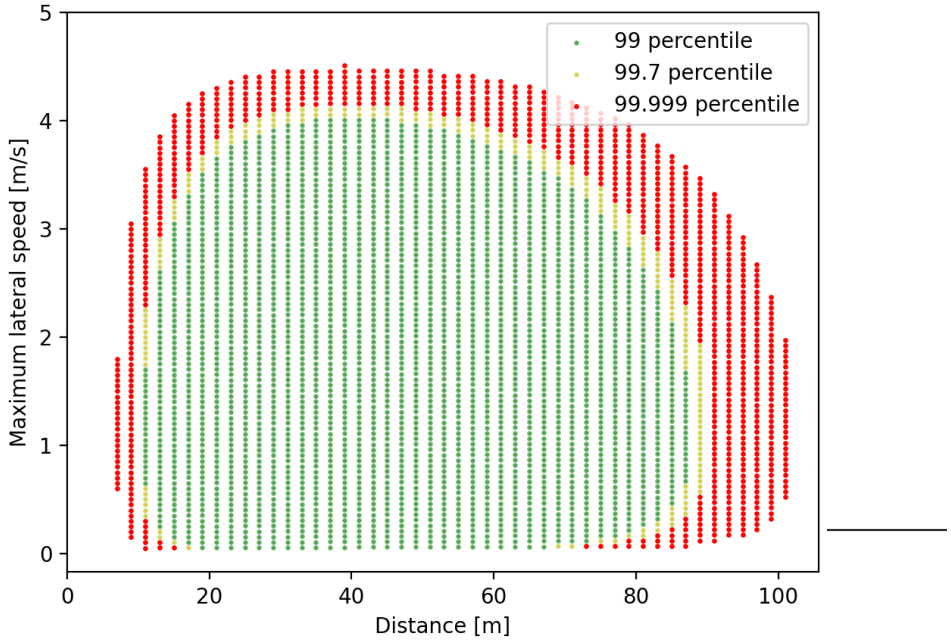
- If *E* is small enough,
  it may be excluded from Reasonably Foreseeable

Calculate accumulate probability

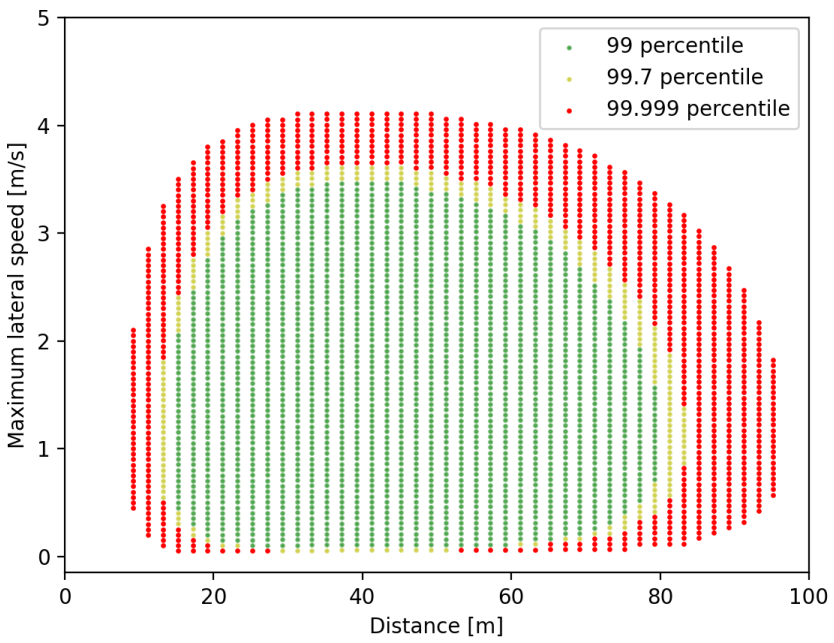
- Calculate occurrence probability of each parameter combination
  - multiply each distribution
- Convert probability to annual encounter
  - assume most frequent driver's travelling distance
- Accumulate numerically from highest occurrence
- Reasonably Foreseeable range is defined with risk acceptance threshold

Examples

Reasonably foreseeable non-critical events



Reasonably foreseeable critical events



Critical events but unforeseeable