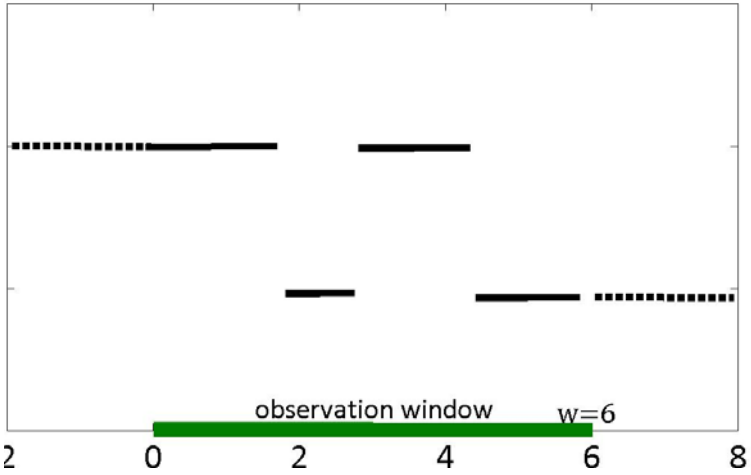
Extreme value methods, tail estimation for window-censored 0-1 processes, and car accidents



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Traffic accidents

- 1.3 miljon deaths/year worldwide, 20-50 million severely injured
- Large economic losses
- Less than 1 death/day in Sweden now. Down from 3 deaths/day a few decades ago – at a time with much less traffic
- First simple measures: seatbelts,helmets, follow traffic rules, drunk driving laws, …, then more sophisticated ones: rebuild roads, better tires, improve driver education, airbags, …, then next level of sophistication: more driver training and retraining, ABS, ESP, … ??

Naturalistic driving studies: cars with drivers like you and me are instrumented with video cameras, radar, GPS, sensors for steering wheel movement, gas- and brake pedal movement, …

Crash Acc.mpg

Generates extremely large data sets – and give completely new opportunities for preventing traffic accidents

Accidents are extreme events – same methods as those for financial risks and for natural catastrophes can be used

New area for statistics

Selection bias/errors
Risk estimation

Active safety systems for next generation cars. Important for competition with other car makers and for safety (?)

Driver training, traffic laws, …

Statistical methods used so far:

Odds ratios and logistic regression: Completly dominant – but can't easily extrapolate from less severe events to more severe ones, can't easily judge extent of selection bias.

Regression: Is relative risk the same for crashes and for near-crashes?

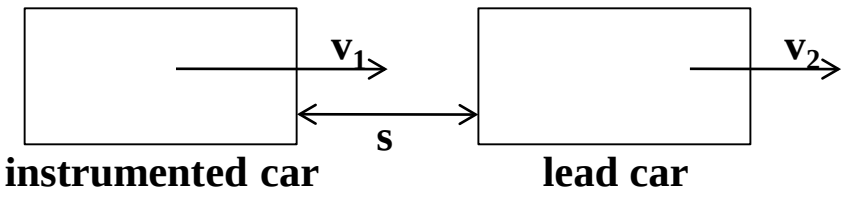
Extreme Value Statistics (almost new): Can near-crashes predict the frequency of real crashes? Do covariates behave in same way for crashes and near-crashes? Requires a continuous crash proximity or crash severity measure.

Underlying philosophy: a traffic accident is a rare and extreme event.

Use near-crashes – require crash proximity measure (EVS uses cont. distributions)

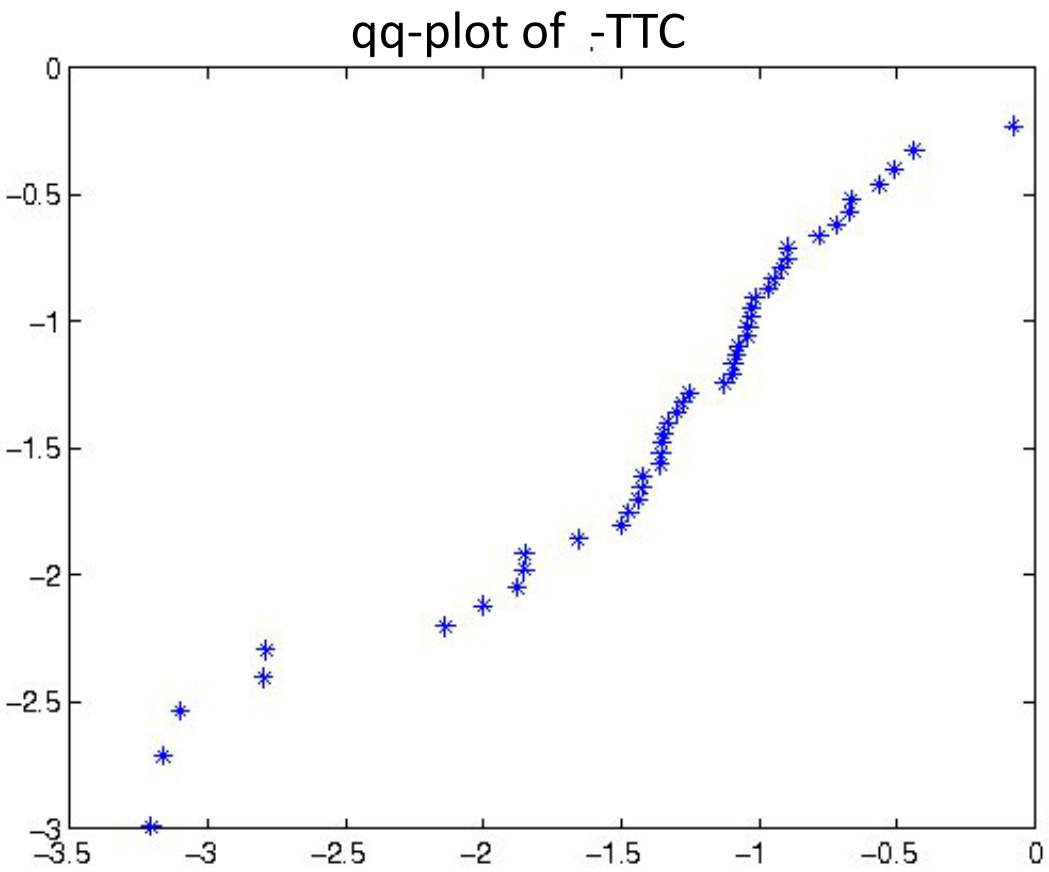
- Measure of how close the near-crash is to a real crash
- Examples: TTEC = Time To edge Crossing, Gap = time between first car leaves conflict area and second car enters conflict area, Time-to-collision (TTC), …
- Here, TTC, the time it takes for the cars to collide when continuing with the same speeds – useful for **rear-ending**

$$TTC = \frac{s}{v_1 - v_2}$$



100-car data, risk of rear-ending, TTC

384 near-crashes, 29 with good enough radar signals, 14 crashes.



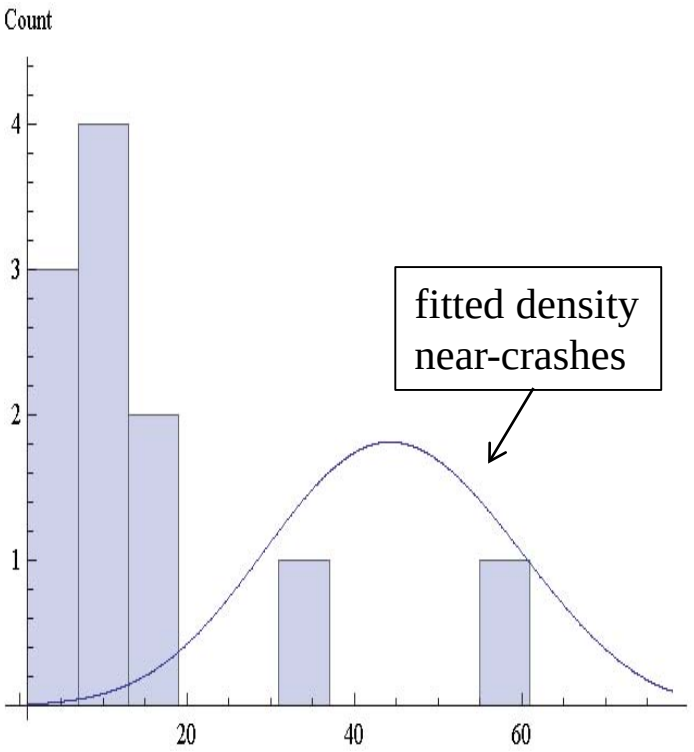
Crash ⇔ TTC < 0

Block maxima 95% confidence interval for expected number of crashes is (0.07, 0,09) (Fitted GEV conditional on –TTC > 0, delta method conf. intervals)

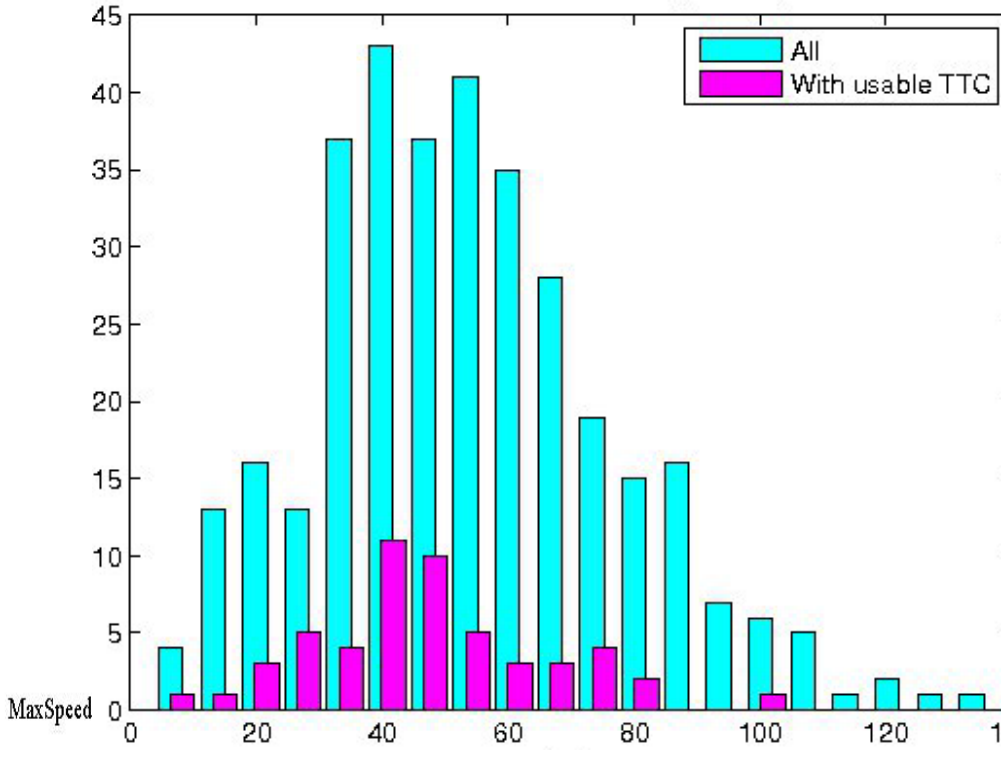
Observed number of crashes = 14

Doesn't match!

Selection bias!



crashes, max speed (km/h)



near-crashes, max speed (km/h)

All but two of the real rear-ending crashes were in start-stop traffic while all the near-crashes with usable TTC were in higher speed situations

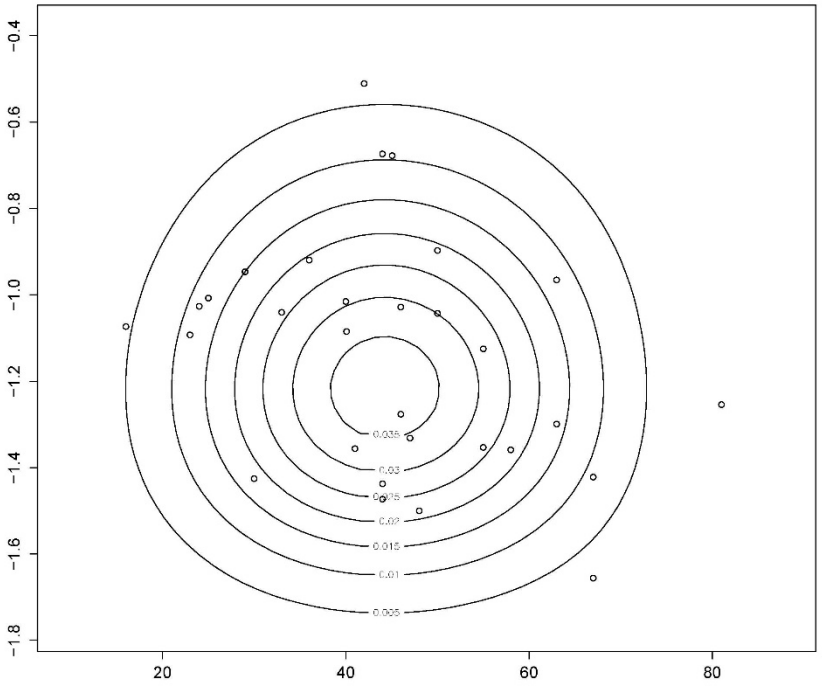
So maybe still: → *yes to question 1 (?)*

- Fitted logistic bivariate extreme value distribution to min/max of each of these variables and TTC for near-crashes, $\alpha \in (0, 1]$ dependence parameter, 1 is independence and 0 is complete dependence

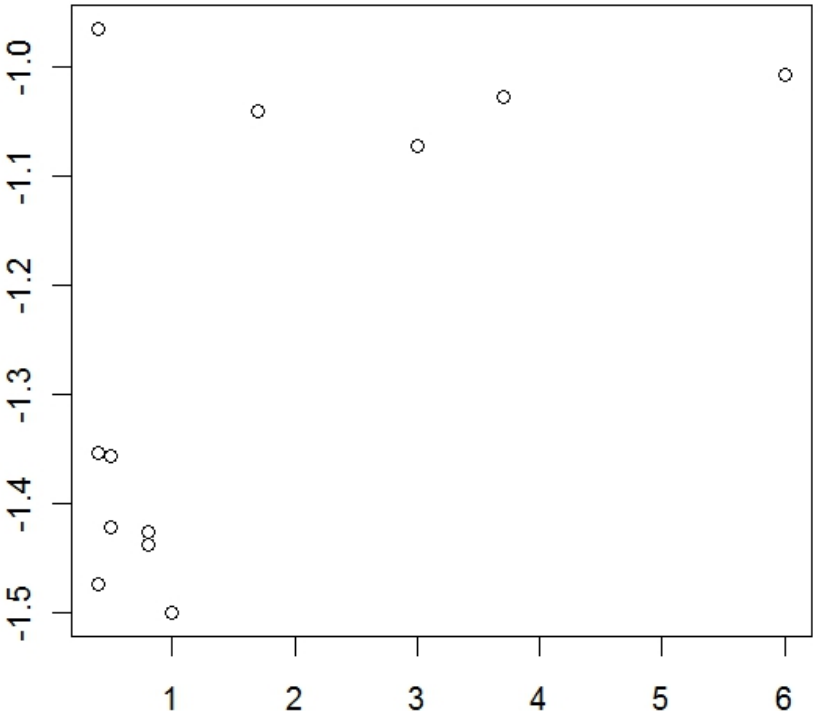
max(eye off road in 3 s window)	α=1.00
max (speed)	α=1.00
max (variance longitudinal acc)	α=1.00
min (dist left markings)	α=1.00
max (dist right markings)	α=0.93

Fitting was not possible for the other variables, however no indication of dependence, except for the last one (length overlapping glance off road)

max -TTC



max speed $\rightarrow \alpha = 1$



length overlapping glance

(12 with overlapping glance, 13 without overlapping glance, 4 vithout video)

Visual behavior/censoring

How much do you look off road while driving?

- ❑ 5% of the time
- ❑ 10% of the time
- ☒ 15% of the time
- ❑ 20% of the time

There is a 1 in 1000 chance that the lengths of an off road glances is longer than

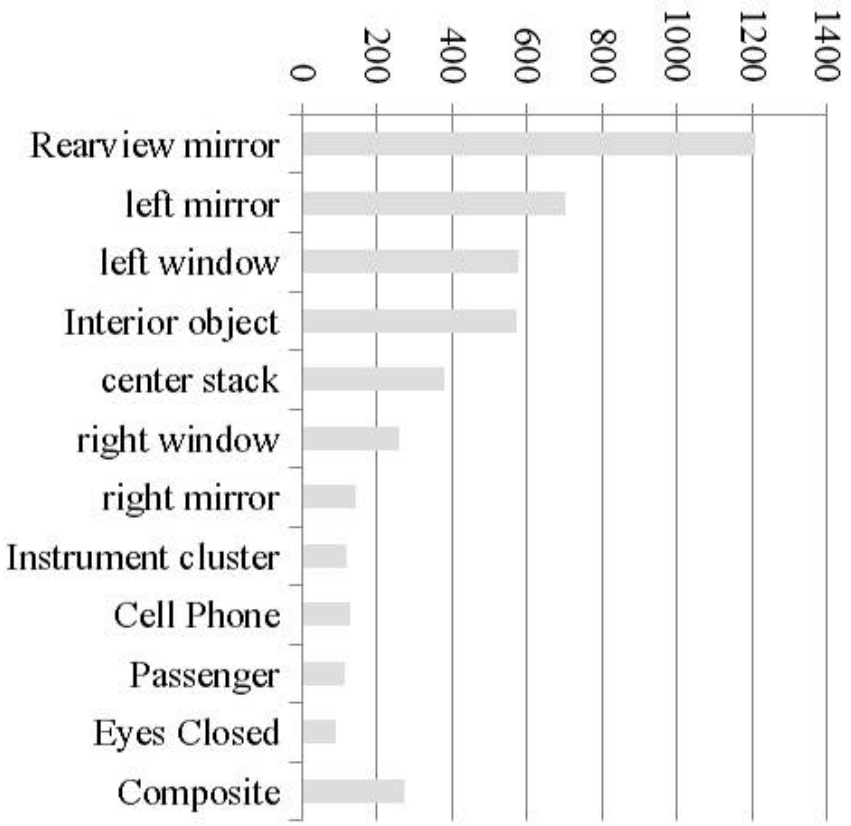
- ❑ 1 second
- ❑ 2 seconds
- ❑ 3 seconds
- ❑ 4 seconds
- ☒ 5 seconds
- ❑ 10 seconds

Is glance behavior different in different circumstances?

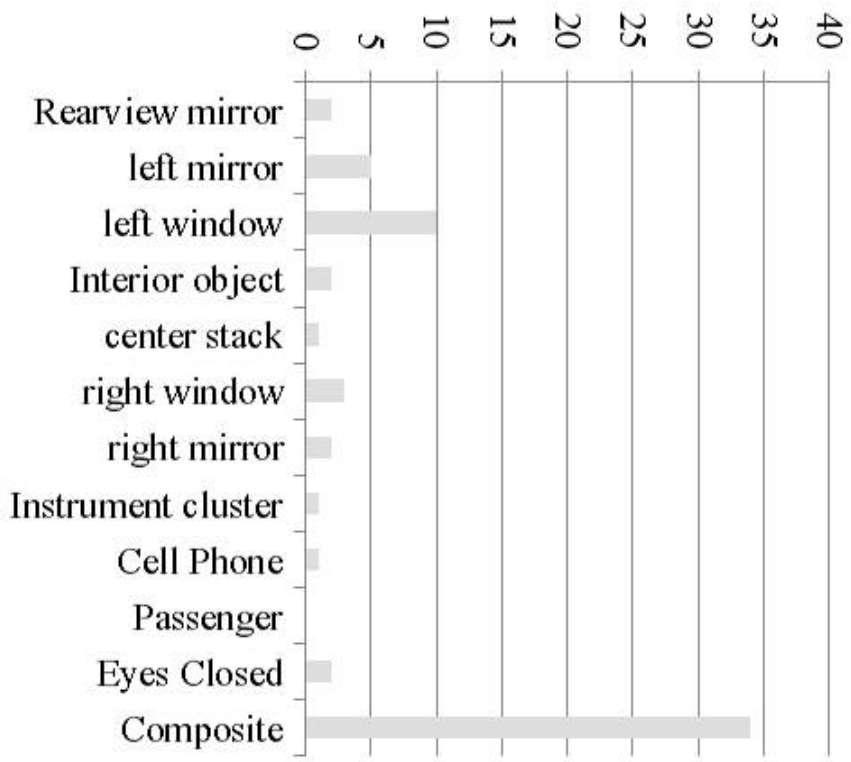
Not well understood

Glance behavior in the 100-car study

Raw data: 19,616 annotated 6-second intervals from 100-car study: 4582 with 1 or more off road glances



Glances shorter than 3 seconds



Glances longer than 3 seconds

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