# COVID-19 SEIR-MODEL TNO : UPDATE APRIL 13 2020

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# CONTENT

## COVID-19 EFFICIENT SEIR-MODEL TNO: UPDATE APRIL 13 2020



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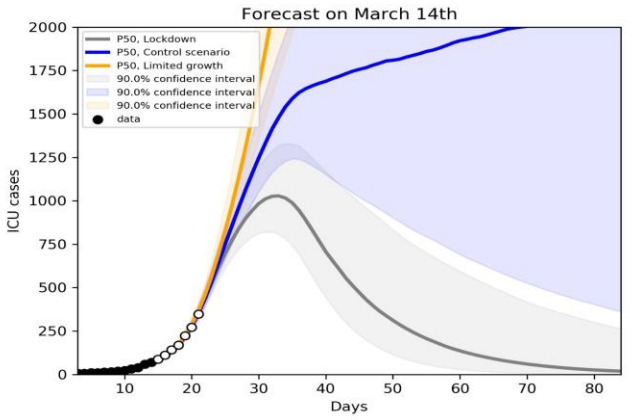
# MODEL
## TNO COVID-SEIR MODEL

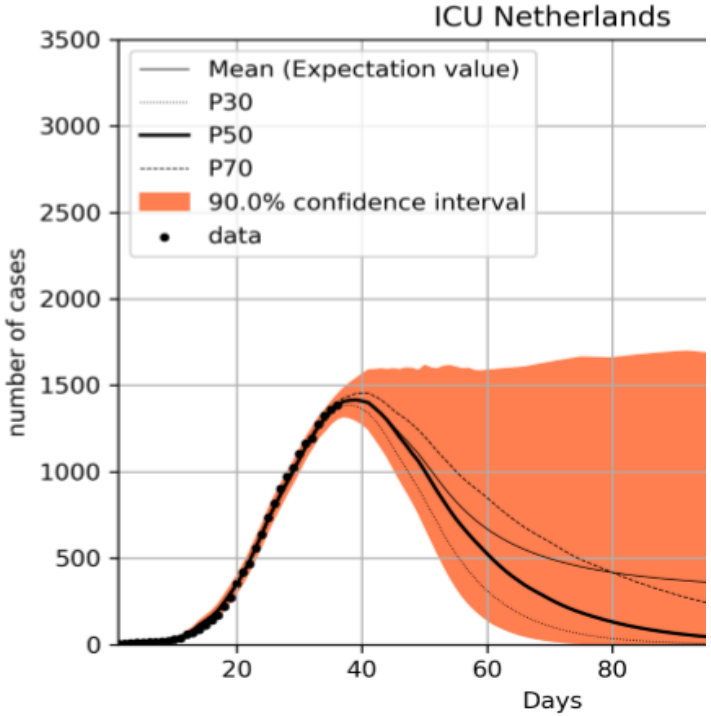
- Developed jointly with MD of Amsterdam UMC, publication submitted to WHO bulletin
  - Publication https://www.who.int/bulletin/online_first/covid-19/en/ http://dx.doi.org/10.2471/BLT.20.256743
  - Open access github https://github.com/TNO/Covid-SEIR
- status
  - Ensemble based & data calibration (log likelyhood and Ensemble Smoother): calibration for $R0^A$ and social distancing through time (reduction of $R0^A$ by (1-α))
  - aggregated $R0^A$ ~ 3.4 ( Netherlands)
  - Calibration on hospital patients (but can also be on mortalities or ICU )
  - Fastly running, <1 minute on laptop, postprocessing with confidence plots

# PREDICTION MARCH 14, APRIL 5 AND APRIL 9

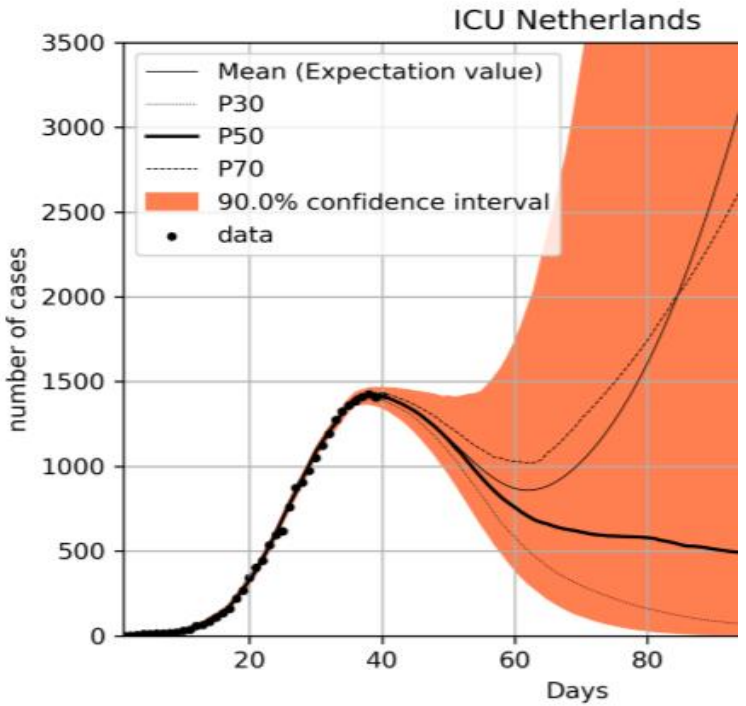
SOURCE: HTTPS://GITHUB.COM/TNO/COVID-SEIR




March 14-21




April 5




April 9

https://github.com/TNO/Covid-SEIR

https://www.who.int/bulletin/online_first/covid-19/en/ http://dx.doi.org/10.2471/BLT.20.256743

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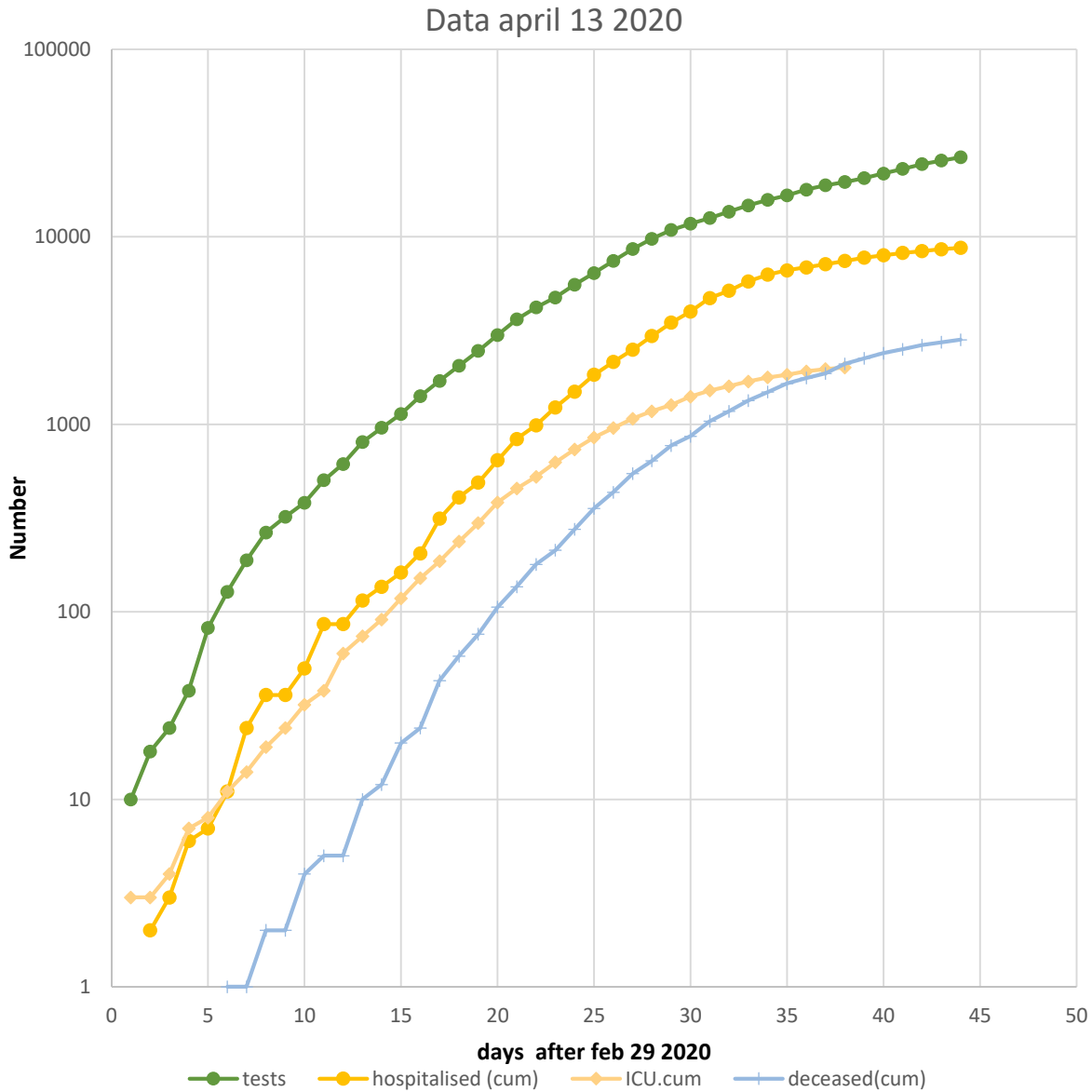
# ACTUAL DATA TESTS, PATIENTS, MORTALITIES, ICU

- Postive tests keep increasing
- Reduced intake hospital
- ICU progressively lags behind patients
  - Initially high, more than 50% to ICU
  - Since march 28 less than 20%
- mortalities
  - Follows hospitalized
  - CFR hospitalized>20%

Sources: RIVM, stichting NICE, NOS

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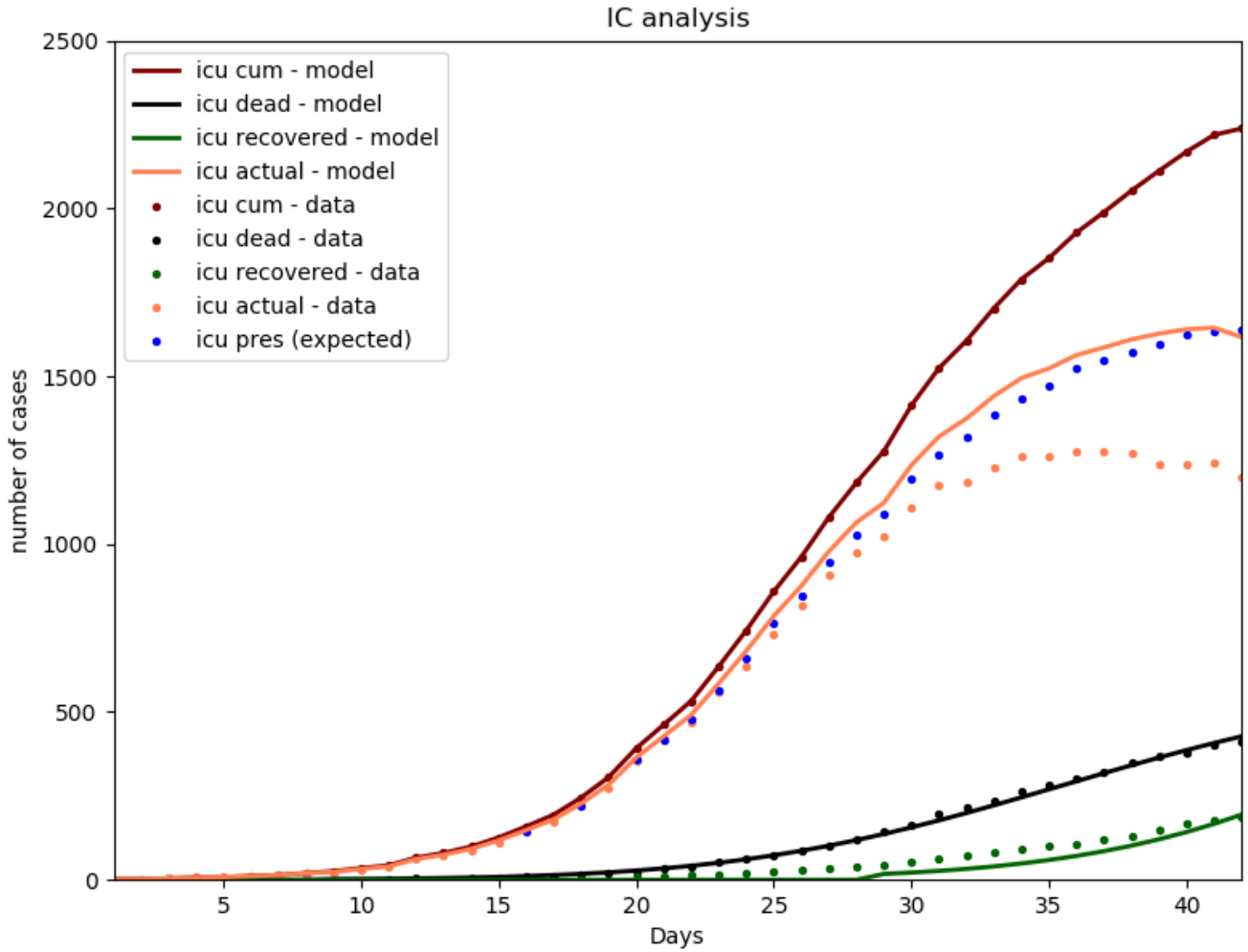
# ANALYSIS OF TRANSIT TIMES IN ICU OF COVID-19 PATIENTS FROM DATA NICE (APRIL 12)

- Best fit (delay and Gaussian smoothing)
  - Mortality 8 days, stddev 5 days
  - CFR (25%)
  - Recovery 28 days, stddev 8 days
  - Icu-actual ≠ icu cum – icu dead – icu recovered
  - Icu-pres (expected) = icu cum – icu dead – icu recovered

April 7: D. Gommers: ICU CFR ca 30%

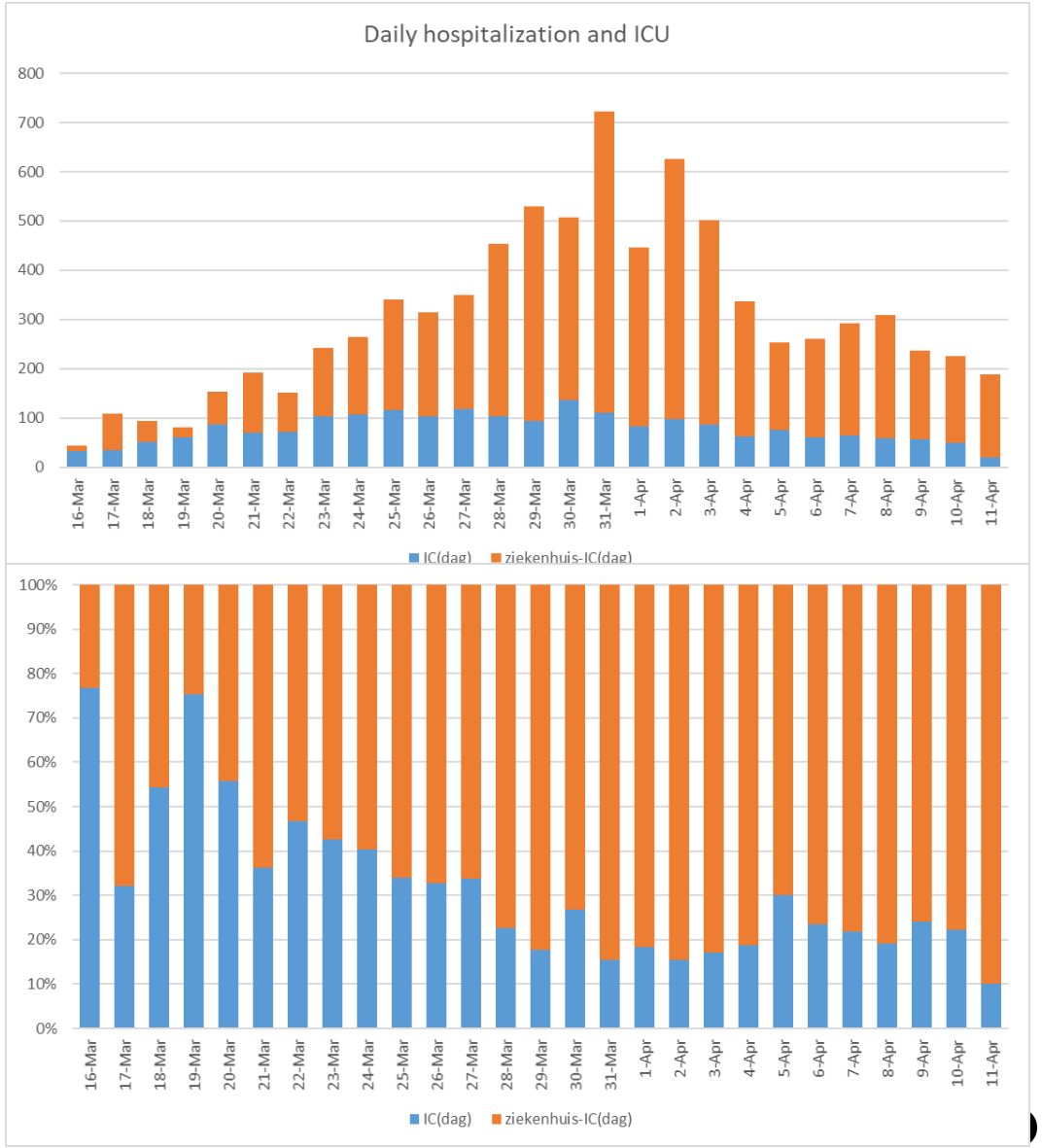


# RELATIONSHIP HOSPITALIZATION AND ICU RATES – DATA UNTIL APRIL 11

- Hospitalization rates (source RIVM)
- ICU rates  (source stichting Nice)
- IC fraction lower through time

- In the model we therefore assume that ratio of hospitalized patients flowing to ICU varies through time

- From March 29 we take 20%, as data is not complete on ICU

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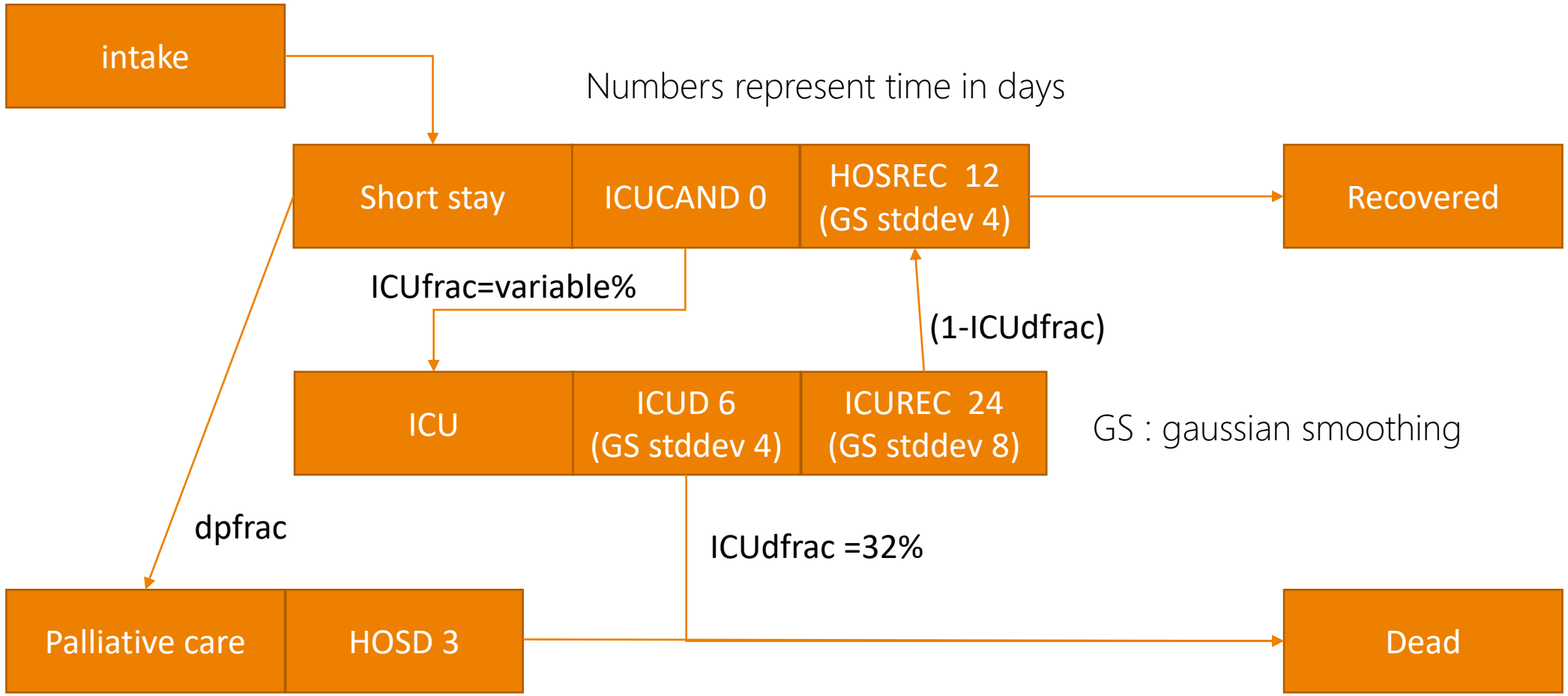
# ASSUMPTIONS FOR FLOW OF HOSPITALIZED PATIENTS AND ICU (POSTERIOR)

11 days between infection and hospitalization (may be as low as 7 days, longer assumed including registration delays)




CFR (hospitalized) = dfrac = 32%

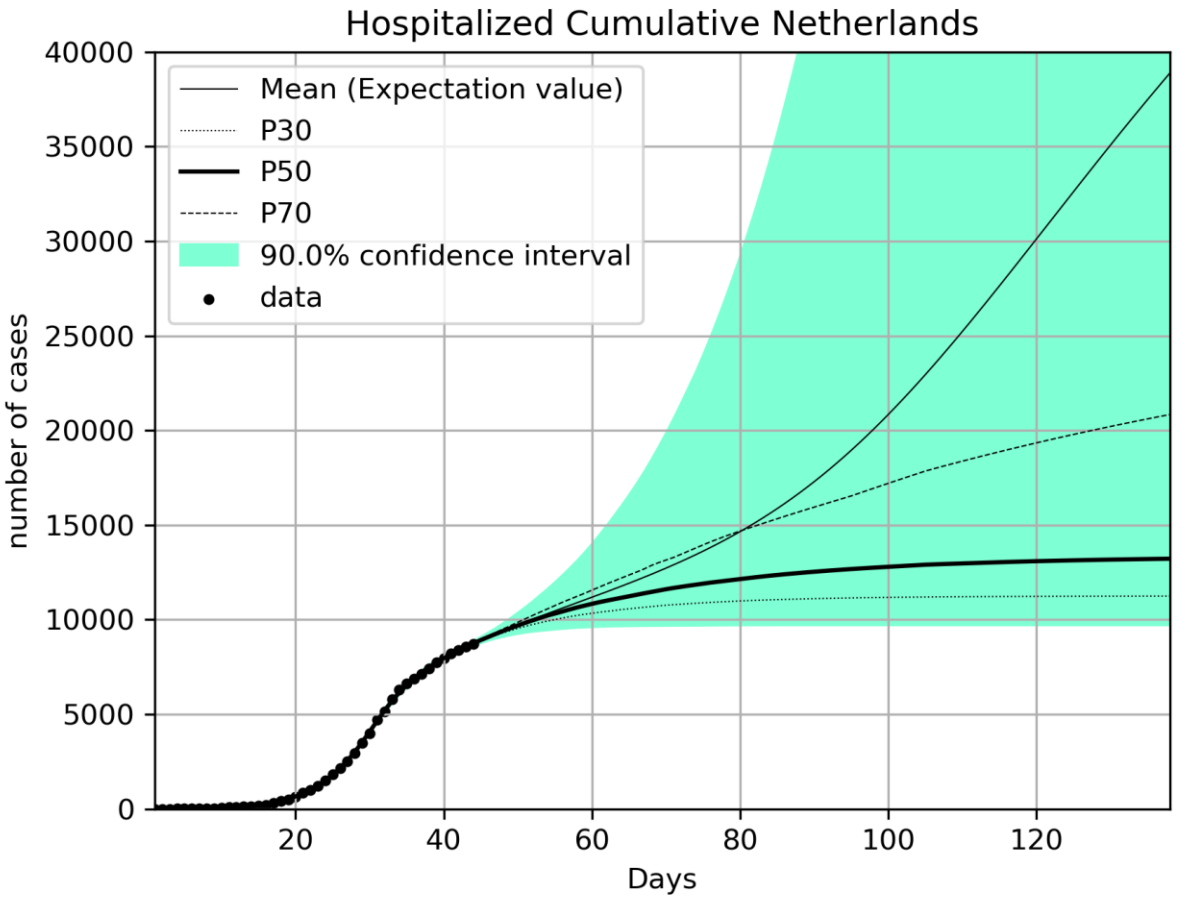
dpfrac = (dfrac - ICUfrac*ICUdfrac) / (1- ICUfrac)

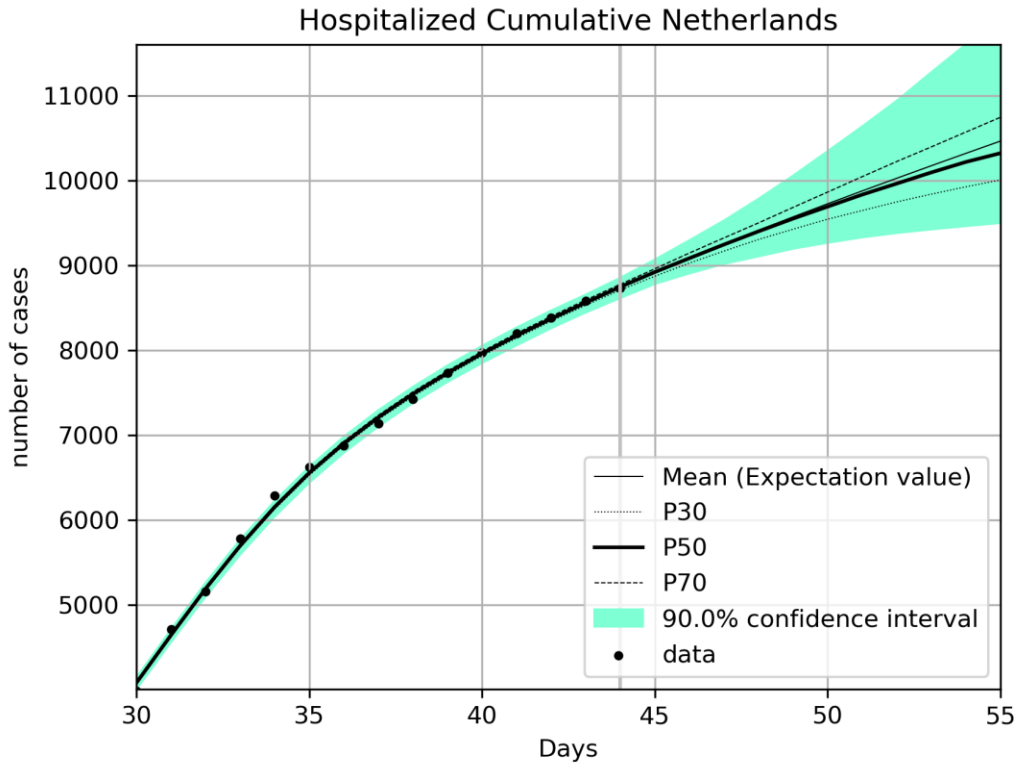
# PRIOR AND POSTERIOR DISTRIBUTIONS (MODEL PERFORMS DATA ASSIMILATION ON HOSCUM, ICU, AND DECEASED JOINTLY)

| Prior | mean | stddev |
|---|---|---|
| HOSD | 3 | 2 |
| HOSD_GS | 0 | 0 |
| ICUD | 8 | 4 |
| ICUD_GS | 5 | 2 |
| ICUREC | 28 | 2 |
| ICUREC_GS | 8 | 4 |
| DFRAC | 0.30 | 0.05 |
| ICUDFRAC | 0.30 | 0.02 |

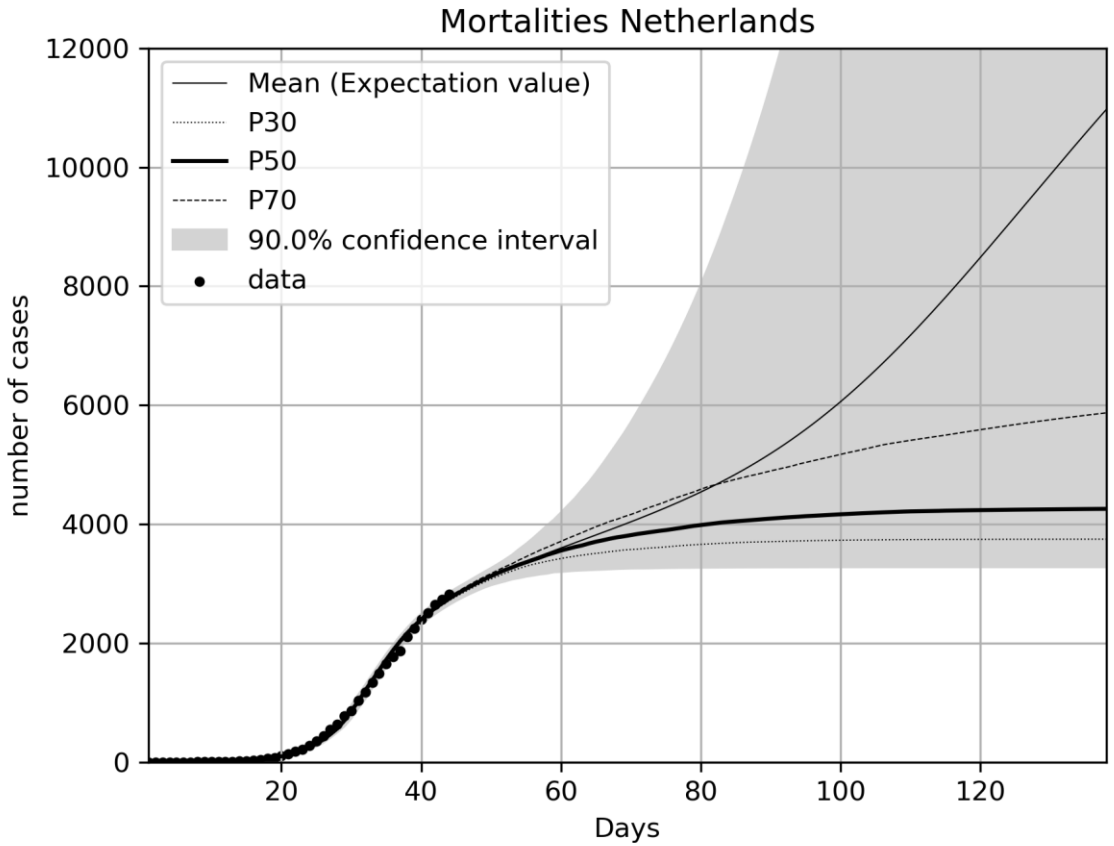
| Posterior | mean | stddev |
|---|---|---|
| HOSD | 3.8 | 0.5 |
| HOSD_GS | 0.0 | 0.0 |
| ICUD | 5.7 | 0.7 |
| ICUD_GS | 3.5 | 1.5 |
| ICUREC | 24.3 | 0.7 |
| ICUREC_GS | 8.0 | 3.6 |
| DFRAC | 0.32 | 0.01 |
| ICUDFRAC | 0.32 | 0.02 |

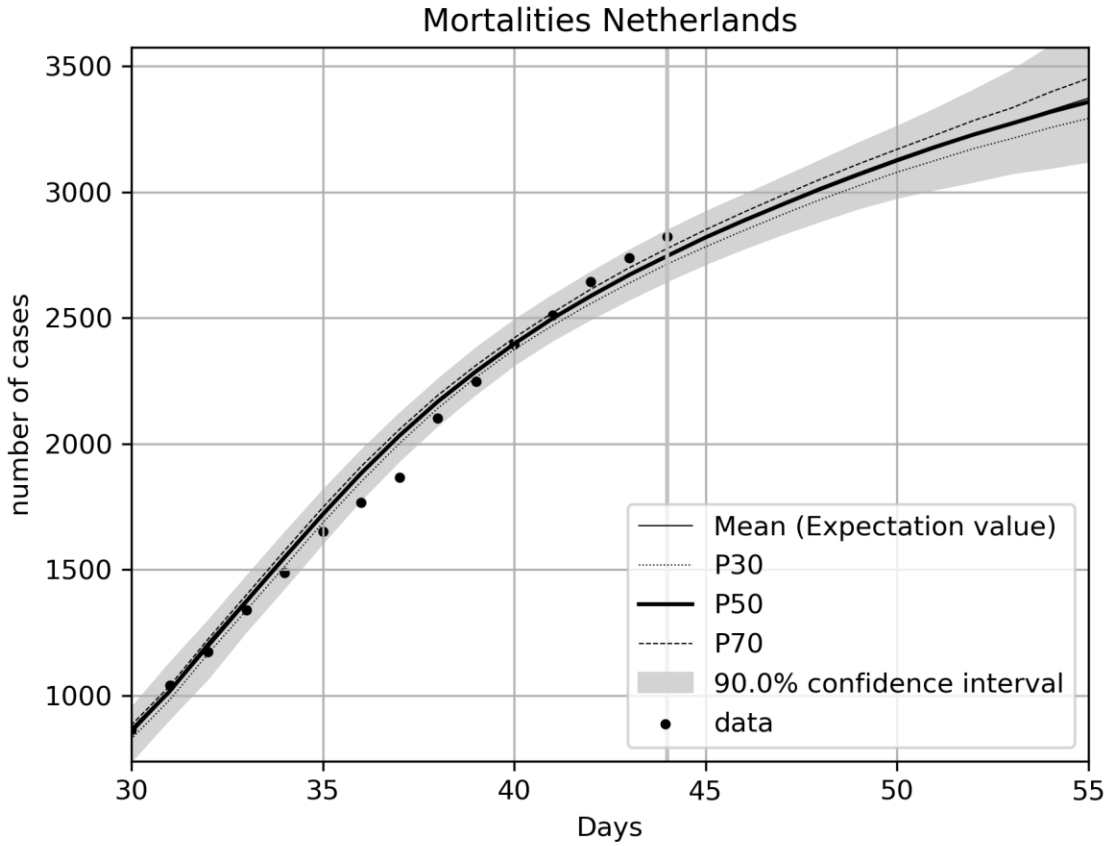
# RESULTS –ENSEMBLE SMOOTHER (ESMDA) ON HOSPITALIZATION



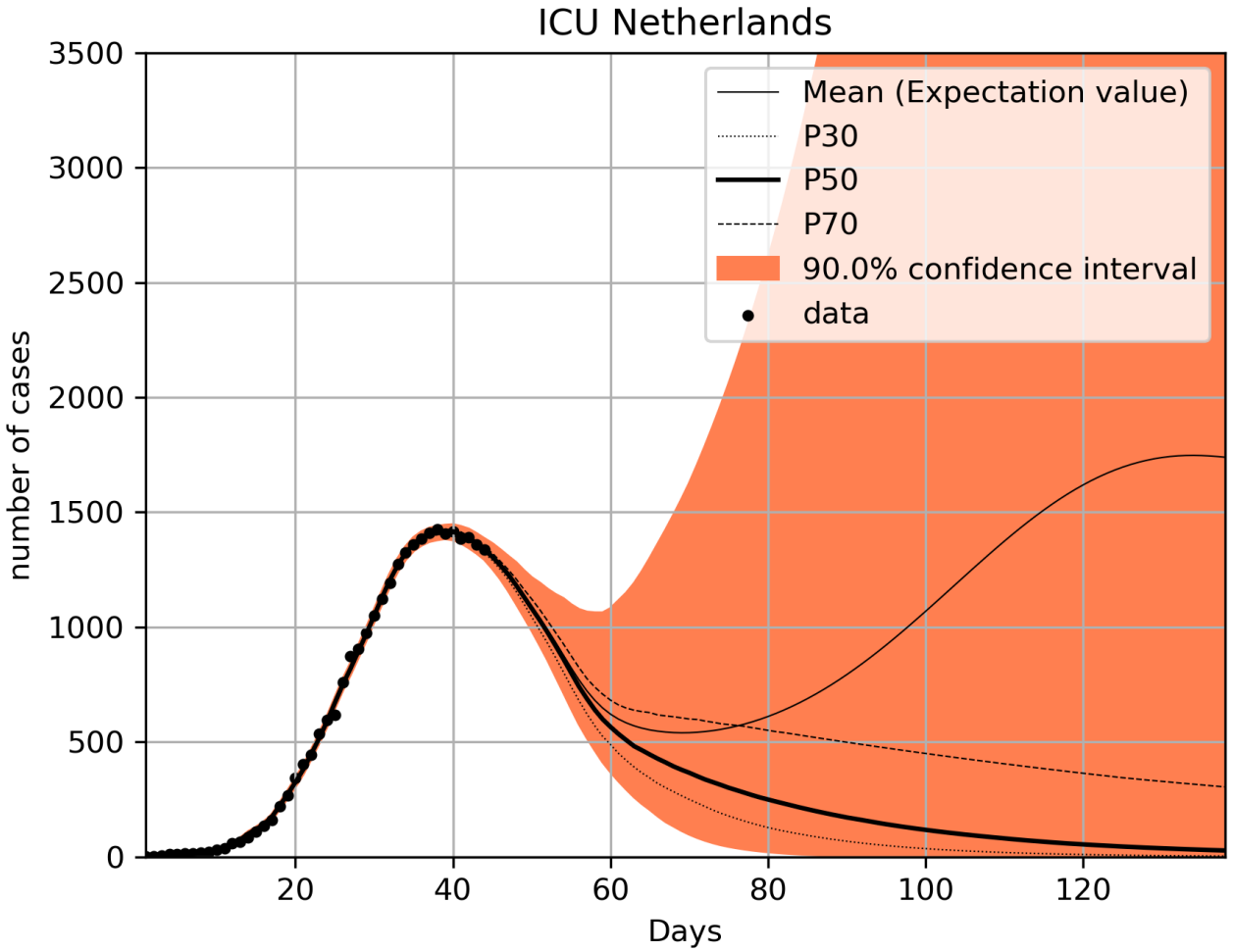



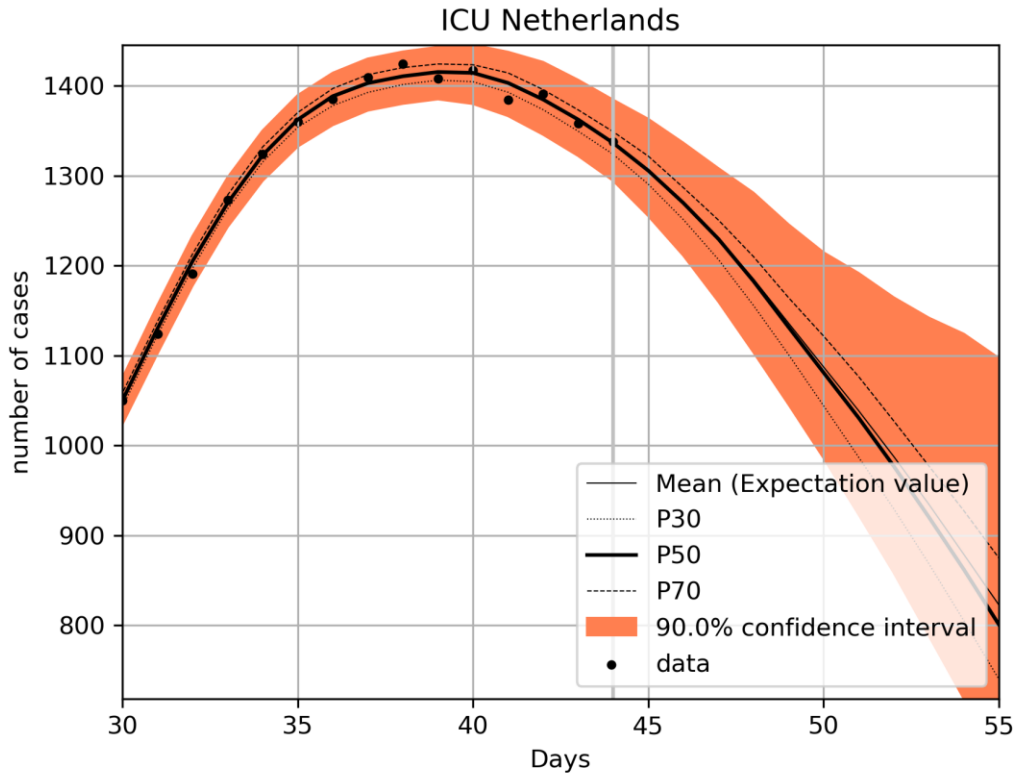
# RESULTS – MORTALITIES



# RESULTS – ICU DATA DAY 33-40 SOURCE NOS, ICU RATES 20% FROM DAY 30



# CONCLUSIONS AND DISCUSSION

- The previous prediction of Sunday April 5 proved correct that peak would be reached in 5-10 days
  - Fit on hospitalized, in agreement with ICU data, and minor deviation in latest reported death rates
  - ICU inflow: very low rates in terms of hospitalized patients (about 20% since end of march
  - ICU  outflow mortalities: assumed ca 30% based on information D. Gommers, and in line with data of Nice (25%)
  - ICU  outflow mortalities: after ca 6 days

- Discussion
  - Mortalities: may be lower in hospital as numbers include deaths outside hospital, this may explain high CFR for patients (29%)
  - Mortalities: creep above expected trend, this can suggest relatively more deaths outside hospital compared to earlier (could be consistent with very low ICU inflow)
  - The ICU down trend next 10-20 days can be strongly influenced by inflow% and actual recovery time needed
  - The ICU down trend is strongly determined by future assumptions on social distancing (long term forecast based on 60-95% range)


THANK YOU
FOR YOUR ATTENTION
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