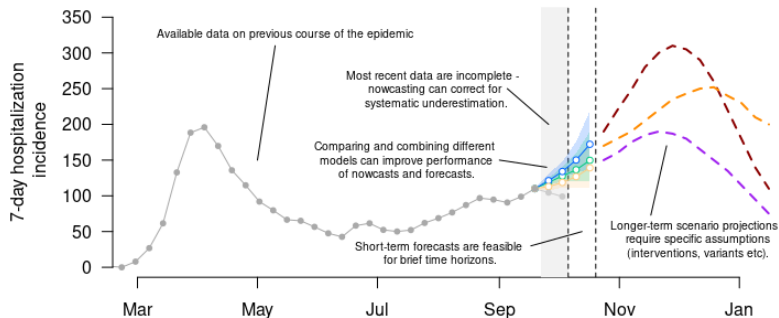


Nowcasting COVID-19 hospitalization incidences in Germany

Johannes Bracher, Daniel Wolffram
(Karlsruhe Institute of Technology and Heidelberg Institute for
Theoretical Studies)

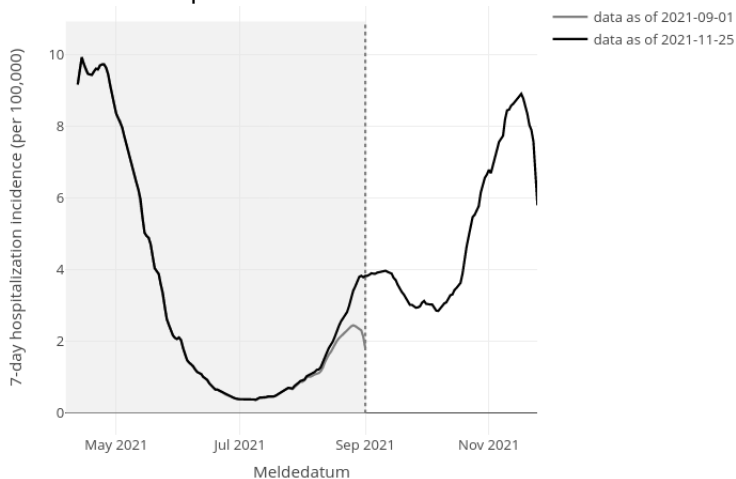
December 8, 2021

Nowcasting, Forecasting and scenario projections



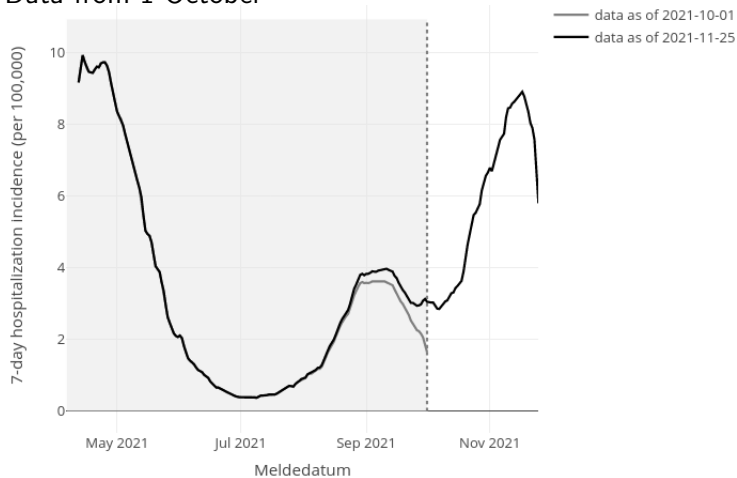
Seven-day hospitalization incidences in Germany

Data from 1 September



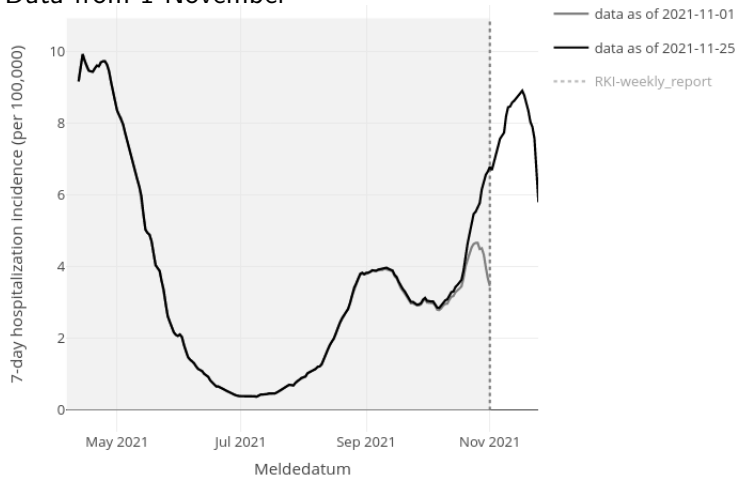
Seven-day hospitalization incidences in Germany

Data from 1 October



Seven-day hospitalization incidences in Germany

Data from 1 November



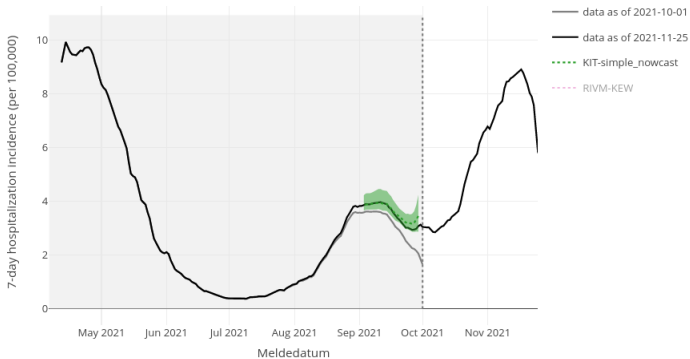
Definition of the 7-day hospitalization incidence

(This definition is specific to Germany)

- ▶ **Legal definition:** The number of persons, who over a seven-day period
 - ▶ have been registered electronically as a COVID-19 case by a local health authority (*Meldedatum*)
 - ▶ and have been hospitalized (not necessarily during the seven-day period)
- ▶ This is *not* the number of new hospitalizations over the last seven days
- ▶ **Most recent values are biased downwards due to two types of delays:**
 - ▶ delay between *Meldedatum* (\approx positive test) and hospitalization
 - ▶ delay between hospitalization and appearance in RKI data

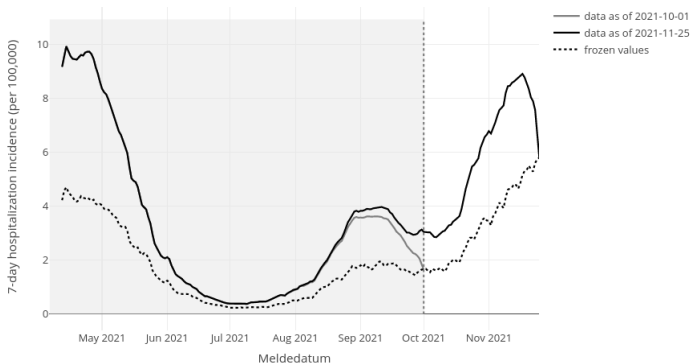
General nowcasting setting

- ▶ Many epidemiological indicators are subject to delays (unless aggregated by time of reporting)
- ▶ **Nowcasting** aims at estimating the total number of events based on preliminary data



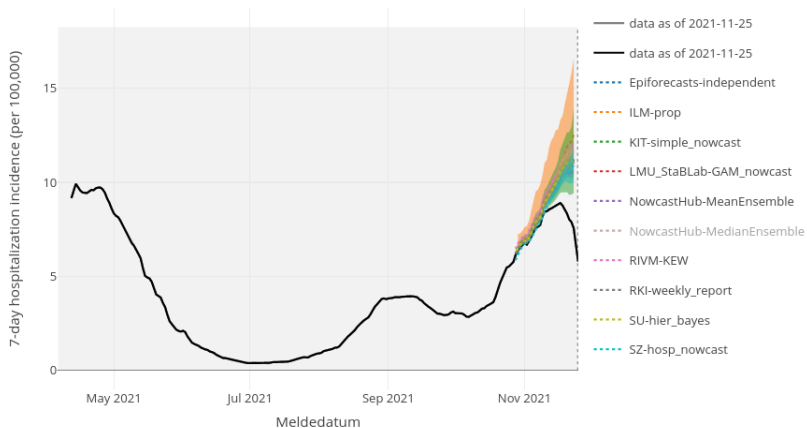
Alternative solution: re-define indicator

- ▶ E.g., all threshold systems in Germany refer to “frozen values”: for each date use value as of that date
- ▶ All values “similarly incomplete” → trends interpretable
- ▶ Upside: no statistical processing
- ▶ Downside: reporting speed varies across federal states



Multi-model approach

- ▶ Showing several models gives a better idea of the uncertainty
- ▶ Combining models can (hopefully) improve nowcasts
- ▶ Allows us to identify particularly reliable models



Interactive online platform

- ▶ Since mid-November available at <https://covid19nowcasthub.de/>
- ▶ Contains nowcasts for current day and 28 days back
- ▶ stratified by federal state and age group

covid19nowcasthub.de

Nowcasts

Hintergrund (DE)

Background (EN)

Kontakt



Nowcasts der Hospitalisierungsinzidenz in Deutschland (COVID-19)

Sprache / language

Deutsch English

Datenstand

< 2021-11-30 >

Nowcasts werden wertlich aktualisiert. Falls ein Nowcast fur das gewahlte Datum nicht vorliegt wird der aktuellste Nowcast der letzten 7 Tage gezeigt.

Stratifizierung

Bundesland Altersgruppe

Bundesland

Alle (Deutschland)

Beachten Sie beim Vergleich der Altersgruppen bzw. der Bundeslander die unterschiedlichen Skalen in der Grafik.

Zeitreihe eingetrennter Werte

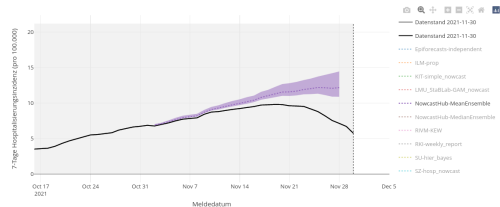
Zeige letzte zwei Tage

Weitere Optionen

Zeige weitere Optionen

Erklarung der Kontrollelemente

Diese Plattform vereint Nowcasts der COVID-19-7-Tage-Hospitalisierungsinzidenz in Deutschland basierend auf verschiedenen Methoden, mit dem Ziel einer verlasslichen Einschatzung aktueller Trends.



Das Wichtigste in Kurze

- Die 7-Tage-Hospitalisierungsinzidenz ist einer der Leitindikatoren fur die COVID-19 Pandemie in Deutschland (siehe "Hintergrund" fur die Definition).

- Aufgrund von Verzogerungen sind die fur die letzten Tage veroffentlichten rohen Inzidenzwerte stets zu niedrig. Nowcasts helfen, diese Werte zu korrigieren und eine realistischere Einschatzung der aktuellen Entwicklung zu erhalten.

- Es gibt unterschiedliche Nowcasting-Verfahren. Diese vergleichen wir hier systematisch und kombinieren sie in einem sogenannten Ensemble-Nowcast. Modellbeschreibungen und Details zur Interpretation sind unter "Hintergrund" verfugbar.

- Starke Belastung des Gesundheits- und Meldewesens kann dazu fuhren, dass sich Meldeverzogerungen anders verhalten als in der Vergangenheit. Die Verlasslichkeit von Nowcasts kann hierdurch beeintrachtigt werden.

Public GitHub repository

- ▶ `https://github.com/KITmetricslab/hospitalization-nowcast-hub`
- ▶ Pretty much the same as the Forecast Hubs

KITmetricslab / **hospitalization-nowcast-hub** Public

Unwatch 1 Star 7 Fork 8

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main 1 branch 0 tags Go to file Add file - Code -

ibrachr Merge pull request #125 from ibrachr/main 43 minutes ago 703 commits

.github/workflows	Update deploy-shiny.yml	3 days ago
code	Adding processing codes.	44 minutes ago
data-processed	Adding ensembles.	7 hours ago
data-processed_retrospective	Adding more of Sam's retrospective nowcasts.	1 hour ago
data-truth/COVID-19	Daily RKI update	13 hours ago
nowcast_viz_de	Daily plot update	7 hours ago
other_data	Add files via upload	23 days ago
.gitignore	SU-hier_bayes 2021-11-22	4 days ago
README.md	Update README.md	14 days ago

About

Collecting nowcasts of the 7-day hospitalization incidence in Germany.

[covid19nowcasthub.de/](#)

Readme

Releases

No releases published
[Create a new release](#)

Packages

No packages published
[Publish your first package](#)

Contributors 9

README.md

Hospitalization Nowcast Hub

Included models

We collect outputs from models run by the following teams:

- ▶ University of Stockholm, SE
- ▶ TU Ilmenau, DE
- ▶ Süddeutsche Zeitung, DE
- ▶ RIVM, Bilthoven, NL
- ▶ Robert Koch Institute, DE
- ▶ LSHTM, UK
- ▶ LMU Munich, DE
- ▶ KIT Karlsruhe, DE

Corrected estimates by RKI

- ▶ Since 1 Dec RKI has published daily nowcasts and incl state-level nowcasts

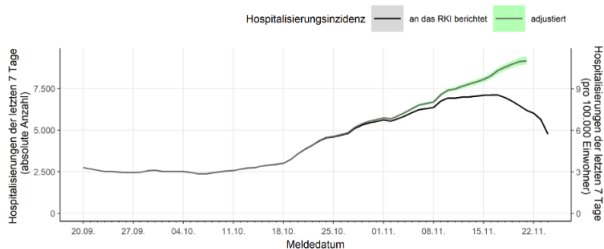


Abbildung 10: Berichtete 7-Tage-Hospitalisierungsinzidenz (schwarze Linie) und Schätzung der adjustierten Hospitalisierungsinzidenz unter Berücksichtigung von verzögert berichteten Hospitalisierungen (dunkelgraue Linie mit grün ausgewiesenem Schätzbereich). Die Skalen geben die jeweilige absolute Anzahl (y-Achse, links) und den Anteil pro 100.000 Einwohner (y-Achse, rechts) an.

- ▶ Thanks a lot to folks at RKI for guidance and publicly providing suitable data.

The reporting triangle

Example with maximum reporting delay of 5 days:

day	$d = 0$	$d = 1$	$d = 2$	$d = 3$	$d = 4$	$d = 5$	total
1	$X_{1,0}$	$X_{1,1}$	$X_{1,2}$	$X_{1,3}$	$X_{1,4}$	$X_{1,5}$	X_1
2	$X_{2,0}$	$X_{2,1}$	$X_{2,2}$	$X_{2,3}$	$X_{2,4}$	$X_{2,5}$	X_2
\vdots							
$t^* - 5$	$X_{t^*-5,0}$	$X_{t^*-5,1}$	$X_{t^*-5,2}$	$X_{t^*-5,3}$	$X_{t^*-5,4}$	$X_{t^*-5,5}$	X_{t^*-5}
$t^* - 4$	$X_{t^*-4,0}$	$X_{t^*-4,1}$	$X_{t^*-4,2}$	$X_{t^*-4,3}$	$X_{t^*-4,4}$	$X_{t^*-4,5}$	X_{t^*-4}
$t^* - 3$	$X_{t^*-3,0}$	$X_{t^*-3,1}$	$X_{t^*-3,2}$	$X_{t^*-3,3}$	$X_{t^*-3,4}$	$X_{t^*-3,5}$	X_{t^*-3}
$t^* - 2$	$X_{t^*-2,0}$	$X_{t^*-2,1}$	$X_{t^*-2,2}$	$X_{t^*-2,3}$	$X_{t^*-2,4}$	$X_{t^*-2,5}$	X_{t^*-2}
$t^* - 1$	$X_{t^*-1,0}$	$X_{t^*-1,1}$	$X_{t^*-1,2}$	$X_{t^*-1,3}$	$X_{t^*-1,4}$	$X_{t^*-1,5}$	X_{t^*-1}
t^*	$X_{t^*,0}$	$X_{t^*,1}$	$X_{t^*,2}$	$X_{t^*,3}$	$X_{t^*,4}$	$X_{t^*,5}$	X_{t^*}

On day t^* , the black cells are known, the blue cells need to be estimated.

Approaches taken by different teams

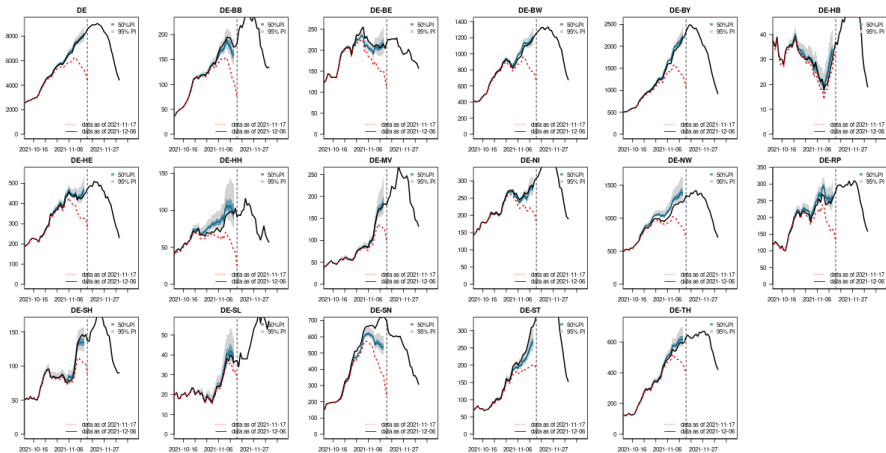
Three main sources of information on unknown values:

- ▶ partial observations for same day
- ▶ (partial) observations from surrounding days
- ▶ number of cases in preceding days/weeks

Strategies to extrapolate the reporting triangle:

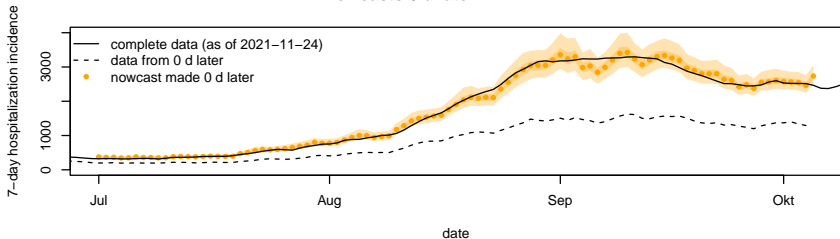
- ▶ Multiplication factors (KIT; the *reference model*, RKI, SZ) ●
- ▶ Regression with splines for time trends (RIVM, LMU) ● ●
- ▶ Random walk / autoregressive approaches with parametric reporting delays (LSHTM, SU) ● ●
- ▶ Regression on case incidences (TU Ilmenau) ●

First ensemble nowcast (17 Nov)

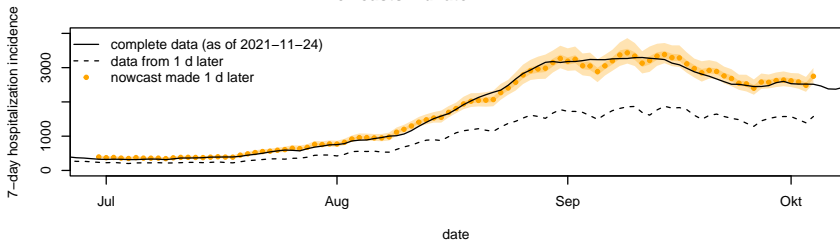


Visually assessing retrospective nowcasts

Nowcasts 0 d later – RIVM-KEW



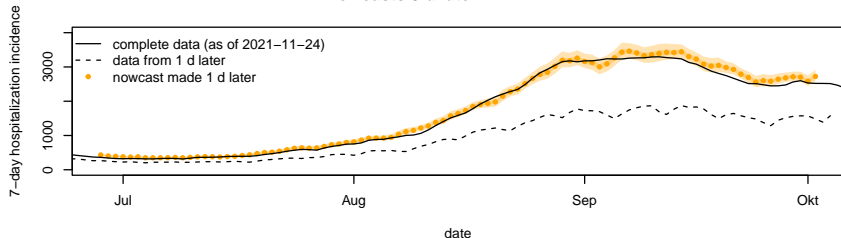
Nowcasts 1 d later – RIVM-KEW



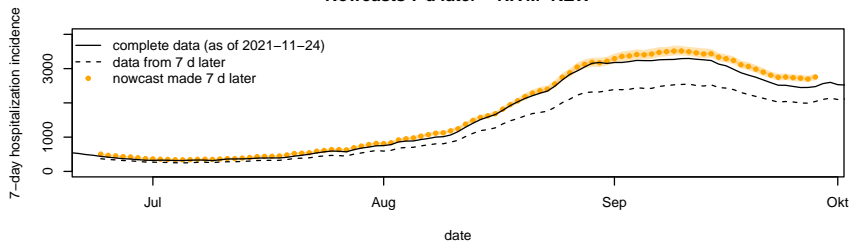
Visually assessing retrospective nowcasts

date

Nowcasts 3 d later – RIVM-KEW

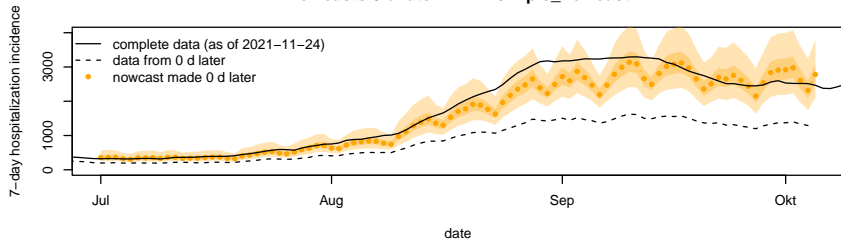


Nowcasts 7 d later – RIVM-KEW

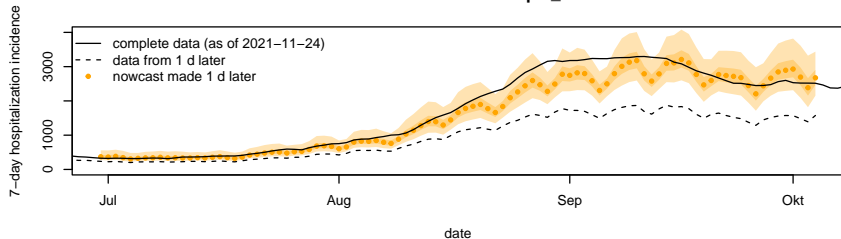


Visually assessing retrospective nowcasts

Nowcasts 0 d later – KIT-simple_nowcast



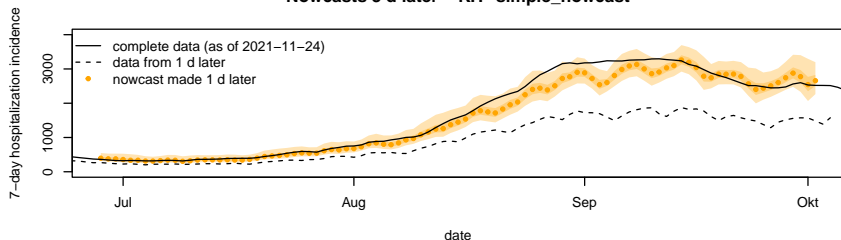
Nowcasts 1 d later – KIT-simple_nowcast



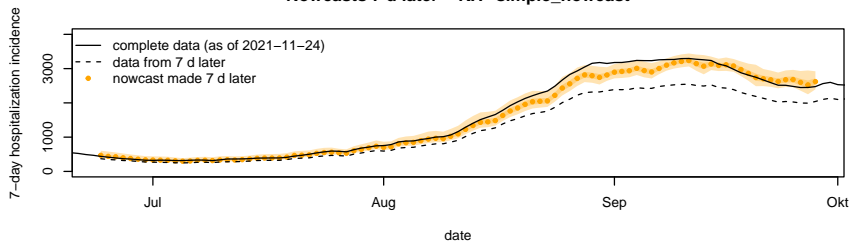
Visually assessing retrospective nowcasts

date

Nowcasts 3 d later – KIT-simple_nowcast

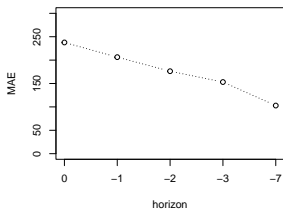


Nowcasts 7 d later – KIT-simple_nowcast

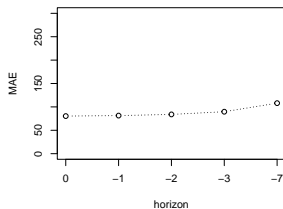


MAE and calibration of retrospective nowcasts

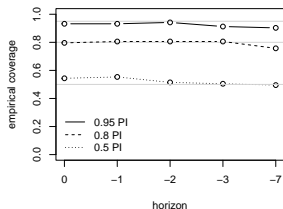
Mean absolute error KIT-simple_nowcast



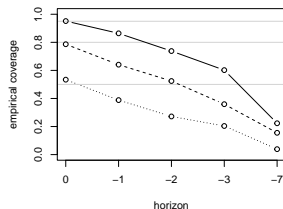
Mean absolute error KIT-simple_nowcast



Coverage KIT-simple_nowcast,
nowcasts made on 1 July 2021 – 11 Oct 2021



Coverage RIVM-KEW,
nowcasts made on 1 July 2021 – 11 Oct 2021

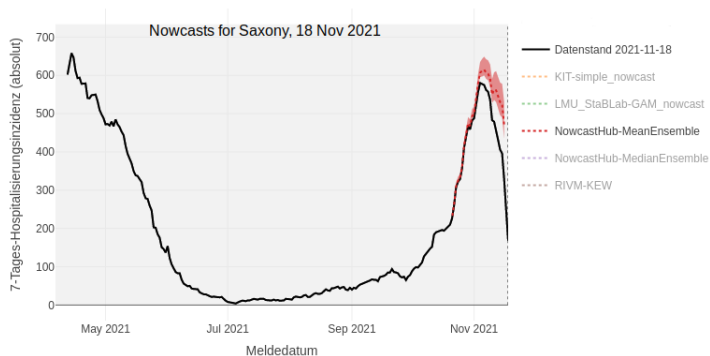


→ different models have different strengths – hopefully the ensemble can strike a good balance

When can things go wrong?

(In principle always.)

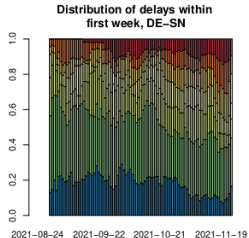
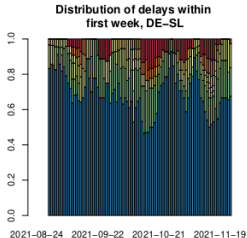
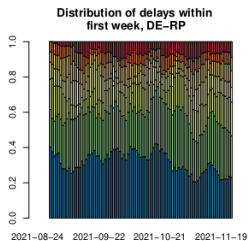
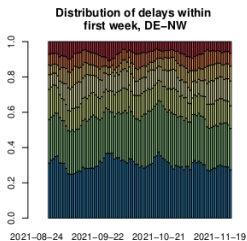
- ▶ Main assumption of most methods: delay distributions remain temporally stable.
- ▶ This may not be the case when the health system is under stress.
- ▶ Nowcasts will tend to under-estimate the true numbers when delays get longer.



- ▶ Difficulty: this is not a rapid feedback environment


Changing delay distributions

Delay distributions (conditional on delay ≤ 7 days), smoothed over 7-day window:



Pre-registered and prospective evaluation study

Study protocol: <https://osf.io/mru75/>

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Comparison and combination of real-time COVID19 forecasts in Germany and Poland

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- [🔗 Links](#) 0
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- [💬 Comments](#) 0

Summary ☰

Provide a narrative summary of what is contained in this registration or how it differs from prior registrations. If this project contains documents for a preregistration, please note that here.

This registration serves to ensure a transparent set of rules and criteria to guide the study. Details are provided in the attached PDF.

Add supplemental files or additional information

- [Preregistration.pdf](#)

Contributors

Johannes Bracher




Description

Short-term forecasts of cases, deaths and hospitalizations can improve situational awareness and provide an additional element to inform public health decision making during the COVID19 pandemic. While early in the pandemic only few prediction models were available, there is now a growing number of forecasts based on diverse methods and data streams. This project

Previous pre-registered studies on short-term forecasts

Article | [Open Access](#) | [Published: 27 August 2021](#)

A pre-registered short-term forecasting study of COVID-19 in Germany and Poland during the second wave

[J. Bracher](#) , [D. Wolfram](#) , [J. Deuschel](#) , [K. Görden](#) , [J. L. Ketterer](#) , [A. Ullrich](#) , [S. Abbott](#) , [M. V. Barbarossa](#) , [D. Bertsimas](#) , [S. Bhatia](#) , [M. Bodych](#) , [N. I. Bosse](#) , [J. P. Burgard](#) , [L. Castro](#) , [G. Fairchild](#) , [J. Fuhrmann](#) , [S. Funk](#) , [K. Gogolewski](#) , [Q. Gu](#) , [S. Heyder](#) , [T. Hotz](#) , [Y. Kheifetz](#) , [H. Kirsten](#) , [T. Krueger](#) , [E. Krymova](#) , [M. L. Li](#) , [J. H. Meinke](#) , [I. J. Michaud](#) , [K. Niedzielewski](#) , [T. Ożański](#) , [F. Rakowski](#) , [M. Scholz](#) , [S. Soni](#) , [A. Srivastava](#) , [J. Zieliński](#) , [D. Zou](#) , [T. Gneiting](#) , [M. Schienle](#) & [List of Contributors by Team](#) [-Show fewer authors](#)

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National and subnational short-term forecasting of COVID-19 in Germany and Poland, early 2021

 [J. Bracher](#),  [D. Wolfram](#),  [J. Deuschel](#),  [K. Görden](#),  [J.L. Ketterer](#),  [A. Ullrich](#),  [S. Abbott](#),  [M.V. Barbarossa](#),  [D. Bertsimas](#), [S. Bhatia](#), [M. Bodych](#), [N.I. Bosse](#), [J.P. Burgard](#), [J. Fiedler](#), [J. Fuhrmann](#), [S. Funk](#), [A. Gambin](#), [K. Gogolewski](#), [S. Heyder](#), [T. Hotz](#), [Y. Kheifetz](#), [H. Kirsten](#), [T. Krueger](#), [E. Krymova](#), [N. Leithäuser](#), [M.L. Li](#), [J.H. Meinke](#), [B. Miasojedow](#), [J. Mohring](#), [P. Nouvellet](#), [J.M. Nowosielski](#), [T. Ozanski](#), [M. Radwan](#), [F. Rakowski](#), [M. Scholz](#), [S. Soni](#), [A. Srivastava](#), [T. Gneiting](#), [M. Schienle](#)

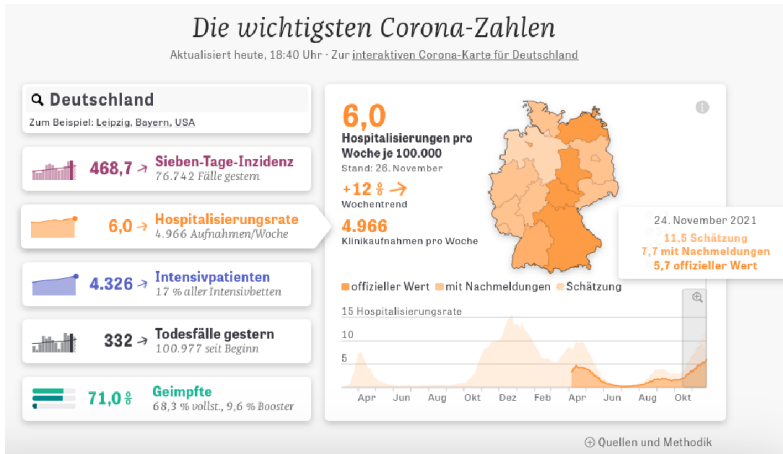
doi: <https://doi.org/10.1101/2021.11.05.21265810>

Real-time evaluation by Sam Abbott

[https://epiforecasts.io/eval-germany-sp-nowcasting/
real-time-method-comparison/](https://epiforecasts.io/eval-germany-sp-nowcasting/real-time-method-comparison/)

Dissemination

- ▶ Everything is publicly available under open licenses
- ▶ Referenced in RKI weekly report
- ▶ Shown with regular updates e.g. at Zeit Online, Neue Zürcher Zeitung, NDR



End

- ▶ It is hard to tell how good current nowcasts are.
- ▶ But they are certainly better than just showing the raw time series.

- ▶ Looking at just one indicator is not a good idea.
- ▶ There may be more useful ways of defining hospitalization indicators (though hampered by practical constraints).

- ▶ If you have a similar setting in your country - don't hesitate to reach out.
 - ▶ our setup is open-source and under MIT license
 - ▶ most teams' analysis codes are public, too

Thanks

Many thanks to (in reverse alphabetical order): D. Wolffram, J. van de Kastele, M. Weigert, A. Ullrich, D. Syliqi, M. Schienle, H. Kuechenhoff, T. Hotz, S. Heyder, D. Hailer, F. Guenther, T. Gneiting, S. Funk, M. an der Heiden, S. Abbott