Timeliness and Accuracy with Machine Learning Algorithms: Early Estimates of the Industrial Turnover Index

UNECE Machine Learning for Official Statistics Workshop 2023

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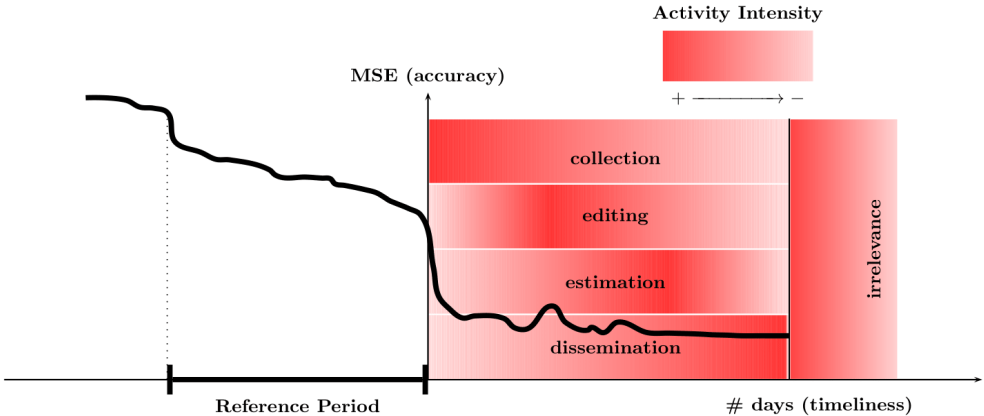
Overview

- General motivation
- The approach: main details
- The results
- Some lessons and conclusions

Timely or accurate? The production process

Main target: to improve **timeliness** under **accuracy** and **cost-efficiency bounds**



Timely or accurate? A critical view

- The pressing demand for timeliness has been put in the basis for the use of new data sources:
  - surveys are slow and expensive
  - digital data are fast and cheap
- The data deluge has favoured the delusion of accuracy

ServiceSectorIndex_202205_raw.txt

```
630044  varGestion@@147929252SS35.@@LI
630045  varGestion@@147930189SS35.@@LI
630046  varGestion@@147930266SS35.@@LI
630047  varGestion@@147930650SS35.@@LI
630048  varGestion@@147930918SS35.@@LI
630049  varGestion@@147931248SS35.@@LI
630050  varGestion@@147931987SS35.@@LI
630051  varGestion@@147932375SS35.@@LI
630052  varGestion@@147932761SS35.@@LI
630053  varGestion@@147933239SS35.@@LI
630054  varGestion@@147933406SS35.@@LI
630055  varGestion@@147933409SS35.@@LI
630056  varGestion@@147933897SS35.@@LI
630057  varGestion@@147933929SS35.@@LI
630058  This is not the economic reality
```

The key for connecting data to reality is on the **statistical methodology**

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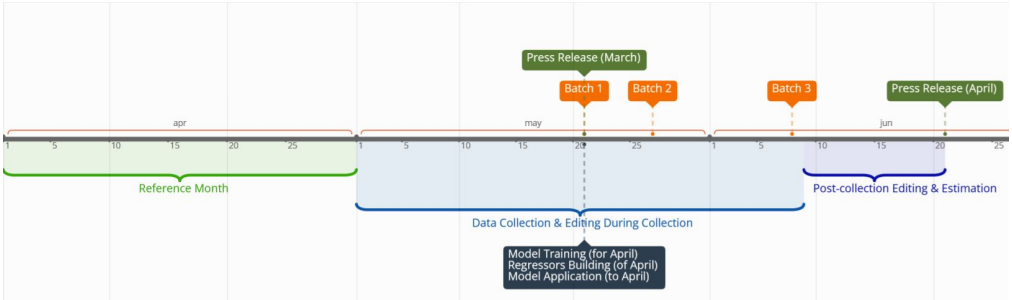
The Spanish Industrial Turnover Index

- Short-term Business Statistics under European Regulation (STS)
- Monthly; around 12000 units per month
- Cut-off sampling + Fixed-base Laspeyres Index



- Subject matter experts receive data batches at $m + 20$, $m + 27$, and $m + 38$.
- First release at $m + 51$.

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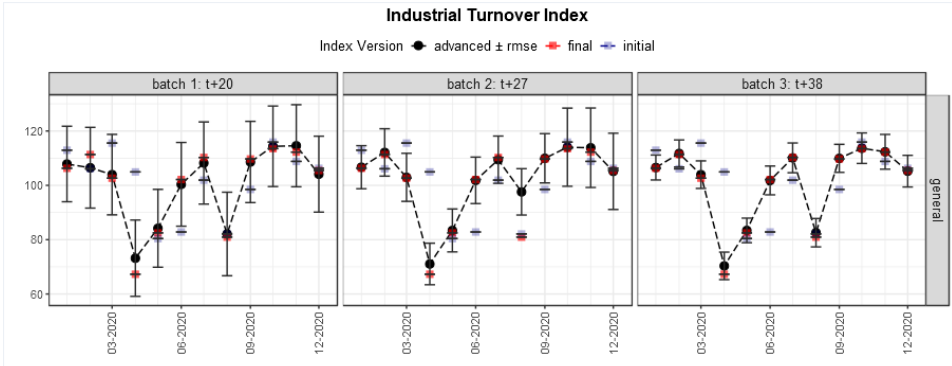
The approach

Reconstruct microdata with predictions using past and on-course information:

r_t **subsample collected** up to time $t < t_{\text{release}}(m)$

$$Y_{U_d}^{(m)}(t) = \sum_{k \in r_{t,d}} y_{kt}^{(m,\text{ed})} + \sum_{k \in U_d - r_{t,d}} \hat{y}_{kt}^{(m,\text{val})}$$



Information Representation: Regressors

From **statistical variables**: Turnover + Geo Location + Economic activity

To **Regressors**:

- Geographical variables

  `code_NUTS2_ent_ed`, `code_NUTS3_ent_ed`, `code_LAU_ent_ed`...

- Time variables

  `year_ref`, `batch`, `nmonths`i`_imputd_xprt`...

- Economic activity variables

  `code_NACE2class_frame_ed`, `code_NACE2group_ed`...

- Target-Related Variables

  `trnovr_val_i`, `MA`i`_trnovr_val`, `q95_MA`i`trnovr_val_NACE2div`...

To **Encoded Regressors**: Dummy and Mean Encoding

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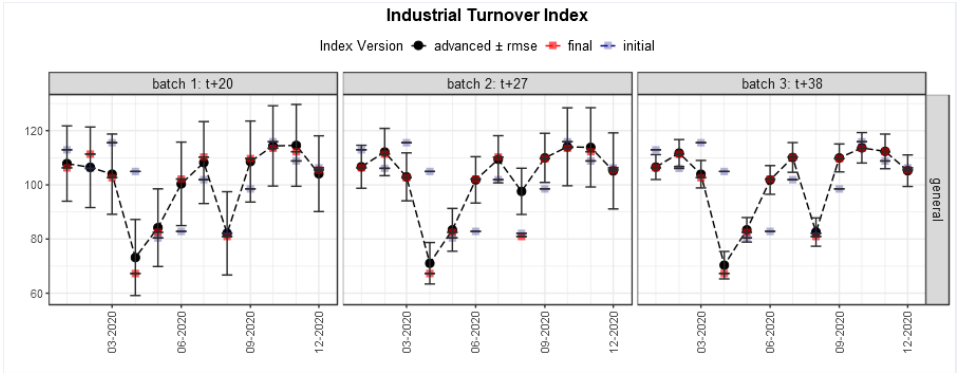
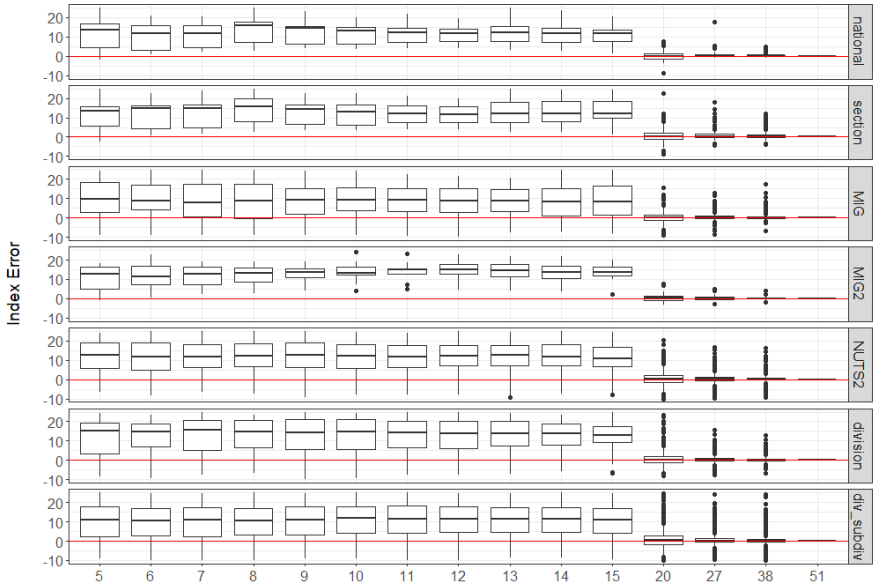
Information Representation: Regressors

q95_MA$i$trnovr_val_NACE2div	
Definition	Quantiles 0.95 of the variable MAi_trnovr_val across the population domain defined by edited values of variable code_NACE2div_ed (NACE Rev. 2 division) of the industrial establishment from the reference time period
Stat Type	Numerical
Values	$\mathbb{R}$, $i = 3, 6, 12$ (3 variables)
Example	150000
Source	Internal-Derived
Formula	$Q_{0.95}^{\text{NACE2div}}(\text{MA}i(z_k^{my,\text{val}}))$, where $\text{MA}i(z_k^{my,\text{val}}) = \frac{1}{i}\sum_{j=1}^{i} z_k^{(m-j)y,\text{val}}$
Stat Progr Ref	Spanish IOE-30052
Unit/Aggr	Aggr
Time Periods	$\{-1, \ldots, -i\}$
Long/Cross	Long + Cross
Cross-Domain Vars	code_NACE2div_ed
Encoding	-

Results: nowcasting



Results: timeliness vs. accuracy



Some lessons and conclusions

- Strategy:
  - Machine learning allows us to **improve statistical business functions**.
  - **Quality** can be improved: timeliness, accuracy, cost-efficiency, sound methodology,. . .
  - Constant **updating of synthetic microdata sets**: process refurbishing.
  - **Repository of regressors** (features).
- Methodology:
  - The core task is more about **information representation** than about statistical modelling.
  - **Combination** with existing methods is possible.
- Computational:
  - Traditional **technological infrastructure** is not enough.
  - **Data architecture** must be standard.
- Organizational:
  - A collaboration among **methodologists**, **computer scientists** and **subject matter experts** is necessary to integrate knowledge.