The use of OR and AI for workforce planning in call centers and health care

Ger Koole

Professor @ Analytics & Optimization research group, VU Amsterdam (0.7)

Founder & science lead @ CCmath (0.2)

Scientist & consultant @ PICA, patient logistics center VUmc (2005-'20, 0.2)

Forecaster & consultant @ LCPS (autumn 2020, 0.4)

Beta symposium AI for OM, Utrecht, 12 May 2023

In honor of Arnoud de Bruin

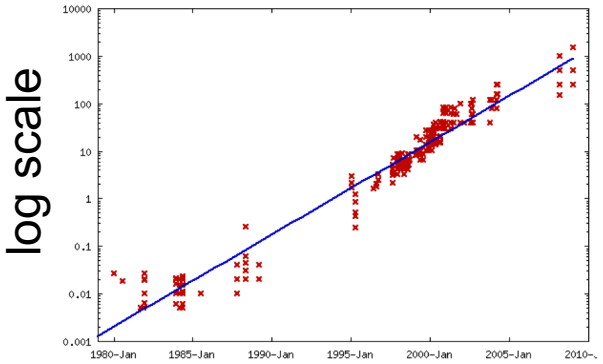
- Aerospace engineer, specialized in process optimization
- Policy advisor (“beleidsadviseur”) @ VUmc
- Initiator of PICA
- Found his vocation in fighting cybercrime @ police
- Currently fighting ALS…

Quality & quantity

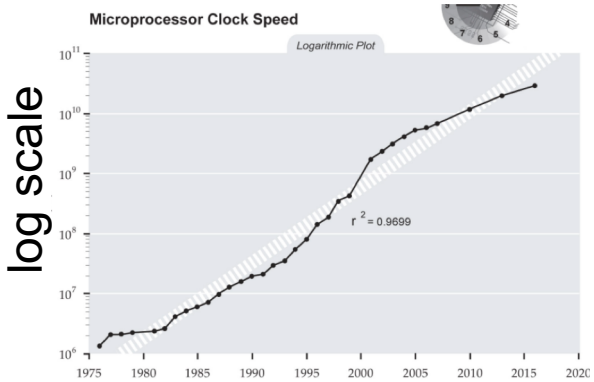
- Customers & patients value good service more than good process
  - Especially in call centers & curative health care (“cure”)
  - Process is more important in (long-term) care
- But: ”the best service is no service” (Price & Jaffe 2008)
  - Good product not needing service/prevention
  - Good self-service
- How does AI impact both quality/self-service & quantity/process?

The AI revolution

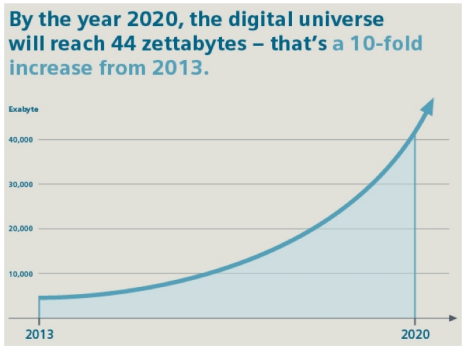
- Moore's law: more data and more computing power



data capacity laptop

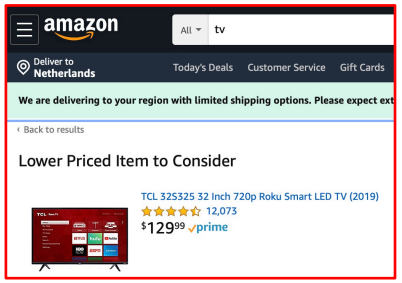


clock speed computers



total data stored

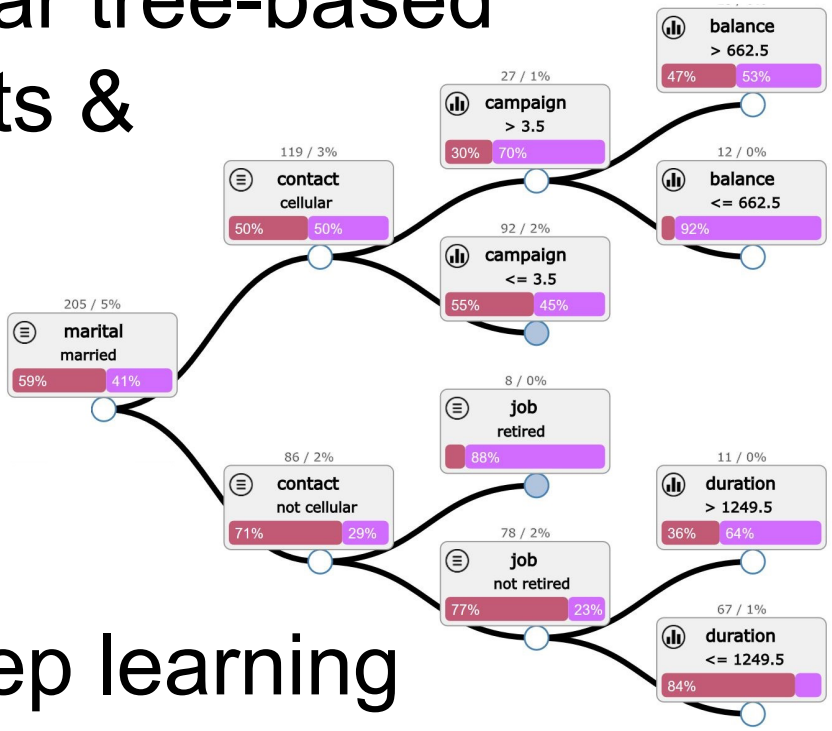
- Availability of data has grown in 2 dimensions
  - more data points
  - more attributes



- Use data to obtain information or make decisions
- New algorithms that utilize this abundance: machine learning

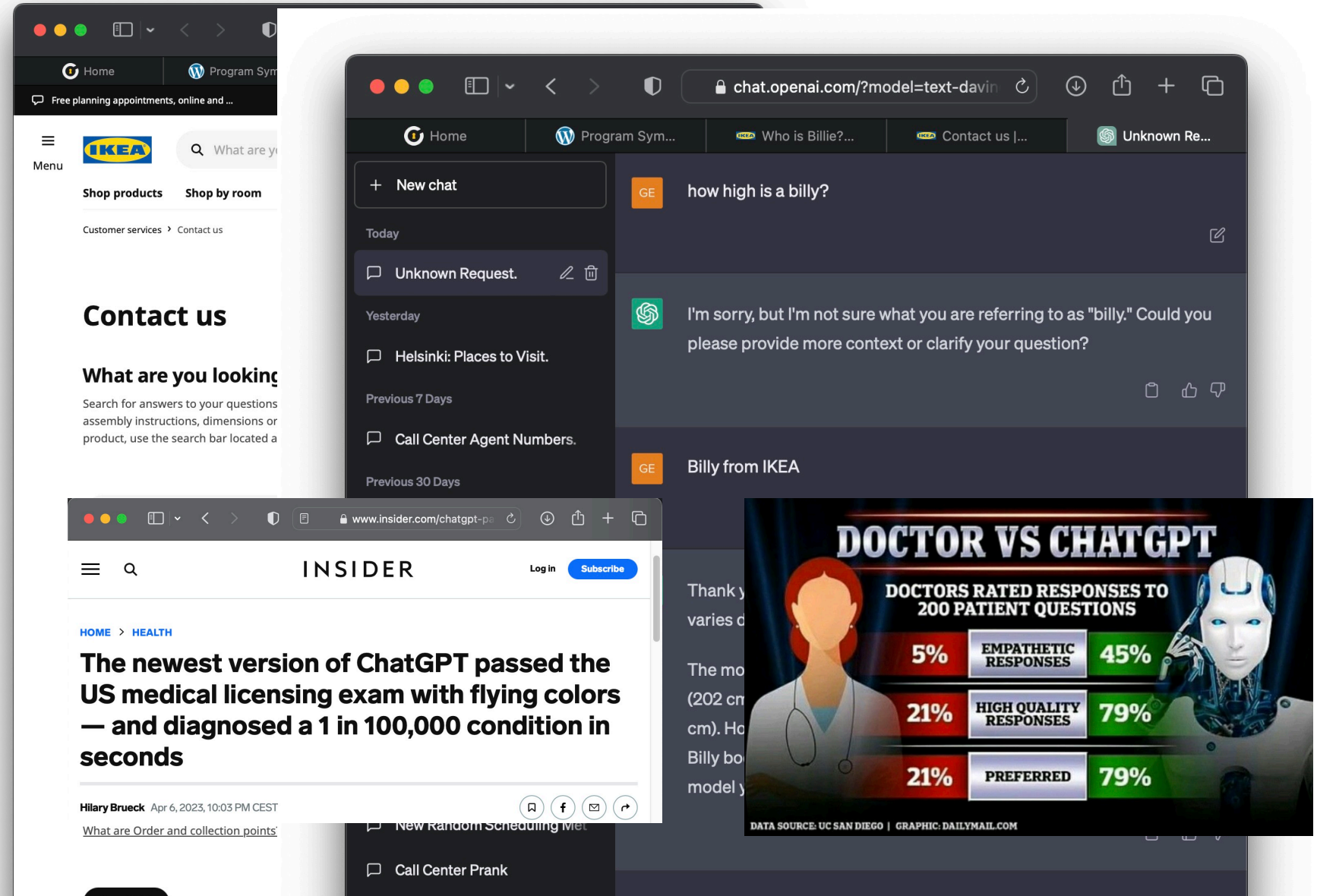
Machine learning algorithms

- Games: Monte Carlo tree search
- Tabular data: non-linear tree-based models (random forests & gradient boosting)
  - Useful for planning



- Unstructured data: deep learning (artificial neural networks)
  - Useful for self-service

Self-service in UX & HC

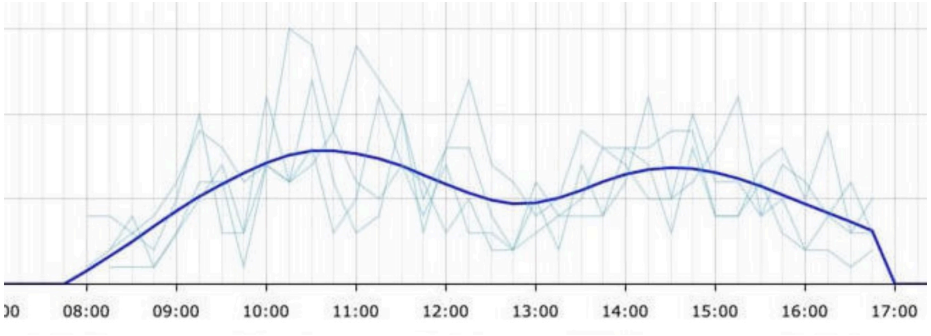


Observations on AI *in* OR

- How does supervised ML work?
  - It finds non-linear relations
  - Generalizes badly to “far away” data points
  - Is not original (and surely not intelligent) in contrast with Linear Programming or Reinforcement Learning
- ML cannot replace OR planning methods
  - Can be helpful in certain steps

Steps in call center planning

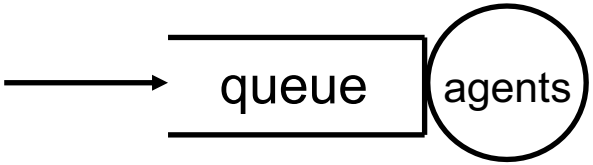
forecasting

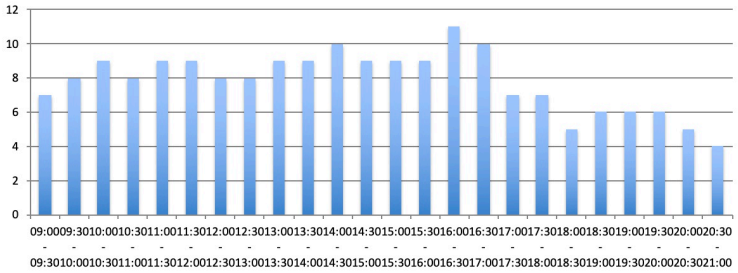


safety staffing

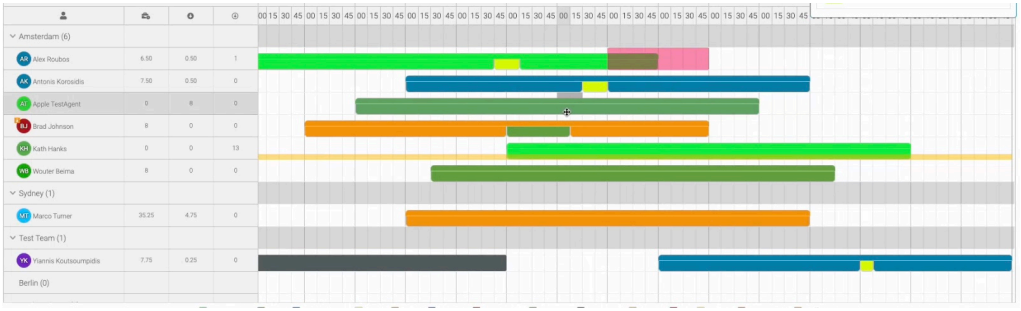
Erlang C/A

SLA, e.g. 80%/20s



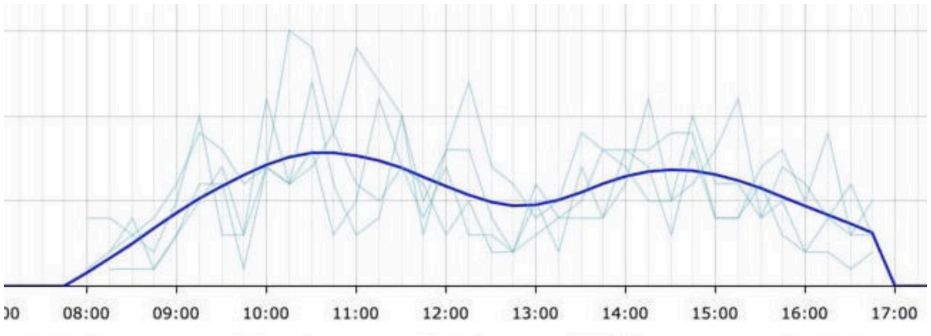


scheduling



ML for forecasting

forecasting



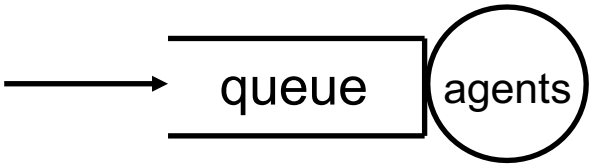
- Many statistical methods
  - Often strong assumptions (stationarity, …)
  - Not flexible (1 form of seasonality, …)
- ML: more flexible & precise
- But: Linear regression (with many dummy variables) works also very well
  - And gives insight

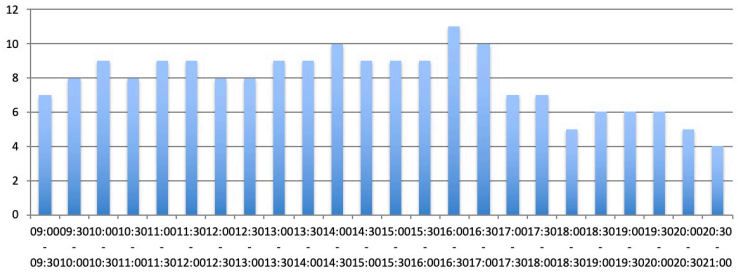
ML for safety staffing

Erlang C/A

SLA, e.g. 80%/20s

safety staffing

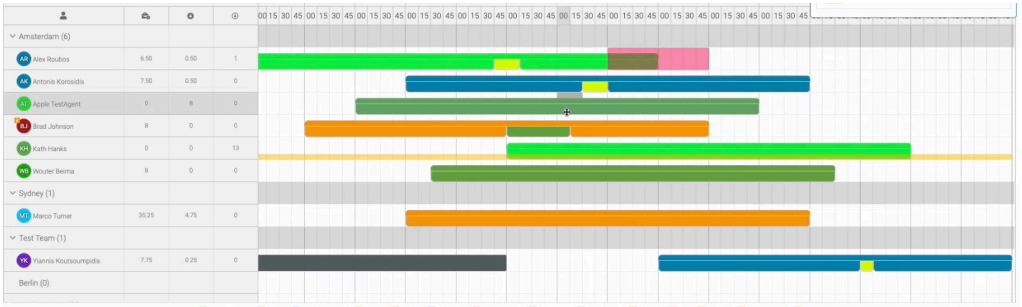




- Queueing models do not capture all aspects
  - E.g., breaks
  - Systematic error
- Black-box ML can discover its own “features”
  - E.g., the 10:00 coffee break that everybody takes
- Hybrid methods?

ML for multi-skill scheduling

scheduling



- Simulation optimization:
  - for fixed schedule simulation of full week in cc
  - local search in “schedule space”
- Problems:
  - simulation is slow
  - simulation has random outcomes
- Solution:
  - fit ML model to simulation using gradient boosting
  - optimize over ML prediction

Conclusion

- ”White box modeling” can be augmented by supervised ML
- Especially in:
  - Parameter estimation
  - Fitting outcomes of simulation or optimization
- Abundance of data makes non-linear regression methods better than “old” linear models

How about health care?

- Less advanced planning technology
  - Although covid gave it a boost
- Some stakeholders block innovation
  - The inmates are running the asylum
- Heading towards a crisis
  - Ageing population
  - More technological possibilities
  - Costs
  - Lack of personnel
- Is ChatGPT (or another LLM) the game changer?