Consultant Interventions and Behavioral Change in Supply Chain Forecasting

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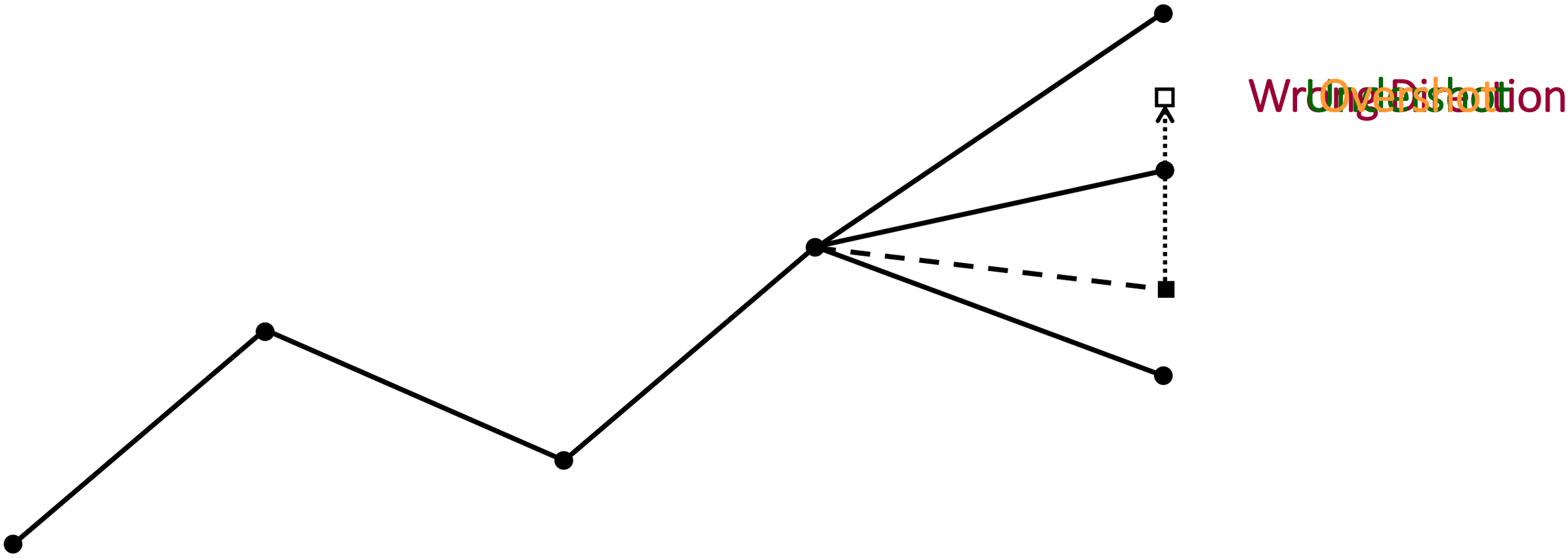
Judgmental adjustments in forecasting



- Actuals (X).
- Model Forecast (MF) or Statistical Forecast or System Forecast.
- Expert Forecast (EF) or Judgmental Adjustment. This is usually used as the Final Forecast (FF).

Lessons learned from the literature

- Model-based forecasts for SKU-level data are **frequently** adjusted by experts. (Franses and Legerstee, 2009)
- Experts adjust model-based forecasts **upwards** more than downwards. (Franses and Legerstee, 2009)
- **Positive** adjustments are **far less effective** than negative ones. (Fildes et al., 2009)
- The **optimism bias** leads to positive adjustments having larger errors than negative ones. (Trapero et al., 2013)
- Expert forecasts often **significantly differ** from model forecasts. (Franses and Legerstee, 2010)
- However small adjustments are also the case: **ownership**. (Fildes et al., 2009; Gonul et al., 2009)

Lessons learned from the literature (cont'd)

- Experts can reduce forecasting error when adjustments size is **not too large**. (Trapero et al., 2013)
- Where the forecasters' principal **motivation** is towards improved accuracy, they can add substantially to forecast accuracy. (Fildes et al., 2009)
- Small improvements to statistical forecasts can translate to **significant gains in terms of utility**. (Syntetos et al., 2009)
- Big losses in judgmental adjustments are most probable to be followed by **another big loss** as a result of a large adjustment. (Petropoulos et al., 2016)
- **Combination** leads to improvements. (Fildes et al., 2009; Franses and Legerstee, 2011)

Adjusting the adjustments

- Franses & Legerstee (2011, ESwA):

$$
\begin{aligned}
FF_t &= \alpha_t EF_t + (1-\alpha_t)MF_t \Leftrightarrow \\
FF_t &= MF_t + \alpha_t(EF_t - MF_t) \Leftrightarrow \\
FF_t &= MF_t + \alpha_t FD_t
\end{aligned}
$$

- **Damping** the judgmental adjustments!
- Blattberg-Hoch approach (50% model + 50% manager; 1990, MnSc).
- Petropoulos et al. (2016, EJOR): will this lead to a **change in forecasters' behaviour** with regards to how they perform judgmental interventions?

A laboratory experiment

- The participants were asked to judgmentally adjust the one-step-ahead statistical forecasts for **30 time series**.
- For each time series, **36 months of history** are available.
- In the past 36 months there has been **no special events** (promotional activity or competitors' activity) and as such there has been **no need for any judgmental adjustment**.
- In the immediate next period there is reliable information that:
  either
    Our company is going on a heavy promotion of a Buy-One-Get-One-Free type
  or
    Our main competitor is going on a heavy promotion of a Buy-One-Get-One-Free type
- Participant were given information with regards to who is running the promotion for each of the time series.

A laboratory experiment (cont'd)

- A computer forecast prepared from an **Exponential Smoothing** based algorithm has also been prepared for the next period - this is a **time series forecast** and is not capturing the forthcoming special event.

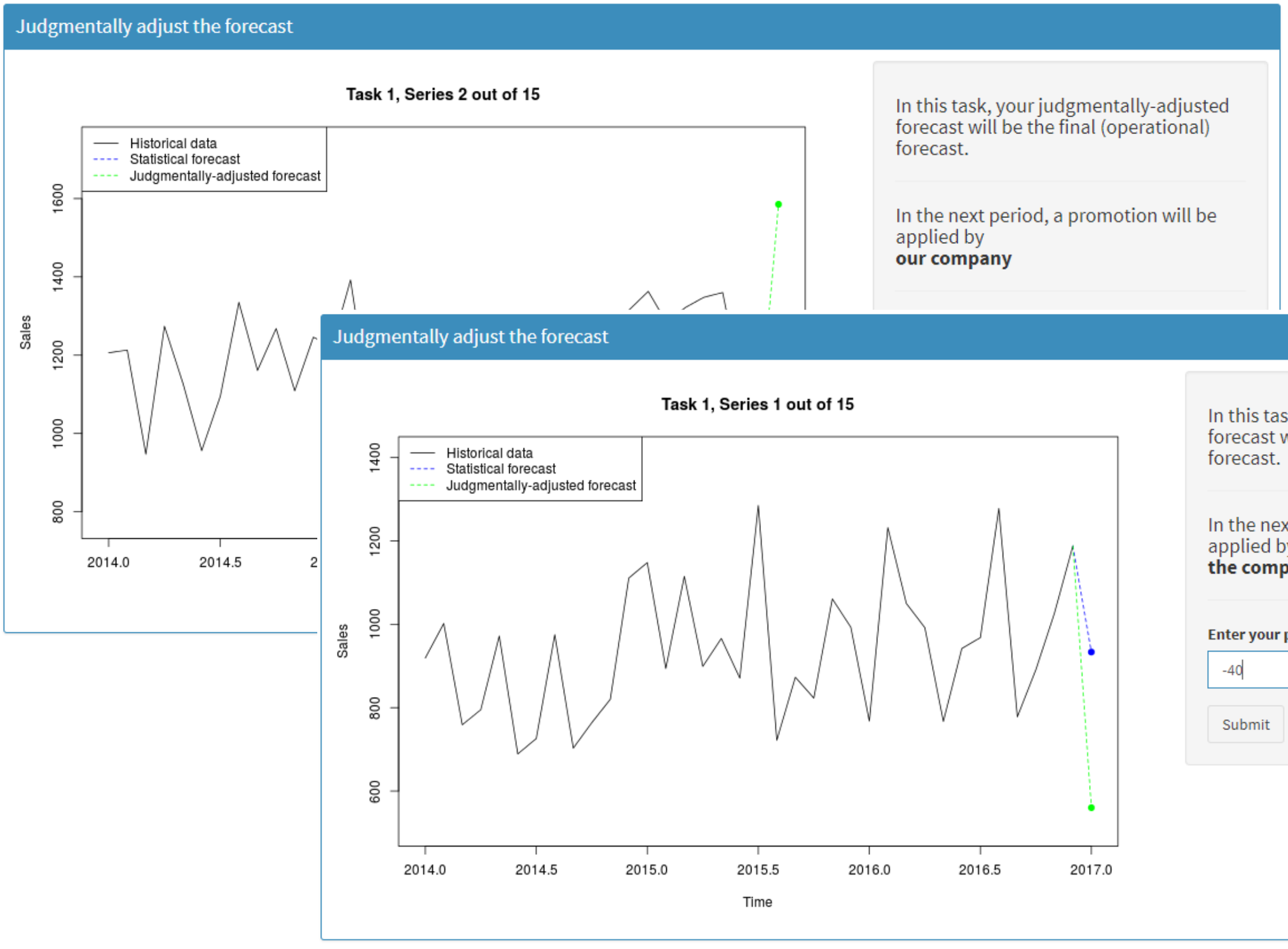
- Participants were asked to make their own **judgmental forecast** (by adjusting the statistical forecast) so as to take into consideration the **additional promotional information**.

- Two tasks:

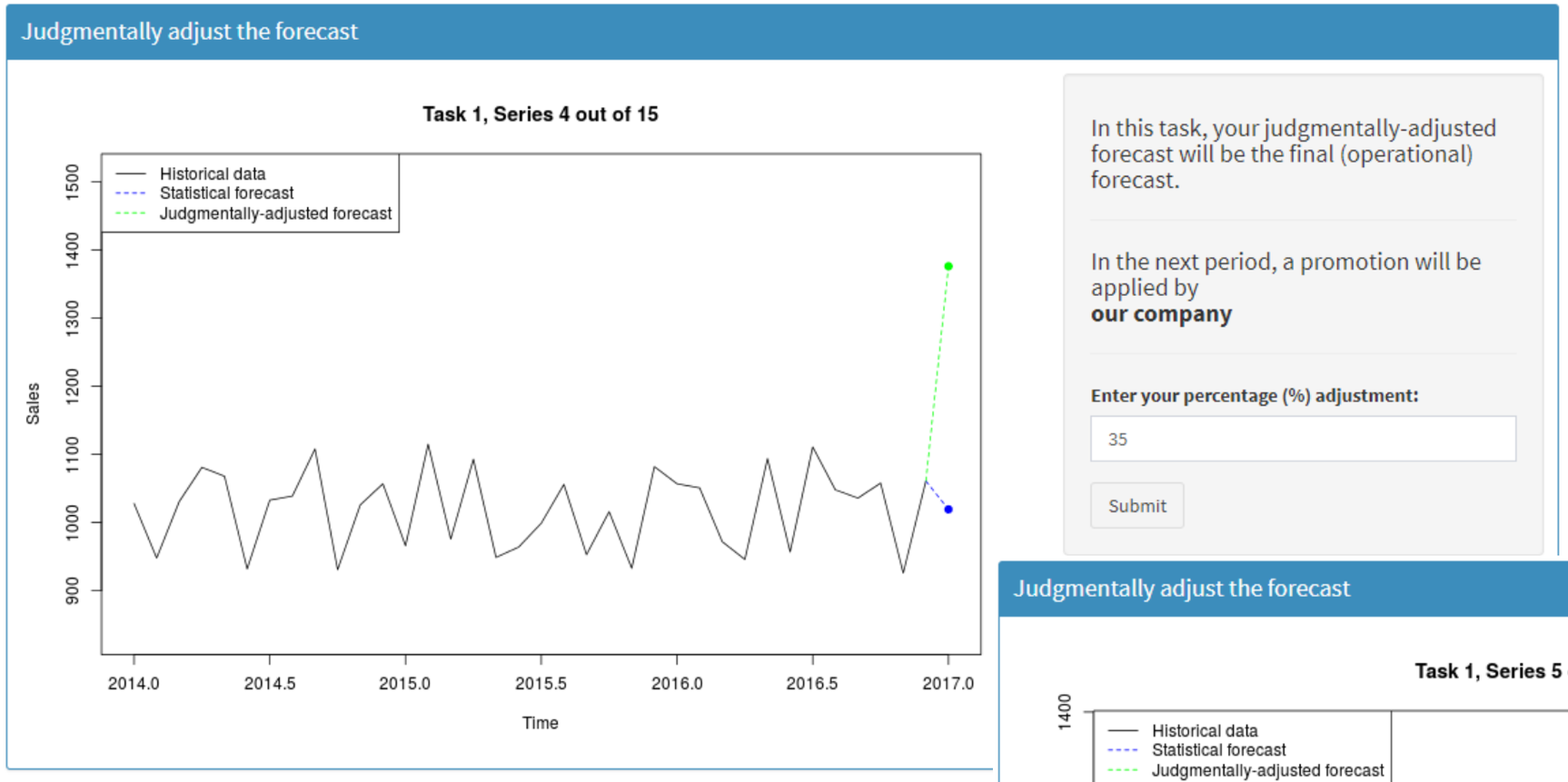
  "The **final forecast** that is going to be used for the decision to be taken (e.g. ordering, replenishment) will be...

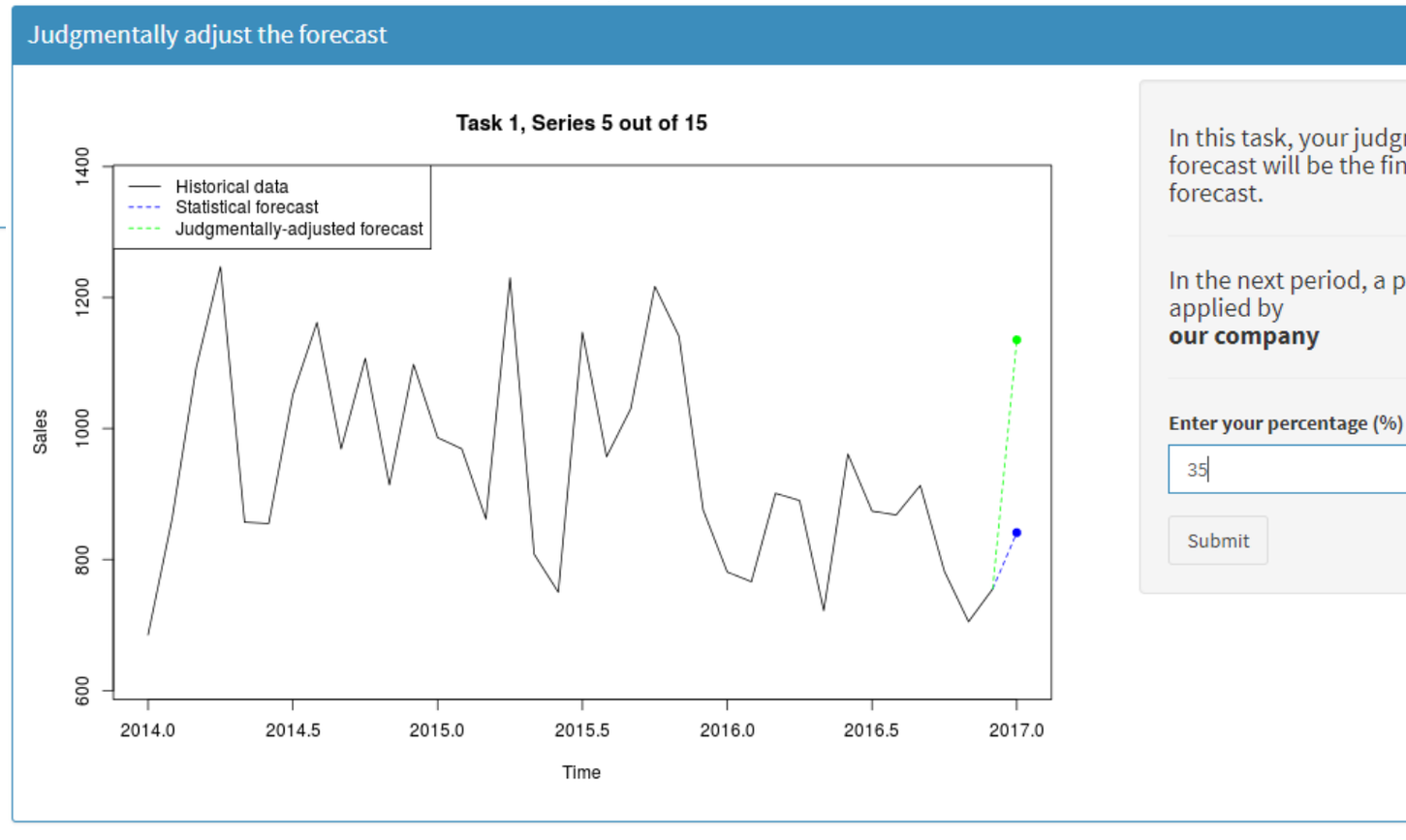
  - ...solely **your forecast** (judgmentally-adjusted forecast)."
  - ...the **simple average** (50-50%) of **your forecast** (judgmentally-adjusted forecast) and the **computer forecast** (statistical forecast)."

Positive versus negative adjustments



Low versus high noise series





Measuring behavioral change

- A representative uplift for promotions was not provided: **avoiding anchoring**.
- Each participant may **interpret** the effect of the promotions **differently**.
- Behavioral change is measured per participant.
- We measure:

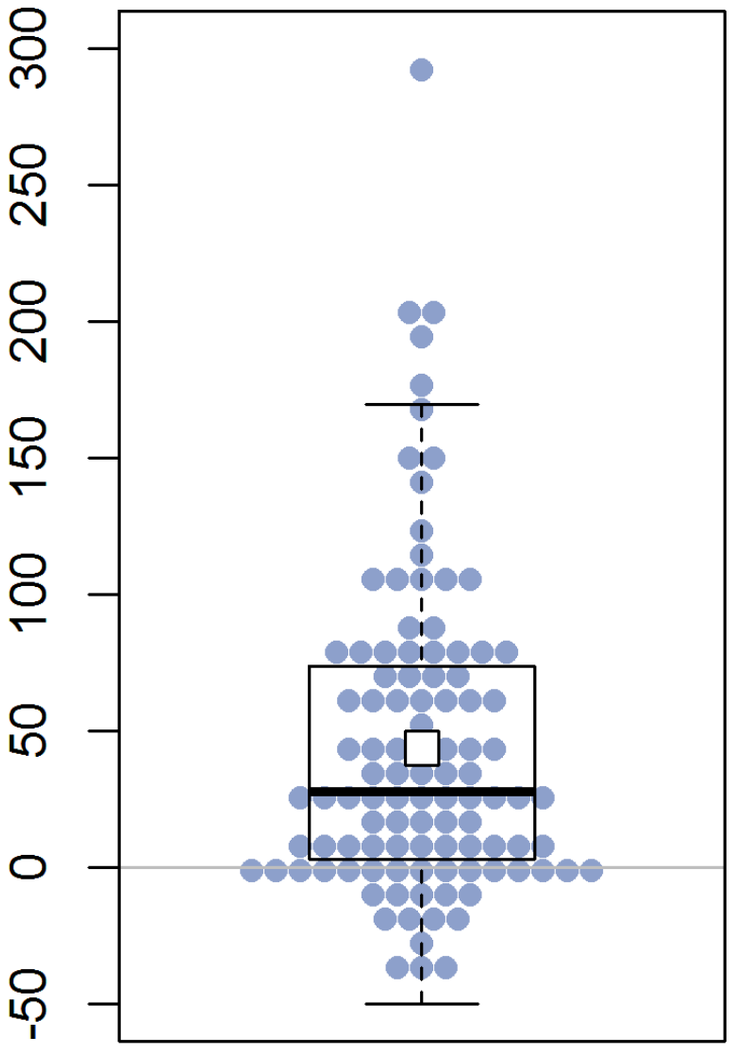
  MAA_1: mean absolute adjustment for task 1, where $FF = EF$

  MAA_2: mean absolute adjustment for task 2, where $FF = 0.5 \cdot (MF + EF)$

- **Behavioral change** (%):

$$100 \cdot \left(\frac{MAA_2}{MMA_1} - 1 \right)$$

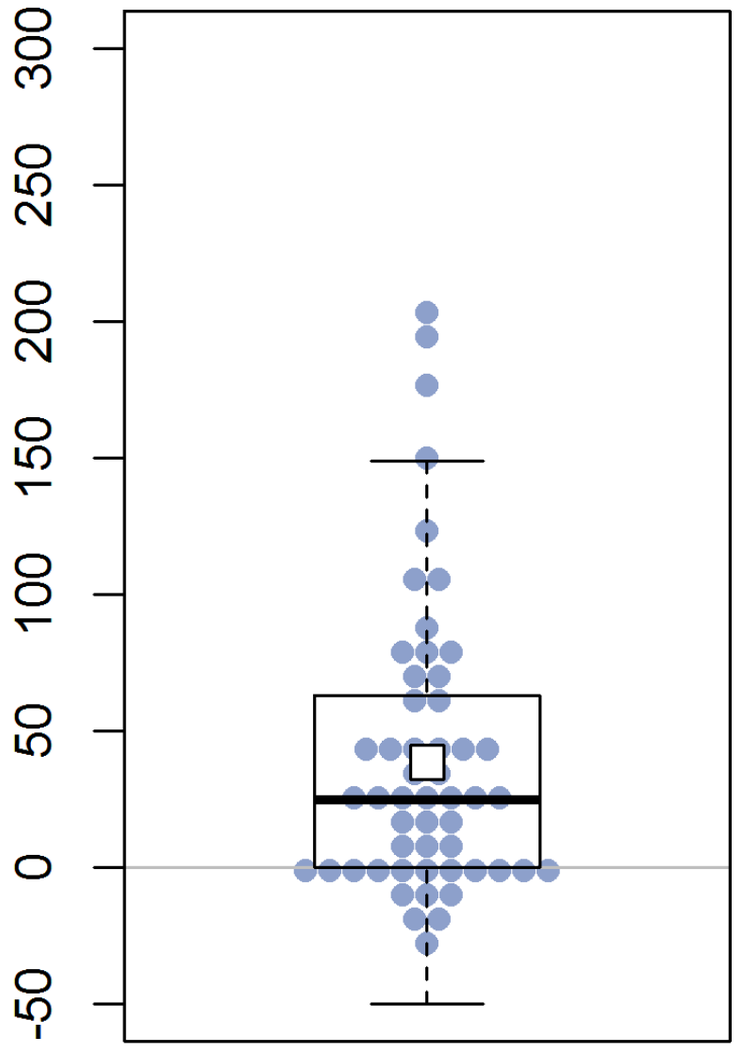
Evidence on behavioral change



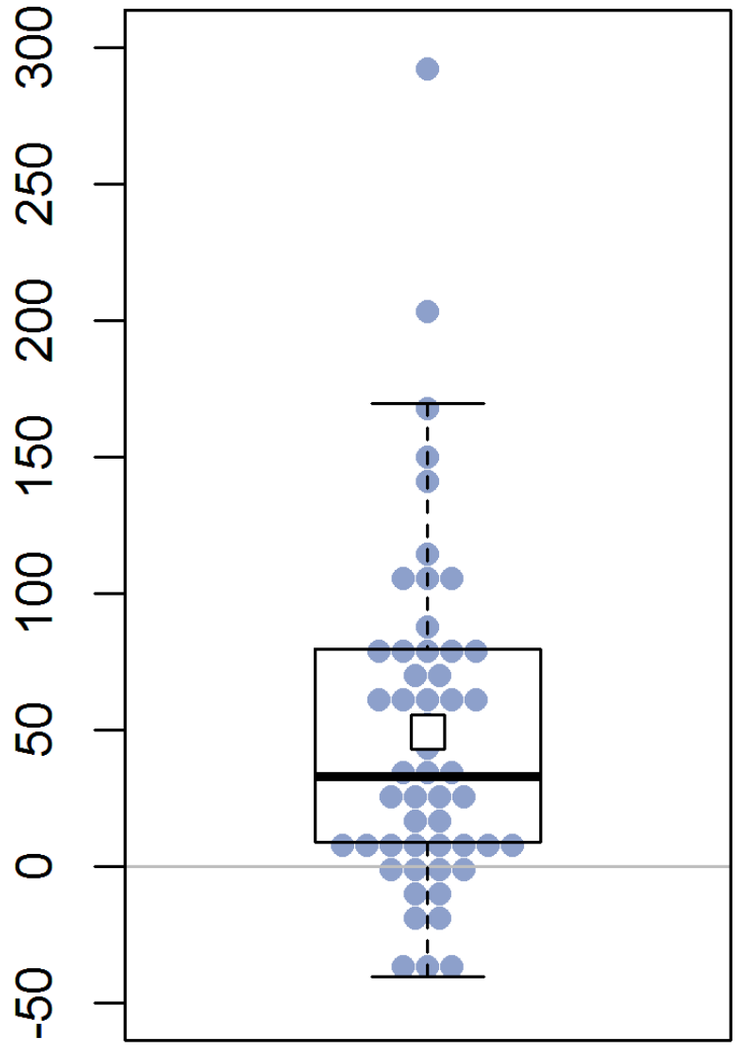
Overall

Mean: 43.8%

% increase > 0 : 76.4%

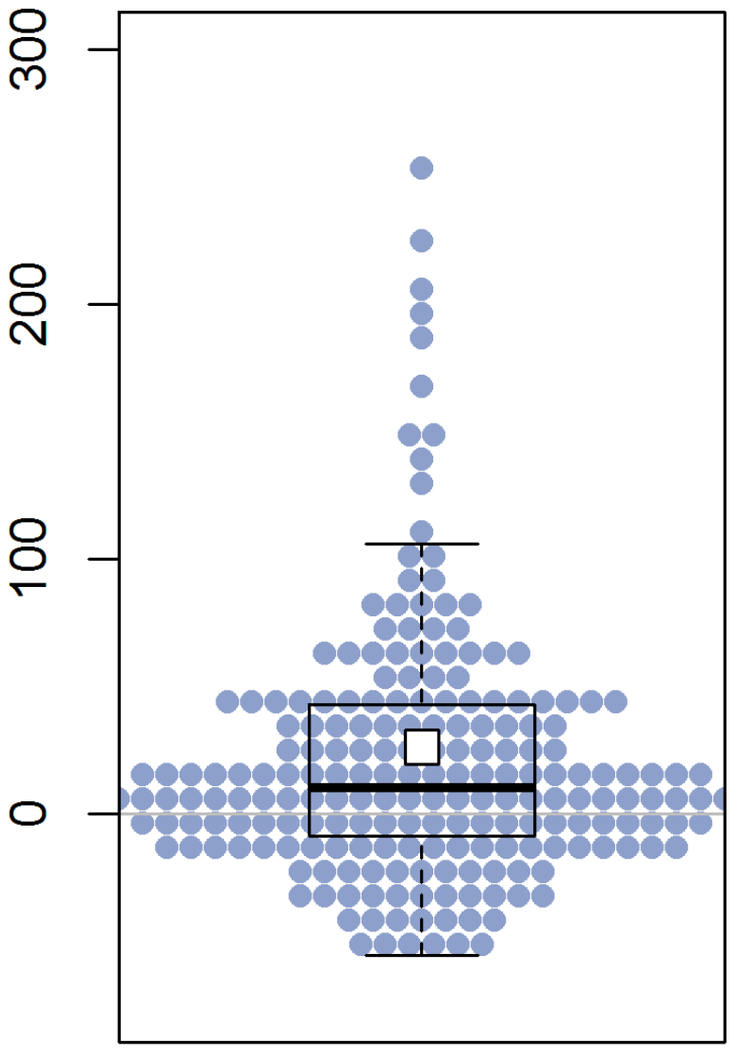


Task 1 → Task 2



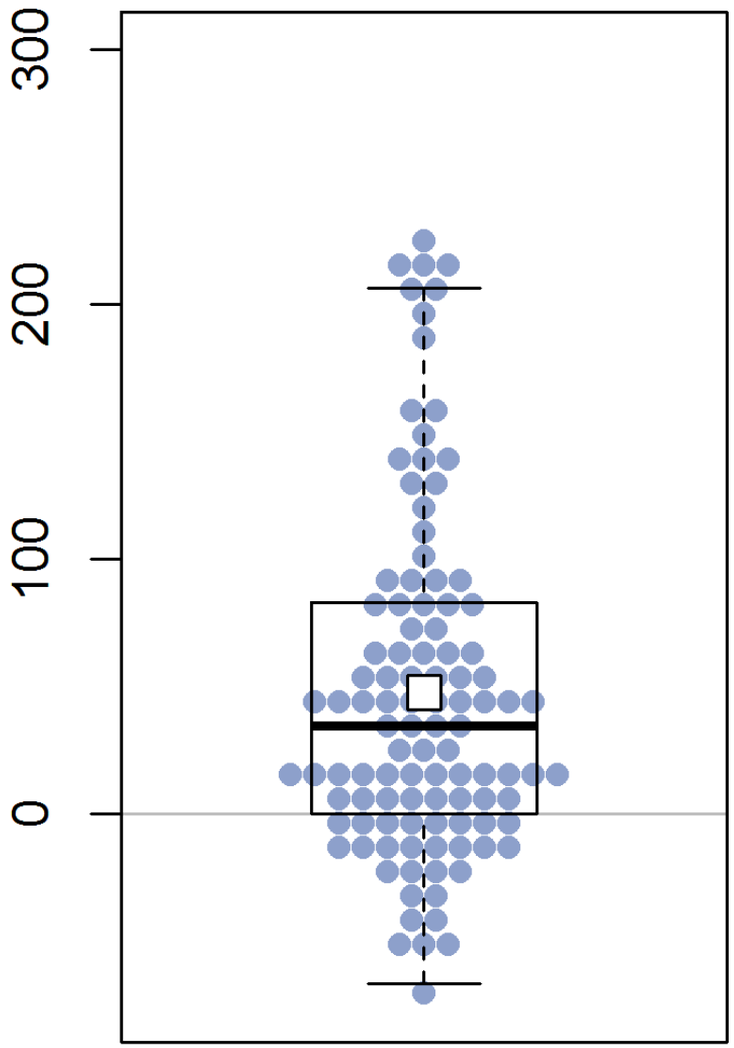
Task 2 → Task 1

The effect of direction of adjustment



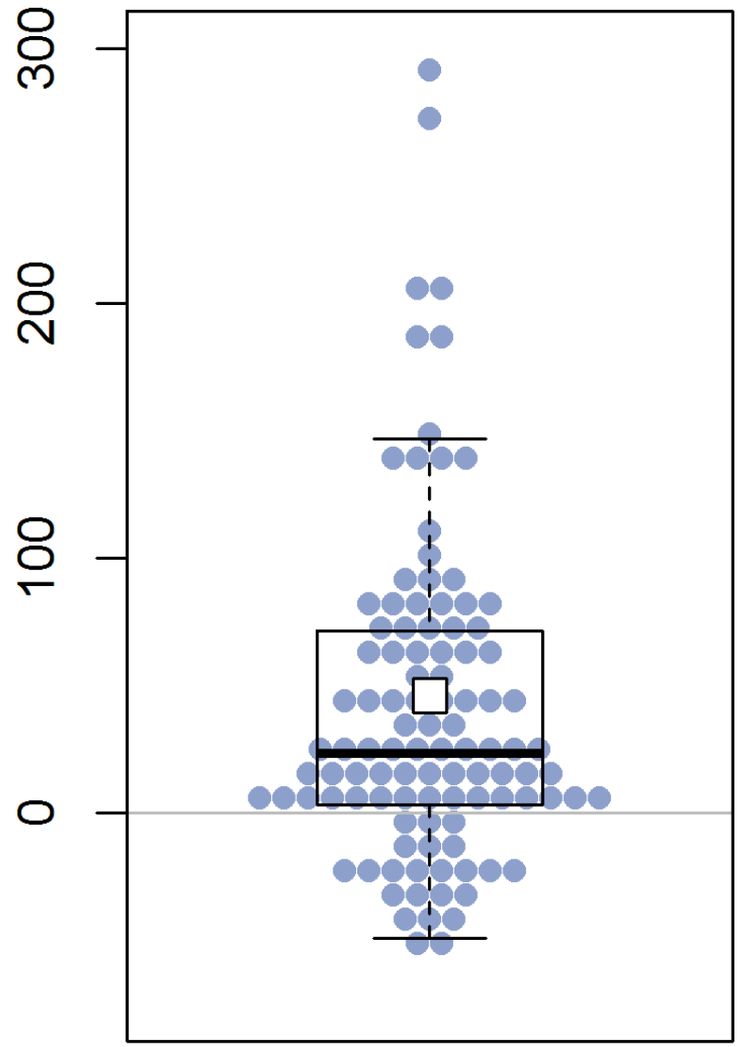
% difference of posivite
over negative adjustments

Overall
Mean: 26.1%
% diff > 0 : 63.2%



% increase

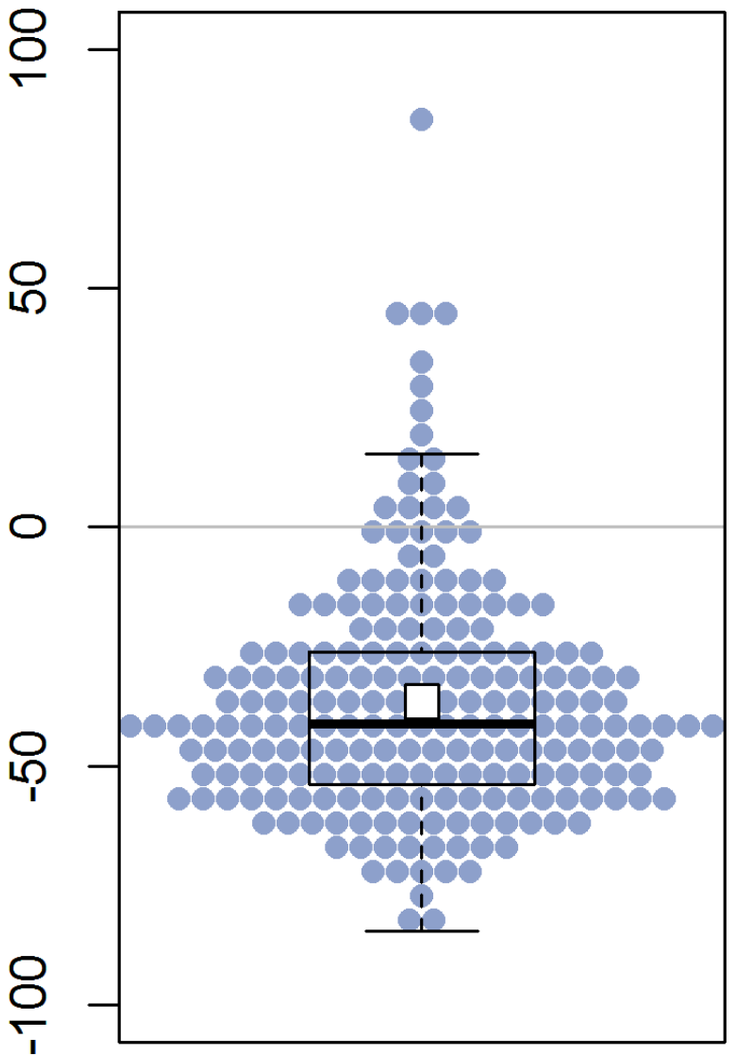
Behavioral change
of **positive** adjustment



% increase

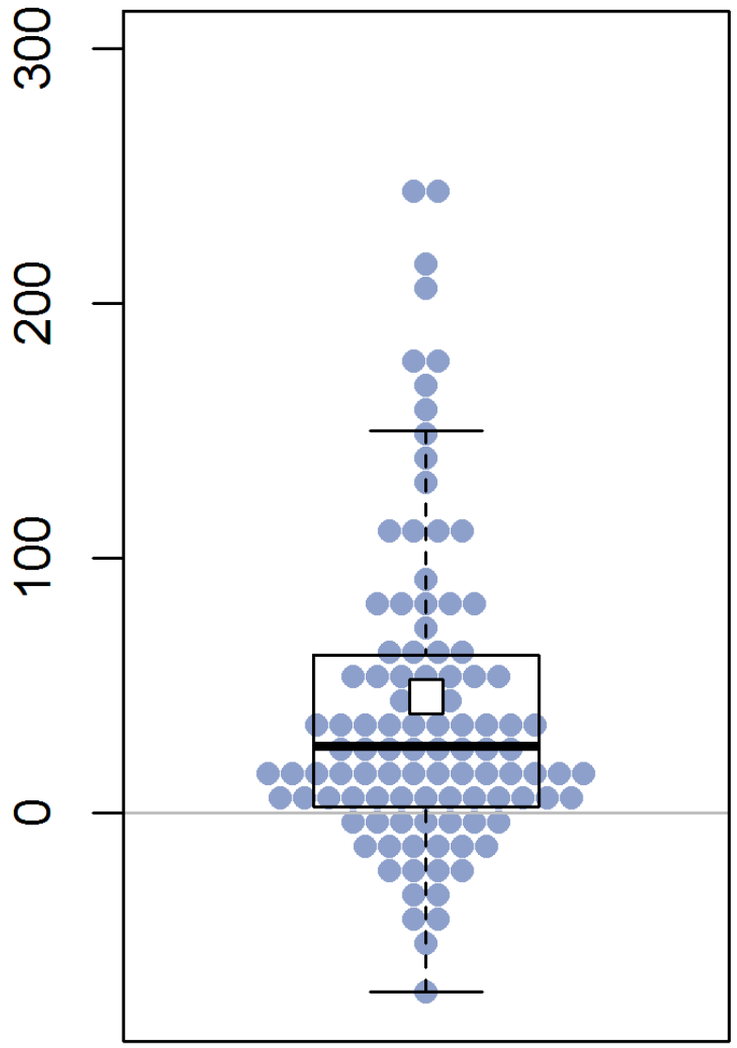
Behavioral change
of **negative** adjustment

The effect of noise in series



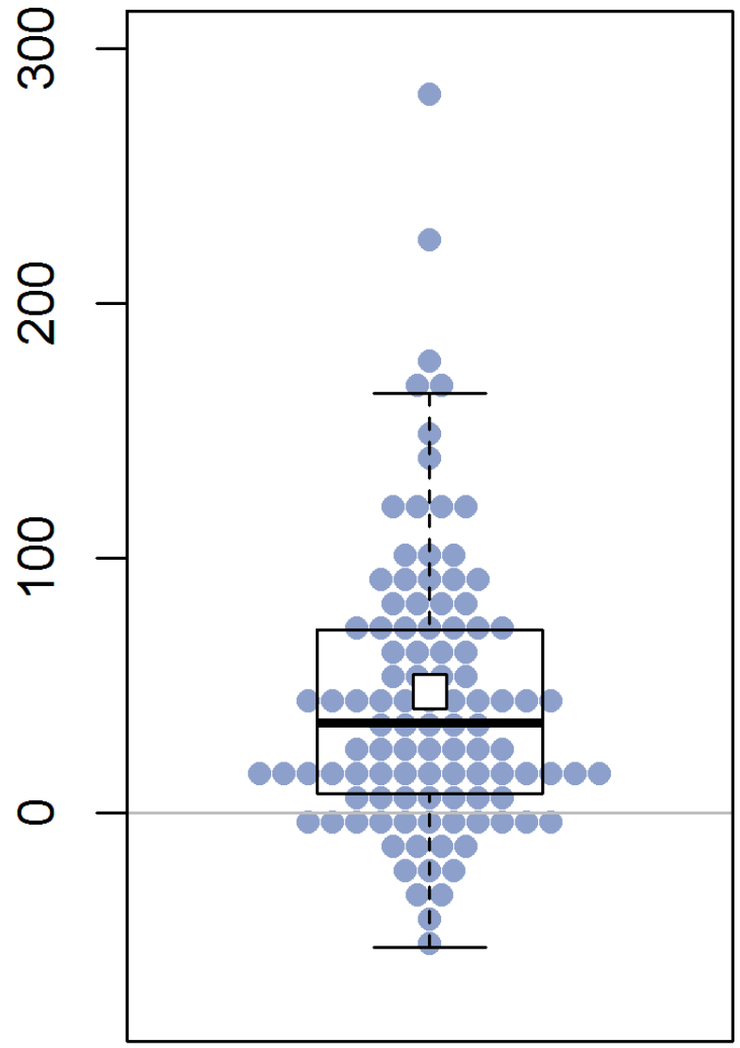
% difference of adjustments
in low over high noise series

Overall
Mean: -36.6%
% diff > 0 : 8.5%



% increase

Behavioral change
in **low noise** series



% increase

Behavioral change
in **high noise** series

Key insights

- Forecasters' behavior does **change**, once they are told that their judgmentally adjusted forecast is further adjusted.
- The **degree of change** does not directly reflect to the degree of the consequent adjustment.
- Also, there exist great differences across the behavior of different forecasters.
- Forecasters' size of interventions is affected by
  - The direction of the adjustment.
  - The degree of noise in data.
- However, neither seem to interact with the behavioral change associated with adjusting the adjustment.

Future work

- A second experiment… Two tasks:
  - Task 1, as before: the final forecast will be the judgmentally-adjusted forecast
  - Task 2: provide evidence on the performance of 50-50% combination, but still make explicit that the final forecast will be the judgmentally-adjusted forecast.
- We expect (hopefully!) that participants will change their behavior in Task 2, but to the **opposite direction**.
- **Possible solution (?):** Provide feedback with regards the efficiency of combined system + expert forecast.
- **Case study**: multibillion North American company in the consumer packaged goods industry.

Questions?

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