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Flip-Flop Index: Quantifying Revision Stability for Fixed Event Forecasts

Deryn Griffiths, Michael Foley, Ioanna Ioannou, Tennessee Leeuwenburg, Nicholas Loveday, Benjamin Price, Alexei Hider, Harry Jack

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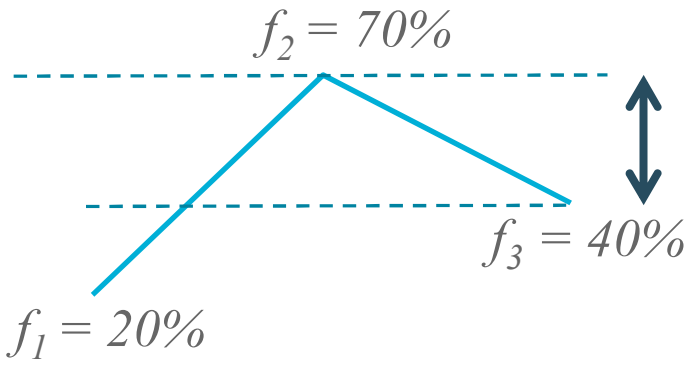
Example of a Flip-Flop

Chance of Rain Forecast



Decision Thresholds experiencing a Flip-Flop

Issue Time

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Motivation

- Messaging
  (Flip-Flops make messaging difficult)
- Soundness of probability forecasts
  (Flip-Flops suggest not all information used)
- Understanding characteristics of a forecast system.
  (Will Flip-Flops become worse if we upgrade a system?)

Examples in this talk compare manual forecasts to automated forecasts (calibrated consensus of NWP).

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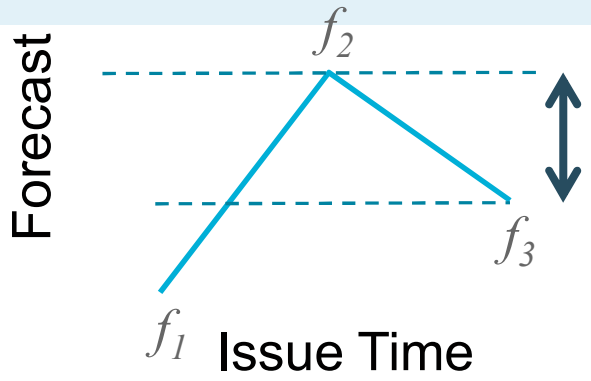
Flip-Flop Index Definition



- For sequence of three forecasts.

$$|f_1 - f_2| + |f_2 - f_3| - \left(\max_i f_i - \min_i f_i\right)$$

For example,

- 50% - 70% - 50% has a Flip-Flop Index of 20%.
- 50% - 90% - 70% has a Flip-Flop Index of 20%.

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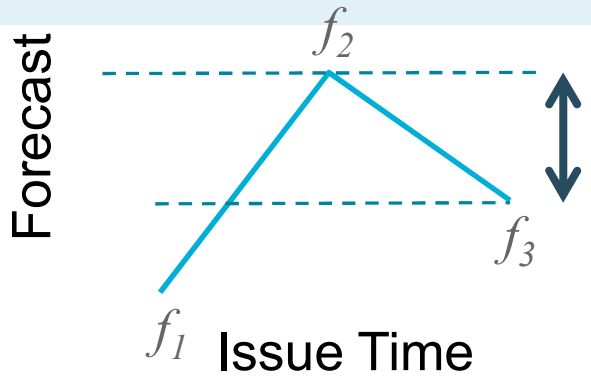
Flip-Flop Index Definition cont.



- No dependence on Observations
- When extended to longer sequences (see abstract),

  lots of small Flip-Flops can equal one large Flip-Flop.
- Accepted for publication (Meteorological Applications)

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Extending to Forecasts of Direction

- What do we do with the circular arithmetic?
- Can we replicate the decision threshold interpretation?

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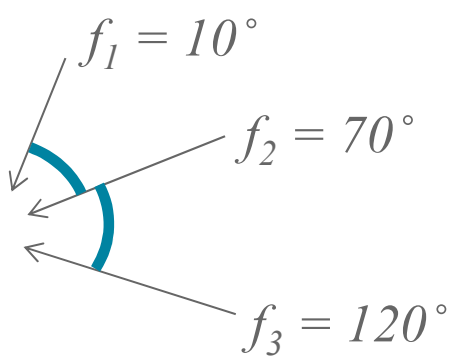
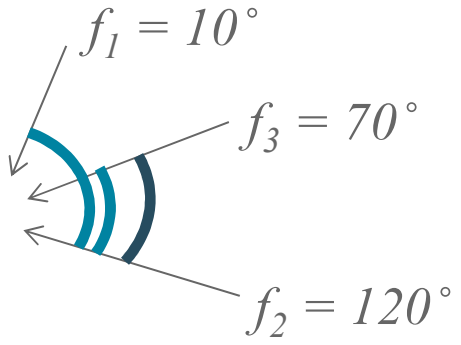
Direction – the easy ones

If all directions are in a 180º sector, we can treat them (essentially) like a scalar.

No Flip-Flop



A Flip-Flop of 50˚



$$\text{Flip-Flop Index} = d(f_1, f_2) + d(f_2, f_3) - \min(180°, \text{ encompassing_sector})$$

$d(f_1, f_2)$ is the smallest angle between the two directions

$\text{encompassing_sector}$ is the angle of the smallest sector that includes all three directions

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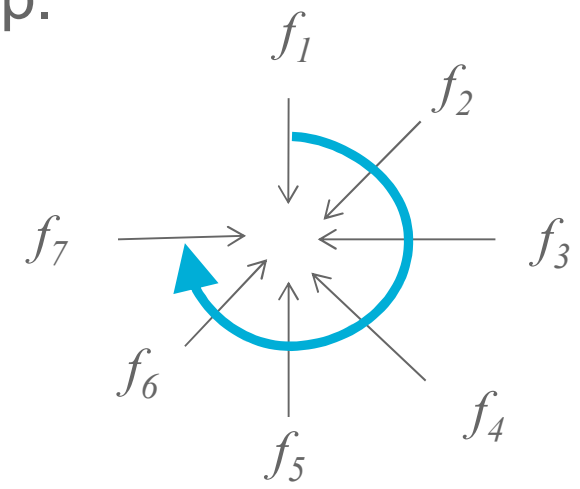
Direction – the harder ones

- The largest directional Flip-Flop is 180º.
- Hence, a forecast sequence

N – NE – E – SE – S – SW – W

has some amount of Flip-Flop.



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Direction – Interpretation

Consider a question: "Does the forecast direction have a northerly component?"

The decision might be how to land on a N-S runway, or where to set up to shelter from the wind.

Then the decision threshold is an east-west line, dividing the northerlies from the southerlies.

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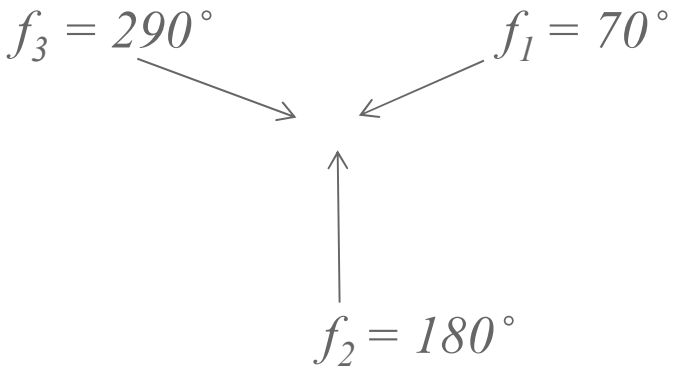
Direction - Interpretation



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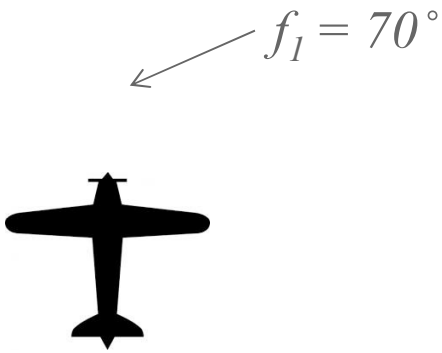
Direction - Interpretation



When we have a northerly component the planes will take off towards the north.

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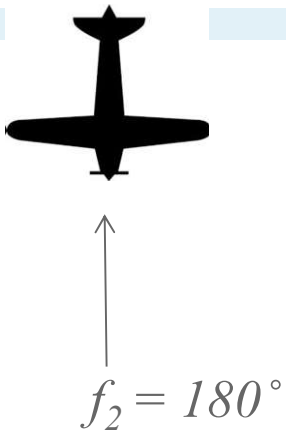
Direction - Interpretation



If we have a southerly component the planes will take off towards the south.

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Direction - Interpretation

$f_3 = 290^\circ$

Here we are back to forecasting a northerly component so have a Flip-Flop.

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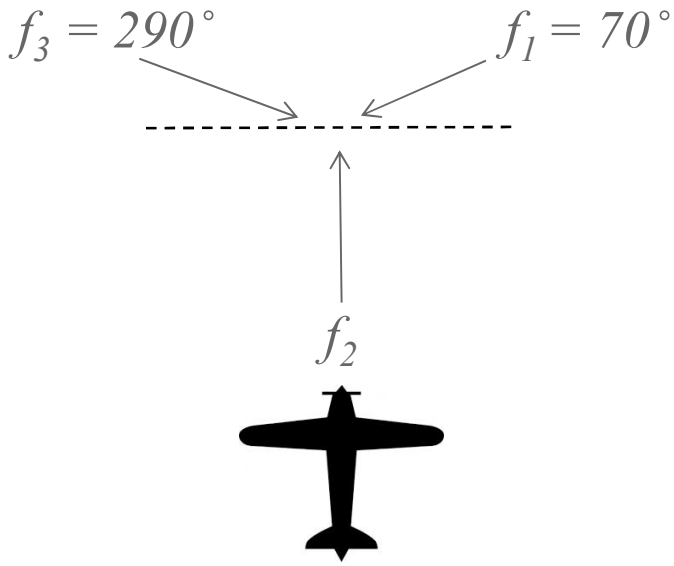
Direction - Interpretation



We discussed N-S aligned runways but there are a range of nearly N-S aligned runways that would consider this a Flip-Flop.

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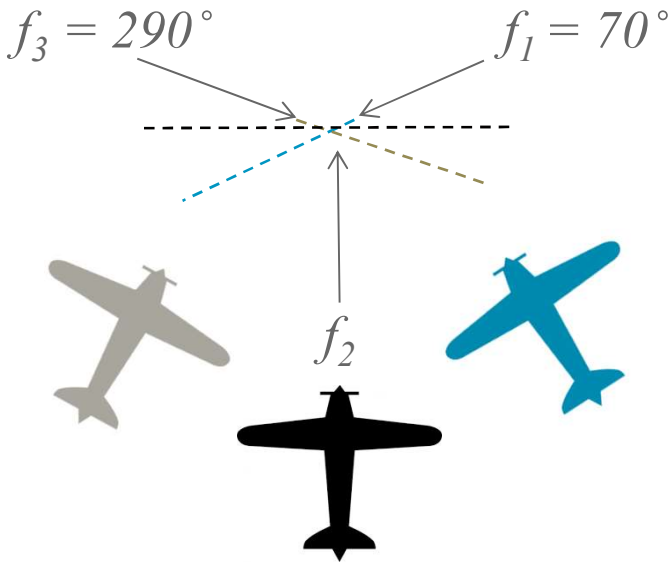
Direction - Interpretation



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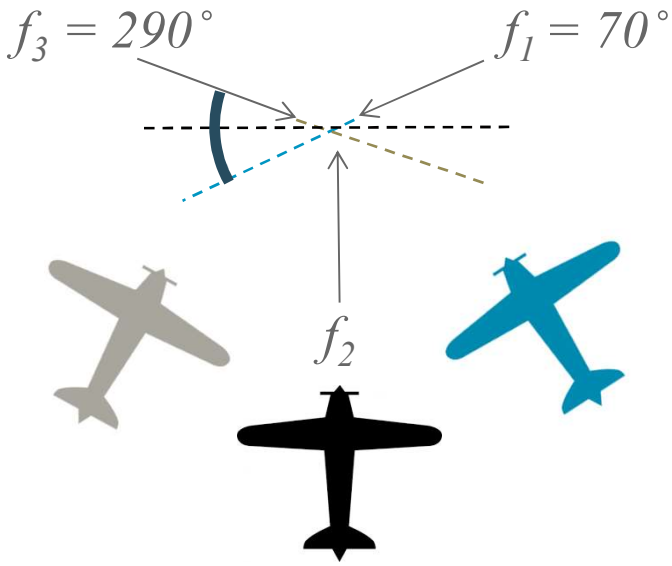
Direction - Interpretation

For this example,

Flip-Flop Index = 40˚



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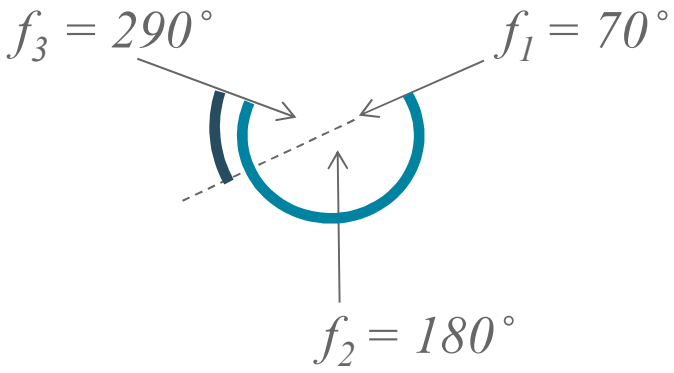

For a sequence of length three, the Flip-Flop Index is

$$d(f_1, f_2) + d(f_2, f_3) - \min(180°,\ \text{encompassing_sector})$$

$d(f_1, f_2)$ is the smallest angle between the two directions

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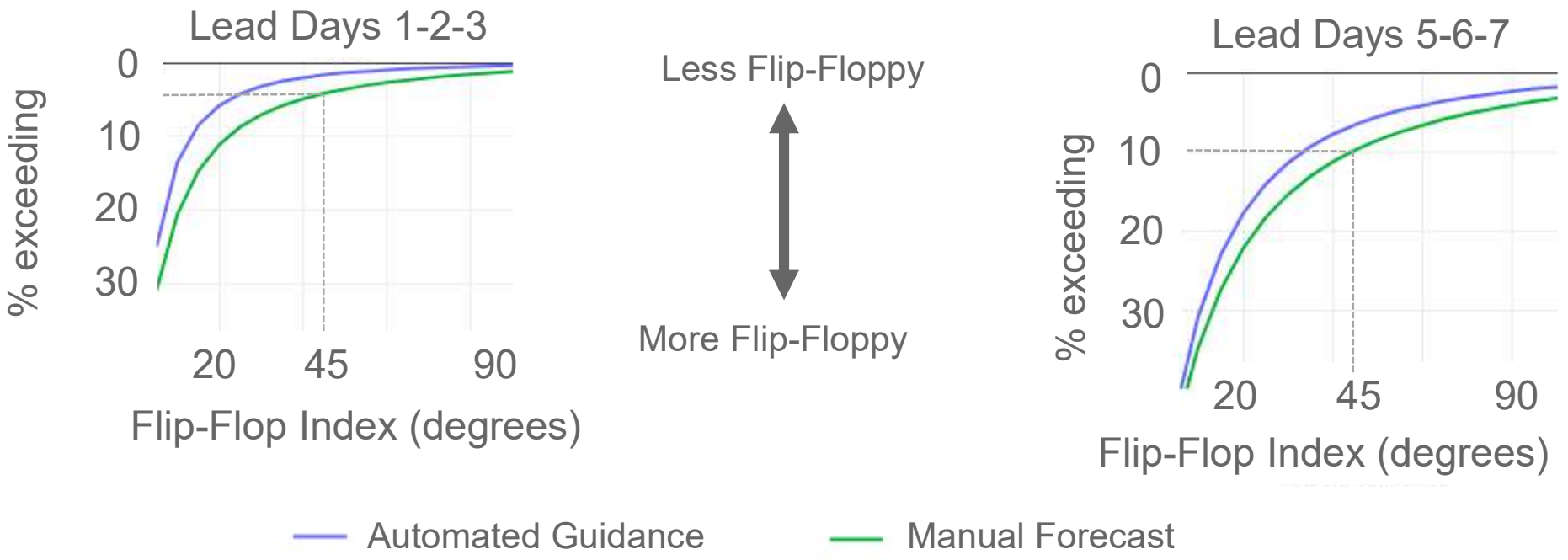
Australian Forecasts of Wind Direction Summer 2017-18



Our short term forecasts Flip-Flop by more than 45 degrees only 4% of the time. Eg N – NE – N or N – E – NE

At longer lead times it is about 10% of forecasts.

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Summary of Australian Results and Implications

Chance of Rain, Wind Speed, Wind Direction:
Automated guidance less flip-floppy than manual forecast.

Decision to use automated guidance can be based on skill.

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Summary of Australian Results and Implications

Chance of Rain, Wind Speed, Wind Direction:
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MinT, MaxT:
Manual forecast less flip-floppy than automated guidance.

Automated guidance shows good skill.

A more difficult decision.

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Thank you…

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