TAP 3

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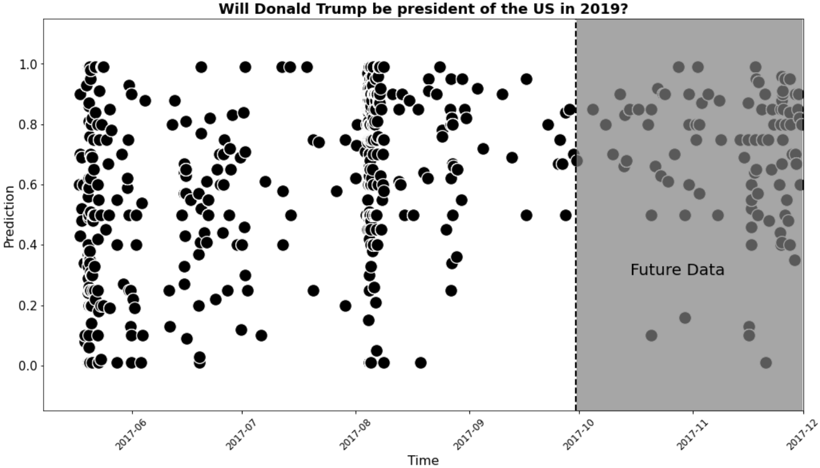
Overview

- Probability forecasting of time-critical events
  - Will the Donald Trump still be in office by Jan 1 2019? (Politics)
  - Will Manchester United score before half time? (Sport)
  - Will an artificial pancreas become mainstream by 2017? (Forecasting Competitions)
- Focusing on constructing methods to extract unobservable methods from time-series data
  - Public opinion changes at certain time points (news influence, court verdicts)
  - Material changes to sports match (goals, red cards,injuries)

Completed Work

- Kairosis: A method for dynamical probability forecast aggregation informed by Bayesian change point detection
  - Planning to submit to the Management Science Fast-Track submission process



Kairosis

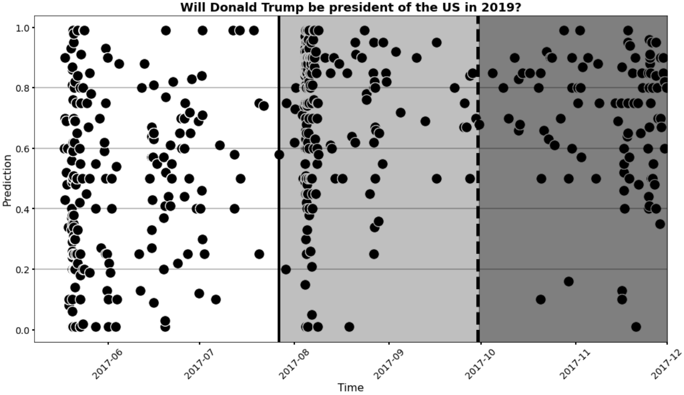


Figure: Weighting a candidate change point. At Oct 10, 2017 (dashed vertical line) we evaluate a candidate change point (solid vertical line) by segregating previous and subsequent forecasts into five bins (separated by horizontal lines), and evaluating the joint likelihood using a Dirichlet-categorical distribution.

Posterior Calculation

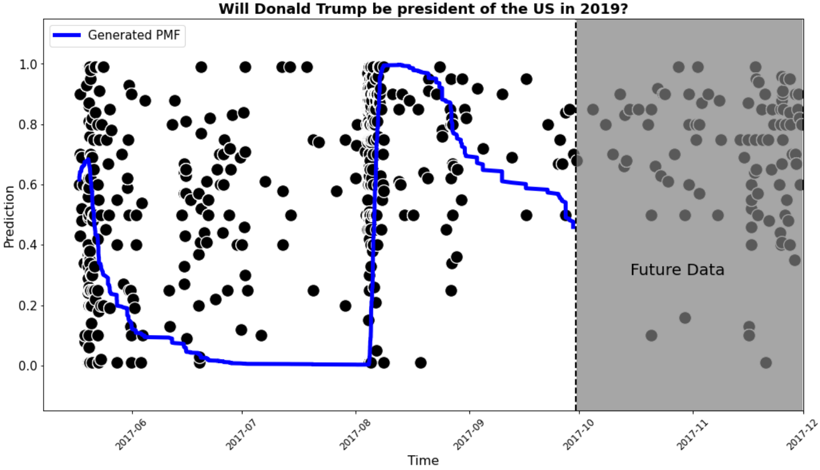
$$P(t^* = t|\text{Forecasts}) = \frac{P(\text{Forecasts}|t^* = t)P(t^* = t)}{P(\text{Forecasts})} \tag{1}$$

$$P(n_1, \ldots, n_K) = \frac{\Gamma(\sum \alpha_k)}{\Gamma(\sum n_k + \alpha_k)} \prod_{k=1}^{K} \frac{\Gamma(n_k + \alpha_k)}{\Gamma(\alpha_k)} \tag{2}$$

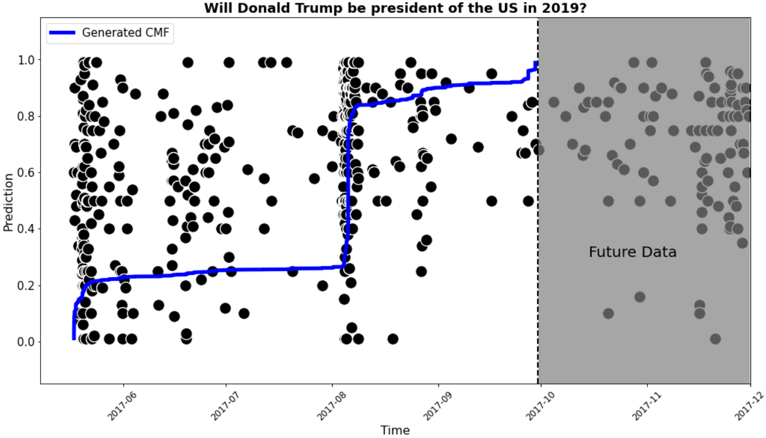
$$P(t^* = t) = p(1-p)^{N-t} \tag{3}$$

$$\begin{aligned} P(t^* = t|\text{Forecasts}) \propto & P(\text{Forecasts}|t^* = t)P(t^* = t) \\ = & \frac{\Gamma(\sum \alpha_k)}{\Gamma(\sum n_k + \alpha_k)} \prod_{k=1}^{K} \frac{\Gamma(n_k + \alpha_k)}{\Gamma(\alpha_k)} \\ & \times \frac{\Gamma(\sum \alpha'_k)}{\Gamma(\sum n'_k + \alpha'_k)} \prod_{k=1}^{K} \frac{\Gamma(n'_k + \alpha'_k)}{\Gamma(\alpha'_k)} \\ & \times p(1-p)^{N-t} \end{aligned} \tag{4}$$

Operational Dynamics



Operational Dynamics



Results

Model	Method	UBS	WBS	ULS	WLS
Unweighted	Median	0.000	0.000	0.000	0.000
	Mean	3.51	0.452	12.9	5.02
Kairosis	Median	$\boxed{-7.07}$	$\boxed{-7.37}$	$\boxed{-15.4}$	$\boxed{-16.6}$
	Mean	−4.46	−6.66	−6.31	−12.5
Most Recent 20%	Median	−4.53	13.4	−11.9	36.8
	Mean	−1.49	2.41	−0.57	7.06
Exponential Decay	Median	−4.83	−5.53	−12.2	−12.6
	Mean	−1.52	−5.98	1.09	−9.55

Table: Model performance comparison. Means and medians in four models (rows) against time-weighted and unweighted Brier and log scores (columns). Table entries are [score minus unweighted median score]$\times 10^3$.

Comparison of Methods

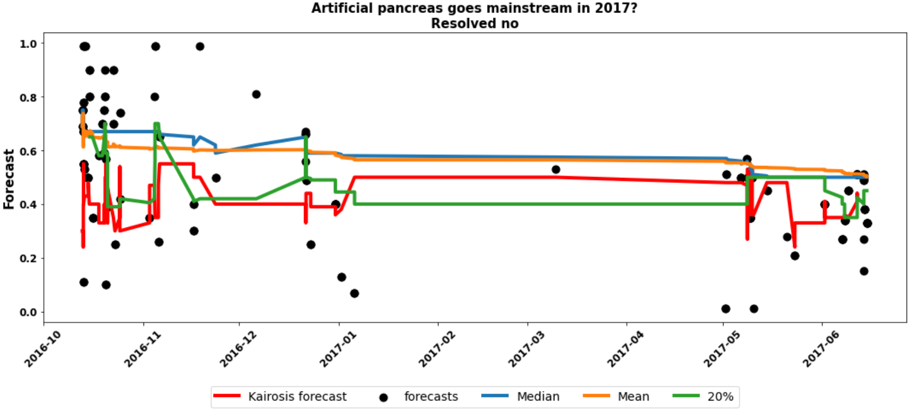


Figure: Comparison of Methods. For a further question resolved as "no", on the general availability of an artificial pancreas by 2017, the plot shows the kairosis forecast along with the mean, median, and median of most recent 20%.

Current Work

- Markov Decision Processes in Football Matches
- Relation to Previous Paper
- Why use sports data?
- Nobuyoshi Hirotsu, Yuki Masui, Yu Shimasaki, Masafumi Yoshimura, Modelling tactical changes in association football using a Markov game, IMA Journal of Management Mathematics, 2024;, dpae002, https://doi.org/10.1093/imaman/dpae002
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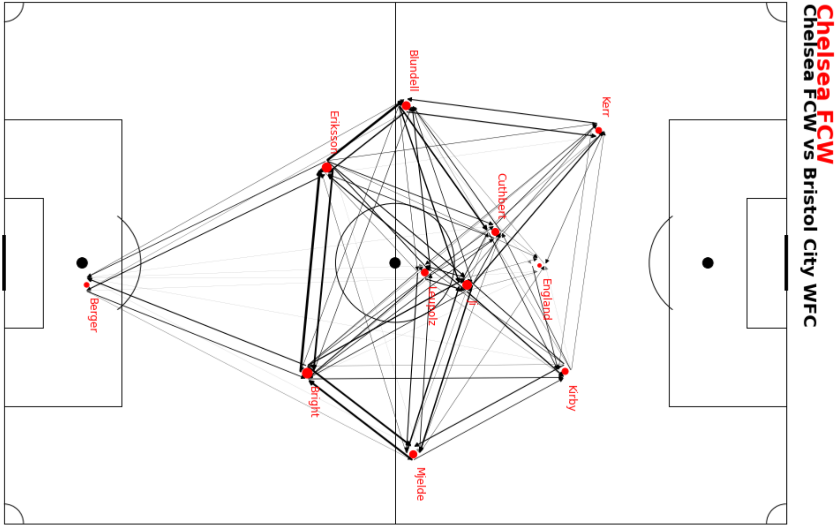
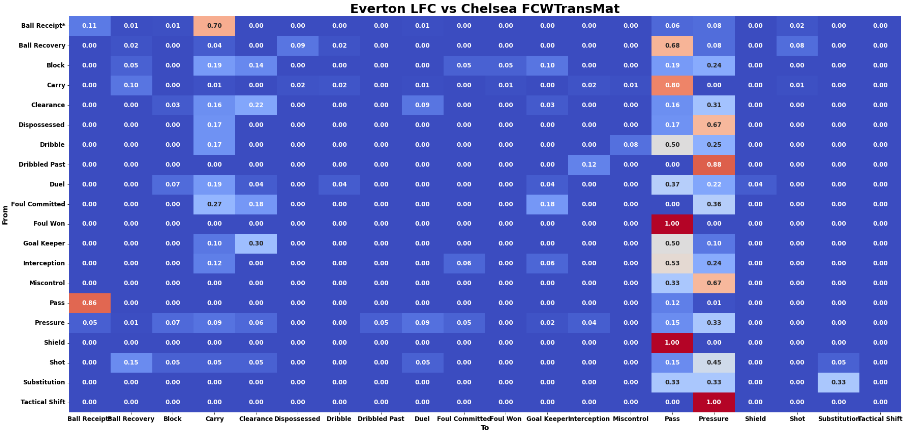
		Proposed Transition Matrix			
		To			
	State	P_Home	P_Away	Goal_Home	Goal_Away
From	P_Home	P(P_Home|P_Home)	P(P_Away|P_Home)	P(G_Home|P_Home)	P(G_Away|P_Home)
	P_Away	P(P_Home|P_Away)	P(P_Away|P_Away)	P(G_Home|P_Away)	P(G_Away|P_Away)
	Goal_Home	ABSORBING STATE	ABSORBING STATE	ABSORBING STATE	ABSORBING STATE
	Goal_Away	ABSORBING STATE	ABSORBING STATE	ABSORBING STATE	ABSORBING STATE

Ex 1


Chelsea FCW
Chelsea FCW vs Bristol City WFC
Blundell
Kerr
Eriksson
Cuthbert
England
Leupolz
Ji
Berger
Bright
Kirby
Mjelde

Ex 2


Everton LFC vs Chelsea FCWTransMat
From
To
Ball Receipt Ball Recovery Block Carry Clearance Dispossessed Dribble Dribbled Past Duel Foul Committed Foul Won Goal Keeper Interception Miscontrol Pass Pressure Shield Shot Substitution Tactical Shift
Ball Receipt* 0.11 0.01 0.01 0.70 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.06 0.08 0.00 0.02 0.00 0.00
Ball Recovery 0.00 0.02 0.00 0.04 0.00 0.09 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.68 0.08 0.00 0.08 0.00 0.00
Block 0.00 0.05 0.00 0.19 0.14 0.00 0.00 0.00 0.00 0.05 0.05 0.10 0.00 0.00 0.19 0.24 0.00 0.00 0.00 0.00
Carry 0.00 0.10 0.00 0.01 0.00 0.02 0.02 0.00 0.01 0.00 0.01 0.00 0.02 0.01 0.80 0.00 0.00 0.01 0.00 0.00
Clearance 0.00 0.00 0.03 0.16 0.22 0.00 0.00 0.00 0.09 0.00 0.00 0.03 0.00 0.00 0.16 0.31 0.00 0.00 0.00 0.00
Dispossessed 0.00 0.00 0.00 0.17 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.17 0.67 0.00 0.00 0.00 0.00
Dribble 0.00 0.00 0.00 0.17 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.08 0.50 0.25 0.00 0.00 0.00 0.00
Dribbled Past 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.12 0.00 0.00 0.88 0.00 0.00 0.00 0.00
Duel 0.00 0.00 0.07 0.19 0.04 0.00 0.04 0.00 0.00 0.00 0.00 0.04 0.00 0.00 0.37 0.22 0.04 0.00 0.00 0.00
Foul Committed 0.00 0.00 0.00 0.27 0.18 0.00 0.00 0.00 0.00 0.00 0.00 0.18 0.00 0.00 0.00 0.36 0.00 0.00 0.00 0.00
Foul Won 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.00 0.00 0.00 0.00 0.00 0.00
Goal Keeper 0.00 0.00 0.00 0.10 0.30 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.50 0.10 0.00 0.00 0.00 0.00
Interception 0.00 0.00 0.00 0.12 0.00 0.00 0.00 0.00 0.00 0.06 0.00 0.06 0.00 0.00 0.53 0.24 0.00 0.00 0.00 0.00
Miscontrol 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.33 0.67 0.00 0.00 0.00 0.00
Pass 0.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.12 0.01 0.00 0.00 0.00 0.00
Pressure 0.05 0.01 0.07 0.09 0.06 0.00 0.00 0.05 0.09 0.05 0.00 0.02 0.04 0.00 0.15 0.33 0.00 0.00 0.00 0.00
Shield 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.00 0.00 0.00 0.00 0.00 0.00
Shot 0.00 0.15 0.05 0.05 0.05 0.00 0.00 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.15 0.45 0.00 0.00 0.05 0.00
Substitution 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.33 0.33 0.00 0.00 0.33 0.00
Tactical Shift 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.00 0.00 0.00 0.00 0.00