Comparison of Parametric Linear Model Identification Techniques for Prediction in Type 1 Diabetes

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1. INTRODUCTION

- Both manual and automatic Blood Glucose (BG) control would greatly benefit of accurate BG predictions
- Key challenge in BG prediction: intra- & inter-subject variability
- To tackle this challenge: identification of individualized model for patient-specific prediction, employing carbohydrate, insulin information and past BG values
- Experimental evidences suggest that a linear approximation can capture the essential dynamics of the nonlinear glucose-insulin system
- Dynamic systems could be approximated by parametrized data-driven models describing the relation between input and output. These models could thus have two different degrees of freedom: the model parametrization, and the model complexity, related to the number of parameters estimated e.g. by different order selection criteria

2. AIM

➢ To explore the impact on prediction performance of the two degrees of freedom: model parametrizations and order selection criteria

3. DESIGN & METHODS

- 14 days of simulated data were generated for 100 virtual subjects using the UVA/Padova T1D Simulator
  - 7 days for training
  - 7 days for test
- Identification of individualized linear predictors based on black-box models[1], by using:
  - Prediction Error Method (PEM) for the estimation of model parameters
  - Different parametrizations:
    - AutoRegressive with eXougenous inputs (ARX)
    - AutoRegressive Moving-Average with eXogenous inputs (ARMAX)
    - Box-Jenkins (BJ)
  - Different order selection criteria:
    - Parsimony criteria, i.e. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)
    - Cross-validation (CV)
- Prediction performance
  - For multiple Prediction Horizons (PH)
  - Assessed with Coefficient Of Determination (COD)
  - Comparison of results with ANOVA

4. RESULTS

➢ 5-min prediction: very similar performance, average COD ~ 99.3%. p-value among model classes and order selection criteria equal to, respectively, 0.5 and 0.3

➢ Higher prediction horizon: deterioration in the prediction's accuracy, but still similar performance (see Table 1)

3-hr COD (%)	CV	AIC	BIC	ANOVA
ARX	41.30	39.20	30.00	
ARMAX	43.30	41.10	38.50	**p-value = 0.20**
BJ	40.30	43.80	39.90	
ANOVA	**p-value = 0.10**			

Table 1: Median values of the 3-hr COD for different combination of model parametrization and automatic technique for individual order selection, with the respective p-values

5. CONCLUSIONS

➢ No significant difference neither between model classes, nor between order selection criteria, suggesting that these degrees of freedom have little impact on the final performance

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