eXiT Control Engineering and Intelligent Systems

Universitat de Girona

CBR BASED BOLUS RECOMMENDER SYSTEM

Ferran Torrent-Fontbona

Introduction

- People with T1DM are usually in basal-bolus therapy
- Timely and accurate insulin dosage avoids hyperglycaemia and its consequent complications and reduces the risk of hypoglycaemia
- Bolus calculators:
  - Available in market products: pumps, glucose meters, apps…
  - They have been proved useful at improving glycaemic self-control
  - Drawbacks: difficulty setting parameters, need to regularly adjust them…
  - Far from achieving optimal results

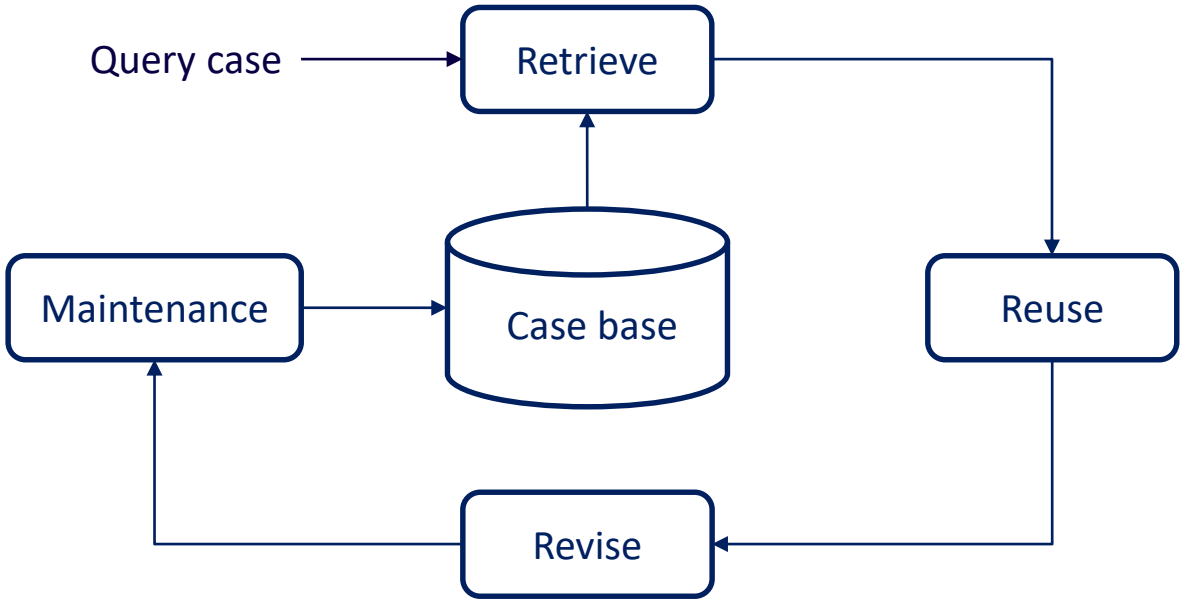
Objectives

- Provide a method capable of:
  - Estimating the personalised bolus calculator parameters
  - Learning from past experiences to adapt to new situations
  - Providing personalised adaptive bolus recommendations

CASE BASED REASONING

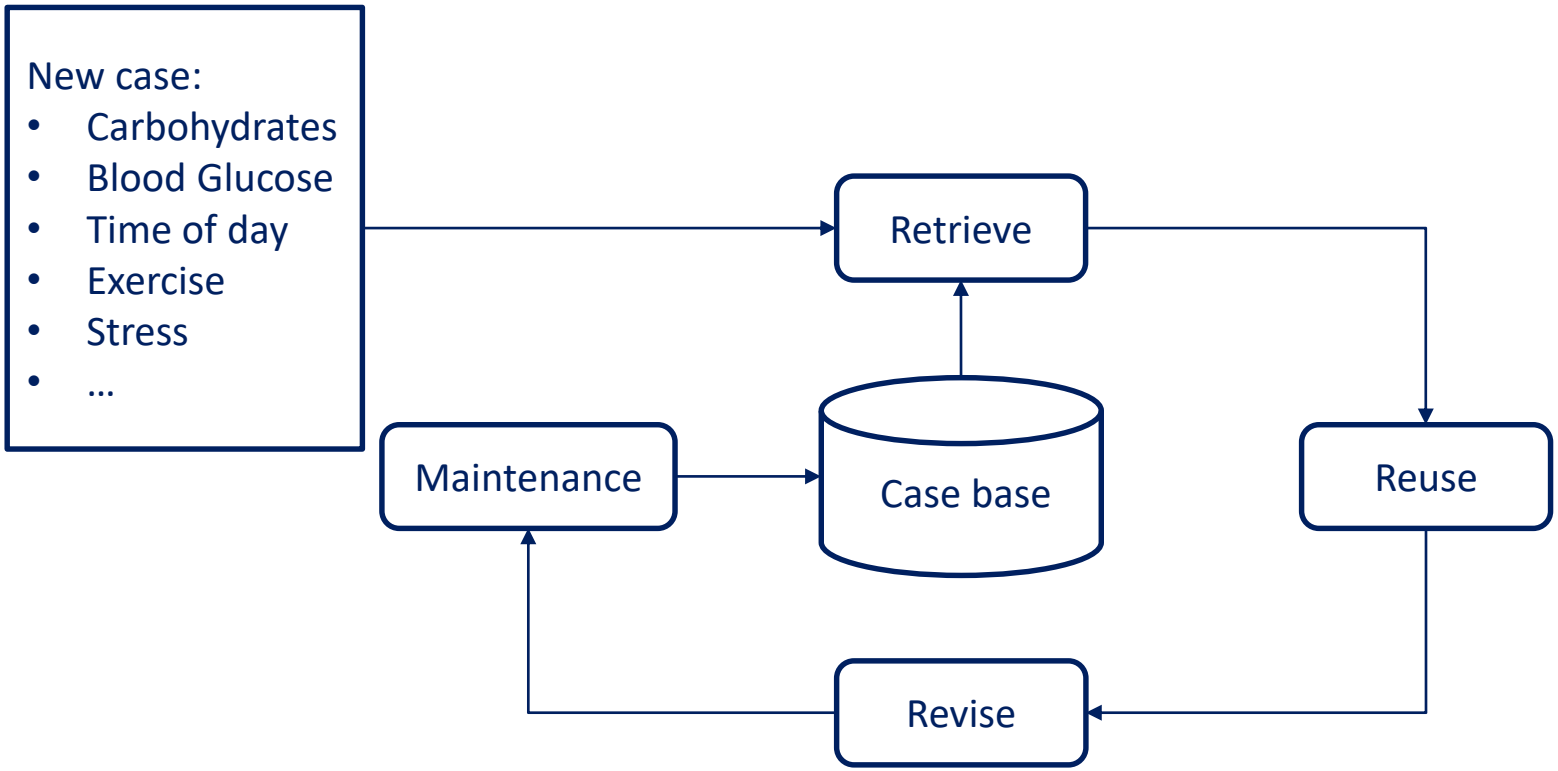
Case based reasoning

- Lazy learning method
- Propose new solutions using past experiences
- Good results with small amounts of data



Bolus recommender system

- The CBR estimates the Insulin to Carbs Ratio (ICR) and Insulin Sensitivity Factor (ISF)
- Then, it calculates the bolus dose



Retrieve

Objective: select similar past experiences

- ISF and ICR depend on several factors: stress, time of day, menstruations, illnesses…
- Not all factors have the same impact
- Proposed retrieve consists of two steps:
  - Context reasoning (select the case base corresponding to the context)
  - Similarity measure and case retrieval

Objective: Adapt past solutions to the new case

- Reuse ICR from retrieved cases
  - Weighted average according to the similarity
- Calculate ISF using the ICR

$$ISF = \frac{341.94 \cdot ICR}{W}$$

Walsh *et al.* (2011). *Journal of Diabetes Science and Technology*

- Calculate bolus dose

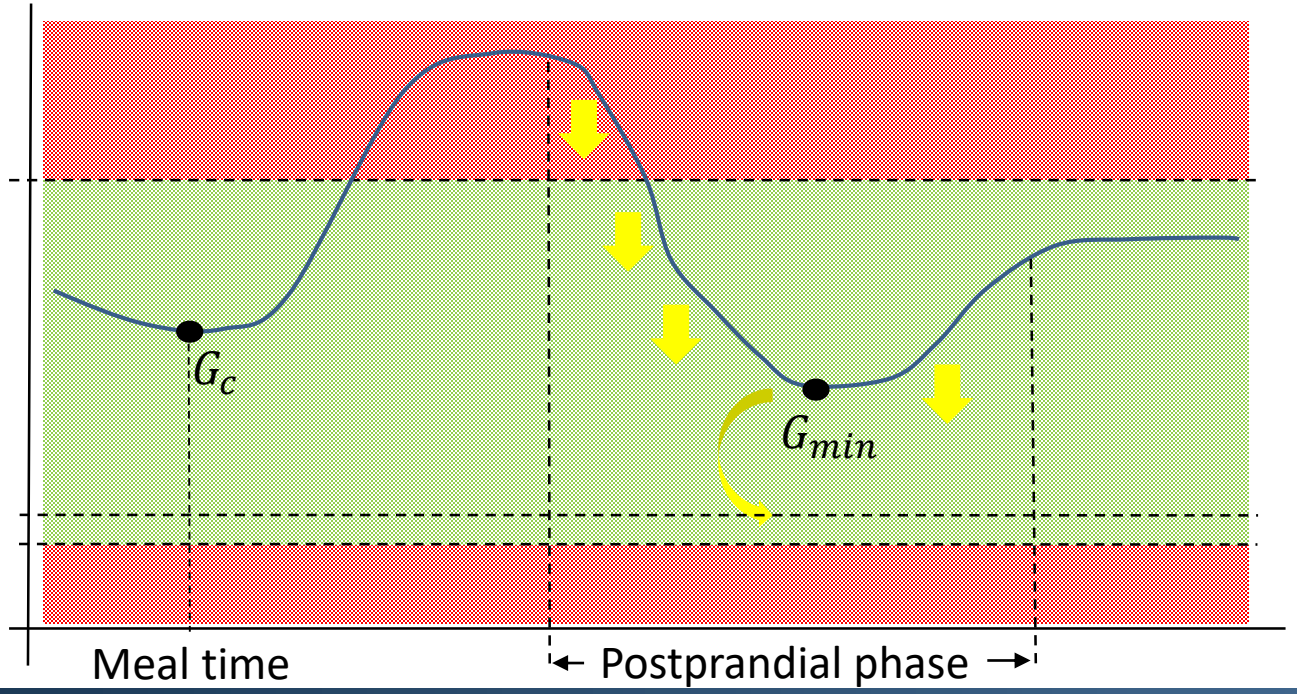
$$B = \frac{CHO}{ICR} + \frac{G_c - G_{sp}}{ISF} - IOB$$

CHO: carbs
G_c: blood glucose level
G_{sp}: blood glucose target
IOB: insulin on board
W: body weight

Objective: revise and repair the proposed solution

- Revise: check minimum postprandial blood glucose and correct the recommended bolus (and ICR and ISF) to bring the value to the target one

$$\widehat{ICR} = (1-\alpha)ICR_{reuse} + \alpha ICR_c$$



Maintenance

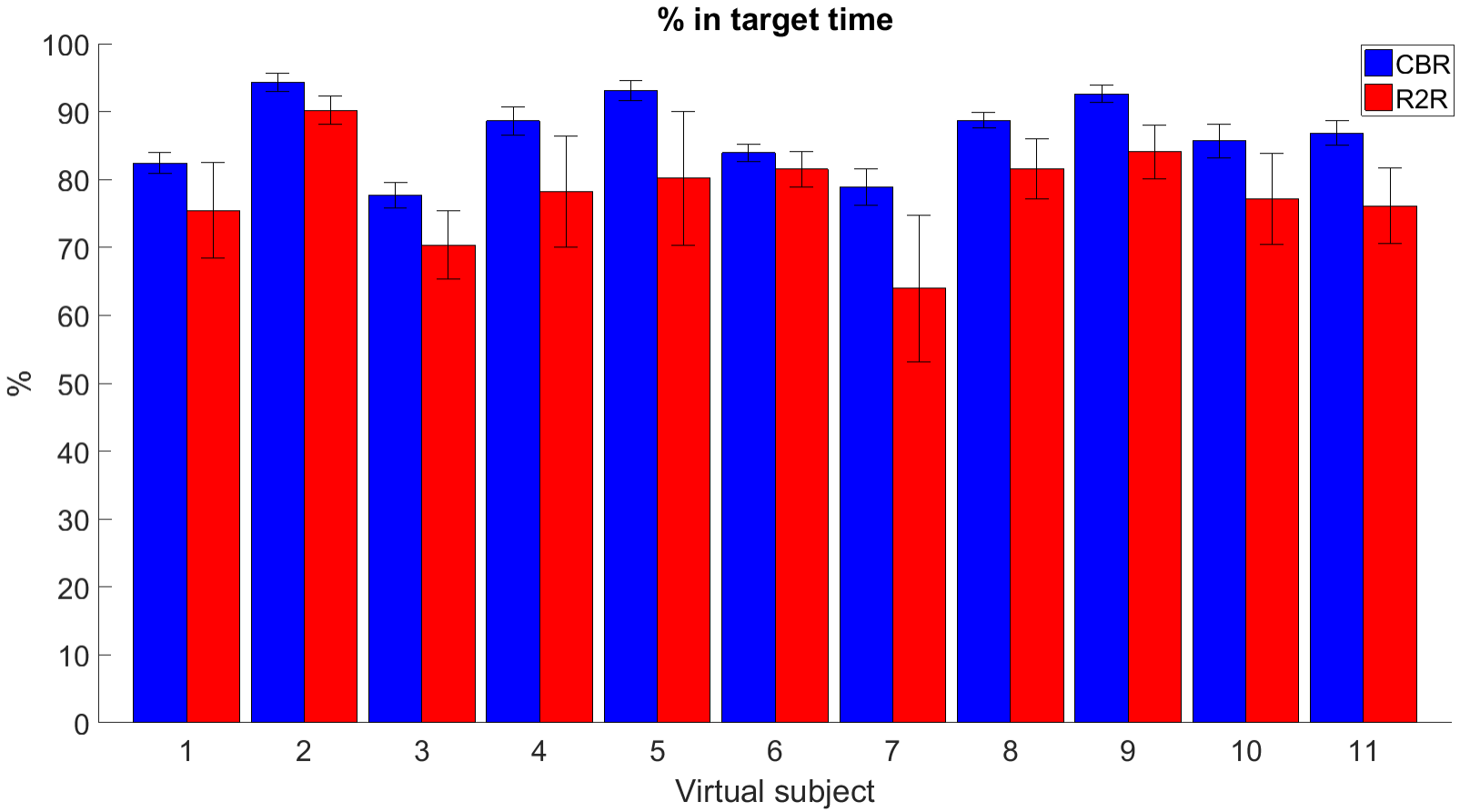
Objective: manage the case base to keep it updated and efficient

- Concept drift problem
- Proposed maintenance
  - Save the revise query case
  - If there are similar enough cases to the query case in the case base, then remove them

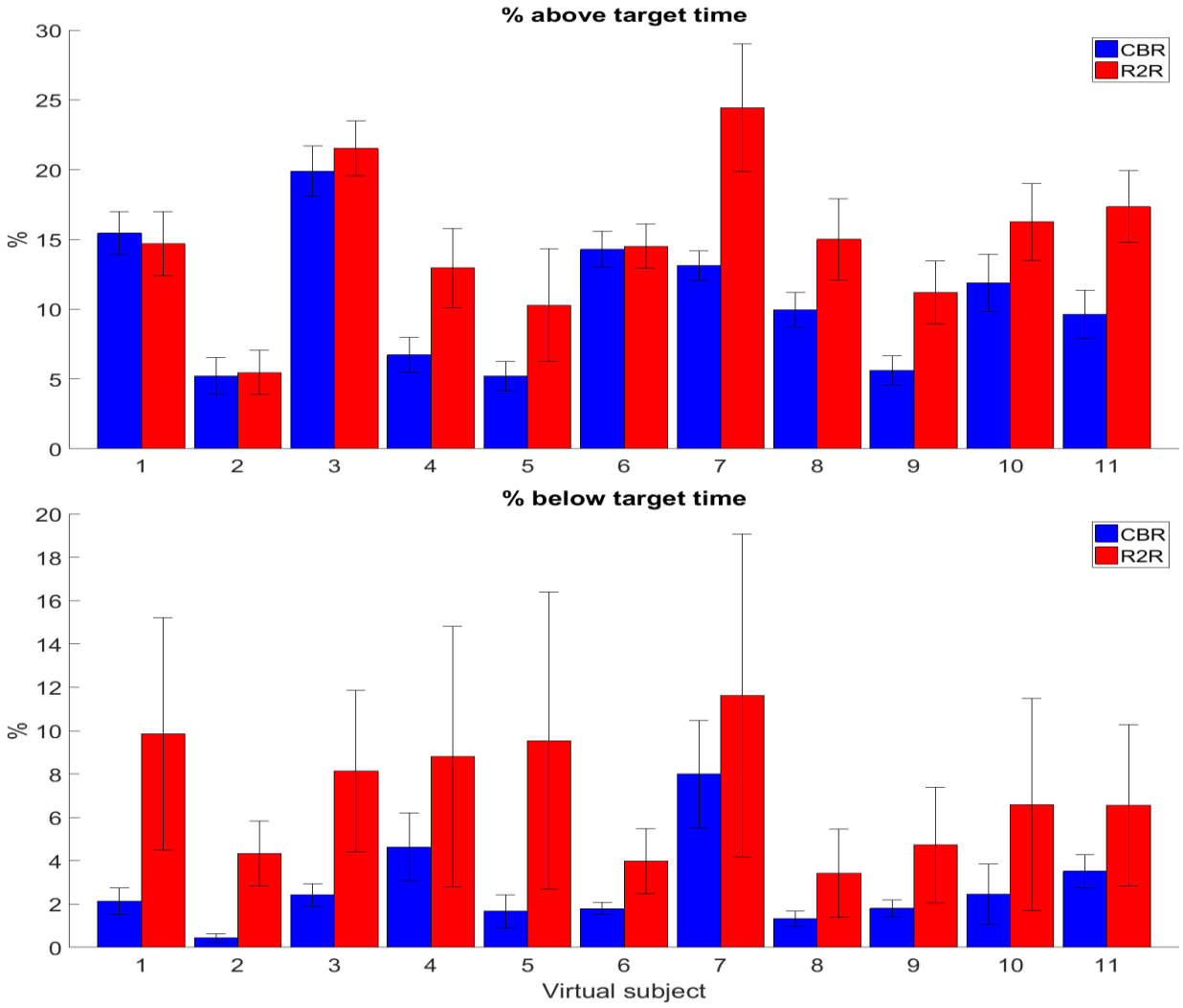
Experimentation

- 11 virtual adults using UVA/PADOVA simulator
- Intra-day and physical activity variability have been added
- 50 simulations of 90-days
- Comparison with a run-to-run algorithm

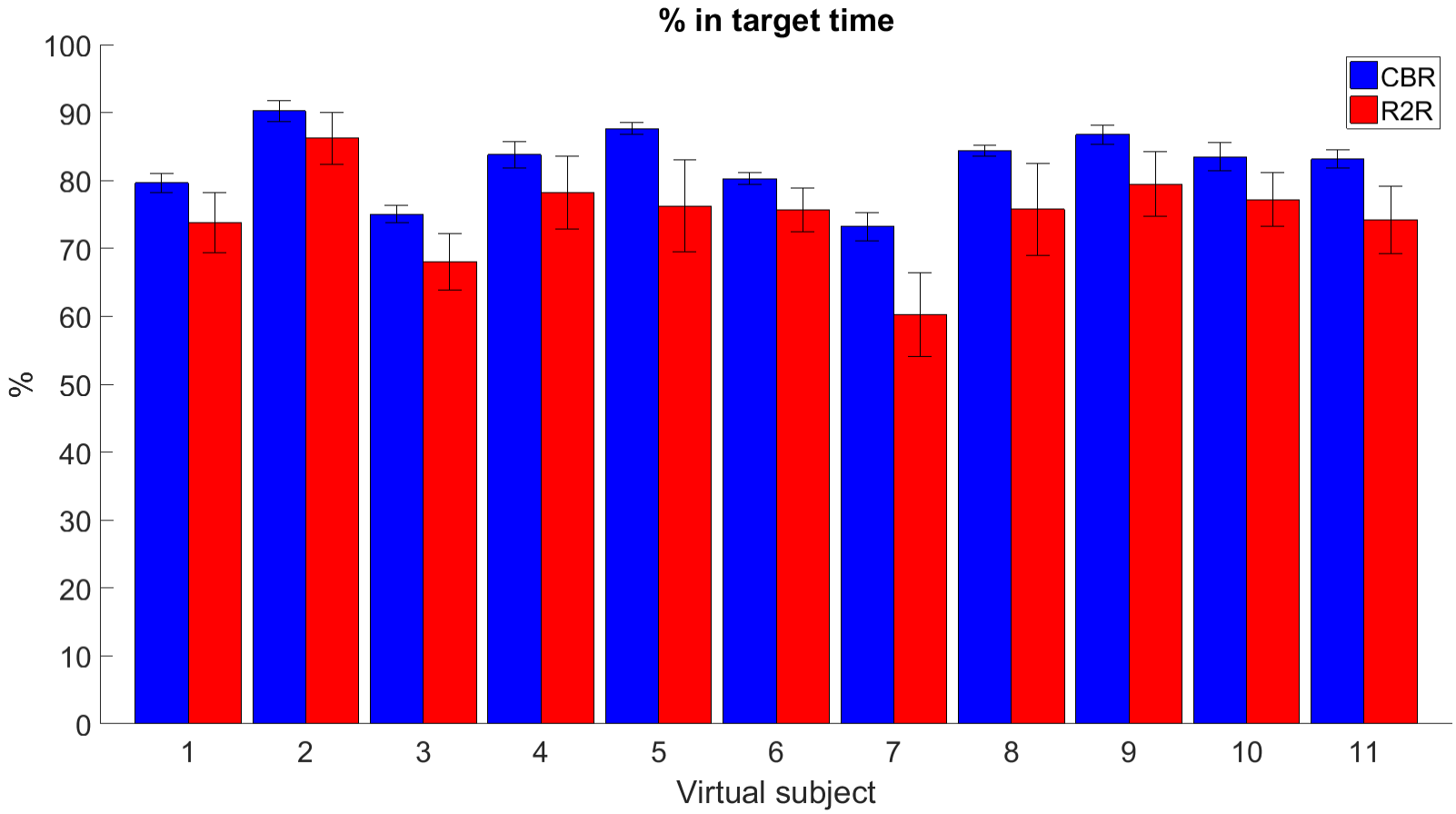
Results (without exercise)



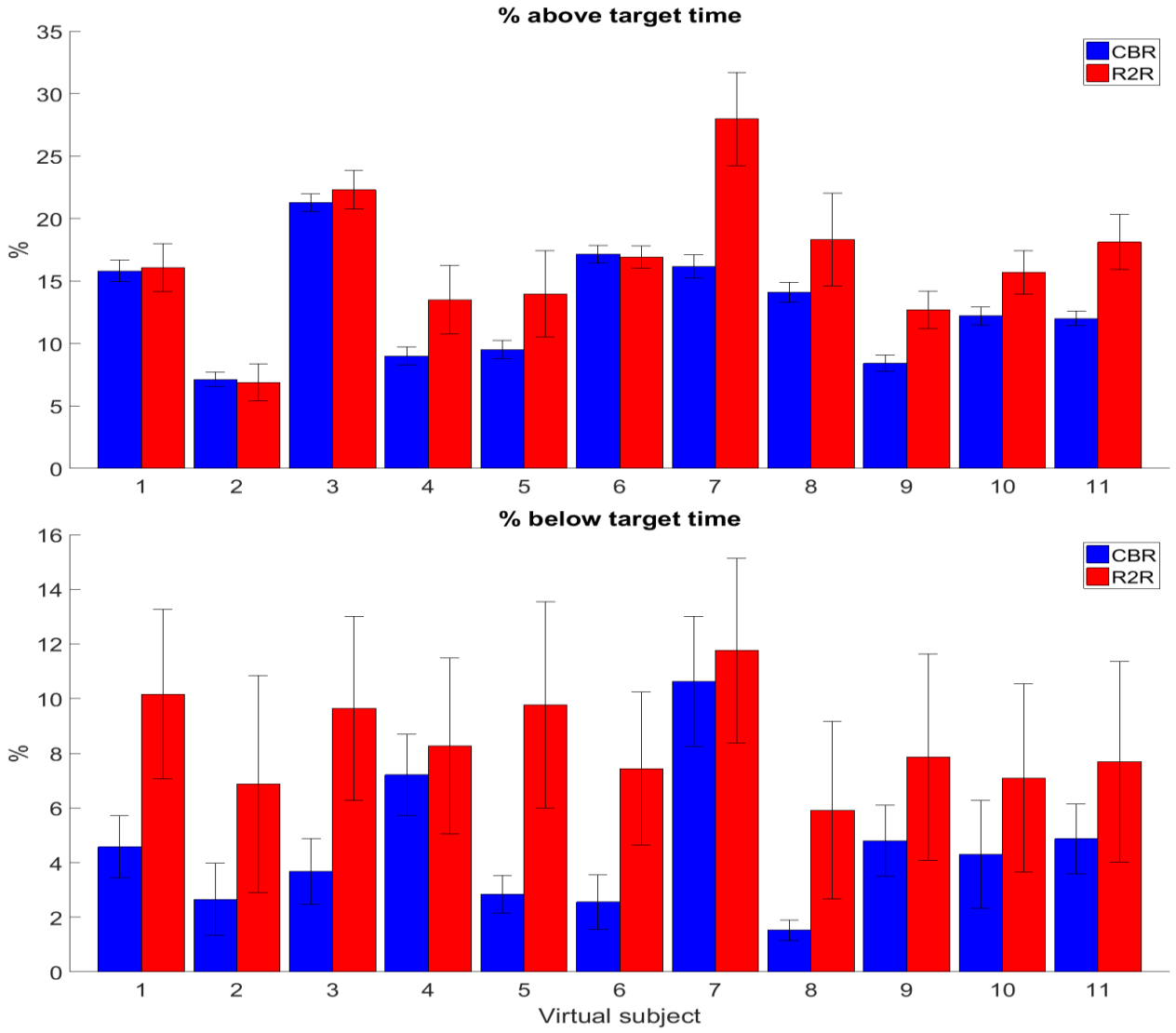
Results (without exercise)



Results (with exercise)



Results (with exercise)



Conclusions

- The proposed system:
  - Automatically estimates the personalised ICR and ISF
  - Is capable of adapting the parameters to new situations
- Results are promising

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pepper
patient empowerment through predictive personalised decision support

THANK YOU FOR YOUR ATTENTION

ferran.torrent@udg.edu

Results (summary)

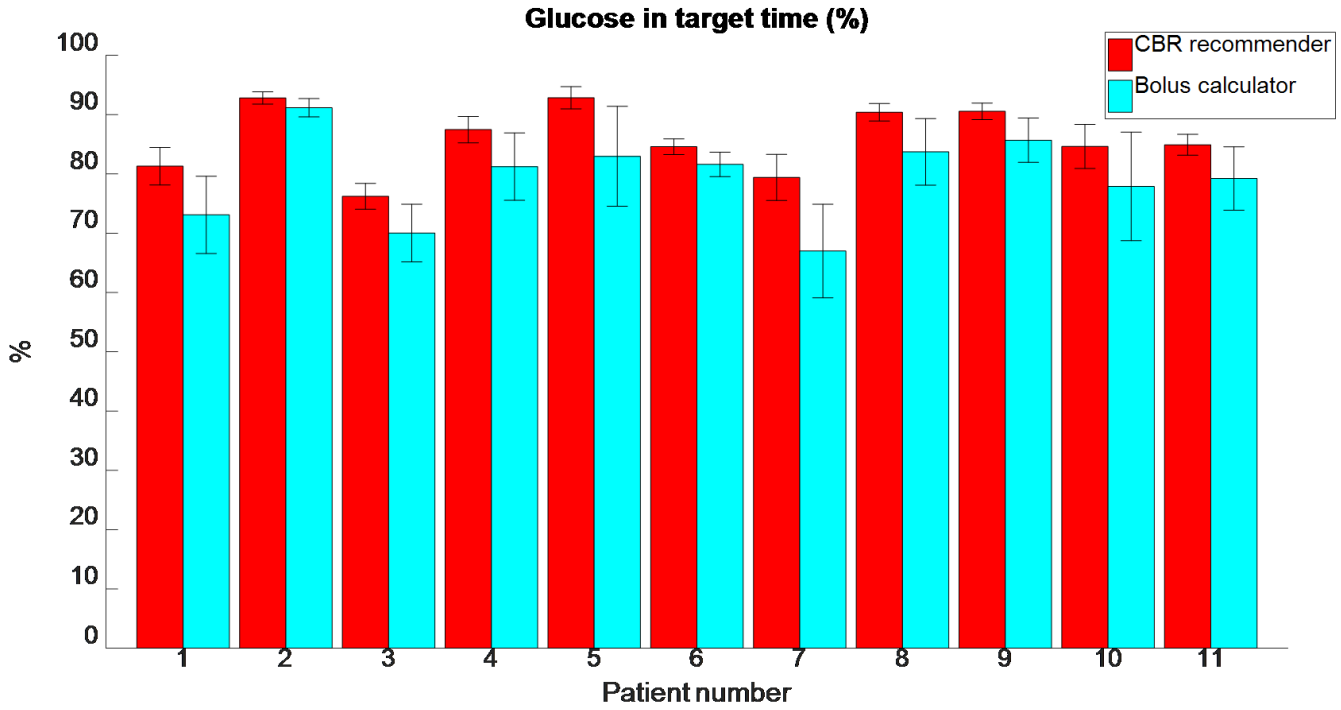
		CBR (avg ± std)	R2R (avg ± std)
Without exercise	In target (%)	86.62 ± 1.73	78.07 ± 6.01
	Below target (%)	2.74 ± 0.85	7.05 ± 4.16
	Above target (%)	10.63 ± 1.40	14.88 ± 2.68
With exercise	In target (%)	82.51 ± 1.43	75.00 ± 4.93
	Below target (%)	4.51 ± 1.29	8.41 ± 3.43
	Above target (%)	12.98 ± 0.73	16.59 ± 2.26

Future work

- Automatically learn similarity measure weights
- Similarity measure capable to deal with missing values
- Adaptable learning rate

Results (I)

- Without physical activity



Results (II)

- With physical activity