



8 – 12 July 2023 | International Convention Centre Sydney (ICC)

Digital Twins for More Precise and Personalized Treatment

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INTRODUCTION

- Digital twins are digital replicas of physical entities.
- Digital twins help efficiently simulate and forecast states of physical entities.
- We explore the creation and use of digital twins of patients in healthcare.
- The aim is to enable precision and personalized care for chronic conditions.



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OUR WORK

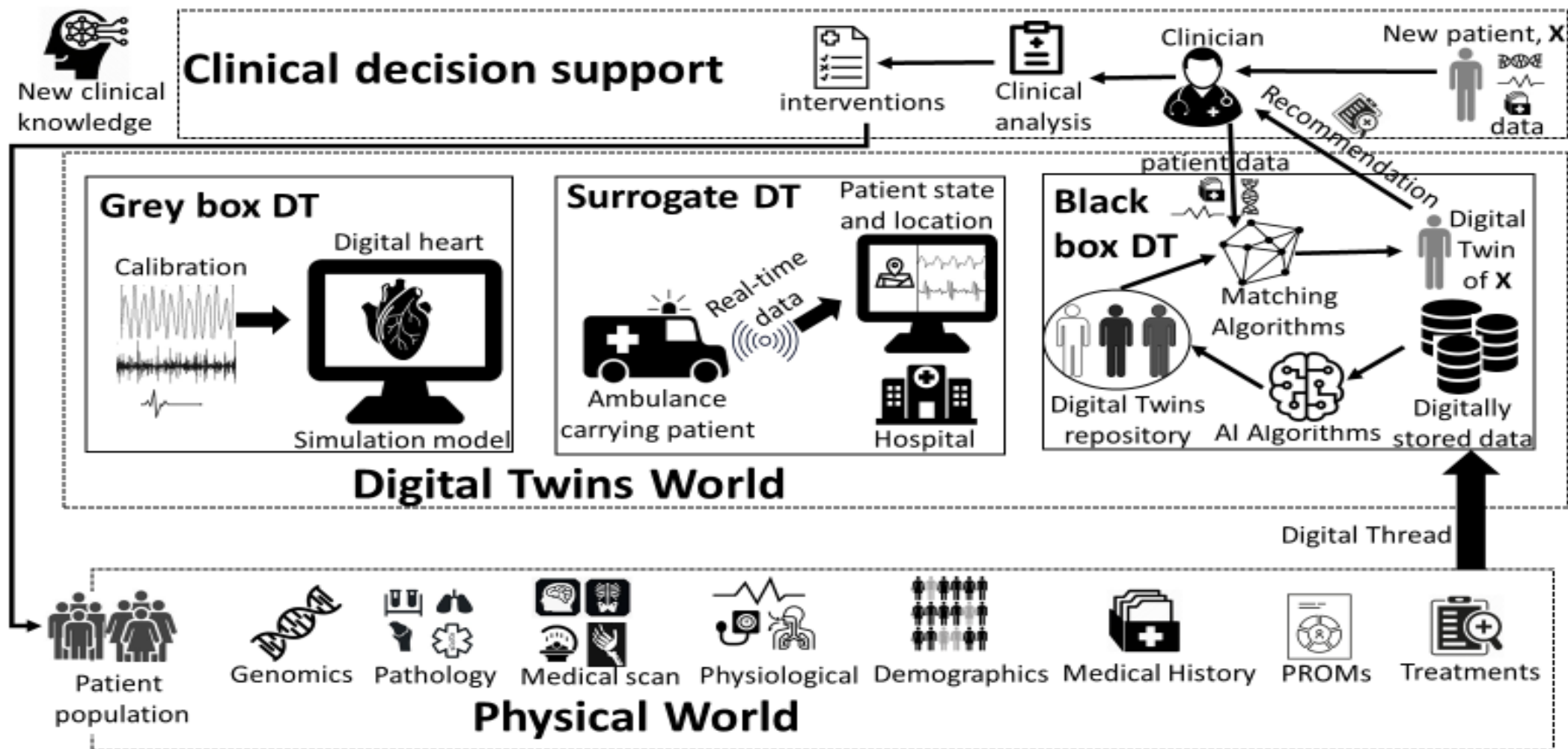
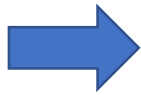


Figure Wickramasinghe et al. 2021

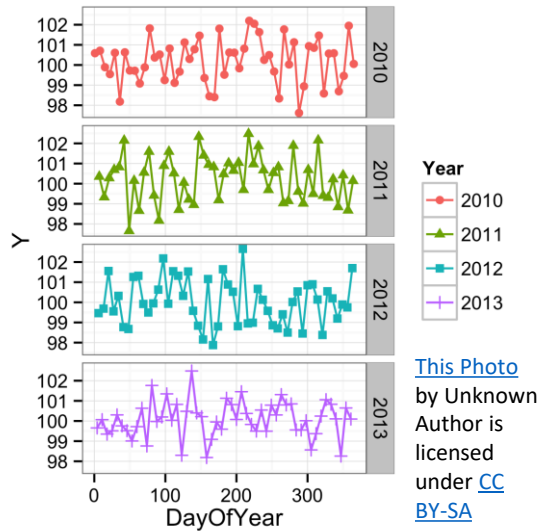
OUR WORK

We propose constructing digital twins form data of previous patients.

Previous patients



Have historical data



Have digital models developed from historical data

$$y^1(t) = f^1 [x^1(t - 1), x^1(t - 2), x^1(t - 3), \dots]$$

$$y^2(t) = f^2 [x^2(t - 1), x^2(t - 2), x^2(t - 3), \dots]$$

$$\vdots$$

$$y^n(t) = f^n [x^n(t - 1), x^n(t - 2), x^n(t - 3), \dots]$$



Construct digital twin from historical data of previous patients

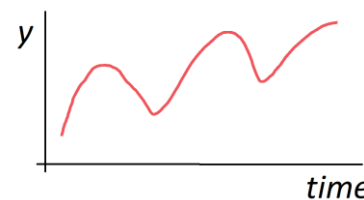
$$y(t) = f [x(t - 1), x(t - 2), x(t - 3), \dots]$$

$$y(t) = a_0 + \sum_{i=1}^n a_i f^i [x^i(t - 1), x^i(t - 2), x^i(t - 3), \dots]$$

New patient

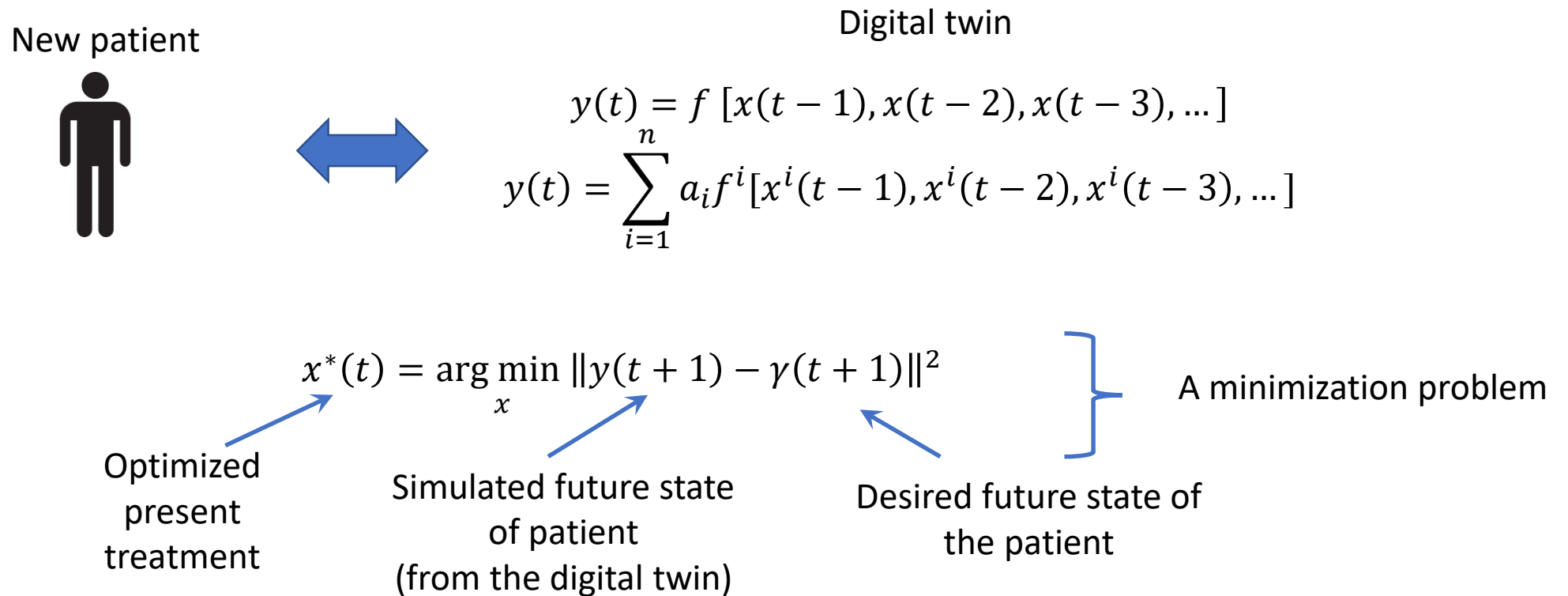


Has minimal data



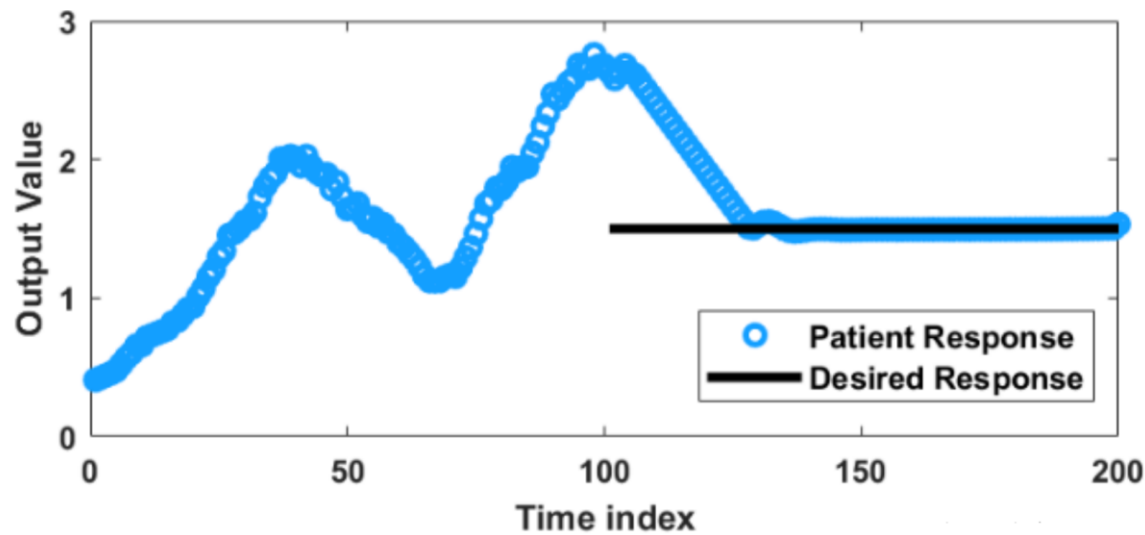
OUR WORK

With the aid of the digital twin, the aim is to compute more precise and personalized treatments.

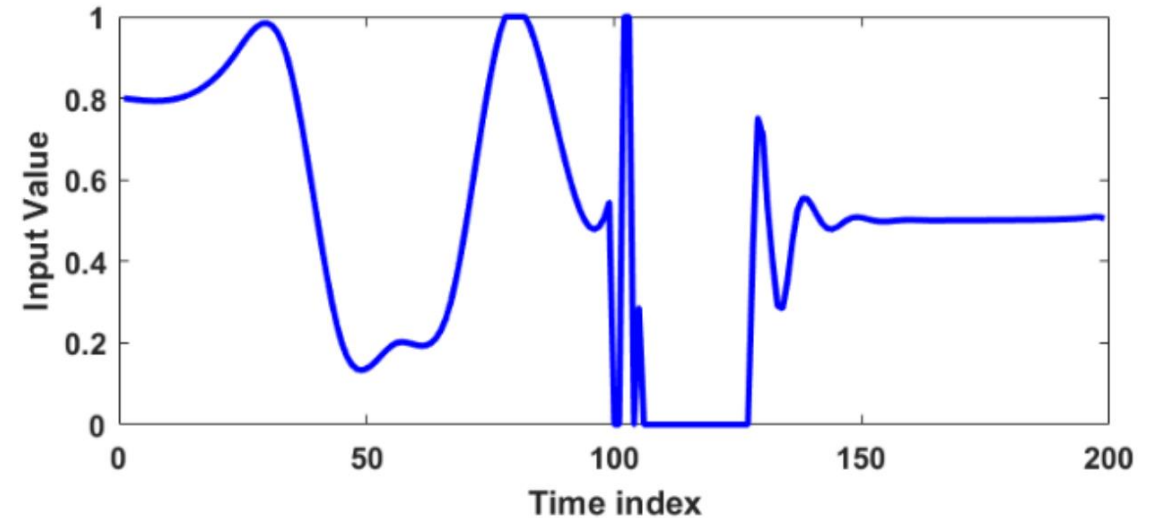


RESULTS TO DATE

We have experimented several cases through synthetic numerical data as proof of concept, prior to working with real data.



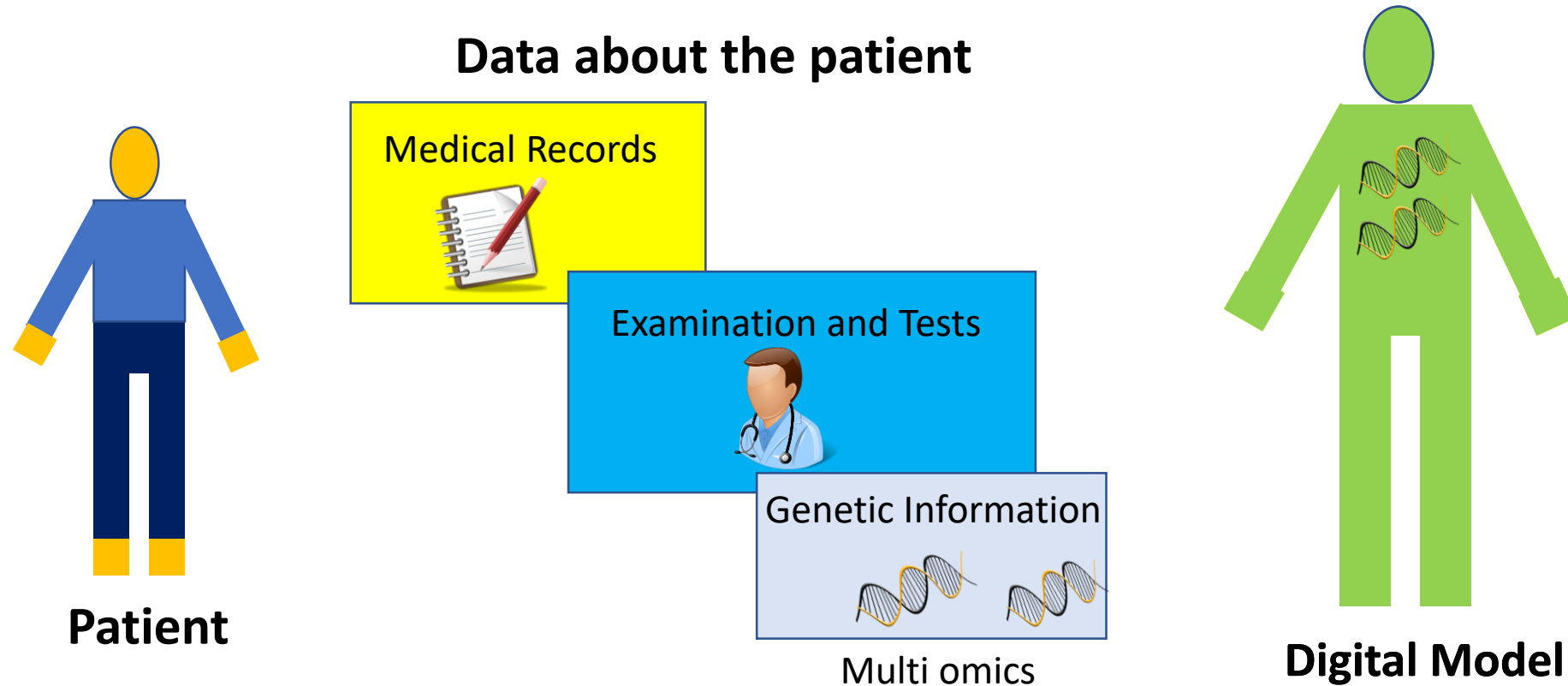
Patient response $y(t)$



Computed input (i.e., treatment) response $x(t)$

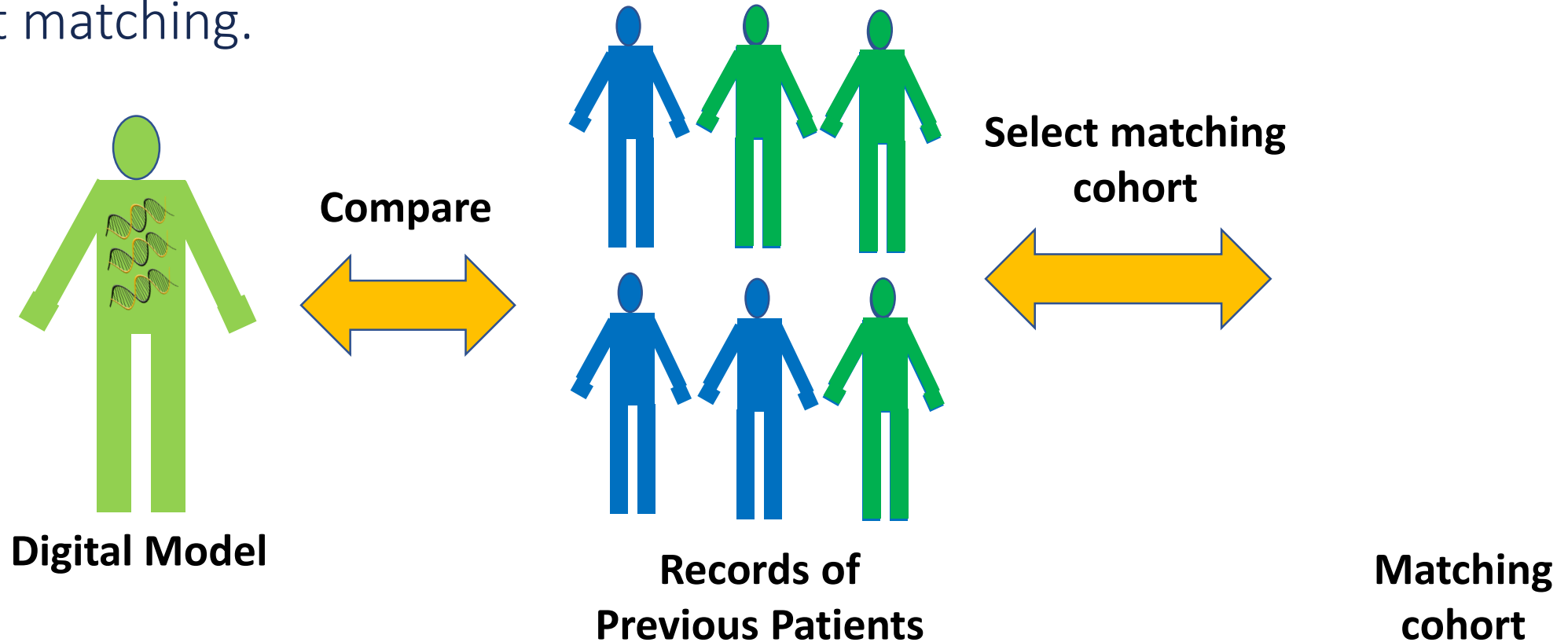
PROPOSED FUTURE WORK

Construct digital models of patients using multimodal data.



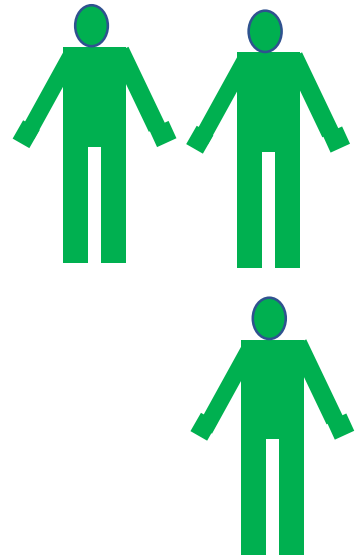
PROPOSED FUTURE WORK

Cohort matching.

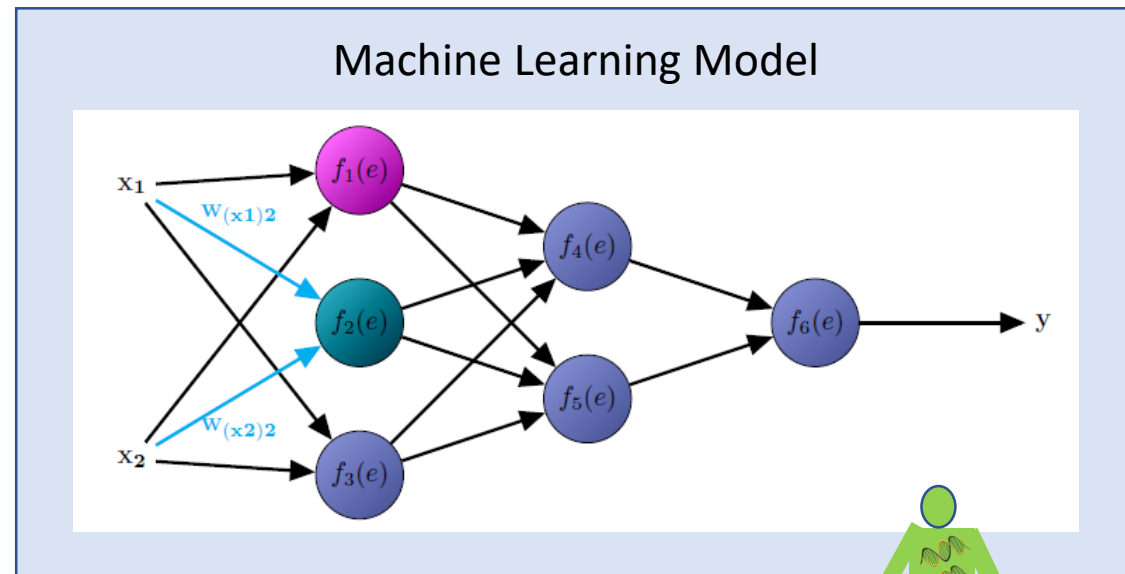
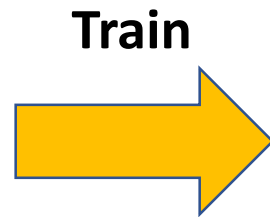


PROPOSED FUTURE WORK

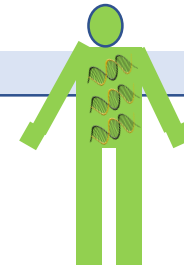
Machine learning.



Matching cohort



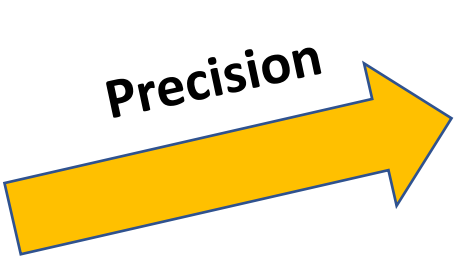
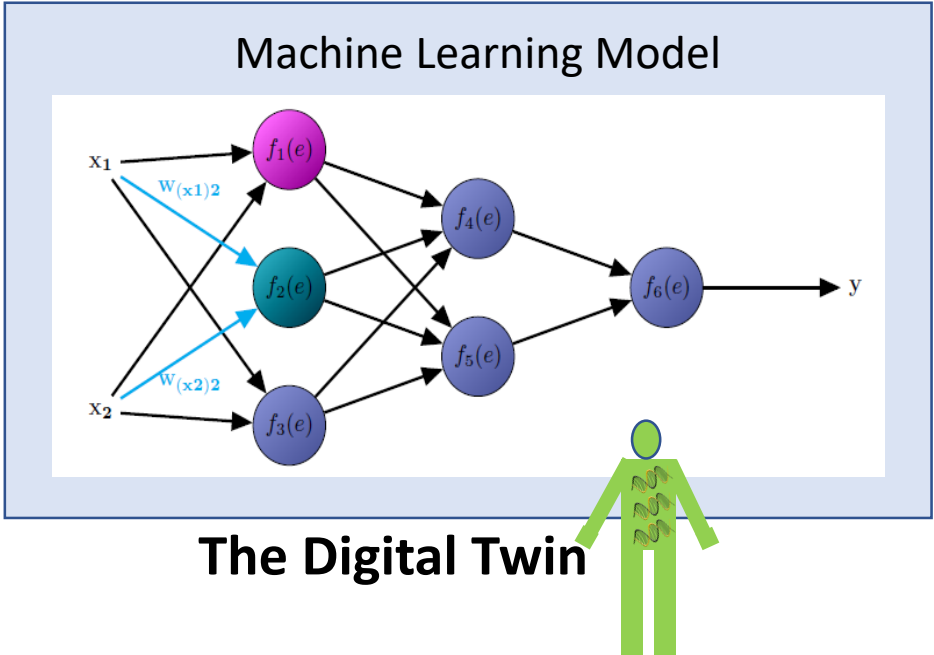
The machine learning model becomes the Digital Twin



PROPOSED FUTURE WORK

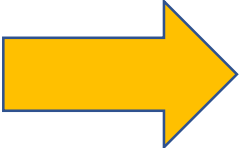
Can use for decisions support

Expected outcomes: The Triple P

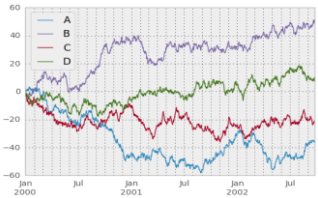


Diagnosis

Personalization



Treatment Plan



Disease Progression

CONCLUSIONS

- Creating DTs of patients was attempted through synthetic data.
- Patients were modelled as time series.
- Attempted modelling is computationally efficient enabling real-time decision support.
- Formulation can be extended to higher dimensional data.
- Multiple techniques available for DT construction.



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Thank you!

