MODELLING EARLY USER-GAME INTERACTIONS FOR JOINT ESTIMATION OF SURVIVAL TIME AND CHURN PROBABILITY

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GENERAL OVERVIEW

The present work proposes a theory inspired deep neural network architecture, Bifurcating Model (BM) (**Fig. 2**), aiming to model engagement related behaviours in a holistic way while maintaining characteristics appealing for industry applications.

THEORETICAL BACKGROUND

We based our modelling approach on a theoretical framework (**Fig 1**) blending the **Engagement Process Model** by O' Brien and Toms with a simplified version of concepts borrowed from **Operant Conditioning.**

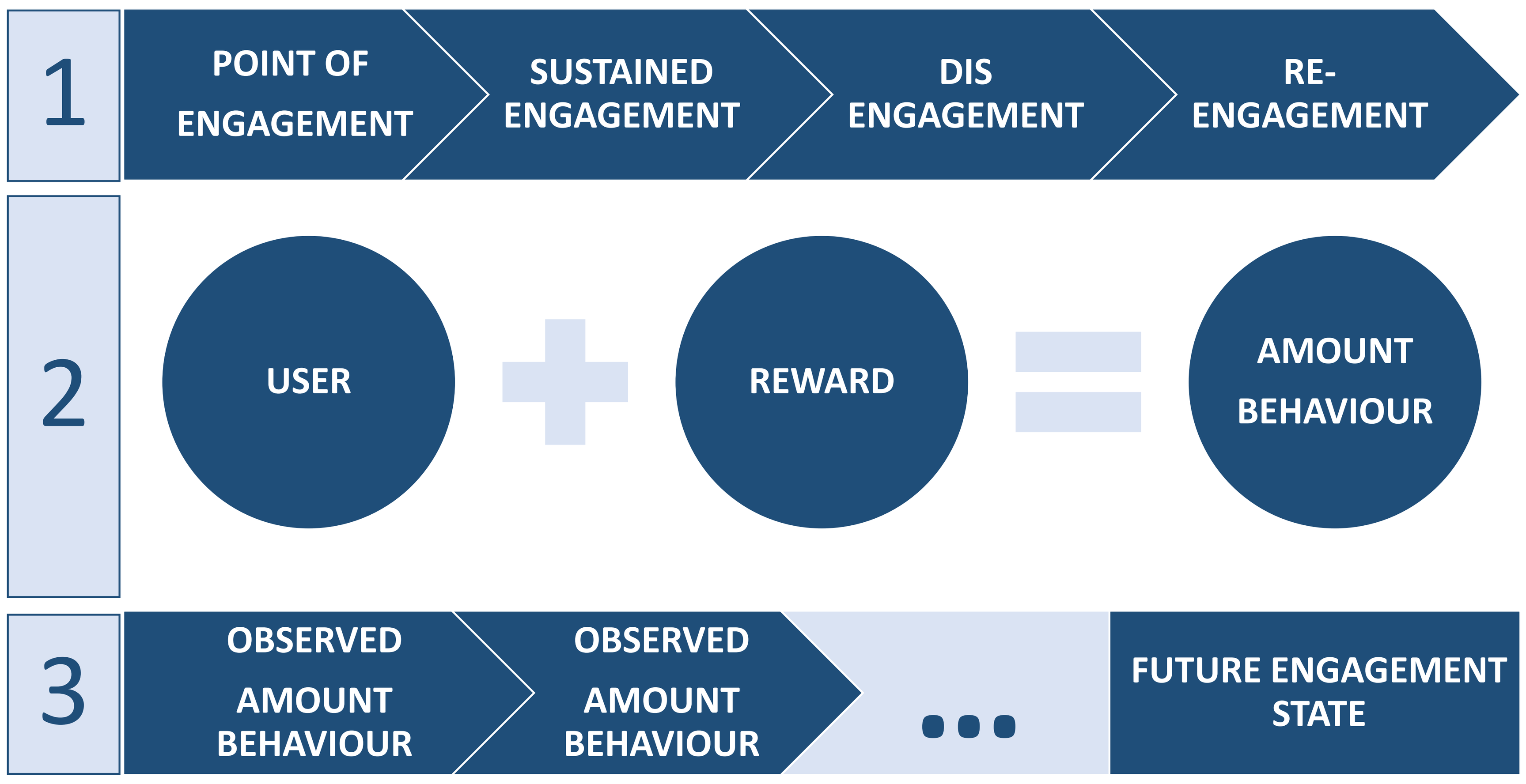

Fig. 1 Combining the Engagement Process Model (1) with the basics of operant conditioning (2) we were able to create an highly operationalizable theoretical framework (3) for our modelling approach.

HYPOTHESES AND MODEL AIMS

Tested hypotheses 1) Churn probability and survival time can be modelled through a single common process **2)** Better performance of non-linear models **3)** Better performance with non collapsed data **4)** Better performance when explicitly modelling temporality.

Aimed BM characteristics 1) Easily generalizable across different games **2)** Able to embed uncertainty in its estimation **3)** Scalable and noise resilient **4)** Features efficient **5)** Relying on early user-game interactions..

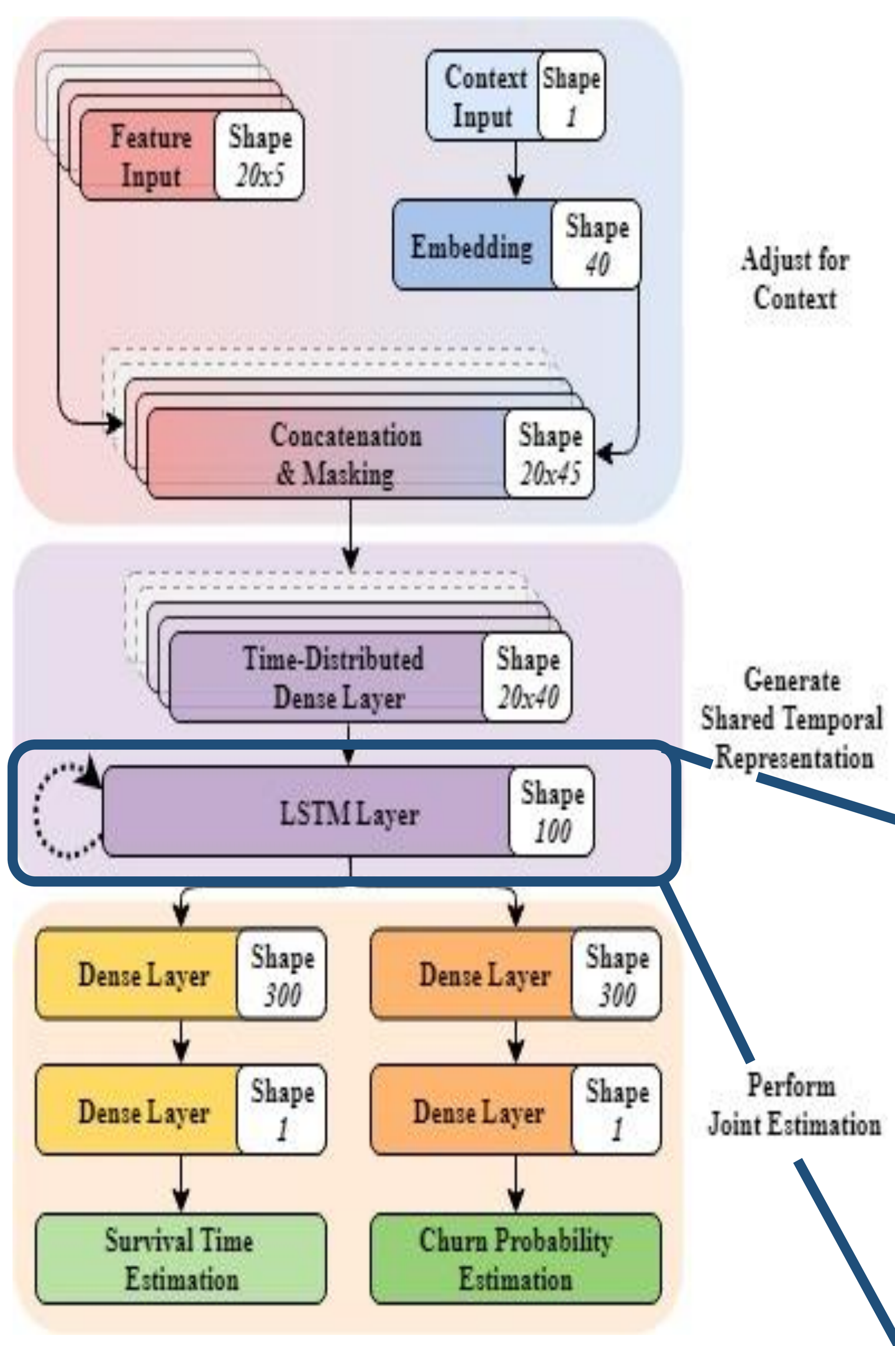

Fig. 2 Our architecture for joint temporal modelling: the Bifurcating Model (BM)

RESULTS

From the point plot (**Fig. 3**) we can see how our initial hypothesis were, with some exceptions, confirmed, with our architecture providing the best model fit..

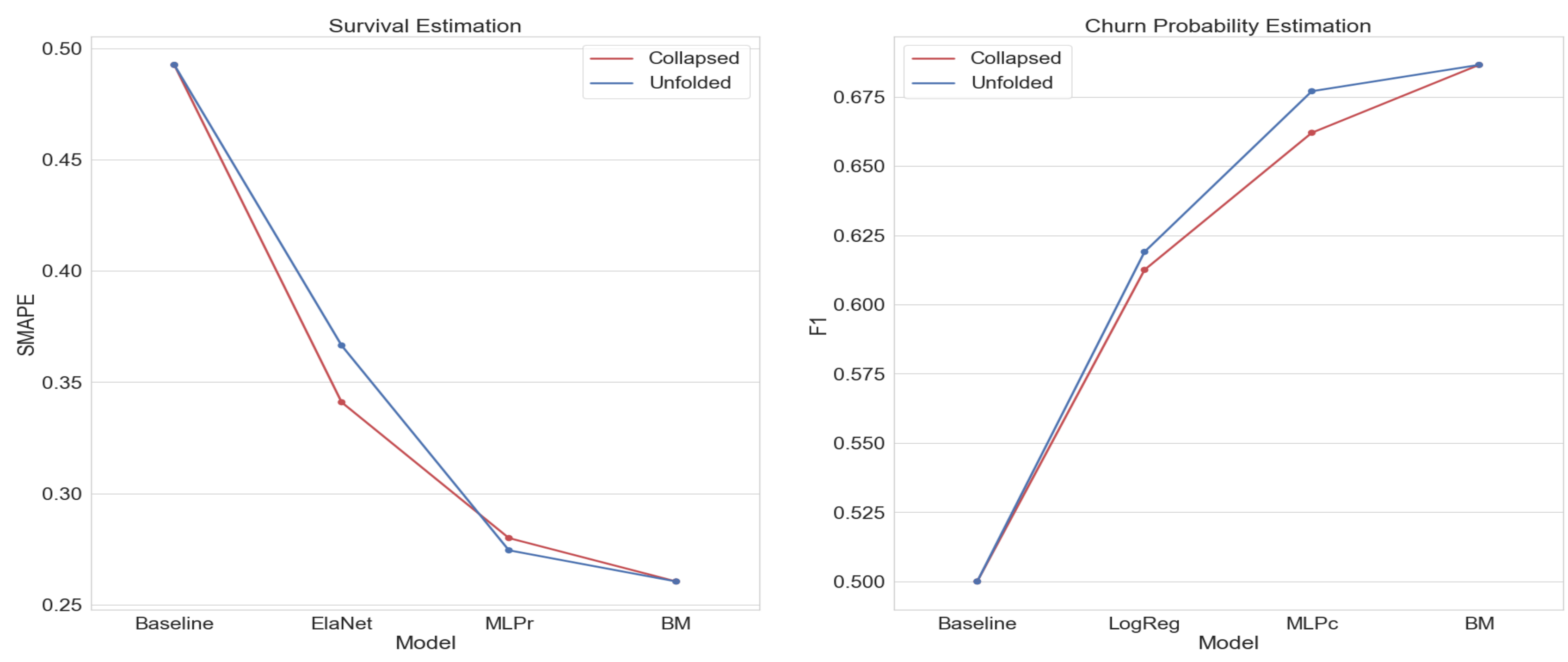

Fig. 3 Model and data format comparison. For Survival Estimation lower SMAPE demonstrates better performance. For Churn Probability Estimation higher F1 Score demonstrates better performance.

The density plots (**Fig. 4**) illustrates the model ability to encode different levels of uncertainty through the variance in its estimates.

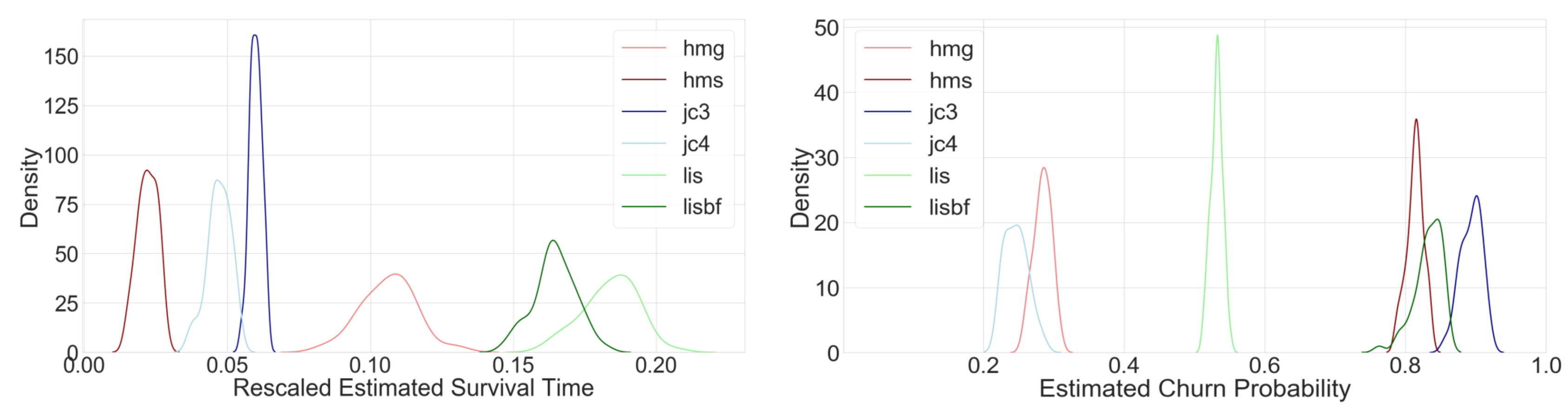

Fig. 4 Estimations provided by the BM for 6 random users, one for each game. The most dense point represents the actual prediction while the area under the curve provide a measure of uncertainty.

One of the advantages of treating and modelling survival time and churn probability as stemming from a single underlying process is that we can more easily employ the embedding generated by the model it as an holistic representation of the user state (**Fig 5**) .

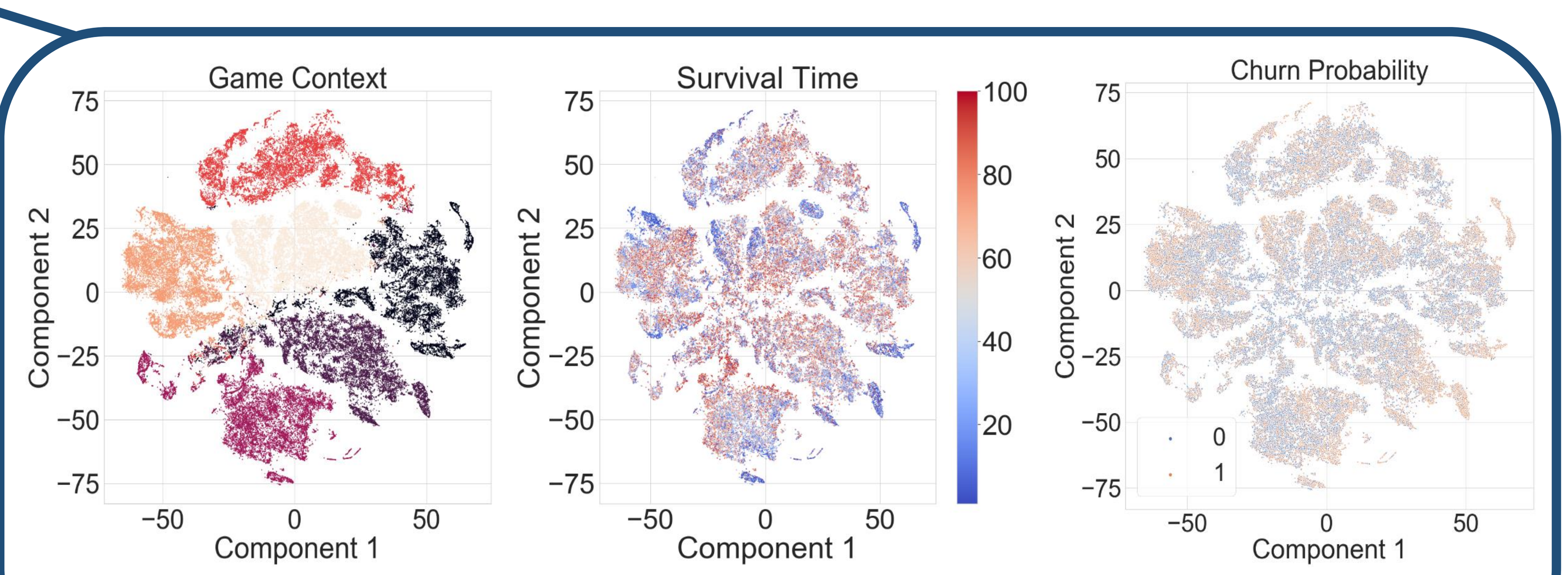

Fig 5. Dimensionality reduction (t-SNE) on the representation created by the shared part of the BM. The learned embedding was roughly able to locate users with similar characteristics closer in space.

DATA AND METODOLOGY

We gathered data from 960,000 users evenly sampled from 6 different games published by our partner company **Square Enix Limited**: We considered a set of 5 metrics, easily generalizable across games and indicative of behavioural activity, and retrieved them temporally over a defined Observation Period. For testing our hypothesis and validating the performance of our proposed architecture, we fit linear and non linear models over aggregated and non-aggregated version of the data in the attempt to estimate survival time and churn probability..

CONCLUSIONS

In light of the promising, although modest, positive results, we hope to employ the insights gathered from the present work for expanding our line of research on telemetry based engagement modelling.

THE DEVIL IS IN THE DETAILS

TALK WITH THE AUTHORS!

PAPER
arxiv.org/1905.10998

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