Mastering Video Gaming with Machine Learning and Flow Detection

Bachelor/Master project "Information Systems"

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1: Project Overview

Background: Among many gamers, a feeling of being completely absorbed and immersed in the video game can be observed. This state, also known as flow state, is of particular interest for gamers themselves, game designers, and business stakeholders.

Project Goal: Developing a machine learning-based system to classify flow states, using a provided dataset that includes both physiological and questionnaire data.

Highlights: Implementation of a machine learning pipeline; handling large datasets; close cooperation with the chair

2: Project Background

According to a 2024 survey by Bitkom Research, 53% of people in Germany play video games occasionally, with that number rising to 91% among those aged 16 to 29 (Bitkom, 2024). These figures highlight that gaming is a very popular recreational activity, which is also growing in importance within the competitive sector. The establishment of a professional esports league around the game *League of Legends* in the 2010s contributed to the rise in popularity of competitive gaming, increasing viewership and sponsorship opportunities (Bousquet & Ertz, 2011).

Many gamers report experiencing a state of complete immersion during gameplay, accompanied by a loss of track of time (Nah et al., 2014). This state of optimal experience, also known as flow state, is closely related to peak performance and results in positive and rewarding feelings after the activity (Harris et al., 2020). This flow state is of particular interest to game designers, who seek to evoke it in order to maximize player engagement (Nah et al., 2014), to players looking to enhance their performance, and to economic stakeholders in professional esports, who profit from that improved performance.

Thus, current research focuses on the measurement of the flow state while gaming. Recent studies have shown that there is an underlying relationship between flow and physiological data such as heart or respiration rate. This enables the detection of a flow state using non-obtrusive devices, such as smartwatches or electrocardiogram (ECG) chest belts. However, the underlying relationship is complex and requires the application of complex mathematical models (Nadj et al., 2023). Machine learning methods, that can detect these patterns, provide a promising solution for facilitating flow classification in the gaming context.

3: Project Objective

The objective of this specific Bachelor/Master project is to classify flow states based on physiological data gathered during gaming using machine learning algorithms. To achieve this, students will use the open-source BIRAFEE dataset (Kutt et al., 2022). This dataset contains data points from 103 participants playing three different jump-and-run games. It consists of ECG data and a game experience questionnaire, which will serve as ground-truth to label flow and non-flow states. Once the classifier has been successfully trained, the algorithm will be applied to an open-access dataset comprising 300 hours of professional and non-professional Counter-Strike: Global Offensive gamers to identify periods of flow (CEPAV dataset: Behnke et al., 2025).

The **objectives of this specific project** are the following:

- Review of relevant literature in the gaming context
- Development of a methodological approach to classify flow states based on the available datasets
- Preprocessing of data, e.g.:
    - Data labeling
    - Filtering and processing of physiological signals
    - Feature extraction
- Training and testing of different machine learning algorithms, e.g.:
    - Implementation of selected algorithms
    - Evaluation of algorithms via performance metrics
- Evaluation of algorithm performance in the context of relevant literature

Depending on group size, adjustments to the project scope can be made. Adjustments will be announced at the kickoff and/or in subsequent milestone meetings. Each finished artifact has to be properly documented to facilitate understanding and further development by students in follow-up projects.

4: Project Registration and further Information

Bachelor and Master students interested in this IS-project may apply via our online application form (Online Application). This application needs to include:

- Your current **Transcript of Records**
- A short **letter of motivation**

The deadline for the application is **Tuesday, 07.10.2025, 23:59.**

You can apply as a group. To do so, each person in that group has to submit an individual application. The group members have to decide on a group keyword to be used in the application form, in order to unambiguously identify each group.

If the number of applications exceeds our capacities, we will select participants based on their prior knowledge and academic performance.

For successful completion of the project, master students receive 12 ECTS (corresponding to 360 working hours) and bachelor students receive 6 ECTS (corresponding to 180 working hours)

- Master students will invest 18 hours per week into the project.
- Bachelor students will invest 9 hours per week into the project.

5: Project Schedule (Dates are to be announced)

Kickoff	Kickoff with accepted participants Clarify project scope and responsibilities
Milestone 1	Development of methodological approach
Milestone 2	Data Preprocessing
Milestone 3	Implementation of machine learning algorithms
Milestone 4	Benchmarking of applied machine learning algorithms
Milestone 5	Scientific poster presentation
Milestone 6	Submission of project report

6: Grading

The final grade will be calculated as following based on the sum of the milestones:

- Milestone 1: 15%
- Milestone 2: 15%
- Milestone 3: 20%
- Milestone 4: 10%
- Milestone 5: 20%
- Milestone 6: 20%

7: Sources

- Behnke, M., Krzyżaniak, W., Nowak, J., Kupiński, S., Chwiłkowska, P., Jęśko Białek, S., Kloskowski, M., Maciejewski, P., Szymanski, K., Laken, D., Petrova, K., Jamieson, J. P. & Gross, J. J. (2025). *The competitive esports physiological, affective, and video dataset*. Scientific Data, 12(1), 56.
- Bitkom (2024). https://www.bitkom.org/Presse/Presseinformation/Haelfte-Deutschen-zockt-Video-Computerspiele, retrieved 11.07.2025
- Bousquet, J., & Ertz, M. (2021). eSports: historical review, current state, and future challenges. In *Handbook of Research on Pathways and Opportunities into the Business of Esports* (pp. 1-24). IGI Global.
- Harris, D. J., Allen, K. L., Vine, S. J., & Wilson, M. R. (2023). A systematic review and meta-analysis of the relationship between flow states and performance. *International review of sport and exercise psychology*, *16*(1), 693-721.
- Kutt, K., Drążyk, D., Żuchowska, L., Szelążek, M., Bobek, S., & Nalepa, G. J. (2022). BIRAFFE2, a multimodal dataset for emotion-based personalization in rich affective game environments. *Scientific Data*, *9*(1), 274.
- Nadj, M., Rissler, R., Adam, M. T., Knierim, M. T., Li, M. X., Maedche, A., & Riedl, R. (2023). What Disrupts Flow in Office Work? The Impact of Frequency and Relevance of IT-Mediated Interruptions. *MIS Quarterly*, *47*(4).
- Nah, F. F. H., Eschenbrenner, B., Zeng, Q., Telaprolu, V. R., & Sepehr, S. (2014). Flow in gaming: literature synthesis and framework development. *International Journal of Information Systems and Management*, *1*(1-2), 83-124.

Recommendation:

- Knierim, M. T., Rissler, R., Dorner, V., Maedche, A., & Weinhardt, C. (2018). The psychophysiology of flow: A systematic review of peripheral nervous system features. *Information Systems and Neuroscience: Gmunden Retreat on NeuroIS 2017*, 109-120.