Course and Examination Fact Sheet: Autumn Semester 2023

11,208: Digital Biomarker Development

ECTS credits: 3

Overview examination/s
(binding regulations see below)
decentral - Quiz, Digital, Individual work individual grade (15%)
Examination time: Term time
decentral - Presentation, Analog, Group work group grade (15%)
Examination time: Term time
decentral - Written work, Digital, Group work group grade (70%)
Examination time: Term time

Attached courses
Timetable -- Language -- Lecturer
11,208,1.00 Digital Biomarker Development -- English -- Kowatsch Tobias

Course information

Course prerequisites

Interest in the **multi-disciplinary** field of **digital biomarkers** at the intersection of **health economics, information systems research, computer science**, and **medicine**.

Learning objectives

Hypoglycemia Detection in People With Diabetes Using Smartwatch Data (Diabetes Care 2023), Engineering digital biomarkers of glucose from non-invasive smartwatches (npj Digital Medicine, 2021);Wearable-based accelerometer activity as digital biomarker of inflammation, biological age, and mortality (Scientific Reports (2023) A digital biomarker of diabetes from smartphone-based vascular signals (Nature Medicine 2020), Wearable sensors enable personalized predictions of clinical laboratory measurements (Nature Medicine 2021).

What are recent developments in **digital biomarkers**? A digital biomarker is quantifiable and objective behavioral or physiological data collected through digital devices. Digital biomarkers explain and predict health-related outcomes and can be classified depending on their purpose (e.g., risk, diagnostic, monitoring, prognostic, predictive, or response biomarkers). They can be gathered continuously and non-invasively, providing valuable insights into an individual's health status. Digital biomarkers can revolutionize healthcare by enabling remote monitoring, personalized, just-in-time adaptive interventions (e.g., digital therapeutics), and early detection of diseases.

To this end, the question arises of how to develop **evidence-based digital biomarkers** that allow **medical doctors** and other **caregivers** to **scale** and **tailor long-term treatments** to **individuals** in need at **sustainable costs**. This lecture aims to help **students** and **upcoming healthcare executives** better understand **digital biomarkers' relevance**, **development, and assessment** at the intersection of **health economics**, **information systems research**, **computer science**, and **medicine**.

After the course, students will be able to...

1. understand the relevance of digital biomarkers for the prevention, management, and treatment of disease
2. understand several classes of digital biomarkers
3. know how to design and evaluate digital biomarkers
4. know digital health technologies used for digital biomarker development
5. assess data of a digital biomarker study in the area of metabolic health
6. propose digital biomarkers for healthy longevity (e.g., biological age)
7. discuss the advantages and disadvantages of digital biomarkers

Course content

1. On the relevance of digital biomarkers for the prevention, management, and treatment of disease
2. Classification of digital biomarkers
3. Study designs for digital biomarkers
4. Assessment of digital biomarkers
5. Advantages and disadvantages of digital biomarkers

Course structure and indications of the learning and teaching design

The lecture is structured in **three parts,** with **on-site sessions** and **complementary online exercises**. In the first part, an **overview of digital biomarkers** is provided. In the second part, a controlled **laboratory experiment** is conducted with the course participants to develop a digital biomarker in **metabolic health**. For that purpose, various **physiological data** will be collected (e.g. with wearables). In the third part, students in groups will assess digital biomarker data and design a **digital biomarker for healthy longevity**, for example, determining **biological age**. The groups will finally **present and discuss their results** with fellow students. Moreover, **coaching sessions** are offered to support the students in preparing their presentations. Complementary **learning material** and **multiple-choicequestions** are provided **online**.

Course literature

1. Adler, D. A., Wang, F., Mohr, D. C., Estrin, D., Livesey, C., & Choudhury, T. (2022). *A call for open data to develop mental health digital biomarkers.* BJPsych Open, 8(2), e58, Article e58. 10.1192/bjo.2022.28
2. Alfalahi, H., Khandoker, A. H., Chowdhury, N., Iakovakis, D., Dias, S. B., Chaudhuri, K. R., & Hadjileontiadis, L. J. (2022). *Diagnostic accuracy of keystroke dynamics as digital biomarkers for fine motor decline in neuropsychiatric disorders: a systematic review and meta-analysis.* Scientific Reports, 12(1), 7690. 10.1038/s41598-022-11865-7
3. Bartolome, A., & Prioleau, T. (2022). *A computational framework for discovering digital biomarkers of glycemic control.* npj Digital Medicine, 5(1), 111. 10.1038/s41746-022-00656-z
4. Bent, B., Wang, K., Grzesiak, E., Jiang, C., Qi, Y., Jiang, Y., Cho, P., Zingler, K., Ogbeide, F. I., Zhao, A., Runge, R., Sim, I., & Dunn, J. (2021). *The digital biomarker discovery pipeline: An open-source software platform for the development of digital biomarkers using mHealth and wearables data.* Journal of Clinical and Translational Science, 5(1), e19, Article e19. 10.1017/cts.2020.511
5. Coravos, A., Khozin, S., & Mandl, K. D. (2019). *Developing and adopting safe and effective digital biomarkers to improve patient outcomes.* npj Digital Medicine, 2(1). 10.1038/s41746-019-0090-4
6. Dunn, J., Kidzinski, L., Runge, R., Witt, D., Hicks, J. L., Schüssler-Fiorenza Rose, S. M., Li, X., Bahmani, A., Delp, S. L., Hastie, T., & Snyder, M. P. (2021). *Wearable sensors enable personalized predictions of clinical laboratory measurements.* Nature Medicine, 27(6), 1105-1112. 10.1038/s41591-021-01339-0
7. Föll, S., Maritsch, M., Spinola, F., Mishra, V., Barata, F., Kowatsch, T., Fleisch, E., & Wortmann, F. (2021). *FLIRT: A Feature Generation Toolkit for Wearable Data.* Computer Methods and Programs in Biomedicine, 106461. 10.1016/j.cmpb.2021.106461 Lehmann, V., Föll, S., Maritsch, M., van Weenen, E., Kraus, M., Lagger, S., Odermatt, K., Albrecht, C., Fleisch, E., Zueger, T., Wortmann, F., & Stettler, C. (2023). *Noninvasive Hypoglycemia Detection in People With Diabetes Using Smartwatch Data. Diabetes Care*, 46(5), 993-997. 10.2337/dc22-2290
8. Manta, C., Patrick-Lake, B., & Goldsack, J. C. (2020). *Digital Measures That Matter to Patients: A Framework to Guide the Selection and Development of Digital Measures of Health.* Digital Biomarkers, 4(3), 69-77. 10.1159/000509725
9. Naegelin, M., Weibel, R. P., Kerr, J. I., Schinazi, V. R., La Marca, R., von Wangenheim, F., Hoelscher, C., & Ferrario, A. (2023). An interpretable machine learning approach to multimodal stress detection in a simulated office environment. *J Biomed Inform*, *139*, 104299. 10.1016/j.jbi.2023.104299
10. Rassouli, F., Tinschert, P., Barata, F., Steurer-Stey, C., Fleisch, E., Puhan, M. A., Baty, F., Kowatsch, T., & Brutsche, M. H. (2020). *Characteristics of Asthma-related Nocturnal Cough: A Potential New Digital Biomarker.* J Asthma Allergy, 13, 649-657. 10.2147/JAA.S278119
11. Shim, J., Fleisch, E., & Barata, F. (2023). *Wearable-based accelerometer activity profile as digital biomarker of inflammation, biological age, and mortality using hierarchical clustering analysis in NHANES 2011–2014. Scientific Reports*, *13*(1), 9326. 10.1038/s41598-023-36062-y
12. Sieberts, S. K., Schaff, J., Duda, M., et al. (2021). *Crowdsourcing digital health measures to predict Parkinson's disease severity: the Parkinson's Disease Digital Biomarker DREAM Challenge.* npj Digital Medicine, 4(1), 53. 10.1038/s41746-021-00414-7
13. Shandhi, M. M. H., Goldsack, J. C., Ryan, K., Bennion, A., Kotla, A. V., Feng, A., Jiang, Y., Wang, W. K., Hurst, T., Patena, J., Carini, S., Chung, J., & Dunn, J. (2021). Recent Academic Research on Clinically Relevant Digital Measures: Systematic Review. J Med Internet Res, 23(9), e29875. 10.2196/29875

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14. Sim, I. (2019). *Mobile Devices and Health.* N Engl J Med, 381(10), 956-968. 10.1056/NEJMra1806949
15. Tams, S., Hill, K., de Guinea, A. O., Thatcher, J., & Grover, V. (2014). *NeuroIS - Alternative or Complement to Existing Methods? Illustrating the Holistic Effects of Neuroscience and Self-Reported Data in the Context of Technostress Research.* Journal of the Association for Information Systems, 15(10), Article 1. 10.17705/1jais.00374
16. Teepe, G. W., Lukic, Y. X., Kleim, B., Jacobson, N. C., Schneider, F., Santhanam, P., Fleisch, E., & Kowatsch, T. (2023). *Development of a digital biomarker and intervention for subclinical depression: study protocol for a longitudinal waitlist control study. BMC Psychology,* 11(1), 186. 10.1186/s40359-023-01215-1
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Additional course information

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Examination information

Examination sub part/s

1. Examination sub part (1/3)

Examination modalities

Examination type	Quiz
Responsible for organisation	decentral
Examination form	Written exam
Examination mode	Digital
Time of examination	Term time
Examination execution	Asynchronous
Examination location	Off Campus
Grading type	Individual work individual grade
Weighting	15%
Duration	--

Examination languages
Question language: English
Answer language: English

Remark
Online assignments (eg multiple choice questions)

Examination-aid rule
Open Book

Students are free to choose aids, apart from the following restrictions:

- pocket calculator models which are not part of the Texas Instruments TI-30 series, as well as any programmable electronic devices that are capable of communication such as electronic dictionaries, notebooks, tablets, smartphones, headsets, additional screens, etc. are not admissible;

- there is an option for faculty members to explicitly define exceptions under supplementary aids.

Procuring any aids, as well as ensuring their working order, is the exclusive responsibility of students.

Supplementary aids
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2. Examination sub part (2/3)

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Examination modalities

Examination type	Presentation
Responsible for organisation	decentral
Examination form	Oral examination
Examination mode	Analog
Time of examination	Term time
Examination execution	Asynchronous
Examination location	On Campus
Grading type	Group work group grade
Weighting	15%
Duration	--

Examination languages
Question language: English
Answer language: English

Remark
Group presentation

Examination-aid rule
Free aids provision

Basically, students are free to choose aids. Any restrictions are defined by the faculty members in charge of the examination under supplementary aids.

Supplementary aids
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3. Examination sub part (3/3)

Examination modalities

Examination type	Written work
Responsible for organisation	decentral
Examination form	Written work
Examination mode	Digital
Time of examination	Term time
Examination execution	Asynchronous
Examination location	Off Campus
Grading type	Group work group grade
Weighting	70%
Duration	--

Examination languages
Question language: English
Answer language: English

Remark
Group presentation document

Examination-aid rule
Free aids provision

Basically, students are free to choose aids. Any restrictions are defined by the faculty members in charge of the examination under supplementary aids.

Supplementary aids
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Examination content

1. On the relevance of digital biomarkers for the prevention, management, and treatment of disease
2. Classification of digital biomarkers
3. Study designs for digital biomarkers
4. Assessment of digital biomarkers
5. Advantages and disadvantages of digital biomarkers

Examination relevant literature

The mandatory material will be provided via the online learning platform.

Please note

Please note that only this fact sheet and the examination schedule published at the time of bidding are binding and takes precedence over other information, such as information on StudyNet (Canvas), on lecturers' websites and information in lectures etc.

Any references and links to third-party content within the fact sheet are only of a supplementary, informative nature and lie outside the area of responsibility of the University of St.Gallen.

Documents and materials are only relevant for central examinations if they are available by the end of the lecture period (CW51) at the latest. In the case of centrally organised mid-term examinations, the documents and materials up to CW 42 are relevant for testing.

Binding nature of the fact sheets:

- Course information as well as examination date (organised centrally/decentrally) and form of examination: from bidding start in CW 34 (Thursday, 24 August 2023);
- Examination information (supplementary aids, examination contents, examination literature) for decentralised examinations: in CW 42 (Monday, 16 October 2023);
- Examination information (supplementary aids, examination contents, examination literature) for centrally organised mid-term examinations: in CW 45 (Monday, 06 November 2023);
- Examination information (regulations on aids, examination contents, examination literature) for centrally organised examinations: two weeks before the end of the de-registration period in CW 45 (Monday, 06 November 2023).