The Department of Intelligent Systems develops new methods and techniques for intelligent computer systems, with applications in the areas of the information society, computer science and informatics, and network communication systems. The main research areas are ambient intelligence, computational intelligence, agent and multi-agent systems, language and speech technologies, electronic and mobile health, and smart cities. The department collaborates closely with the Faculty of Computer and Information Science of the University of Ljubljana in the joint research program “Artificial Intelligence and Intelligent Systems. The department also continuously collaborates with industry and contributes significantly to the inclusion of intelligent systems in products and services.

Intelligent systems simulate intelligence so that a typical user perceives them as truly intelligent. In reality, these systems use complex mechanisms and implement them on digital platforms to imitate human behaviour by exploiting raw, exponentially growing computer power. This field is somewhat broader than artificial intelligence, both are rapidly growing worldwide and are enabling the development of the information society.

Ambient intelligence is a research area aiming to introduce technology into our everyday environment in a friendly way that is undemanding for the user. The main area where the department applies methods of ambient intelligence is health. We finished the H2020 project HeartMan, which developed an application to help congestive-heart-failure patients manage their condition. A clinical trial showed that the application helps patients both physically and psychologically. The objective of the H2020 project CrowdHealth is to mine health data to help craft better public-health policies. In collaboration with the Faculty of Sports of the University of Ljubljana, we built methods to accurately forecast physical fitness and the characteristics of students, as well as predict their health risk. The H2020 project WellCo is creating a virtual coach to advise older users on wellbeing and health. We developed methods to monitor nutrition with sensors in a smart watch and with questionnaires. We also developed methods to recognize the users’ emotions from their voice, to enable an affective user interface. The H2020 project Insension will help people with severe intellectual disability use digital services. We are developing methods for camera-based monitoring of heart rate, as well as methods to reason about the users’ intent from observations of them and their context. In the Flemish-Slovenian project STRAW, whose objective it is to develop stress recognition from physiological signals and to learn more about stressors in the workplace, we finished the preparation for data collection. We also started the AAL project CoachMyLife, whose objective is to help seniors with memory impairment perform everyday tasks. As a doctoral research project, we developed a method that can intelligently adjust the operation of sensors in such a way that the energy consumption is as small as possibly without sacrificing a lot of quality of the results obtained with these sensors. Another doctoral student is working on advanced machine learning in the area of affective computing. Finally, we were successful at competitions in activity recognition with sensors: we won the Sussex-Huawei Locomotion Recognition Challenge for the second time, and together with colleagues from North Macedonia we won Challenge UP and Emteq Activity Recognition Challenge. Because of this, we received the Information Society conference award for current work, while related achievements in the past year received the Excellent in Science award from the Slovenian Research Agency.

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Computational intelligence is the study of stochastic search, optimization and learning methods, inspired by biological and physical systems. Research in this area at the Department of Intelligent Systems focuses on evolutionary computation and optimization. We study evolutionary algorithms for multiobjective optimization, their acceleration through parallel computing and surrogate models, visualization of their results, methodology of algorithm benchmarking, and their applicability in science and engineering. In 2019 we completed the H2020 Twinning project SYNERGY, aimed at strengthening our research and innovation potential in parallelization, surrogate modelling and combining the two techniques in multi-objective optimization. The project was carried out by three partners with complementary...
We are designing a computer system to schedule flexible offers for electricity production and consumption aimed at reducing the mismatch between the available and the needed electrical energy.

![Illustration of machine learning and end-to-end deep learning for the detection of chronic heart failure from heart sounds.](image)

**Our paper entitled “Artificial intelligence and ambient intelligence” published in the “Journal of Ambient Intelligence and Smart Environments” is in the top three most-read and cited articles of that journal in 2019.**

**Figure 2.** We are carrying out a Key Enabling Technologies for Clean Production (KET4CP) project devoted to the improved planning of tool manufacturing for injection molding.

**Figure 3.** Showing a scheme that combines classical feature-based machine learning and end-to-end deep learning, used for the detection of chronic heart failure from heart sounds. The model’s accuracy is 93% (on 947 subjects from seven datasets). Published as: Machine learning and end-to-end deep learning for the detection of chronic heart failure from heart sounds.
In the InnoStars European project HomeCare2020 we upgraded the existing smart bracelet for the elderly. The JSI upgraded the fall-detection algorithms and extended the functionality with additional features (idle detection, warnings, wear detection, irregular activity detection), that were possible due to new sensors. We also started with ERA PerMed European project called BATMAN, where we will research Acne Inversa condition and system for offering support to patients. The JSI will take care of support systems for collecting and presenting the obtained data. In the final phase, we will use machine learning to analyze the data and present the models. For the project ROBKONCEL, we started, in cooperation with Gorenje and Unior, the development of the intelligent system for comprehensive quality control in production with a reconfigurable robotic control cell and intelligent process control system. Additionally, we also started with two commercial projects. In the first one we were chosen by the Comland Company for help in the development of a hands-free system to control application in natural language. The second one will be done in cooperation with the NiceLabel Company, where we will develop the Smart Issue Retrieval Application for grouping different incoming emails and in the next phase also suggesting what to answer to those emails.

In the field of speech and language technologies we work on speech synthesis, semantic analysis of text and question answering. Together with companies Alpineon and Amebis we developed a new, high-quality speech synthesizer eBralec (http://ebralec.si/). The synthesizer is improved for both comprehensibility and the natural perception of the speech. The software package has more than a thousand subscribers and is an indispensable tool for blind and visually-impaired users (it is the ‘official’ speech synthesizer of the Slovenian Association for the Blind and Visually Impaired) and people with reading impairments (the Bravo association). For these users, eBralec is free of charge and can be ordered at the Library for the Blind and Visually Impaired (http://www.kss-ess.si/ebralec-sintetizator-govora-slovenskega-jezika/). eBralec is also an integral part of the DarsTraffic+ application, which provides traffic information, while its server version has been used by the National and University Library since 2017. We have also developed a service of speech synthesis for mobile devices (http://dis.ijs.si/dyslex/), which is free for anyone to use.

We are involved in the CityVOICE project: “Speech Technologies with Advanced Language Resources”, and the AudiBook project: “Education accessibility through a digital audio library for the blind and visually impaired”.

The 22nd International Multiconference Information Society – IS 2019 (is.ijs.si) took place at the Jožef Stefan Institute from October 7 to 11, 2019. It consisted of 12 independent conferences with 200 presentations. Four conference awards were presented: for lifetime achievements (“Donald Michie and Alan Turing” award) to prof. dr. Marjan Mernik, for current achievements in the field of information society to the department of intelligent system E9 JSI, and the information strawberry (Veš kaj ješ?) and lemon (E-Zdravje) for the best and worst public information-society services.

Some outstanding publications in the past year
Organization of conferences, congresses and meetings

1. BBOB (Blackbox Optimization Benchmarking) workshop at the Genetic and Evolutionary Computation Conference, GECCO 2019, Prague, Czech Republic, 13. 7. 2019
2. GBEA (Game-Benchmark for Evolutionary Algorithms) workshop at the Genetic and Evolutionary Computation Conference, GECCO 2019, Prague, Czech Republic, 14. 7. 2019
3. GECCO Job Market at the Genetic and Evolutionary Computation Conference, GECCO 2019, Prague, Czech Republic, 15. 7. 2019
4. Session Evolutionary Computation in Practice (ECiP) at the Genetic and Evolutionary Computation Conference, GECCO 2019, Prague, Czech Republic, 15. 7. 2019
5. 34th Slovenian Workshop on Nature-Inspired Algorithms, AVN, Boč, Slovenia, 13. 9. 2019
6. 22nd International Multiconference Information Society, IS 2019, Ljubljana, Slovenia, 7.–11. 10. 2019; independent conferences:
   • 6. Student computer science research conference
   • Professional ethics
   • Human-computer interaction in information society
   • Data mining and data warehouses
   • Cognitive science
   • International conference on cognitronics
   • People and environment
   • International conference of transfer of technologies
   • Robotics
   • Slovenian conference on artificial intelligence
   • Middle-European conference on applied theoretical computer science
   • Education in information society
7. 35th Slovenian Workshop on Nature-Inspired Algorithms, AVN, Ljubljana, Slovenia, 29. 11. 2019
8. Workshop Machine Learning for the Diagnosis and Treatment of Affective Disorders (ML4AD), ACII 2019

Awards and appointments

4. Božidar Čvetković, Robert Szeklicki, Vito Janko, Przemyslaw Lutomski, Mitja Luštrek: Excellent in science; Ljubljana; Slovenian Research Agency; human activity recognition with sensors
5. Marko Katrašnik, Junoš Lukan, Mitja Luštrek, Vitomir Struc: Best paper award, Ljubljana, Program and organizing committee of Slovenian conference on artificial intelligence 2019 (International multiconference Information society), “Diarization procedure development using machine learning algorithms”E9 members: Award for current work in the area of information society; Ljubljana; Information Society 2019 multiconference programme and organisation committee; recent success at scientific competitions

Patent granted

1. Tomaz Kompara, Igor Gornik, Peter Virtič, Rene Markovič, Miha Mlakar, Matjaž Gams, Danijel Jankovec, Jože Dermol
   A smart home control system using artificial intelligence
INTERNATIONAL PROJECTS

1. ERASUMUS+: Audio Library for Visually Impaired; Education Accessibility through a Digital Audio Library for the Blind and Visually-Impaired  
   Dr. Tomaz Seif  
   European Commission

2. CardioRNA - Catalysing Transcriptomics Research in Cardiovascular Disease  
   Dr. Mitja Luštrek  
   COST Association Asibl

3. H2020 - CrowbRHEALTH; Collective Wisdom Driving Public Health Policies  
   Dr. Mitja Luštrek  
   European Commission

4. H2020 - INSENSION; Personalized Intelligent Platform Enabling Interaction with Digital Services to Individuals with Profound and Multiple Learning Disabilities  
   Dr. Mitja Luštrek  
   European Commission

5. H2020 - HeartMan; Personal Decision Support System for Heart Failure Management  
   Dr. Mitja Luštrek  
   European Commission

6. H2020 - Synergy for Smart Multi-Objective Optimisation  
   Prof. Bogdan Filipič  
   European Commission

7. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
   Prof. Matjaž Gams  
   Slovenian Research Agency

   Prof. Matjaž Gams

9. Digital Services to Individuals with Profound and Multiple Learning Disabilities  
   European Commission

10. H2020 - CrowdHEALTH; Collective Wisdom Driving Public Health Policies  
    Dr. Mitja Luštrek  
    European Commission

11. H2020 - CrowdHEALTH; Collective Wisdom Driving Public Health Policies  
    Dr. Mitja Luštrek  
    European Commission

12. H2020 - INSENSION; Personalized Intelligent Platform Enabling Interaction with Digital Services to Individuals with Profound and Multiple Learning Disabilities  
    Dr. Mitja Luštrek  
    European Commission

13. H2020 - Synergy for Smart Multi-Objective Optimisation  
    Prof. Bogdan Filipič  
    European Commission

    Prof. Matjaž Gams

15. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
    Prof. Matjaž Gams

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17. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
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18. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
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22. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
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23. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
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37. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
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38. Development of AI Methods for Monitoring Affective States Using Unobtrusive Sensors  
    Prof. Matjaž Gams

    Prof. Matjaž Gams

NEW CONTRACTS

1. Multiobjective optimization for transparent tunnel design  
   Dr. Tea Tušar  
   Xlab, d. o. o.

2. Development of reconfigurable robotic cell for final product inspection  
   Prof. Matjaž Gams  
   Gorenje Gospodinjski Aparati, d.d.

3. Machine vision quality control of molded plastic parts  
   Prof. Bogdan Filipič  
   MPT, d. o. o.

4. Improved planning of manufacturing processes for individualized tools  
   Prof. Bogdan Filipič  
   Plastint Int., Trgovina in Proizvodnja, d. o. o.

5. MagitylFields with voice control  
   Dr. Aleš Tavčar  
   Comland, d. o. o.

6. NiceLabel virtual assistant  
   Dr. Miha Miklar  
   Euro Plus, d. o. o.

RESEARCH PROGRAMME

1. Artificial Intelligence and Intelligent Systems  
   Prof. Matjaž Gams

R&D GRANTS AND CONTRACTS

1. Disentangling the sources and context of daily work stress: a comprehensive real-time modelling study using wearables and technological detections  
   Dr. Mitja Luštrek

VISITORS FROM ABROAD

1. Prof. Boris Naujoks, Beate Breiderhoff, Cologne University of Applied Sciences (TH Köln), Gammersbach, Germany, 17.–18. 1. 2019

2. Prof. El-Ghazali Talbi, prof. Nouredine Melab, University of Lille, Lille, France, 17.–18. 1. 2019

3. Yoshiaki Ichikawa, dr. Norihiko Moriwaki, Masaki Itó, Hitachi, Tokyo, Japan, 7. 2. 2019

4. Pia Aara Oik, University of Tübingen, Tübingen, Germany, 1. 5.–30. 6. 2019

5. Jörg Aschenbrenner, AVL Software and Functions, Regensburg, Germany, 2.–3. 4. 2019

6. Dr. Heiko Borchart, CSET, Vienna, Austria, 2.–3. 4. 2019

7. Paul Elberg, Mirem, Tallinn, Estonia, 2.–3. 4. 2019

8. Dr. Andreas Fognini, Single Quantum, Delft, The Netherlands, 2.–3. 4. 2019


10. Dr. Bernhard Peischl, AVL List GmbH, Graz, Austria, 2.–3. 4. 2019

11. Roland Pittacher, Hirtenberger Defence Systems, Hirtenberg, Austria, 2.–3. 4. 2019

12. Johannes Sequard-Base, Ballistix Academy, Rittschen, Austria 2.–3. 4. 2019

13. Dr. Aslak Silijander, VTT Research, Espoo, Finland, 2.–3. 4. 2019

14. Chiara Moltrasio, Fondazione IRCCS Ca' Granda-Ospedale Maggiore Policlinico, Milano, Italy, 13. 9. 2019

15. Rossella Gratton, IRCCS, Trieste, Italy, 13. 9. 2019


17. Prof. Esther von Stet inertia, Institute für Dermatologie und Venerologie, Köln, Germany, 13. 9. 2019

18. Prof. Matthias Schmitt, Medical University Innsbruck, Innsbruck, Austria, 13. 9. 2019

19. Prof. Vincent Flacher, CNRS, Strasbourg, France, 13. 9. 2019

20. Chiara Moltrasio, Fondazione IRCCS Ca' Granda-Ospedale Maggiore Policlinico, Milano, Italy, 13. 9. 2019

21. Prof. Sergio Crovella, IRCCS, Trieste, Italy, 30. 5. and 13. 9. 2019


23. Dr. Octavian Machidon, Department of Electronics and Computers, Transilvania University of Brasov, Brasov, Romania, 1.–20. 7. and 25.–30. 9. 2019

24. Rossella Gratton, IRCCS, Trieste, Italy, 13. 9. 2019

25. Luisa Zupin, IRCCS, Trieste, Italy, 13. 9. 2019

26. Dr. Anna Auger, Dr. Dino Brodoff, INIBA Palaiseau, France, 23. 4.–3. 5. 2019

27. Dr. Carlos Kavka, dr. Mariapia Marchi, ESTECO, Trieste, Italy, 21.–22. 10. 2019

28. Dr. Paul Elberg, Milrem, Tallinn, Estonia, 2.–3. 4. 2019

29. Alexander Tietz, University of Rostock, Institute for Biostatistics and Informatics in Medicine and Ageing Research, Rostock, Germany, 15. 9.–1. 10. and 12.–26. 10. 2019

30. Prof. Asst. Anton Gradišek

31. Prof. Matjaž Gams, Head  
   Department of Intelligent Systems E-9

32. Prof. Bogdan Filipič

33. Prof. Matjaž Gams, Head

34. Asst. Prof. Anton Gradšek

35. Dr. Mitja Luštrek
BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Anton Gradišek, Mario Cifelli, Micham Wojcik, Tomaž Apih, Sergey V. Dvinškikh, Ewa Górecka, Valentina Domenici, “Study of liquid crystals showing two isotropic phases by 1H NMR diffusionometry and 1H NMR relaxometry”, Crystals, 2019, 9, 3, 178.


PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)


PUBLISHED CONFERENCE CONTRIBUTION


6. Matej Ćiğale, Mitja Luštrek, “"Kako preprečiti izumiranje slovenskega naroda!"”, In: Professional Ethics: proceedings of the 22nd International MultiConference Information


ACM, 2019, 718-726

Poglajen, “Toward early detection and monitoring of chronic heart failure using heart sounds”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform”, In: "Learning by real-world problems within the COCO platform", Proceedings, (Studies in health technology and informatics, volume 139), 2019, 105-109.

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INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH


PATENT