FORTH

INSTITUTE OF COMPUTER SCIENCE

FORTH Retreat 2022

Prof. Dimitris Plexousakis, Director
dp@ics.forth.gr

INSTITUTE OF COMPUTER SCIENCE

Institute of Computer Science

- Established in 1983 as one of the first 3 Institutes of FORTH
- Currently, ICS is the largest of the 9 Institutes of FORTH
  - It is also the largest research institute in Greece in the domain of ICTs
- ICS lab / office spaces spread in 4 buildings in the Central and the East Campus of FORTH (~ 5700m^2)
- The Institute has been pursuing basic and applied research activities spanning the broader ICT domain
- Since its early years of operation, ICS has adopted an evolving strategy
  - Pursuing excellence in research
  - Supporting education and training
  - Promoting innovation
  - Contributing to the development of an Information Society and Knowledge Economy at all levels
- Approach: <u>challenge-driven</u>, rather than project-driven
  - ICS provides resources, including own funds, to enable researchers pursue new activities even in the absence of external funding
- ICS has excelled in all evaluations of Research Institutes conducted by the GSRI, ranking consistently 1st in the ICT domain

ICS Research Laboratories

- Computer Architecture and VLSI Systems Laboratory (https://www.ics.forth.gr/carv/)
- Computational Biomedicine Laboratory (https://www.ics.forth.gr/cbml/)
  - Center for E-Health Applications and Services (https://www.ics.forth.gr/ceha/)
- Computational Vision and Robotics Laboratory (https://www.ics.forth.gr/cvrl/)
- Distributed Computing Systems and Cybersecurity Laboratory (https://www.ics.forth.gr/discs/)
- Human Computer Interaction Laboratory (https://www.ics.forth.gr/hci/)
- Information Systems Laboratory (https://www.ics.forth.gr/isl/)
  - Center for Cultural Informatics (https://www.ics.forth.gr/isl/centre-cultural-informatics)
- Signal Processing Laboratory (https://www.ics.forth.gr/spl/)
- Telecommunications and Networks Laboratory (https://www.ics.forth.gr/tnl/)

- Horizontal programmes
  - Ambient Intelligence (https://ami.ics.forth.gr/en/home/)
  - Data Science (https://www.ics.forth.gr/isl/data-science-programme)
  - Advanced Hybrid Imaging Systems (https://www.ics.forth.gr/hmiu/)

ICS Strategy and Policies

- Support schemes for the scientific directions and priorities
  - researchers are encouraged to pursue directions based on scientific and technological interest rather than availability of external funding
  - ICS has supported activities that lacked external funding with own resources
  - horizontal programmes to strengthen the capacity of ICS in addressing multidisciplinary challenges
  - new (joint) research activities introduced
    - Social and Cognitive Robotics (ISL, CVRL)
    - Space Technologies (SPL, CVRL)
    - Defense Technologies (CVRL)
    - cooperation with European and National Agencies (ESA, EDF, Ministry of Digital Governance, GRNET) and private companies (OHB, Naval Group)
    - Computational vision for the (privacy-preserving) monitoring of human activities (CVRL)
    - Bias and deception detection (ISL)
    - Game-theoretic approaches in multi-agent systems (ISL, TNL)
    - Bioinformatics analysis for rare pediatric diseases (ISL, CBML)

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# ICS Strategy and Policies

- Support schemes for the scientific directions and priorities
  - Internal grants programme
    - seed funds of up to 50Keuros
    - first call for proposals in October 2021; selected 4 proposals (out of 24 submissions) with a total of 193Keuros for the 1st round following an evaluation by external evaluation committee
    - the programme will issue calls on a yearly basis
    - source of funds: income from the acquisition (buyout) of ICS shares in Forthnet
  - Promotion of Innovation
    - The Institute supports spin-off activities with financial and in-kind contributions
    - ICS maintains a strong portfolio of patents and exploitable results
    - Innovative spin-off activities
      - OramaVR, codeBGP, Exapsys, TraQbeat, ForthSight (forthcoming)
    - Licensing or professional services agreements (Toshiba, Honda, Apple, …)
  - Digital Transformation and Societal contributions
    - numerous contributions to organizations of various types (governmental, scientific, cultural, health, commercial) with economic and societal impact

Outlook

- ICS will continue contributing in European flagship initiatives (e.g. EuroHPC, European Processor Initiative, AI and Robotics), National initiatives and joint new actions (e.g. Chips JU, Quantum Computing Initiative)
- ICS will intensify its collaboration with all Institutes of FORTH in new areas, e.g.,
  - Quantum Computing (w. IESL)
  - Precision Medicine and new technologies for health (w. IMBB, IBR)
  - Data-enabled Astrophysics research, Space technologies (w. IA)
  - Environmental Monitoring (w. IACM)
  - Additive Manufacturing (w. ICEHT)
  - Digital Humanities (w. IMS)
  - Signal and Image Analysis applications (w. IGE)
- Efforts to strengthen the Institute's excellence will continue, taking advantage of funding opportunities
  - Widening actions (ERA Chairs, Teaming, Twinning), EIC, ERC, MSCA programmes, ….
- ICS will continue to support research activities using own funds when external funds are not available
- ICS will continue investing in the education and training of young researchers
  - maintain close relationships with the Univ. of Crete and other higher education institutions
- ICS is committed to actively pursue exploitation prospects for mature technological results that bear a significant potential for industrial exploitation in international markets
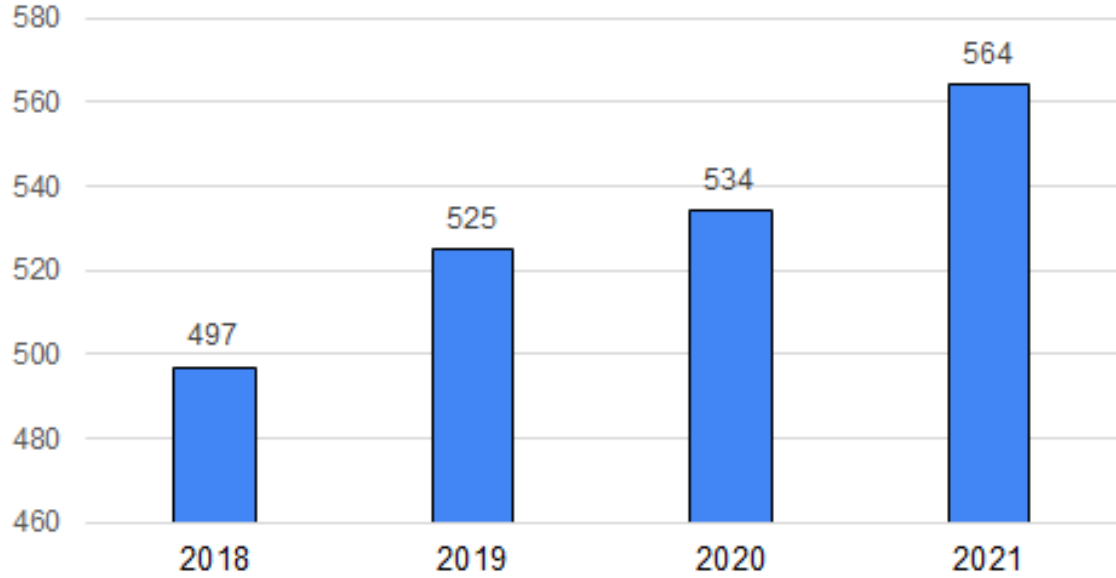
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Outlook

- Approach towards fulfilling the Institute's mission: *"Continuity – Agility – Scale-Up"*
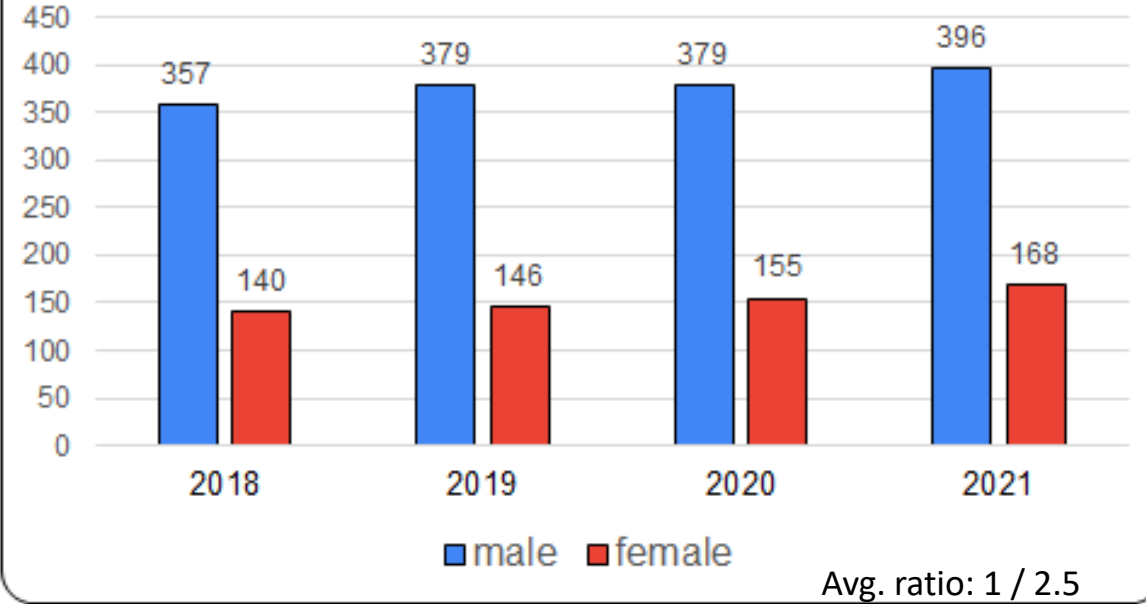- …with dedication and adherence to its core values
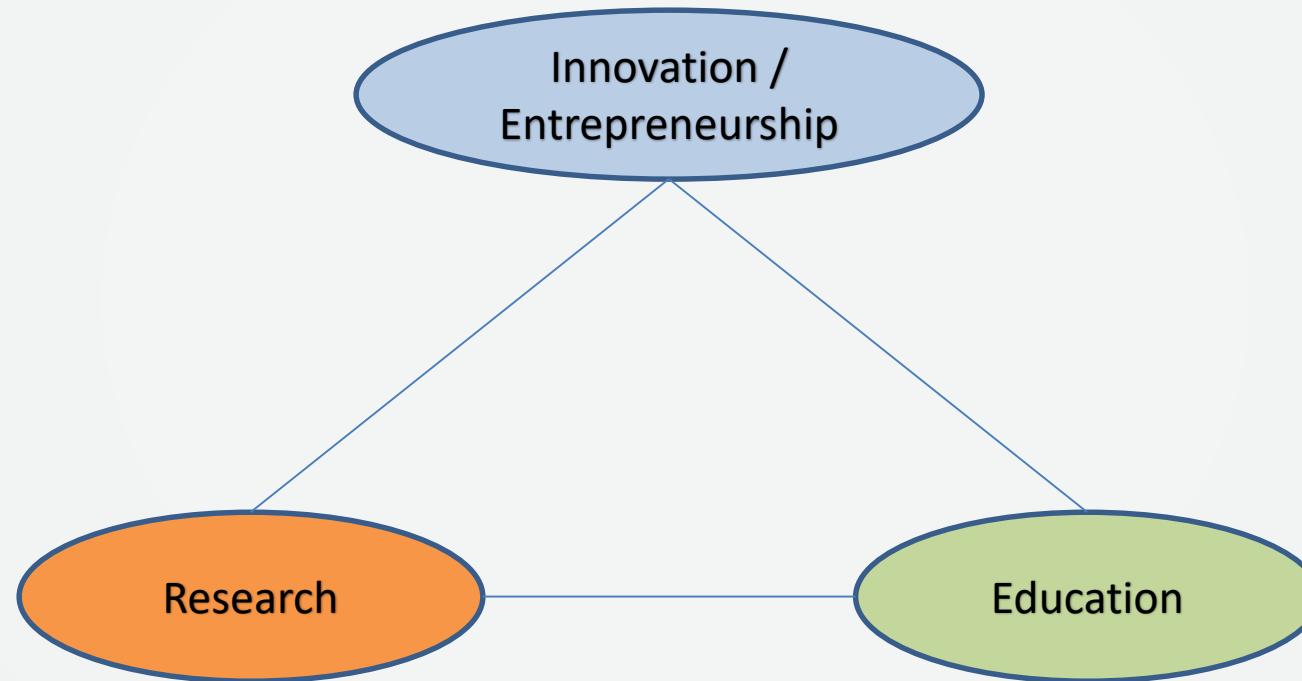
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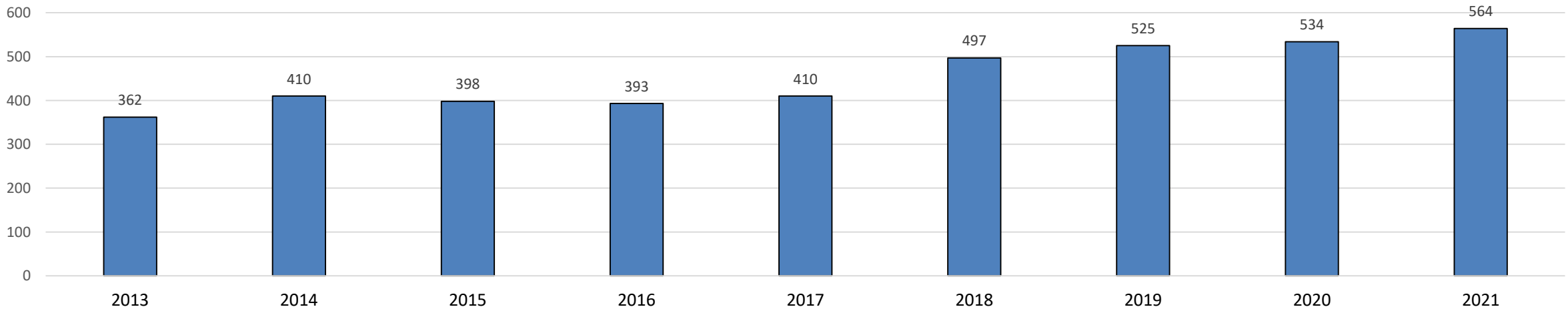
ICS Personnel (2018-2021)

Avg. ratio: 1 / 2.5
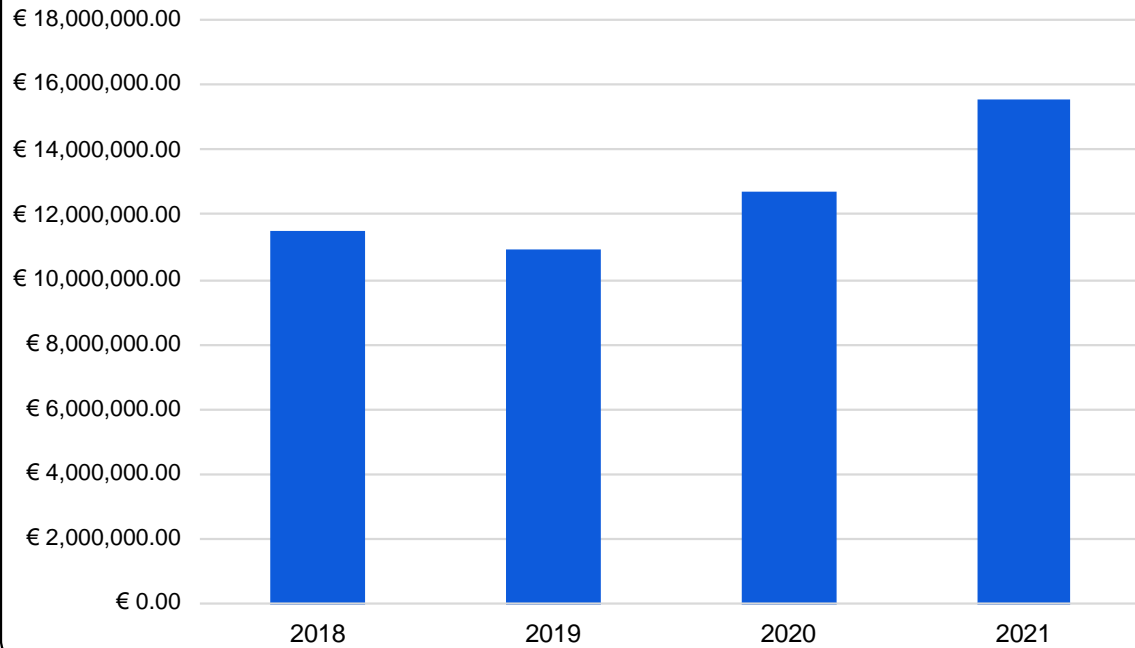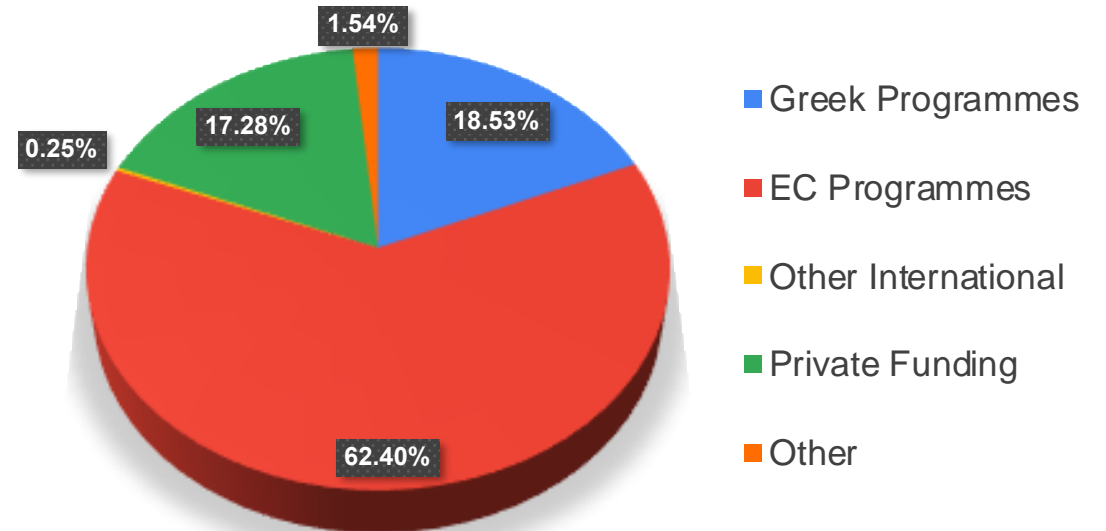
ICS Funding – Competitive Grants

Annual financial distribution of ICS competive grants


**Distribution of ICS funding in 2018-2021 period**

- Greek Programmes
- EC Programmes
- Other International
- Private Funding
- Other

1.54%
0.25%
17.28%
18.53%
62.40%

Results and Achievements

- ## Bibliometric Output

	2018	2019	2020	2021	TOTAL
Journal Publications	59	86	101	144	390
International conference proceedings	107	113	84	106	410
Other conferences	32	42	24	30	128
Book chapters	19	9	15	6	49
Books - monographs	9	8	20	16	53
TOTAL	226	258	244	302	1.030
Citations	4.367	3.300	2.135	1.147	10.949

Distribution of journal publications in quartiles (2018-2021)
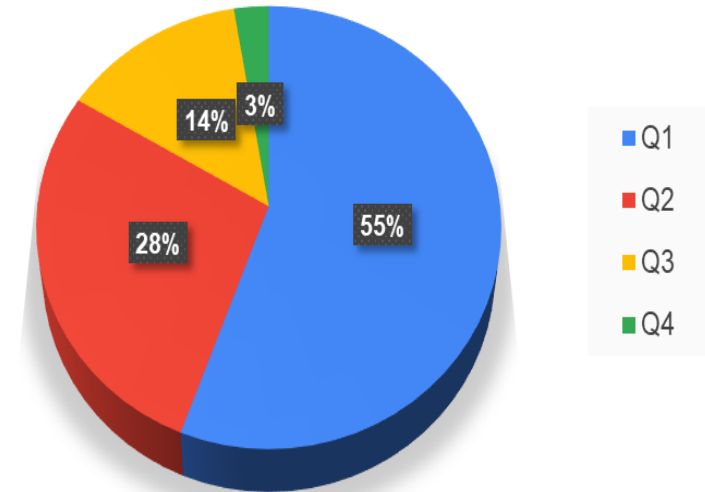
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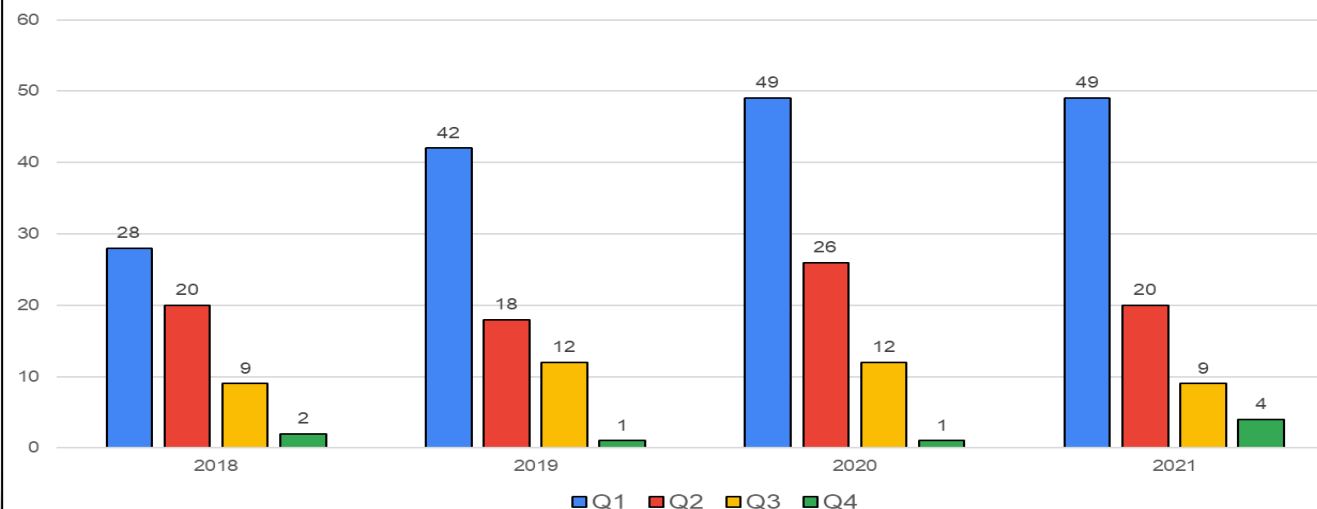
Computer Architecture & VLSI Systems (CARV) Lab

- High Performance Computer (HPC) Architectures
  - how tens of thousands of processors will work together to solve one problem thousands of times faster
- Parallel Programming & Runtime Systems
- Systems Software, Storage, I/O, Big Data

- European Processor (EPI)
  - for technological sovereignty & competitiveness of Europe
- CARV Lab is the main driver in *Greece ranking 5th* among all European countries in EPI and in HPC research
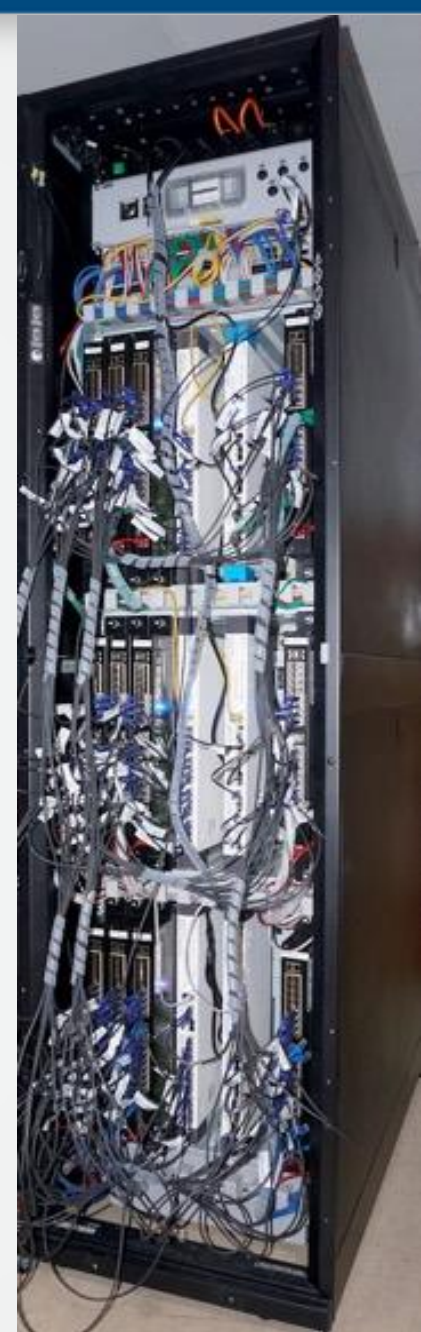
CARV

Computational Biomedicine Laboratory (CBML)

- The mission of the Computational Medicine Laboratory (CML) is to develop novel ICT technologies in the wider context of personalized medicine.

- CBML promotes translational biomedical research activities in all fields of biomedical sciences, by employing cutting-edge in vivo pre-clinical hybrid molecular imaging techniques (HMIU facility).

- CBML has run ~40 national and EC projects in the last four years with a total budget >8 Meuros and published ~80 peer reviewed articles per year on average (conference and journals).

- CBML is focusing on

  - Medical Image Analysis and AI modelling being part of the EC 'AI for Health Imaging network' (AI4HI) and participates in FUTURE AI towards trustworthy AI

  - R&D activities on the Integration of multilevel, heterogeneous health data (imaging, clinical & psychological data) through data models & ontologies in support of AI models in healthcare.

  - Evolutionary Bioinformatics and Translational Bioinformatics Research (part of BBMRI – Greece and ELIXIR).

  - Novel research in cancer computational modelling and computational neuroscience in the field of BCI (patents pending).
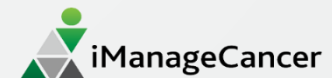
Computational Vision and Robotics Laboratory (CVRL)

CVRL in a Nutshell: Study & Develop Autonomous / Smart Robotic Systems that Exhibit

- Advanced *visual perception* capabilities → human-centered computer vision and machines looking at their environment

- Advanced *action* capabilities → *Motion, manipulation, behavioral* capabilities of rigid/soft robots, including ground, (under)water, aerial systems
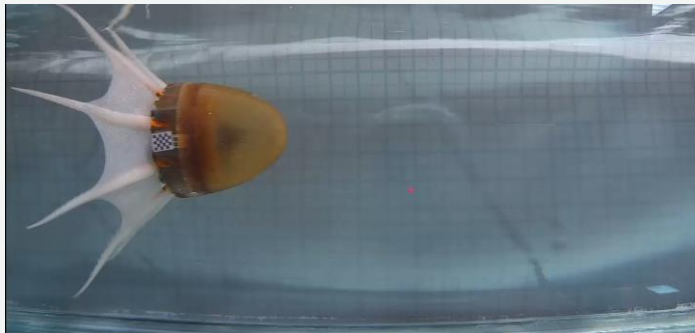
Distributed Computing Systems and Cybersecurity (DiSCS)

- **Focus**: Cyber Security and Privacy
- Areas of **expertise**:
  - Systems Security, Privacy, Social Media,
  - Analytics, IoT
- Contributions to **EU Policy**:
  - ENISA: Research Priorities
  - ECSO (European CyberSecurity Organizations): Strategic Research and Innovation Agenda
  - Participation in the pilot projects for the **European CybersEcurity Competence Network** (CONCORDIA and CyberSec4Europe)
- **Service** to the Community:
  - Safer Internet Access: SaferInternet4kids.gr

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Human Computer Interaction Laboratory (HCI)

User Experience Design, Methods and Tools

e-Accessibility, Design for All and Universal Access

Interaction in intelligent environments

Human-Centered AI

Real-time Computer Graphics systems

Presence and interaction in X-Reality

HCi LAB

Prof. Constantine Stephanidis
cs@ics.forth.gr
https://www.ics.forth.gr/hci

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Applications of societal, cultural & industrial / market impact

Programming Languages & IDEs for User Interfaces

Indicative key results

- UX evaluation framework for intelligent environments
- Innovative large-scale e-Government services
- User studies with disabled individuals
- Accessibility audits and consultancy
- Accessible serious games for children
- Applications for stress management and sleep hygiene
- Applications for precision agriculture
- Digitization and preservation of traditional crafts
- Virtual Humans for oral and sign language narrations
- Immersive presentations of cultural heritage sites
- Anonymization, analysis, and visualization of big data
- Transmedia storytelling and immersive experiences in the New Media
- Human-Centered Design framework for AI
- Real-time adaptation of context-aware Intelligent User Interfaces for enhanced situational awareness
- Computational geometric algebra approaches for real-time virtual character simulation and HCI

Information Systems Laboratory (ISL)

Core research themes

- Semantic Data Management
- Knowledge Representation and Reasoning / Symbolic AI
- Service-Oriented Computing / Scalable data-intensive services
- Information Retrieval and Analysis
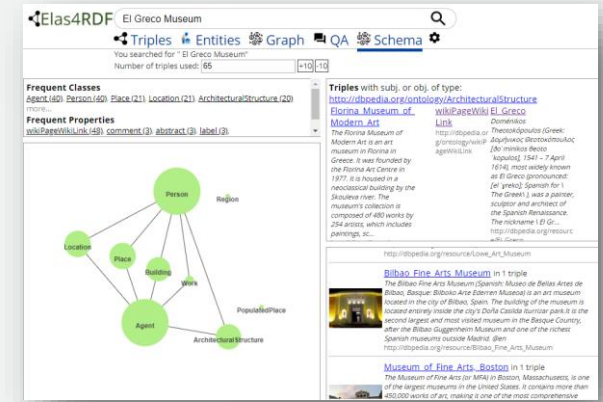
ISL coordinates <u>a horizontal activity</u> among ICS laboratories on Data Science

Core application themes

- Cultural Informatics
- Digital Preservation
- Social and Cognitive Intelligent Systems
- ICT Ecosystems for Precision Medicine

- Addressing technical challenges with a strong inter-disciplinary character
  - understanding and modelling domains using formally-founded conceptualizations
- Development of products, services and standards

Centre for Cultural Informatics (CCI)
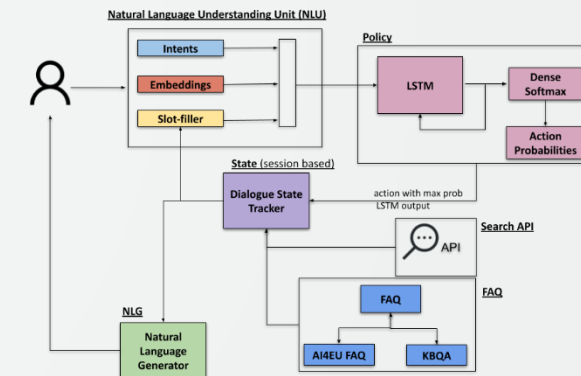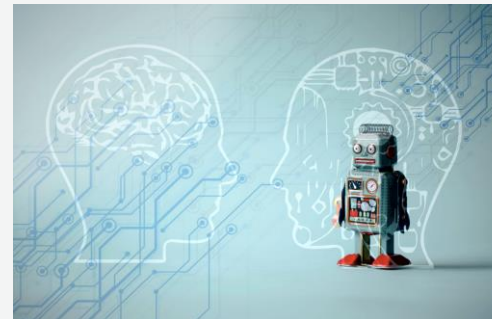
About CCI
- Founded in 1994, **28 years** of successful course!
- First and pioneer **in cultural informatics** in Greece
- Significant successes
  - **CIDOC CRM** (the only ISO Standard .. made in Greece!)
  - Over **90 projects** (> 40 European)
  - International collaborations

Recent Achievements and Current Activities
- Evolution of the **ISO standard CIDOC CRM**
  - Coordinated the development of the standard (version 7.1 2021).
  - In 2021 CIDOC CRM became national **standard in China**
- Participation to major EU projects
  - **PARTHENOS, E-RIHS, SSHOC, ARIADNEplus, 4CH, ReKnow**
- Participation to major National projects
  - **APOLLONIS, METOPO, ΨΗΦΙΑΚΟ ΑΠΟΣΦΡΑΓΙΣΜΑ ΑΓΙΩΝΥΜΩΝ ΝΗΣΩΝ, ΠΟΛΙΤΕΙΑ ΙΙ, C.A.L.L.O.S, PROTEAS**
- Platform support of two ERC programmes: **SeaLiT** and **RICOTRANS**
- Funding: **~2m Euros** for 2018-2021
- Enriched Suite of Tools/Services/Systems

www.ics.forth.gr/isl/cci
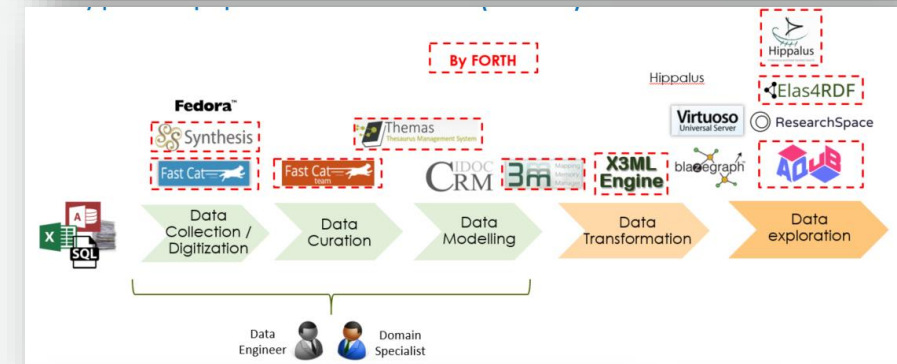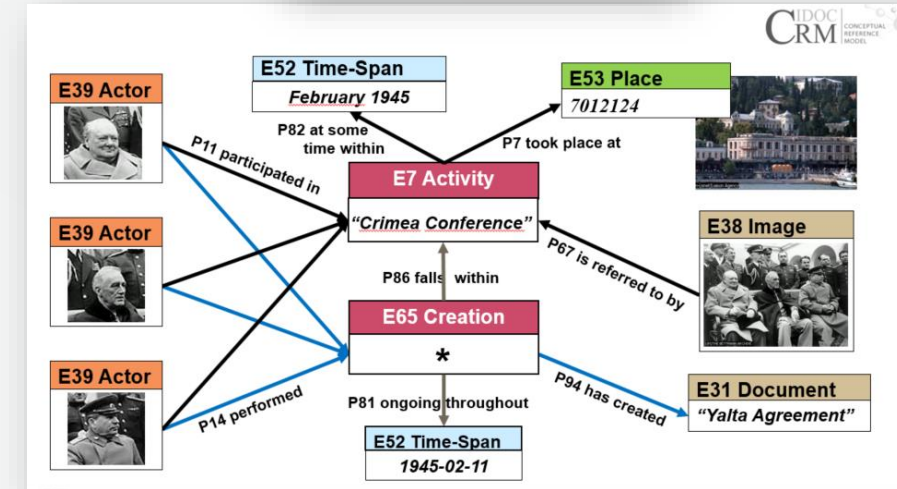
Signal Processing Laboratory (SPL)

MATHEMATICAL SIGNAL PROCESSING & LEARNING

Statistical signal processing; Compressed sensing
Machine/deep learning; Big data analysis

- 3 best paper awards in the field of sparse representations for optimization and learning
- 10 European and 13 national projects with a budget in excess of 15 M€ totaling
more than 7 M€ in actual funding for FORTH

COMPUTATIONAL IMAGING

Hyperspectral imaging;
satellite & medical imaging video coding;
neuro-inspired imaging

- Developed a multi-source observation fusion system (with USC and NASA)
- Subcontracted by OHB-Hellas for an ESA dual-camera satellite with on-board AI capabilities

DISTRIBUTED SENSOR NETWORKS

Autonomic networking; Body sensor networks;
Distributed computing for IoT/CPS applications

Developed an end-to-end smart water monitoring and control system

AUDIO & SPEECH

(3D) Audio coding; Wireless acoustic sensor networks;
Immersive performance; Speech enhancement

6 USPTO patents on microphone arrays and user generated content systems

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Telecommunications and Networks Laboratory (TNL)

Research

- Interdisciplinary approach: Apply theory, methodologies, tools, algorithms, processing techniques, and hardware developed for telecommunications and networks to other fields and applications, providing solutions to non-trivial problems
  - Network Systems Neuroscience: functional network connectivity in the context of learning, under various neurological disorders and Neuroscience-driven AI
  - Real time instrumentation for extremely high-speed laser experiments' data acquisition and processing,
- 5G, 6G and beyond, SDR, SDN, Space communications for LEO satellites
- IoT vertical approach
- ML on communications

Achievements

- Prof. Xenofontas Dimitropoulos acquired two ERC Proof of Concept grants following the successful completion of his starting ERC grant – delivered ARTEMIS software for real-time BGP hijacking detection
- The spin-off Code BGP was created, as a result of the ERC grants work, attracting 1.5 Meuros funding
- Prof. Maria Papadopouli was among the 13 N2Women "Stars in Networking and Communications" in 2021
- Designed the first metropolitan LoRaWAN infrastructure in Cyprus, covering over 90% of the city of Larnaca
- Developed an SDR-based with GPU processing real-time spectrum analyzer achieving 160 MHz of real-time bandwidth
- Three FORTH Synergy Grant project proposals accepted in the past 4 calls

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Horizontal Programmes

- Ambient Intelligence Programme (AmI) – Prof. C. Stephanidis, coordinator
  - design, develop and apply human-centric AmI technologies and Smart Environments, capable of "understanding" and fulfilling individual human needs
  - study AmI-related technologies and assess their impact on the individual /society as a whole
  - development of integrated pilot solutions in laboratory environment (in vitro), technology transfer and application in real settings (in vivo)
- Advanced Hybrid Imaging Systems Programme (AHIS) – Prof. A. Karantanas, coordinator
  - (pre-)clinical applications of hybrid imaging systems (positron emission tomorgraphy / magnetic resonance imaging) for improving the diagnostic capacity of current image-based techniques
  - Hybrid Molecular Imaging Unit with PET/MRI (4.7T) scanner
  - in-vivo analyses at a molecular level using small animal models
  - relies on the synergy of several ICS Labs (CBML, SPL, CVRL, ISL) for the development of new computational tools and interfaces for more effective disease diagnosis and monitoring

Horizontal Programmes

- Data Science Programme (DS) – Profs. D. Plexousakis, N. Spyratos, coordinators
  - managing, analyzing and visualizing large volumes of data, with the purpose of exploring the value chain related to big data
  - relies on the synergies of several ICS Labs (ISL, CARV, CBML, HCI, SPL, TNL)
  - subjects of interest include
    - storage, indexing and querying very large volumes of heterogeneous data
    - data provenance and summarization
    - large-scale data integration
    - data mining and causal discovery
    - information extraction from the Web
    - linked data management, querying and updating
    - data quality assurance
    - metadata extraction from low-level signals
    - statistical machine learning / deep learning
    - real-time visualization
    - large-scale analytics for decision support
    - resource-constrained reasoning with large volumes of data
    - applications in medicine, biology, neuroscience, astrophysics

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