ISP@IPL@UV

People:
- 12 senior researchers (6 professors + 6 postdocs)
- 6 PhD students

Profiles: Physics + Maths + Electronics + Optics + Telecos

Research
- Machine learning + Visual neuroscience
- Signal/Image processing + Remote sensing/Geoscience

Production
- ISP is 12 years old
- 12 journal papers/yr, 20 confs/yr, 1 book chapter/yr
- Continuous funding from CICYT, H2020, ERC, and ventures

Compromise with teaching
Compromise with open code/data
A beautiful story ...

Machine Learning \( f(x, \theta) \) should be flexible, nonlinear, smooth, theoretically solid, analytically tractable, differentiable, and scalable.
Mapping functions \( f(x, \theta) \) and \( g(y, \omega) \) should be flexible, nonlinear, smooth, theoretically solid, analytically tractable, differentiable, and scalable.
Research lines: 10 niches of theory interest

1. Kernel methods: SVMs, Gaussian processes
2. Mainly regression nowadays, yet classification expertise
3. Multioutput regression for consistency
4. Fusion of multiple data sources
5. Combine/Emulate physical models
6. Credible confidence intervals
7. Smart sampling in high dim spaces
8. Dimensionality reduction and feature extraction
9. Scalability of kernel machines
10. Causal inference in time series and instant processes
Research lines: 3 main applications of interest

1. Improve estimates of states (land, ocean, atmos) from space
   - Higher accuracy (better kernels, learned from data, physics)
   - Spatial, spectral and temporal structures
   - Large scale kernels to deal with millions of points

EO data → Machine Learning → Predictions
Research lines: 3 main applications of interest

1. Improve estimates of states (land, ocean, atmos) from space
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2. Encode and extract knowledge
   - Interpretability: sensitivity and ranking
   - Sensible confidence intervals
   - Consistency and credibility: Physically meaningful results

![Graph showing GPP (Pg C/yr) per unit area for different biomes.]
- Tropical
- Temperate
- Boreal
- Savannahs
- Shrublands
- Deserts
- Tundra
- Croplands
Research lines: 3 main applications of interest

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3. Causality and (cond) independence estimation
Three representative papers...

**Composite kernels for data fusion**

**Information-theoretic measures of independence**

**Remote sensing and geoscience applications**
... and 2 books

Kernel Methods for Remote Sensing Data Analysis

Digital Signal Processing with Kernel Methods
Our network

Collaborators

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Research groups

Empirical Inference, MPI Intelligent Systems, Tübingen, Germany
Dept. Biogeochemical Integration, MPI Biogeochemistry, Jena, Germany
GFZ German Research Centre for Geosciences, Berlin, Germany
Laboratory for Earth Observation, València, Spain
Environmental Remote Sensing Group, València, Spain

Lab. Computat. Vision, Center for Neural Science, NYU, New York, USA
NASA Vision Group, Ames Research Center, Moffett Field, CA, USA
Dept. of Computer Science, University of Helsinki, Finland
Computat. Neurosci., MPI Biological Cybernetics, Tübingen, Germany
Biomedical Image Group, Hospital La Fe, València, Spain
Neurobiology Lab., Inst. Príncipe Felipe, València, Spain

Companies

EUMETSAT
ESA
GOOGLE

DigitalGlobe
Analog Devices
Instituto Geográfico Nacional
Institut Cartogràfic Valencià

Vistakon (Johnson & Johnson)
Davalor Salud
StarLab
Related projects and activities to KERMES


- FLUXCOM: An initiative to upscale biosphere-atmosphere fluxes from FLUXNET sites to continental and global scales. MPI 2014-2022

- SEDAL: Statistical Learning for Earth Observation Data Analysis. ERC Consolidator Grant, 01/15 - 12/19


- Cloud detection in the cloud. Google Earth Engine Research Award, 16-17
ISP interest and contributions to KERMES

- Learn, publish and have fun with friends
- Improve prediction methods in Earth science
- From regression to causation
ISP at KERMES

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Expected contributions from KERMES
- Explore new methods and code
- Cool publications
- Collaborations, visits, exchange
- Future H2020 projects
- Transfer to industry