

# Research Activities and Publications

## Research Activities

Elena Casiraghi's interest in the information technology research field date to the year 2000, when she was hired as a "trainee researcher" in VTT (Valtion Teknillinen Tutkimuskeskus), Department of Information Technology. During the year spent at VTT, she started to work in the European project Internet Middleware for Customized Service Bundling to develop mathematical methods for the automatic insertion of digital photographs into a 3D virtual world; this problem required a continuous adaptation of the image according to the user movements into the 3D world. Her work was highly judged and treated as an important issue during the international reporting of the project. After the end of the project, she worked in a research project studying computational methods for observing early signs of deterioration of CD-ROM discs; after presenting a detailed analysis of the problem, the developed recovering system was considered as efficient and effective.

Since she began to work in Università degli Studi di Milano, Elena Casiraghi's research interests have been mainly focused in the field of artificial intelligence, to develop automatic systems for image processing and pattern recognition.

Specifically, she began her researches with investigations in the field of image processing, to develop automatic applications for face localization, identification, and recognition. These problems allowed her to study and apply supervised and unsupervised learning algorithms.

Subsequently, she focused on the medical and biomedical image processing fields, where she studied and developed computer aided diagnosis (CAD) systems. In detail, she started working on digital chest radiographs, to detect subtle lung nodules at their early stages; the developed CAD system can be successfully applied to aid radiologists during their decision making process, thus increasing their nodule identification performance. After these researches she focused on the problem of living donor liver transplantation and developed an automatic system for the 3D reconstructions of abdominal organs (e.g. liver, spleen, and kidney) from computed tomography (CT) images, with the final aim of measuring their volume. Both these systems required the development of applications being able to cope with data of high dimensionality. Furthermore, her investigations lead her to the development of learning systems treating highly unbalanced learning datasets of high cardinality.

Other minor researches in the medical field were aimed at 3D volume reconstruction and biometric analysis of fetal brain from MR images.

In the bio-medical field, she developed an automatic system for the segmentation of mice images produced with molecular imaging. The system identifies anatomical organs of interest where it computes specific measurements; the precision of the obtained measures has been considered particularly helpful by pharmacologists that needed to evaluate and compare the pharmacological effect produced by different drugs, that is drugs produced according to different biochemical interactions.

After these researches, she has successfully investigated and developed learning algorithms

dealing with high dimensional data belonging to unbalanced datasets of both high and low cardinality.

In the latest years, she has been investigating in the field of pattern recognition, manifold learning, and intrinsic dimensionality estimation, to develop novel theories and automatic algorithms dealing with high-dimensional datasets characterized by a small cardinality (Small Sample Size Problem). These researches led to the development of methods whose performance has been evaluated both by the comparison with state of the art techniques and by tests on synthetic and real datasets related to problems in the fields of signal processing, image analysis, and bioinformatics.

The aforementioned studies are currently exploited to investigate and experiment solutions to reduce one of the main problem of deep learning techniques, which is the huge computational (time and memory) costs. To this aim, researches are aimed at compressing deep neural networks, by reducing their layer size to the intrinsic dimension estimated on the layers' filters. To effectively reduce the filter dimension different techniques are going to be experimented.

At the present, she is involved in researches in the field of microscopic image analysis. Regarding the latest, she is collaborating with expert biologists as well as cardiovascular surgeons to investigate the main factors behind carotid plaques' instability, the latest being the main cause of cerebral stroke. More specifically, the aim is the development of an automatic system to compare different biological structures (such as vascular structures) which appear in different microscopic images of contiguous carotid sections containing plaques. The plaques have been extracted by chirurgical procedures to avoid cerebral strokes, since the clinical patients' history suggested an high risk of plaque instability. To avoid unnecessary chirurgical procedures, the reasons and main factors involved in plaque instability are still to be discovered. For this reason the aim of the present study is to highlight biological factors of interest from contiguous carotid sections (containing plaques). The sections are immuno-histochemically stained with different markers, each highlighting a particular biological structure; the accurate detection of each marker allows to study and develop measures for the automatic comparison of the density and co-localization of the different biological structures. This measurements and studies will help to discover structures whose appearance could be exploited as an early alert of plaque instability, avoiding unnecessary surgical procedures. Discovering factors positively or negatively relate at plaques' instability would have an high impact on cerebral stroke prevention.

## Journal Publications

- [1] E. Casiraghi, V. Huber, M. Frasca, M. Cossa, M. Tozzi, L. Rivoltini, B.E. Leone, A. Villa, B. Vergani (2017). A novel computational method for automatic segmentation, quantification and comparative analysis of immunohistochemically labeled tissue sections. Accepted for publication at BMC BioInformatics.
- [2] E. Casiraghi, M. Cossa, V. Huber, M. Tozzi, L. Rivoltini, A. villa, B. Vergani (Nov. 2017). MIAQuant, a novel system for automatic segmentation, measurement, and localization comparison of different biomarkers from serialized histological slices. *European Journal of Histochemistry*, vol. 61 (4):2838. doi: 10.4081/ejh.2017.2838.
- [3] E. Casiraghi, S. Ferraro, M. Franchin, A. Villa, B. Vergani, M. Tozzi (December 2016). Analisi semi automatica nella valutazione della neo-vascolarizzazione della placca carotidea. *Italian Journal of vascular and endovascular surgery* (Minerva Medica Publishing), vol. 23 (4), pp. 55-56, Suppl.I, ISSN 1824-4777, Online ISSN 1827-1847.
- [4] P. Campadelli, E. Casiraghi, C. Ceruti, A. Rozza (2015). Intrinsic Dimension Estimation: Relevant techniques and a Benchmark Framework. *Mathematical Problems in Engi-*

- neering (Hindawi Publishing Corporation), vol. 2015, Article ID 759567, 21 pages, 2015. doi:10.1155/2015/759567.
- [5] A.A. Esposito, M. Zilocchi, P. Fasani, C. Giannitto, S. Maccagnoni, M. Maniglio, M. Campoleoni, R. Brambilla, E. Casiraghi, P.R. Biondetti (2015). The value of precontrast thoraco-abdominopelvic CT in polytrauma patients. *European Journal of Radiology*. doi:10.1016/j.ejrad.2015.02.015. ISSN 0720-048X. - 84:6 (2015 Jun), pp. 1212-1218 (Available online 3 March 2015).
- [6] C. Giannitto, A.A. Esposito, E. Casiraghi, P.R. Biondetti (2014). Epidemiological profile of non-traumatic emergencies of the neck in CT imaging: our experience. *La Radiologia Medica*. doi: 10.1007/s11547-014-0389-9 (Epub ahead of print).
- [7] C. Ceruti, S. Bassis, A. Rozza, G. Lombardi, E. Casiraghi, and P. Campadelli (2014). DANCo: Dimensionality from Angle and Norm Concentration. *PATTERN RECOGNITION*, vol. 47, Issue 8, pp. 2569-2581, ISSN: 0031-3203, doi:10.1016/j.patcog.2014.02.013.
- [8] A. Rozza, G. Lombardi, C. Ceruti, E. Casiraghi, P. Campadelli (2012). Novel high intrinsic dimensionality estimators. *MACHINE LEARNING*, vol. 89, Issue 1, pp.37-65, ISSN: 0885-6125, doi: 10.1007/s10994-012-5294-7.
- [9] A. Rozza, G. Lombardi, E. Casiraghi, P. Campadelli (2012). Novel fisher discriminant classifiers. *PATTERN RECOGNITION*, vol. 45, pp. 3725-3737, ISSN: 0031-3203, doi: 10.1016/j.patcog.2012.03.021.
- [10] F. Bredolo, A. Esposito, E. Casiraghi, G. Cornalba, P. Biondetti (2011). Intestinal interposition: the prevalence and clinical relevance of non-hepatodiaphragmatic conditions (non-Chilaiditi forms) documented by CT and review of the literature. *LA RADIOLOGIA MEDICA*, pp. 607-619, ISSN: 0033-8362, doi: 10.1007/s11547-011-0665-x.
- [11] P. Campadelli, E. Casiraghi, and S. Pratisoli (2010). A segmentation framework for abdominal organs from CT scans. *ARTIFICIAL INTELLIGENCE IN MEDICINE*, vol. 50, pp. 3-11, ISSN: 0933-3657, doi: 10.1016/j.artmed.2010.04.010.
- [12] A. Rozza, G. Lombardi, M. Rosa, E. Casiraghi (2010). O-IPCAC and its application to EEG classification. *JOURNAL OF MACHINE LEARNING RESEARCH*, vol. 11, pp. 4-11, ISSN: 1533-7928.
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- [14] P. Campadelli, E. Casiraghi, and A. Esposito (2009). Liver Segmentation from CT Scans : a Survey and a New Algorithm. *ARTIFICIAL INTELLIGENCE IN MEDICINE*, vol. 45, pp. 185-196, ISSN: 0933-3657, doi: 10.1016/j.artmed.2008.07.020.
- [15] P. Campadelli, E. Casiraghi, and D. Artioli (2006). A Fully Automated Method for Lung Nodule Detection From Postero-Anterior Chest Radiographs. *IEEE TRANSACTIONS ON MEDICAL IMAGING*, vol. 25, pp. 1588-1603, ISSN: 0278-0062, doi: 10.1109/TMI.2006.884198.
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## International Conference Publications

- [17] C. Ceruti, P. Campadelli, E. Casiraghi (2017). Linear Regularized Compression of Deep Convolutional Neural Networks (ICIAP 2017). LNCS 10484, pp. 244-253, ISBN=978-3-319-68559-5, doi=10.1007/978-3-319-68560-1\_22, url=http://dx.doi.org/10.1007/978-3-319-68560-1\_22, Springer International Publishing.
- [18] P. Campadelli, E. Casiraghi, C. Ceruti (2015). Neighborhood Selection for Dimensionality Reduction. Proceedings of International Conference on Image Analysis and Processing (ICIAP 2015). LNCS 9279-81, pp. 183-191, ISBN=978-3-319-23230-0, doi=10.1007/978-3-319-23231-7\_17, url=http://dx.doi.org/10.1007/978-3-319-23231-7\_17, Springer International Publishing.
- [19] Vitellaro M., Signoroni S., Casiraghi E., Sala P., Ballardini G., Delconte G., and Bertario L. (2015) Survival rate of patients who develop cancer in rectal stump after Colectomy and IRA in FAP patients. Selected for oral Presentation at the International Society for Gastrointestinal Hereditary Tumours (InSiGHT 2015). The 6th Biennial Meeting. Sao Paulo-Brazil.
- [20] Campadelli P., Casiraghi E., Ceruti C., Lombardi G., Rozza A. (2013). Local Intrinsic Dimensionality Based Features for Clustering. Image Analysis and Processing – ICIAP 2013: 17th International Conference, Naples, Italy, September 9-13, 2013. Proceedings, Part I, , pp. 41-50, Springer Berlin Heidelberg, Berlin Heidelberg, ISBN: 978-3-642-41181-6, DOI: 10.1007/978-3-642-41181-6\_5.
- [21] Bassis S., Rozza A., Ceruti C., Lombardi G., Casiraghi E., and Campadelli P. (2012), A Novel Intrinsic Dimensionality Estimator based on Rank-order Statistics. International Workshop on Clustering High-Dimensional Data (CHDD12), Naples, Italy, May 15th, 2012, Springer Verlag, LNCS, 2012.
- [22] Rozza A., Lombardi G., Rosa M., Casiraghi E., Campadelli P. (2011). IDEA: Intrinsic Dimension Estimation Algorithm. In: G. Maino, G. Foresti (Eds.). 16th International Conference on Image Analysis and Processing (ICIAP 2011): Proceedings (part I). Ravenna, Italy, September 14-16, 2011. vol. 6979, pp. 433-442, Springer New York, ISBN: 9783642240843, doi: 10.1007/978-3-642-24085-0\_45.
- [23] Lombardi G., Rozza A., Ceruti C., Casiraghi E., Campadelli P. (2011). Minimum Neighbor Distance Estimators of Intrinsic Dimension. In: D. Gunopulos, T. Hofmann, D. Malerba, and M. Vazirgiannis (Eds.). Machine learning and knowledge discovery in databases: European conference (ECML PKDD 2011): Proceedings (part II). Athens, Greece, September 5-9, 2011. vol. 6912, pp. 374-389, Springer-Verlag Berlin Heidelberg, ISBN: 978-960-89282-2-0, doi: 10.1007/978-3-642-23783-6\_24.
- [24] Rozza A., Lombardi G., Re M., Casiraghi E., Valentini G. (2010). DDAG K-TIPCAC: an ensemble method for protein subcellular localization. In: O. Okun, G. Valentini, and M. Re (Eds.). Supervised and Unsupervised Ensemble Methods and their Applications (ECML-SUEMA 2010): Proceedings. Barcelona, Spain, 2010.
- [25] Rozza A., Lombardi G., Casiraghi E. (2010). PIPCAC: A Novel Binary Classifier Assuming Mixtures of Gaussian Functions. In: Artificial Intelligence and Applications 2010 (AIA 2010). Innsbruck, Austria, CALGARY: M.H. Hamza, ACTA Press, ISBN: 978-0-88986-817-5.
- [26] Campadelli P., Casiraghi E., Lombardi G., Serrao G. (2009). 3D Volume Reconstruction and Biometric Analysis of Fetal Brain from MR Images. In: F. Masulli, R. Tagliaferri, and G.M. Verkivker (Eds.). Computational Intelligence Methods for Bioinformatics and Biostatistics, 5th International Meeting (CIBB 2008): Revised Selected Papers. Vietri sul Mare, Italy, October 3-4, 2008. vol. 5488, pp. 188-197, Springer-Verlag Berlin Heidelberg, ISBN: 978-3-642-02503-7, doi: 10.1007/978-3-642-02504-4\_17.

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- [30] Campadelli P., Casiraghi E., Pratisoli S. (2008). Fully Automatic Segmentation of Abdominal Organs from CT Images using Fast Marching Methods. In: *21st IEEE International Symposium on Computer-Based Medical Systems (CBMS 2008): Proceedings*. Jyväskylä, Finland, June 17-19, 2008. pp. 554-559, IEEE Computer Society Press, Los Alamitos, CA (USA), ISBN: 978-0-7695-3165-6, doi: 10.1109/CBMS.2008.9.
- [31] Campadelli P., Casiraghi E., Lombardi G. (2008). The Neighbors Voting Algorithm. In: O. Okun, G. Valentini (Eds.). *Second Workshop on Supervised and Unsupervised Ensemble Methods and Their Applications (SUEMA 2008): Proceedings*. University of Patras, Patras, Greece, July 21-25, 2008. pp. 31-35, ISBN: 978-960-89282-2-0.
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- [40] Campadelli P., Casiraghi E. (2004). Nodule Detection in Postero Anterior Chest Radiographs. In: C. Barillot, D.R. Haynor, and P. Hellier (Eds.). 7th International conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI 2004): Proceedings. Saint-Malo, France, September 26-29, 2004. vol. 3217, pp. 1048-1049, Springer, ISBN: 9783540229773, doi: 10.1007/978-3-540-30136-3\_132.
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## National Conference Publications

- [42] Lombardi G., Rozza A., Casiraghi E., Campadelli P. (2012). A Novel Approach for Geometric Clustering based on Tensor Voting Framework. In: B. Apolloni, S. Bassis, A. Esposito, F. Morabito (Eds.). Neural Nets WIRN11: Proceedings of the 21st Italian Workshop on Neural Nets. Vietri sul Mare, Salerno, Italy, June 3-5, 2011. vol. 234, pp. 129-138, IOS Press, 2012, ISBN: 978-1-60750-971-4.
- [43] Rozza A., Arca S., Casiraghi E., Campadelli P., Natale M., Bucci E., Consoli P. (2012). Automatic Alignment of Gel 2D Images. In: B. Apolloni, S. Bassis, A. Esposito, F. Morabito (Eds.). Neural Nets WIRN11: Proceedings of the 21st Italian Workshop on Neural Nets. Vietri sul Mare, Salerno, Italy, June 3-5, 2011. vol. 234, pp. 3-10, IOS Press, 2012, ISBN: 978-1-60750-971-4.
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- [45] Arca S., Campadelli P., Casiraghi E., Lanzarotti R. (2005). An Automatic Feature Based Face Authentication System. In: B. Apolloni B., Marinaro M., Nicosia G., and Tagliaferri R. (Eds.). Neural Nets: 16th Italian Workshop on Neural Nets (WIRN 2005) and International Workshop on Natural and Artificial Immune Systems (NAIS 2005): Revised Selected Papers. Vietri Sul Mare, Italy, June 8-11, 2005. vol. 3931, pp. 120-126, Springer Berlin, ISBN: 3540331832, doi: 10.1007/11731177\_18.

- [46] Campadelli P., Casiraghi E., Columbano S. (2004). Lung Segmentation and Nodule Detection in Postero Anterior Chest Radiographs. In: B. Apolloni B., Marinaro M., Nicosia G., and Tagliaferri R. (Eds.). Proceedings of the second National Conference of Gruppo Italiano Ricercatori in Pattern Recognition (GIRPR 2004), Perugia, September 15-17.
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## Book Chapters

- [49] Rozza A., Lombardi G., Re M., Casiraghi E., Valentini G., Campadelli P. (2011). A Novel Ensemble Technique for Protein Subcellular Location Prediction. In: O. Okun, G. Valentini, and M. Re (Eds.). Ensembles in Machine Learning Applications. vol. 373/2011, pp. 151-167, Springer-Verlag Berlin Heidelberg, ISBN: 978-3-642-22909-1, doi: 10.1007/978-3-642-22910-7\_9.
- [50] Lombardi G., Casiraghi E., Campadelli P. (2010). The Neighbors Voting Algorithm and its Applications. In: O. Okun, G. Valentini. Applications of Supervised and Unsupervised Ensemble Methods. vol. 245/2009, pp. 151-173, Springer-Verlag Berlin Heidelberg, ISBN: 9783642039980, doi: 10.1007/978-3-642-03999-7\_9.

## Poster Presentations

- [51] Gliozzo J., Notaro M., Petrini A., Perlasca P., Mesiti M., Casiraghi E., Grossi G., Re M., Paccanaro A., Valentini G. (2017). Modeling biomolecular profiles in a graph-structured sample space for clinical outcome prediction with melanoma and ovarian cancer patients. 14th Annual Meeting of the Bioinformatics Italian Society (BITS 2017), July 5-7, 2017, Cagliari, Italy.
- [52] Casiraghi E., Vergani B., Villa A. (2017). An automated method for biological marker segmentation, quantification, and colocalization, from histochemical and immunohistochemical images. 14th Annual Meeting of the Bioinformatics Italian Society (BITS 2017), July 5-7, 2017, Cagliari, Italy.
- [53] Casiraghi E., Ferraro S., Franchin M., Villa A., Vergani B., Tozzi M. (2016). Analisi semi automatica nella valutazione della neo-vascularizzazione della placca carotidea. SICVE 2016, XV Annual Meeting of Societ italiana di Chirurgia Vascolare ed Endovascolare, 22-25 Rome, Italy.
- [54] Rozza A., Lombardi G., Re M., Casiraghi E., Valentini G., Campadelli P. (2011). A novel ensemble approach for the subcellular localization of proteins. In: BITS 2011: 8th annual meeting of the Bioinformatics Italian Society: June 20-22, 2011, Pisa, Italy: Proceedings. Pisa, 2011, p. 105-106, PISA:ETS, ISBN: 9788846730695.

## Conference talks and Awards

- [55] The 25th of October the Abstract/Poster presented at SICVE (entitled: “Analisi semi automatica nella valutazione della neo-vascularizzazione della placca carotidea.”) won the award for being judged the best work presented at the Conference.
- [56] The 16th of February, 2005 she an invited speaker at the Workshop: “Digital Image Processing in medicine and biology” (Palermo), organized by “Centro Interdipartimentale Tecnologie della Conoscenza” (CITC, Università degli Studi di Palermo), “Scuola di specializzazione in Anatomia Patologica” (Università degli Studi di Palermo) and the Department of biotechnologies and Legal Medicine (Università degli Studi di Palermo). She presented her research “Computerized lung nodule detection from Postero-Anterior chest radiographs”.
- [57] The 9th of March, 2007 she was an invited speaker at the Workshop: “Biomedical Imaging Systems for diagnosis” (Palermo), organized by “Centro Interdipartimentale Tecnologie della Conoscenza” (CITC, Università degli Studi di Palermo), “Scuola di specializzazione in Anatomia Patologica” (Università degli Studi di Palermo) and the Department of biotechnologies and Legal Medicine (Università degli Studi di Palermo). She presented her research “Computerized liver segmentation method from Computed Tomography (CT) images”.
- [58] The 28th-29th of April, 2008 she was an invited speaker at the Workshop: “Shape and Size in Medicine, Biotechnology and Materials Science”, organized by the Department of Mathematics, Università degli Studi di Milano. She presented her research “Computer aided diagnosis systems in medical imaging”.
- [59] The 30th of November 2006 she participated at “Obiettivo ICT” award, presenting her business idea project, together with Prof. Paola Campadelli. The project was selected as one of the best 10 projects.
- [60] The 26th of October 2007 she participated at “Start Cup Milano Lombardia” award, presenting her research project, together with Prof. Paola Campadelli. The project won the Special award of CCIIA Milano.

## Phd Thesis

Elena Casiraghi. A computer aided diagnosis system for lung nodules detection in postero anterior chest radiographs. Phd. Thesis, University of Milan, Computer Science Department, 2004.

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Elena Casiraghi. A computer aided diagnosis system for lung nodules detection in postero anterior chest radiographs. Phd. Thesis, University of Milan, Computer Science Department, 2004.