

Santiago Mazuelas

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Present Work Address

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Education

- **Doctor of Philosophy in Telecommunications Engineering** 2007 – 2011
University of Valladolid, Spain
Thesis: Wireless localization in harsh environments by means of distance estimates:
Theoretical framework and techniques to optimize accuracies
Advisors: Prof. Ruben Lorenzo and Prof. Patricia Fernandez
- **Doctor of Philosophy in Mathematics** 2002 – 2009
University of Valladolid, Spain
Thesis: Projective interpretation of metric, equiform, and inversive geometries
Advisor: Prof. Jose Manuel Aroca
- **Bachelor's Degree in Telecommunication Technical Engineering** 2003 – 2006
University of Valladolid, Spain
- **Bachelor's Degree in Mathematics** 1996 – 2002
University of Valladolid, Spain

Work Experience

- **Basque Center for Applied Mathematics (BCAM)** December 2017 – Present
Data science area. Bilbao, Spain
Ramon y Cajal Researcher
- **Laboratory for Information and Decision Systems (LIDS)** October 2018 – November 2020
Massachusetts Institute of Technology (MIT). Cambridge MA
Research Affiliate
- **Qualcomm Incorporated** March 2014 – November 2017
Research and Development Department. San Diego, CA
Staff Engineer
- **Laboratory for Information and Decision Systems (LIDS)** February 2013 – February 2014
Massachusetts Institute of Technology (MIT). Cambridge MA
Postdoctoral Associate
- **Wireless Information and Network Sciences Laboratory** September 2009 – January 2013
Massachusetts Institute of Technology (MIT). Cambridge MA
Postdoctoral Fellow
- **Center for the Development of Telecommunications (CEDETEL)** 2006 – 2009
Radiolocation group. Valladolid, Spain
Researcher
- **School of Electrical Engineering** 2008 – 2009
University of Valladolid, Spain
Lecturer Professor for the subjects "Digital Electronics" and "Microelectronic Design" in the School of Electrical Engineering

Research Interests

I am a mathematician that finds in engineering the source of problems to solve or an engineer that uses mathematics to think about technical problems. My ambition is to pursue, in Academia, Industry, or both, this interplay between mathematics and engineering.

My general research interest is the application of mathematics to solve engineering problems. Specific current research interests include: machine learning, statistical signal processing, data science, and navigation networks.

Research Highlights

- **Minimax Classifiers:** Presented a framework for supervised classification based on the generalized maximum entropy principle that leads to minimax risk classifiers (MRCs). Differently from conventional techniques, MRCs can utilize 0-1 loss and provide tight performance guarantees in practice. Specific contributions include:
 - **Theoretical framework:** developed the principle of maximum entropy for supervised classification. The framework presented yields a manifold of classification techniques that are based on minimizing worst-case expected losses. Such methods can accommodate to assorted goals and situations by varying the entropy function and type of uncertainty set.
 - **Learning techniques:** developed learning algorithms that determine MRCs with general entropy functions and uncertainty sets by means of convex optimization. The proposed methods can provide tight performance guarantees in practice, rely on expectation estimates instead of specific samples, and are universally consistent using rich feature mappings.
- **Filtering Techniques:** Developed a general framework for filtering techniques, and designed belief condensation (BC) filters for nonlinear/non-Gaussian problems. This work provides a new methodology for the design and analysis of filtering techniques, and can be employed in numerous applications with a given accuracy and complexity requirement. Specific contributions include:
 - **General framework:** Established a unifying framework and formulated optimality criteria for generalized filtering techniques, which enfold conventional techniques such as Kalman and particle filters, as well as their variants; developed a methodology for optimal filtering called BC filtering (BCF) that accurately approximates complex statistical distributions.
 - **Algorithm design:** Developed BC algorithms that condense complex continuous distributions into mixtures of exponential families or discrete distributions; demonstrated the accuracy and complexity advantages of the BC filters via representative nonlinear/non-Gaussian filtering problems.
- **Network Localization and Navigation:** Established a theoretical foundation for cooperative network localization and navigation (NLN), in which nodes exploit both spatial and temporal cooperation for positional inference. This paradigm will enable accurate and reliable location-awareness, essential for many location-based applications, in challenging environments. Specific contributions include:
 - **Theoretical foundation:** Determined the fundamental limits of NLN accuracy based on spatiotemporal cooperation; determined the information coupling induced by such cooperation in terms of network parameters; and proposed the methodology of soft information (SI) for localization in harsh environments.
 - **Algorithms for SI based on unsupervised machine learning:** Developed techniques for SI learning based on dimensionality reduction and generative model estimation. The new techniques have been evaluated in practical systems showing that this approach can significantly improve the performance of wireless localization in harsh environments.

Awards

- 2022 **Best Applied Contribution in the Statistics Field** awarded by the Spanish Society of Statistics and Operations Research-BBVA Foundation
- 2020 IEEE Communication Letters Senior Editor Award
- 2018 IEEE Communication Letters Associate Editor Award
- 2018 **Leonardo Information and Communication Technologies Fellowship** for Researchers and Cultural Producers awarded by the BBVA Foundation
- 2018 **Early Achievement Award** from the IEEE Communications Society's Radio Communications Committee "for contributions to theoretical and algorithmic research in radio localization"
- **Ramon y Cajal Grant**. Spanish Ministry of Economy, Industry and Competitiveness, 2017
- **Ikerbasque Research Fellow**. Basque Foundation for Science, 2014 and 2017
- **Best Paper Award**. IEEE International Conference on Communications (ICC), 2013
- The 2012 **IEEE Communications Society Fred W. Ellersick Prize**. This prize is given annually to the best article published in a Communications Society magazine in the previous 3 calendar years
- 2012 Outstanding Reviewer, IEEE Transactions on Instrumentation and Measurement
- Best Doctorate Thesis Award. University of Valladolid, 2011
- **Best Paper Award**. IEEE Global Communications Conference (GLOBECOM), 2011
- **Best Paper Award**. IEEE International Conference on Ultra-Wideband, 2011
- Young Scientists Prize. Union Radio-Scientifique Internationale XXII Simposium 2007, Spain
- Best Student Prize in Telecommunications Technical Engineering. University of Valladolid, 2006

Professional Service

Review panels

- Spanish State Research Agency (AEI). Evaluator for Juan de la Cierva fellowship, 2023
- Spanish State Research Agency (AEI). External reviewer, 2022
- German Research Foundation (DFG). External reviewer, 2021
- German Research Foundation (DFG). External reviewer, 2020
- Icelandic Research Fund (IRF). External reviewer, 2019
- United States' National Science Foundation (NSF). Computer & Information Science & Engineering area, 2017

Editor Activities

- Associate Editor for IEEE Transactions on Wireless Communications from Apr. 2023
- Area Editor for IEEE Communications Letters (signal processing area) from Oct. 2019 to Jun 2022
- Associate Editor for IEEE Communications Letters from Jan. 2017 to Sep. 2019

Conference Organization

- IEEE Global Communications Conference, **Technical Program Vice-chair** in 2021
- European Conference on Machine Learning (ECML), Sponsorship chair in 2021
- European Conference on Machine Learning (ECML), Local Co-chair in 2021

- IEEE International Conference on Communications Symposium on Signal Processing for Communications, Co-chair in 2020
- International Congress on Industrial and Applied Mathematics, organizer for the minisymposium on Data and Geometry in 2019
- International Conference on Distributed Computing and Artificial Intelligence, Steering Committee Member for the special session on Communications and Signal Processing in 2018
- IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Track Co-chair in 2018
- IEEE International Conference on Communications Workshop Advances in Network Localization and Navigation, Co-chair in 2018, 2019, and 2020
- IEEE International Conference on Communications Symposium on Wireless Communications, Co-chair in 2015
- IEEE Global Communications Conference Symposium on Wireless Communications, Co-chair in 2014
- IEEE Wireless Telecommunications Symposium in 2010

Technical Program Committee Member

- International Joint Conference on Artificial Intelligence (IJCAI-ECAI) in 2022
- Knowledge Discovery and Data Mining (KDD) Workshop on Machine Learning in Finance in 2021
- European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML/PKDD) in 2021 and 2022
- Association for the Advancement of Artificial Intelligence Conference (AAAI) in 2020, 2021, and 2022
- IEEE Global Communications Conference in 2010 – 2020
- IEEE International Conference on Communications in 2013 – 2021
- IEEE 5G World Forum in 2018 and 2019
- IAICT International Conference on Industry 4, Artificial Intelligence, and Communications Technology in 2019 and 2020
- 5th International Conference on Internet of Things, Big Data and Security - IoTBDS 2020
- IEEE International Conference on Ultra-Wideband in 2011, 2013 and 2014
- IEEE International Conference on Ubiquitous Wireless Broadband in 2015, and 2017
- IEEE Vehicular Technology Conference in 2012, 2014, 2015, 2018, and 2021
- IEEE Wireless Communications and Networking Conference 2018
- IEEE Symposium on Industrial Electronics & Applications in 2012
- IEEE International Conference on Connected Vehicles & Expo in 2012 – 2015
- IEEE International Conference on Power and Energy in 2012
- IEEE 3rd Latin-American Conference on Communications in 2011
- IEEE International Symposium on Personal, Indoor and Mobile Radio Communications in 2013 and 2016.
- IEEE Wireless Telecommunications Symposium in 2010 and 2011
- IEEE International Conference on Communication, Networks and Satellite in 2016, and 2017
- IEEE Military Communications Conference in 2016, and 2017

- International Conference on Control, Electronics, Renewable Energy, and Communications in 2017, and 2018
- ISWCS'15-17, ICACCI'15, ICCME'15, IPIN'16-17, ICL-GNSS'16, APCC'16, CIAP'17, IUCC'17, and ICOIN'18

Reviewer Activities

- Machine Learning, Springer
- Conference on Neural Information Processing Systems (NeurIPS)
- John Wiley & Sons books
- Proceedings of the IEEE
- IEEE Transactions on Signal Processing
- IEEE Transactions on Information Theory
- IEEE Transactions on Wireless Communications
- IEEE Journal on Selected Areas in Communications
- Random Matrices: Theory and Applications
- IEEE Transactions on Instrumentation and Measurement
- IEEE Access
- IEEE Transactions on Parallel and Distributed Systems
- IEEE Communications Letters
- IEEE Transactions on Vehicular Technology
- IEEE Transactions on Networking
- EURASIP Journal on Advances in Signal Processing
- EURASIP Journal on Wireless Communications and Networking
- Hindawi Mathematical Problems in Engineering, Wireless Communications and Mobile Computing, and Journal of Sensors
- IEEE Signal Processing Letters
- IEEE Transactions on Mobile Computing
- IEEE Wireless Communications Letters
- IEEE Transactions on Aerospace and Electronic Systems
- Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales
- Elsevier Pervasive and Mobile Computing
- Journal of the Electronics and Telecommunications Research Institute (ETRI)
- International Journal of Distributed Sensor Networks

Professional Membership

- Senior member of the Institute of Electrical and Electronics Engineers (IEEE)
- Member of the IEEE Information Theory Society
- Member of the IEEE Communications Society
- Member of the IEEE Signal Processing Society

- Representative of the Radio Communications Committee (RCC) for the Wireless Communications Symposia at IEEE Globecom 2014 and IEEE ICC 2015
- Mentor in ECUSA international mentor program

Patents and Publications

Selected Publications

- J. Segovia, S. Mazuelas, and A. Liu, "Double-Weighting for Covariate Shift Adaptation," in *Proceedings of the 40th International Conference on Machine Learning (ICML)*, Jul 2023, Accepted.
- V. Álvarez, S. Mazuelas, and J. A. Lozano, "Minimax classification under concept drift with multidimensional adaptation and performance guarantees," in *Proceedings of the 39th International Conference on Machine Learning (ICML)*, 17–23 Jul 2022, pp. 486–499.
- Y. Li, S. Mazuelas, and Y. Shen, "Variational Bayesian framework for advanced image generation with domain-related variables," in *2022 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2022, pp. 2684–2688.
- S. Mazuelas, Y. Shen, and A. Pérez, "Generalized maximum entropy for supervised classification," *IEEE Trans. Inf. Theory*, vol. 68, no. 4, pp. 2530–2550, Apr. 2022.
- S. Mazuelas, A. Zaroni, and A. Pérez, "Minimax classification with 0-1 loss and performance guarantees," in *Advances in Neural Information Processing Systems (NeurIPS)*, vol. 33, 2020, pp. 302–312.
- S. Mazuelas, Y. Shen, and M. Z. Win, "Spatiotemporal information coupling in network navigation," *IEEE Trans. Inf. Theory*, vol. 64, no. 12, pp. 7759–7779, Dec. 2018.
- S. Mazuelas, A. Conti, J. C. Allen, and M. Z. Win, "Soft range information for network localization," *IEEE Trans. Signal Process.*, vol. 66, no. 12, pp. 3155–3168, Jun. 2018.
- S. Mazuelas, Y. Shen, and M. Z. Win, "Belief condensation filtering," *IEEE Trans. Signal Process.*, vol. 61, no. 18, pp. 4403–4415, Sep. 2013.
- S. Mazuelas, R. M. Lorenzo, A. Bahillo, P. Fernandez, J. Prieto, and E. J. Abril, "Topology assessment provided by weighted barycentric parameters in harsh environment wireless location systems," *IEEE Trans. Signal Process.*, vol. 58, no. 7, pp. 3842–3857, Jul. 2010.
- S. Mazuelas, A. Bahillo, R. Lorenzo, P. Fernandez, F. A. Lago, E. Garcia, J. Blas, and E. Abril, "Robust indoor positioning provided by real-time RSSI values in unmodified WLAN networks," *IEEE J. Sel. Topics Signal Process.*, vol. 3, no. 5, pp. 821–831, Oct. 2009.

Patents

1. P. Zappi, A. Swaminathan, S. Mazuelas, and R. F. Quick, "Power delay profile based indoor outdoor detection," U.S. Patent 0,337,978, May 11, 2016.
2. S. Mazuelas, P. Tinnakornsriruphap, and S. Chen, "Controlling a load and an energy source based on future energy level determinations," U.S. Patent 0,040,798, Feb. 9, 2017.
3. S. Mazuelas, A. Swaminathan, P. Zappi, M. R. Akula, A. Bisain, A. N. Srivastava, and S. H. Sheshadri, "Auto-calibrating light sensor data of a mobile device," U.S. Patent, 10,145,733, Dec. 4, 2018.
4. A. Swaminathan, P. Zappi, S. Mazuelas, A. Bisain, S. H. Sheshadri, M. R. Akula, A. N. Srivastava, and S. Sadasivam, "Augmenting indoor-outdoor detection using side information," U.S. Patent 0,078,854, Mar. 16, 2017.
5. M. Z. Win, S. Mazuelas, and Y. Shen, "Tracking a body by nonlinear and non-Gaussian parametric filtering," U.S. Patent 9,062,978, Jun. 23, 2015.

6. S. Mazuelas, R. M. Lorenzo, P. Fernandez, A. Bahillo, J. Blas, E. J. Abril, and J. Prieto, "Procedimiento y sistema de localización de un dispositivo móvil a partir del retardo temporal de propagación de las señales en una red inalámbrica mitigando la falta de visión directa entre dispositivos y sin necesidad de calibración in situ," Spain Patent 2,372,512. Mar. 2012.
Title in English: "Procedure and system of a mobile device localization from the propagation delay of signals in a wireless network mitigating the lack of line-of-sight between devices and without in-situ calibration."
7. S. Mazuelas, R. M. Lorenzo, P. Fernandez, A. Bahillo, J. Blas and E. J. Abril "Procedimiento y sistema de localización en redes inalámbricas que determina distancias entre dispositivos a partir de niveles de potencias recibidas," Spain Patent 2,345,698. Oct. 2011.
Title in English: "Procedure and system of localization in wireless networks that determines distances between devices from signal strength levels."

Journal Papers

1. M. Straka, L. Buzna, N. Refa, and S. Mazuelas, "The role of asymmetric prediction losses in smart charging of electric vehicles," *International Journal of Electrical Power & Energy Systems*, vol. 143, p. 108486, 2022.
2. S. Mazuelas, Y. Shen, and A. Pérez, "Generalized maximum entropy for supervised classification," *IEEE Trans. Inf. Theory*, vol. 68, no. 4, pp. 2530–2550, Apr. 2022.
3. A. Conti, F. Morselli, Z. Liu, S. Bartoletti, S. Mazuelas, W. C. Lindsey, and M. Z. Win, "Location awareness in beyond 5G networks," *IEEE Communications Magazine*, vol. 59, no. 11, pp. 22–27, Nov. 2021.
4. V. Alvarez, S. Mazuelas, and J. A. Lozano, "Probabilistic load forecasting based on adaptive online learning," *IEEE Transactions on Power Systems*, vol. 36, no. 4, pp. 3668 – 3680, Jul. 2021. **Best Applied Contribution in the Statistics Field** awarded by the Spanish Society of Statistics and Operations Research-BBVA Foundation
5. A. Conti, S. Mazuelas, S. Bartoletti, W. C. Lindsey, and M. Z. Win, "Soft information for localization-of-things," *Proc. IEEE*, vol. 107, no. 11, pp. 2240–2264, Nov. 2019.
6. S. Mazuelas, Y. Shen, and M. Z. Win, "Spatiotemporal information coupling in network navigation," *IEEE Trans. Inf. Theory*, vol. 64, no. 12, pp. 7759–7779, Dec. 2018.
7. S. Mazuelas, A. Conti, J. C. Allen, and M. Z. Win, "Soft range information for network localization," *IEEE Trans. Signal Process.*, vol. 66, no. 12, pp. 3155–3168, Jun. 2018.
8. J. Prieto, S. Mazuelas, and M. Z. Win, "Context-aided inertial navigation via belief condensation," *IEEE Trans. Signal Process.*, vol. 64, no. 12, pp. 3250–3261, Jun. 2016.
9. T. Wang, Y. Shen, S. Mazuelas, H. Shin, and M. Z. Win, "On OFDM ranging accuracy in multipath channels," *IEEE Syst. J.*, vol. 8, no. 1, pp. 104–114, Mar. 2014.
10. S. Mazuelas, Y. Shen, and M. Z. Win, "Belief condensation filtering," *IEEE Trans. Signal Process.*, vol. 61, no. 18, pp. 4403–4415, Sep. 2013.
11. F. Montorsi, S. Mazuelas, G. M. Vitetta, and M. Z. Win, "On the performance limits of map-aware localization," *IEEE Trans. Inf. Theory*, vol. 59, no. 8, pp. 5023–5038, Aug. 2013.
12. Y. Shen, S. Mazuelas, and M. Z. Win, "Network navigation: Theory and interpretation," *IEEE J. Sel. Areas Commun.*, vol. 30, no. 9, pp. 1823–1834, Oct. 2012.
13. J. Prieto, S. Mazuelas, A. Bahillo, P. Fernandez, R. M. Lorenzo, and E. J. Abril, "Adaptive data fusion for wireless localization in harsh environments," *IEEE Trans. Signal Process.*, vol. 60, no. 4, pp. 1585–1596, Apr. 2012.

14. S. Mazuelas, Y. Shen, and M. Z. Win, "Information coupling in cooperative localization," *IEEE Commun. Lett.*, vol. 15, no. 7, pp. 737–739, Jul. 2011.
15. M. Z. Win, A. Conti, S. Mazuelas, Y. Shen, W. M. Gifford, D. Dardari, and M. Chiani, "Network localization and navigation via cooperation," *IEEE Commun. Mag.*, vol. 49, no. 5, pp. 56–62, May 2011, IEEE Communications Society **Fred W. Ellersick Prize**.
16. S. Mazuelas, R. M. Lorenzo, A. Bahillo, P. Fernandez, J. Prieto, and E. J. Abril, "Topology assessment provided by weighted barycentric parameters in harsh environment wireless location systems," *IEEE Trans. Signal Process.*, vol. 58, no. 7, pp. 3842–3857, Jul. 2010.
17. S. Mazuelas, F. A. Lago, P. Fernandez, A. Bahillo, J. Blas, R. M. Lorenzo, and E. Abril, "Ranking of TOA measurements based on the estimate of the NLOS propagation contribution in a wireless location system," *Wireless Personal Communications*, vol. 53, no. 1, pp. 35–52, Mar. 2010.
18. A. Bahillo, S. Mazuelas, R. M. Lorenzo, P. Fernandez, J. Prieto, R. J. Duran, and E. Abril, "Hybrid RSS-RTT localization scheme for indoor wireless networks," *Eurasip Journal on Advances in Signal Processing*, vol. 2010, no. 1, pp. 1–12, Apr. 2010.
19. A. Bahillo, S. Mazuelas, R. M. Lorenzo, P. Fernandez, J. Prieto, R. J. Duran, and E. Abril, "Accurate and integrated localization system for indoor environments based on IEEE 802.11 round-trip time measurements," *Eurasip Journal on Advances in Signal Processing*, vol. 2010, no. 1, pp. 1–13, Apr. 2010.
20. S. Mazuelas, A. Bahillo, R. Lorenzo, P. Fernandez, F. A. Lago, E. Garcia, J. Blas, and E. Abril, "Robust indoor positioning provided by real-time RSSI values in unmodified WLAN networks," *IEEE J. Sel. Topics Signal Process.*, vol. 3, no. 5, pp. 821–831, Oct. 2009.
21. A. Bahillo, S. Mazuelas, J. Prieto, R. M. Lorenzo, P. Fernandez, and E. J. Abril, "Indoor location based on IEEE 802.11 round-trip time measurements with two-step NLOS mitigation," *Progress in Electromagnetics Research, PIER B*, vol. 15, pp. 285–306, Sep. 2009.
22. J. Prieto, A. Bahillo, S. Mazuelas, R. M. Lorenzo, P. Fernandez, and E. J. Abril, "Characterization and mitigation of range estimation errors for an RTT-based IEEE 802.11 indoor location system," *Progress in Electromagnetics Research, PIER B*, vol. 15, pp. 217–244, Sep. 2009.
23. S. Mazuelas, F. A. Lago, J. Blas, A. Bahillo, P. Fernandez, R. Lorenzo, and E. Abril, "Prior NLOS measurements correction for positioning in cellular wireless networks," *IEEE Trans. Vehicular Technology*, vol. 58, no. 5, pp. 2585–2591, Jun 2009.
24. J. Blas, R. M. Lorenzo, P. Fernandez, E. J. Abril, A. Bahillo, S. Mazuelas, and D. Bullido, "A new metric to analyze propagation models," *Progress in Electromagnetics Research, PIER*, vol. 91, pp. 101–121, Apr. 2009.
25. A. Bahillo, J. Blas, P. Fernandez, R. M. Lorenzo, S. Mazuelas, and E. Abril, "E-field assessment errors associated with RF dosimeters for different angles of arrival," *Radiation Protection Dosimetry*, vol. 132, no. 1, pp. 51–56, Dec. 2008.
26. J. Blas, P. Fernandez, R. M. Lorenzo, E. J. Abril, S. Mazuelas, A. Bahillo, and D. Bullido, "A model for transition between outdoor and indoor propagation," *Progress in Electromagnetics Research, PIER*, vol. 85, pp. 147–167, Sep. 2008.
27. S. Mazuelas, "Interpretación proyectiva de las métricas del plano real," *Rev. Semin. Iberoam. Mat.*, vol. 5, no. 3, pp. 109–125, 2008.
28. S. Mazuelas, "Rectas proyectivas sobre R-algebras bidimensionales y cuádras en el espacio proyectivo," *Boletín de la Sociedad Puig Adam de Profesores de Matemáticas*, no. 80, pp. 57–76, Jun. 2008.
29. S. Mazuelas, "R-algebras de dimension 2 y métricas del plano real," *Boletín de la Sociedad Puig Adam de Profesores de Matemáticas*, no. 78, pp. 46–63, Feb. 2008.
30. S. Mazuelas, "Proyecciones estereográficas y geometrías en el plano," *Boletín de la Sociedad Puig Adam de Profesores de Matemáticas*, no. 75, pp. 37–54, Feb. 2007.

Refereed Conference Proceedings

1. J. Segovia, S. Mazuelas, and A. Liu, "Double-Weighting for Covariate Shift Adaptation," in *Proceedings of the 40th International Conference on Machine Learning (ICML)*, Jul 2023, Accepted.
2. V. Álvarez, S. Mazuelas, and J. A. Lozano, "Minimax classification under concept drift with multidimensional adaptation and performance guarantees," in *Proceedings of the 39th International Conference on Machine Learning (ICML)*, 17–23 Jul 2022, pp. 486–499.
3. Y. Li, S. Mazuelas, and Y. Shen, "Deep generative model for simultaneous range error mitigation and environment identification," in *2021 IEEE Global Communications Conference (GLOBECOM)*, 2021, pp. 1–6.
4. Y. Li, S. Mazuelas, and Y. Shen, "A deep learning approach for generating soft range information from RF data," in *2021 IEEE Globecom Workshops (GC Wkshps)*, 2021, pp. 1–5.
5. Y. Li, S. Mazuelas, and Y. Shen, "Deep GEM-based network for weakly supervised UWB ranging error mitigation," in *MILCOM 2021 - 2021 IEEE Military Communications Conference (MILCOM)*, 2021, pp. 528–532.
6. Y. Li, S. Mazuelas, and Y. Shen, "A semi-supervised learning approach for ranging error mitigation based on UWB waveform," in *MILCOM 2021 - 2021 IEEE Military Communications Conference (MILCOM)*, 2021, pp. 533–537.
7. R. Armañanzas, A. Díaz, M. Martínez, and S. Mazuelas, "Derivation of a cost-sensitive COVID-19 mortality risk indicator using a multistart framework," in *2021 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2021, pp. 2179–2186.
8. S. Mazuelas, A. Zanoni, and A. Pérez, "Minimax classification with 0-1 loss and performance guarantees," in *Advances in Neural Information Processing Systems (NeurIPs)*, vol. 33, 2020, pp. 302–312.
9. S. Mazuelas and A. Perez, "General supervision via probabilistic transformations," in *24th European Conference on Artificial Intelligence-ECAI 2020*, Aug. 2020, pp. 1348–1354.
10. F. Morselli, S. Bartoletti, S. Mazuelas, M. Z. Win, and A. Conti, "Crowd-centric counting via unsupervised learning," in *Proc. IEEE Int. Conf. Commun.*, Shanghai, China, May 2019, pp. 1–6.
11. S. Mehryar, P. Malekzadeh, S. Mazuelas, P. Spachos, K. N. Plataniotis, and A. Mohammadi, "Belief condensation filtering for RSSI-based state estimation in indoor localization," in *2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brighton, United Kingdom, May 2019, pp. 8385–8389.
12. J. Prieto, S. Mazuelas, F. D. la Prieta, and J. M. Corchado, "Feasibility of single-agent localization from sequential measurements," in *Proc. IEEE Int. Conf. Commun.*, Kansas City, MO, May 2018, pp. 1–6.
13. H. Lu, S. Mazuelas, and M. Z. Win, "Ranging likelihood for wideband wireless localization," in *Proc. IEEE Int. Conf. Commun.*, Budapest, Hungary, Jun. 2013, pp. 4397–4401, **Best Paper Award**.
14. F. Montorsi, S. Mazuelas, G. M. Vitetta, and M. Z. Win, "On the impact of a priori information on localization accuracy and complexity," in *Proc. IEEE Int. Conf. Commun.*, Budapest, Hungary, Jun. 2013, pp. 4385–4390.
15. J. Prieto, S. Mazuelas, A. Bahillo, P. Fernandez, R. M. Lorenzo, and E. J. Abril, "Pedestrian navigation in harsh environments using wireless and inertial measurements," in *Workshop on Positioning, Navigation and Commun. (WPNC)*, Dresden, Germany, Mar. 2013, pp. 1–6.
16. S. Mazuelas, Y. Shen, and M. Z. Win, "Spatio-temporal information coupling in cooperative navigation," in *Proc. IEEE Global Telecomm. Conf.*, Anaheim, CA, Dec. 2012, pp. 2403–2407.

17. S. Mazuelas, Y. Shen, and M. Z. Win, "Framework of belief condensation filtering and deterministic discrete filters," in *Proc. IEEE Int. Conf. on Ultra-Wideband*, Syracuse, NY, Sep. 2012, pp. 1–5, **Invited Paper**.
18. T. Wang, Y. Shen, S. Mazuelas, and M. Z. Win, "Distributed scheduling for cooperative localization based on information evolution," in *Proc. IEEE Int. Conf. Commun.*, Ottawa, Canada, Jun. 2012, pp. 576–580.
19. J. Prieto, A. Bahillo, S. Mazuelas, P. Fernandez, R. Lorenzo, and E. J. Abril, "Self-calibration of TOA /distance relationship for wireless localization in harsh environments," in *Proc. IEEE Int. Conf. Commun.*, Ottawa, Canada, Jun. 2012, pp. 1–5.
20. A. Bahillo, J. Prieto, S. Mazuelas, P. Fernandez, R. J. Duran, R. Lorenzo, and E. J. Abril, "Human shadow effect assessment when integrating inertial navigation system with signal strength measurements for pedestrian dead reckoning," in *Progress in Electromagnetics Research Symposium*, Kuala Lumpur, Malaysia, Mar. 2012, pp. 1–5.
21. Y. Shen, S. Mazuelas, and M. Z. Win, "A theoretical foundation of network navigation," in *Proc. IEEE Global Telecomm. Conf.*, Houston, TX, Dec. 2011, pp. 1–6, **Best Paper Award**.
22. S. Mazuelas, Y. Shen, and M. Z. Win, "Wideband cooperative localization via belief condensation," in *Proc. IEEE Int. Conf. on Ultra-Wideband*, Bologna, Italy, Sep. 2011, pp. 150–154, **Best Paper Award**.
23. T. Wang, Y. Shen, S. Mazuelas, and M. Z. Win, "Bounds for OFDM ranging accuracy in multipath channels," in *Proc. IEEE Int. Conf. on Ultra-Wideband*, Bologna, Italy, Sep. 2011, pp. 450–454.
24. A. Bahillo, J. Prieto, S. Mazuelas, P. Fernandez, R. M. Lorenzo, and E. J. Abril, "Estimación de distancias en redes IEEE 802.15.4 usando TOF y RSS," in *Proc. Seminario Anual de Automática, Electrónica Industrial e Instrumentación*, Badajoz, Spain, Jul. 2011, pp. 1–5.
25. J. Prieto, S. Mazuelas, A. Bahillo, P. Fernandez, R. M. Lorenzo, and E. J. Abril, "Cota de Cramér-Rao a posteriori para sistemas de localización inalámbrica basados en RSS y TOA," in *Proc. Seminario Anual de Automática, Electrónica Industrial e Instrumentación*, Badajoz, Spain, Jul. 2011, pp. 1–5.
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49. J. Blas, A. Bahillo, F. Lago, P. Fernandez, R. M. Lorenzo, E. J. Abril, and S. Mazuelas, "Variabilidad espacial del campo eléctrico en un recinto próximo a una estación base GSM," in *Symposium Nacional de la Unión Científica Internacional de Radio*.

Invited Talks

1. "Beyond empirical risk minimization: minimax risk classifiers for distribution shifts," ETH Zürich, Switzerland, Apr. 2023.
2. "Beyond empirical risk minimization," Telecom Paris, France, Apr. 2023.
3. "Minimax risk classifiers," van der Schaar Lab, University of Cambridge, United Kingdom. Apr. 2022.
4. "Machine learning aplicado al pronostico del COVID-19," Sondersland Festival, La Nave. Madrid, Spain. Sep. 2021.
5. "Machine learning: what, why, and how," Mathematics Research Institute, University of Valladolid, Spain. Jan. 2021.
6. "Minimax classification with 0-1 loss and performance guarantees," BBVA Data & Analytics. Madrid, Spain. Nov. 2020.
7. "Supervised classification via minimax probabilistic transformations," Department Computer Science, Brown University, Providence, Nov. 2019.
8. "Generalized entropies and divergences for machine learning," Algebraic Coding Theory and Information Theory Minisymposium, International Congress on Industrial and Applied Mathematics, Valencia, Spain, Jul. 2019.
9. "Projective geometry of probabilistic transformations," Data and Geometry Minisymposium, International Congress on Industrial and Applied Mathematics, Valencia, Spain, Jul. 2019.
10. "Minimax probabilistic transformations for supervised learning," Seminar on Artificial Intelligence, University of California, San Diego, May 2019.
11. "Data processing under uncertainty and tractability limitations," Tsinghua University, Beijing, China, May 2019.
12. "Data processing under uncertainty and tractability limitations," University Pompeu Fabra, Barcelona, Spain, Apr. 2019.
13. "Probabilistic data processing and localization in harsh environments," University Autònoma of Barcelona, Spain, Apr. 2019.
14. "Probabilistic data processing," University of Basque Country, Quantum Technologies for Information Science Laboratory, Leioa, Spain, Jun. 2018.
15. "Probabilistic processing of complex data," IEEE Comsoc RCC meeting, IEEE ICC, Kansas City, May 2018.
16. "Probabilistic processing of complex data," University of Deusto, Forotech 2018, Spain, Apr. 2018.
17. "Rational data processing in complex networks," University Pompeu Fabra, Barcelona, Spain, Dec. 2017.
18. "Rational data processing in complex networks," Institute of Industrial Robotics (CSIC), Barcelona, Spain, Dec. 2017.

19. "Rational data processing and probabilistic approximations," University Polytechnic of Valencia, Telecommunications Department, Valencia, Spain, Dec. 2017.
20. "Rational data processing in complex networks," University Polytechnic of Valencia, Computer Science Department, Valencia, Spain, Dec. 2017.
21. "From Data to Information," Analog Devices Lyric Labs, Cambridge MA, Jul. 2013.
22. "From Complex Data to Reliable Information," Qualcomm Corporate Research & Development Department, San Diego CA, Jul. 2013.
23. "Network Localization and Navigation," 2012 IEEE International Conference on Ultra-Wideband, Syracuse NY, Sep. 2012.
24. "Belief Condensation Filtering," Engineering School, University of Ferrara, Italy, Sep. 2011.
25. "Wireless Localization in Harsh Environments," Master on Research on Information Technologies and Telecommunications, University of Valladolid, Spain. Mar. 2011.
26. "Location-aware Wireless Networks," GEINTRA - Department of Electronics, University of Alcala, Spain, Jun. 2010.
27. "Projective Interpretation of metric, equiform, and inversive geometries," 2009 I-Math Conference of Young Iberoamerican Researchers, University of Valladolid, Spain, Jun. 2009.

Student Supervision

Ph.D. Student Supervision

- Javier Prieto Tejedor, "Adaptive Bayesian Estimation Applied to the Localization of Mobile Users," University of Valladolid, Nov. 2012. (co-supervised with Patricia Fernandez), Best Doctorate Thesis Award, University of Valladolid, 2013.
- Veronica Alvarez, "Robust online learning under concept drift and its application to load forecasting," BCAM and University of the Basque Country, ongoing. (co-supervised with Jose Antonio Lozano).
- Jose Segovia, "Covariate shift for minimax supervised learning," BCAM and University of the Basque Country, ongoing.
- Kartheek Bondugula, "High-dimensional minimax risk classifiers," BCAM and University of the Basque Country, ongoing.

M.Sc. Student Supervision

- Sara Ambrosi, "Cost-sensitive binary minimax risk classifiers: a theoretical performance bound and application to the medical field," BCAM and University of Turin, Mar. 2023.
- Lucia Filippozzi, "Minimax risk classifier with noisy labels," BCAM and University of Trento, Oct. 2022.
- Kartheek Bondugula, "MRCpy: a library for minimax risk classifiers," BCAM and the University Oberta of Catalonia, Sep. 2021.
- Veronica Alvarez, "Probabilistic load forecasting based on adaptive online learning," BCAM and Polytechnic University of Valencia, Jul. 2020.
- Filippo Buoncompagni, "Robust risk minimization for noisy labels," BCAM and Politecnico di Torino, Oct. 2019. (co-supervised with Giuseppe Calafiore).

Thesis Committees

- Pasquale Di Viesti, “Colocated multiple-input multiple-output radars for smart mobility,” Ph.D. Thesis, University of Modena and Reggio Emilia. *Advisor:* Giorgio Matteo Vitetta and Paolo Pavan.
- Tianheng Wang, “Network Navigation with Scheduling,” Ph.D. Thesis, Massachusetts Institute of Technology. *Advisor:* Moe Z. Win.
- Giovanni Chisci, “Context-aware massive wireless networks: modeling and design,” Ph.D. Thesis, University of Ferrara. *Advisors:* Andrea Conti and Lorenzo Mucchi.
- Nicolo Decarli, “Context-aware wireless networks,” Ph.D. Thesis, University of Bologna. *Advisors:* Marco Chiani and Davide Dardari.
- Enrique Garcia Nuñez, “Efficient complementary sequences-based architectures and their application to ranging measurements,” Ph.D. Thesis, University of Alcalá. *Advisors:* Juan Jesus Garcia Dominguez and Jesus Ureña Ureña.

Selected Research Projects

- **CNS2022-135203 SLEDS: Minimax supervised learning in environments affected by distribution shifts** 2023–2025
Participants: BCAM-Basque center for applied mathematics
Funded by the Spanish Ministry of Science and Innovation
Funding: 144,595 €
Principal investigator
The proposed project will develop techniques for lifelong learning and covariate shift adaptation based on the methodology of MRCs. Differently from existing methods, the techniques developed in the project effectively exploit forward and backward learning for lifelong learning with time-dependent tasks, and adapt to general covariate shift situations in which train and test regions are not contained in each other.
- **CHARGER+: New generation of charging points for electric vehicles with autonomous and collaborative functionalities** 2022–2023
Participants: Tecnalia, IK4-Vicomtech, BCAM, UPV
Funded by Basque Government-ELKARTEK Programme
Funding: 93,264 €
Principal investigator at BCAM-Basque center for applied mathematics
The overall objective of project CHARGER+ is to generate the necessary knowledge to define a new generation of electric vehicle (EV) charging points, so that the related Basque companies (electric companies, charging post installers and charger companies) position themselves in an advantageous position for the massive deployment of charging points adapted to the decentralized and minimal impact concept of Smart Grids
- **MIA.2021.M04.0008. IA4TES: Artificial intelligence for the sustainable energy transition** 2022–2024
Participants: IBERDROLA, ARIADNA, BCAM, INDRA, RATED POWER, STEMY ENERGY, UNIV. GRANADA, UNIV. POL. MADRID, UNIV. SAL., VICOMTECH, TECNALIA
Ministry of Economic Affairs and Digital Transformation. R&D Missions on Artificial Intelligence
Funding: 200,000 €
Principal investigator at BCAM-Basque center for applied mathematics
The aim of this grant is to finance Artificial Intelligence projects to address the major social challenges or country missions referred to in the ENIA, for the digital transformation of Spain’s society and economy. The project will develop forecasting techniques based on machine learning methods. In particular, the project develops adaptive supervised learning methods that address temporal changes of the characteristics of energy-related data.

- **AUTOEV@L: Technological evolution for the multivehicular automatization and functions evaluation for highly autonomous driving** 2021–2022
 Participants: IK4-Vicomtech, Tecnalia, BCAM, UPV
 Funded by Basque Government-ELKARTEK Programme
 Funding: 71,439 €
 Principal investigator at BCAM-Basque center for applied mathematics

The overall objective of the project is to enable the consortium to ensure effective and efficient establishment of quality criteria, tools and methods, as well as scenarios and situations for the launch of highly automated functions for all types of vehicles (automotive, rail and commercial vehicles), as well as the development of procedures for automated test procedures for such advanced functions.
- **5G: Federated experimental infrastructure for 4.0 industry applications** 2021–2022
 Participants: IK4-Vicomtech, Tecnalia, BCAM, UPV
 Funded by Basque Government-ELKARTEK Programme
 Funding: 60,378 €
 Principal investigator at BCAM-Basque center for applied mathematics

The overall objective of the project is to enable an internationally leading 5G technology platform based on the coordination of a set of advanced 5G laboratories provided by technology centers, and the incorporation to this platform of research in 5G technologies to be carried out in the project.
- **Early prognosis of COVID-19 infections via machine learning** 2020–2023
 Participants: BCAM-Basque center for applied mathematics
 Funded by the AXA Research Fund under the Exceptional Flash Call “Mitigating risk in the wake of the COVID-19 pandemic”
 Funding: 230,000 €
 Principal investigator

The project develops machine learning techniques for the early prognosis of COVID-19 infections that predict infections’ future severity using health data obtained at the time of infections’ detection. The learning techniques developed in the project use a large amount of electronic health records to learn the complex relationship between health data instances and future severity of COVID-19 infections. The project addresses several scientific and technical challenges both for data processing and learning algorithms’ design including the usage of unbalanced training samples affected by selection bias, and the development of privacy-preserving and cost-sensitive techniques.
- **PID2019-105058GA-I00 UNIPROB: Unifying data processing via probabilistic transformations** 2020–2023
 Participants: BCAM-Basque center for applied mathematics
 Funded by the Spanish Ministry of Science and Innovation
 Funding: 41,000 €
 Principal investigator

The project main goals are to establish a theoretical unifying framework for data-driven problems (DPs), and to develop probabilistic data processing techniques (DTs) that effectively exploit data in a unified manner. UNIPROB proposes a comprehensive exploration of general DPs and DTs covering unifying theory and methodologies as well as efficient algorithms and practical assessments.
- **TWIN-NET: Digital twin of the electric distribution network for the optimization of renewable energies integration** 2020–2021
 Participants: Tecnalia, BCAM, UPV
 Funded by Basque Government-ELKARTEK Programme
 Funding: 102,690 €
 Principal investigator at BCAM-Basque center for applied mathematics

This project develops a digital twin for the electric distribution network to provide a reliable replica of electric network that tracks the network state, forecasts the network behavior, and allows to optimize the technical operation.

- **5G4BRIS3**

Participants: IK4-Vicomtech, BCAM, Tecnalia, Ikerlan, CEIT, UPV
Funded by Basque Government-ELKARTEK Programme
Funding: 29,398 €
Principal investigator at BCAM-Basque center for applied mathematics

The main goal of this project is to establish the methodological foundations for research on a set of technologies based on 5G networks that are specially relevant for the basque RIS3.

2020

- **Artificial intelligence for energy management in environments with high penetration of renewable generators and electric cars**

Participants: BCAM-Basque center for applied mathematics
Funded by IBERDROLA Foundation. 2019 Research Grants
Funding: 20,000 €
Principal investigator

This project develops techniques based on artificial intelligence and machine learning to predict energy generation, consumption, and price. In addition, the project develops techniques for sequential and distributed learning of generation, consumption, and price probabilities as well as methods for energy management based on probability forecasts.

2019–2020

- **KK-2019/00035 AUTOLIB 2.0: Technological readiness for the multi-vehicular automatization in the industrial sector**

Participants: VICOMTECH, TECNALIA, CEIT-IK4, IKERLAN, BCAM, UPV, AIC, MU
Funded by Basque Government-ELKARTEK Programme
Funding: 88,105 €
Principal investigator at BCAM-Basque center for applied mathematics

The main goal of this project is the collaborative fusion of technologies for automatization in the industrial sector. In particular, the project develops complete solutions for autonomous mobility.

2019–2020

- **Machine learning and battery management optimization**

Participants: BCAM
Funded by Basque Government
Funding: 20,000 €
Principal investigator

The project develops artificial intelligence and machine learning techniques for probabilistic prediction of generations, consumption and energy prices; sequential/distributed learning of the probabilities of future generations, consumptions and prices; and automated demand management through probabilistic predictions.

2019–2020

- **Ramon y Cajal Grant**

Participants: BCAM
Spanish Ministry of Science, Innovation and Universities
Funding: 308,600 €
Principal investigator

2018–2022

- **Data processing for decision making and open machine learning**

Participants: BCAM-Basque center for applied mathematics
Funded by BBVA foundation
Funding: 40,000 €
Principal investigator

This project unifies under the same approach multiple machine learning problems that use heterogeneous training data. The unifying framework developed enables to obtain machine learning techniques that efficiently exploit general training data.

2018–2020

- **TIN2017-82626-R GECECPAST: Efficient Management of the Electric Energy Consumption by Means of the Classification, Prediction and Clustering of Time Series**

Participants: BCAM-Basque center for applied mathematics

2018–2021

Funded by the Spanish Ministry of Economy, Industry and Competitiveness

This project develops techniques for clustering, classification, and prediction of complex data such as energy consumption/generation, and algorithms for energy management aided by energy-related data.

- **KK-2018/00104 TEKINTZE: Teknologia Ekin Hagin (T)Zerra Erabiliz** 2018 –2019
Funded by the Basque Government-ELKARTEK Programme
Funding: 63,832 €
Principal investigator at BCAM-Basque center for applied mathematics
- **AVANTE: Autonomous driving. Precise positioning and mapping algorithms.** 2014 –2017
Participants: Qualcomm Corporate R&D
This project develops system architecture, hardware IP blocks, software development environment, and algorithms for autonomous driving. The main goals of the project are 1) to provide Qualcomm CDMA Technologies (QCT) the capabilities to deliver autonomous driving solutions to automotive OEMS and Tier 1s, and 2) to enable Qualcomm to pursue business models and partnerships that allow greater participation in the upside.
- **eZero: A learning, distributed, and comprehensive energy management solution** 2014 – 2016
Participants: Qualcomm Corporate R&D
This project develops novel energy management solutions that can deliver both user-level and grid-level savings automatically without explicit user involvement. It also leverages a distributed closed loop control technique and scales to millions of individual controllers.
The project main tasks are the development of adaptive online learning algorithms, distributed closed-loop control algorithms, and architecture/prototype based on QC chipsets.
- **AWARE: Context awareness for mobile devices.** 2010 – 2015
Participants: Qualcomm Corporate R&D
This project develops techniques and software apps to infer daily life situations by applying machine learning techniques and reasoning over data from a variety of sources on the the mobile device. Sources of data include location, physical sensors (e.g., accelerometer, gyro, light, proximity, and microphone), and device status (e.g., screen/keyboard usage, connectivity, and application status). The project main tasks are inference of motion state and environment of the user from sensor data, reasoning via rules to infer a set of daily life situations, semi-supervised learning to refine training models, and algorithm optimizations for implementation on QC chipsets.
- **Network Localization and Navigation in GPS-Challenged Environments.** 2011 – 2015
Participants: Massachusetts Institute of Technology, University of Southern California, and University of California Santa Barbara.
Funded by the Office of Naval Research.
This project provides reliable and accurate alternatives/supplements to GPS systems for distributed groups of warfighters. The project's approach is based on wideband wireless technology and cooperative fusion of information available in harsh environments. Theory-inspired experimentation guides the development of practical new positioning and navigation methods.
Key parts of the research are as follows: Machine-learning algorithms are used to extract ranging beliefs, which provide a statistical description of range estimates in terms of waveform features. New scheduling techniques are designed to minimize inter-node communications for cooperative localization. In order to accommodate network bandwidth and power limitations, compression of location beliefs (statistical description of position) and generalized filtering algorithms for position estimation are also developed. The algorithm development proceeds in parallel phases, in which lightweight versions are designed as alternatives to enable hardware- and waveform-agnostic implementations. Thus the localization/navigation system can potentially be implemented in a range of hardware from military-grade radios to Zigbee-type sensor networks and smartphones.
The project is driven both by theoretical research and experimentation to validate the proposed localization and navigation algorithms. Extensive measurements of ultra-wideband (UWB) waveforms

in harsh environments are performed to create a large database for development and verification of ranging beliefs. The localization and navigation algorithms are implemented in embedded processors, using information from sensors such as UWB radios and inertial measurement units (IMUs), in both static and dynamic networks. The culmination of the project is a proof-of-concept demonstration of localization and navigation by mobile nodes with meter accuracy in GPS-challenged environments.

- **Cooperative Tracking in Harsh Environments:
Statistical Framework and Network Experimentation.** 2009–2012
Participants: Massachusetts Institute of Technology.
Funded by the National Science Foundation.

This research is motivated by the need for accurate positional information in numerous commercial, public service, and military applications. In cooperative localization and tracking, network devices work together to determine positional information. In contrast to non-cooperative technologies, cooperative localization and tracking are provably more accurate and more robust. Additionally, they can be designed to be energy-efficient and, because they rely less on fixed infrastructure, more cost-effective. The main tasks of this project are: 1) determine ultimate theoretical limits and performance bounds on tracking networks; 2) design and implement an ultrawide bandwidth (UWB) radio network that demonstrates cooperative localization and tracking; 3) develop algorithms to detect and correct for NLOS situations to further increase performance. These algorithms are based on experimental data from a UWB testbed and machine learning techniques to detect and classify objects, and to mitigate NLOS impairments on ranging algorithms.

- **Geo-Location for Non-Intrusive Instrumentation in GPS-Denied Environments.** 2010–2011
Participants: Massachusetts Institute of Technology.
Funded by the Charles Stark Draper Laboratory.

This project focuses on the design of non-intrusive geo-location systems in Global Positioning System (GPS)-denied environments. These systems require sub-meter localization accuracy in harsh operating conditions with non-intrusive minimal infrastructure. Ultra-wide bandwidth (UWB) technology is particularly well suited for non-intrusive geo-location in harsh environments due to its fine delay resolution and low interference to other wireless signals. With such transmission technology, location information can be obtained from the waveforms received between pairs of nodes in combination with prior knowledge of beacon positions. From the received waveforms, the relative position of the nodes, i.e., the distances and angles among the nodes, can be inferred by extracting the relevant information contained in the waveforms. From prior position knowledge, one can obtain better accuracy of position inference as well as absolute positional information, i.e., position with respect to a reference frame. This project determines optimal techniques to extract the localization information inherent in UWB waveforms adapting to the changing wireless environments. The project also develops new algorithms for efficient beacon deployment and communication scheduling for localization, based on a deep theoretical understanding of Fisher information geometry.