

Research and Scholarship

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1 Evidence of Success in Research and Publication

1.1 Research Overview

My passion is to design approaches to solving potentially large problems with uncertainty in such a way that, despite the challenge of facing uncertainty, guaranteed decisions can be made. And one area that I like particularly is that of predictions: Can we figure out how a phenomenon is going to unfold? Can we predict how experts would rate a particular system? The core of the research I have conducted over the past five years has been in optimization and uncertainty quantification: for this, I have used many different techniques, from interval computations to fuzzy computing, constraint solving, stochastic approaches, etc. The target classes of problems I have attacked are multi-expert multi-criteria decision making problems and dynamic systems, all of which with uncertainty.

I seek excellence in what I propose and my priority is to involve students in my research (from early undergraduates – starting in CS1 – and even high-school students as interns in summer) as I believe that it is a fantastic way to help them develop as professionals, to discover their passion in computer science, and to broaden their network and opportunities for their future careers.

I also seek to informally mentor many more students, those who take my classes, those who took it before. In class, I inform students about current research topics. Outside of class, I encourage them to join research groups and seek research opportunities at UTEP and outside. I help them identify what they like and facilitate their connection with colleagues when relevant. I inform them and identify students who would be great candidates for opportunities outside UTEP (summer research and other industry internships).

My work has been funded through three main sources: NSF (a CAREER grant project whose half lifetime was executed during the last 5 years – about \$560K), AAAS (for my international collaboration with Perugia in Italy – about \$19K), and ARL (for my work on dynamic systems via the Army High-Performance Computing Research Center at Stanford – about \$1M). In addition, I have made efforts to acquire funding, submitting 20 proposals in total over these 5 years, 8 of which were funded, 6 with researchers from outside UTEP, 3 of which for international projects. Publishing my work has been a priority: I have published in peer-reviewed conference proceedings (20), in books as chapters (17), and in journals (12); I also participated and contributed abstracts and/or short papers in workshops. I have been invited to give a plenary talk in an international conference on guaranteed computing SCAN'16 in Uppsala, Sweden) and to give a seminar talk at the University of Paris Pierre and Marie Curie (in September 2017). I was a visiting professor in Perugia, Italy, working with Dr. S. Bistarelli 4 times during the last 5 years (for a total of about 1.5 month). I indeed value collaboration above all. Internationally, my work with the University of Perugia has resulted in an MOU between UTEP and Perugia, allowing for more exchanges, including of students, and we are working on finalizing a curriculum exchange program. Locally, my interdisciplinary collaborations have resulted in joint papers with researcher from departments of mathematics, biological sciences, geological sciences, and education, to name a few. I always involved students in my work to catch any opportunity to train them and to teach them team-working first hand.

Some background for my work

Decision making is everywhere and the abundance of data just makes it harder. There are two dimensions of decisions that I tackled over the past 5 years: **1/ decisions with conflicting criteria**, and **2/ decisions based on large systems of equations where uncertainty might be present**. Hereafter, I go over some of the rationale for my work in these areas.

1/ Decisions that matter are often based on conflicting criteria; e.g., what defines a good software, what makes a student an at-risk student, what policy is best to address a given situation. Although experts can usually make such decisions, when they are not available, understanding and replicating their decision-making process proves to be hard. Nevertheless, being able to replicate / model experts' decision making process would make expertise widely available and the possibility of making critical difficult decisions ubiquitous. In particular, one can imagine health care decisions could be made in remote locations where experts are a scarce resource. Although there are plenty of techniques to emulate decision making processes based on knowledge of prior decisions of experts; including techniques from soft computing (e.g., using fuzzy measures) and traditional machine learning, none has yet come to a satisfactory level of replication of experts' reasoning process. This is mainly due to the lack of consistency in decision making: a single expert might not always follow the same decision-making path; multiple experts might disagree.

Specifically, the type of decisions I have worked on are known as multi-criteria decisions. In the area of Multi-Criteria Decision Making (MCDM), there exist plenty of techniques to model and process such decisions; ranging from naive weighted sums, to fuzzy measures and integrals such as Choquet and Sugeno, to machine learning. In the case of fuzzy measures and integral, specifically the Choquet integral, as this is our approach, predicting experts' decisions based on the knowledge of prior decisions comes down to solving a non-linear continuous large constrained optimization problem. Although our in-house solver was able to address such problems, the problems themselves are ill-posed as they contain conflicting decisions (among experts) and decisions that do not come from a similar reasoning path (even in the case of a single expert). Such drawbacks were not at that time addressed in the literature and needed to be. On the other hand, in philosophy, the notion of disagreement is very widely developed and studied. In the computation world, there exist frameworks to represent decision-making processes and model conflicts/disagreements. Dr. Bistarelli, my main international collaborator over the last 5 years, had in particular worked on Dung's argumentation framework, which has very rich semantics and is suited to the kind of problems we studied. However, there was no work that addressed the above problems at once.

2/ Following on the type of problems of Point 1, where large optimization problems have to be solved, I looked at how decisions can be made in the case when they rely on data obtained from large and complex systems. This can be the case of dynamic systems with no analytical solutions. In such cases, the setting of the problem itself or the need to get very accurate data (to make equally good decisions), without knowing what aspects of the problem really matter, can result in "inflated" problems, problems whose size may be larger than it should. If this happens, it means that in fact, for such "inflated" problems, there should exist a counterpart "smaller" equivalent problem, which should be much faster to solve. Being able to identify such reductions and act on them has essential applications in many fields, from engineering to defense, to cybersecurity, etc.

The ability to conduct fast and reliable simulations of dynamic systems is indeed of special interest to Army operations for instance. An example is the need to obtain reliable under-body blast simulations to evaluate impacts on vehicles and personnel safety, as well as to study configurations

critical in the design and decision-making stages. However, such simulations can be very complex and, to be thorough, involve millions of variables, making it prohibitive in CPU time to run repeatedly on many different configurations. Reduced-order modeling (ROM) methods provide a concrete way to handle such complex simulations using a realistic amount of resources. They constitute a cornerstone to improving predictions and reducing the risk of decisions on Army applications, such as Underbody Blast vehicle studies.

Uncertainty is an added but practical challenge: it is part of the realities of what we model. However nicely we model some phenomenon, in practice, there will be uncertainty involved. So how can we handle uncertainty in practice? There are many techniques for handling uncertainty, ranging from probabilistic to stochastic approaches, to interval computations and p-box computations. However, not all of these produced **guaranteed results**. In my work I am interested in providing guaranteed results as often as practical.

Multi-Criteria Decision Making using Argumentation Framework and Choquet

This work was a collaboration with Dr. S. Bistarelli from the University of Perugia, started in 2012, and funded by AAAS (see list of funded projects). It also involved one Master's student and two undergraduate students from UTEP. As a team, we sought to integrate our own existing approaches: the fuzzy measure and integral approach (Ceberio) was preconditioned by a control stage in which argumentation networks (Bistarelli, using Dung's argumentation framework) was used to model conflicts. In particular, at this stage, prior data can be modeled using a directed graph where nodes are experts (or arguments) and arrows are conflicting theses versus arguments. The team of Bistarelli already had a tool, based on soft constraints, to approach such problems: this tool is named ConArg. The team worked on extending ConArg to handle multi-criteria decision problems and the specific applications chosen by the team to demonstrate and validate the approach: this application was software evaluation.

Our joint work resulted in a proposed (and published) new model for MEMCDM using argumentation networks. As we were designing the semantics of our new model, the existing solver for argumentation frameworks needed to be adjusted. In doing this, we received a lot of help from Francesco Santini and Fabio Rossi (from the University of Perugia) since both had been involved in ConArg's original implementation.

Although this specific project ended in 2015, Dr. Bistarelli and I have continued to work and to mentor students together. We are still working on Argumentation Frameworks and are starting (as of fall 2017) a joint work on bitcoin and cybersecurity.

Addressing Large Nonlinear Systems with Uncertainty

My work on large nonlinear systems started in spring 2013 and has been on-going since then. It has and still is a funded project of Stanford's Army High-Performance Computing Research Center (funded by ARL). This was a team work that I have led since January 2014. The team includes Dr. Argaez from Math at UTEP, one PhD student, and one post-doctoral researcher (in total we have had two post-doctoral researchers so far). Collaborators from the Army Research Lab have also been instrumental in our successes: Rad Balu from ARL ALC, Luis Bravo, Simon Su, Craig Barker from ARL APG, have allowed us, through our conversations and interactions, to better understand their computational problems and the reality of the practical applications. This work

has led to different research directions and contributions as outlined below:

1/ New Model-Order Reduction methods (MOR): Our work was driven by two objectives: (a) decreasing the time needed to compute a reduced basis and (b) freeing MOR from the need to pick good snapshots to build a reduced basis. In this aim, we designed a snapshot-free approach based on Wavelets, which has the same numerical properties as the snapshot/SVD (POD) approach. Both provide an orthogonal reduced basis, but using wavelets is an “off-the-shelf” approach and does not require computing snapshots. Although much faster, our wavelet approach does not yet match the quality of a traditional POD approach and further inquiry and development is needed. To enhance the performance of our approach, we implemented a hybrid “snapshots & wavelets” approach where SVD is conducted on a portion of snapshots coming from simulations of the full-order model (FOM) and the rest from the wavelets-based fast simulations (this can be seen as data – snapshots – fusion). Our further contribution to MOR consists of an interval version of the POD approach. Instead of obtaining snapshots from multiple simulations of the FOM, we proposed to solve FOM on an interval (or intervals) of parameters’ values, hence allowing us to solve it once and sample the snapshots from the thick surface that constitutes the solution of the one interval FOM simulation we ran. This idea so far has provided results similar to those of the traditional snapshots/SVD approach in quality. We called this approach IPOD for Interval POD. A positive side effect of this contribution is that IPOD also works when there is uncertainty in the definition of FOM.

2/ Another focus of our work was in improving optimization techniques for the obtained reduced problems. In this respect, we contributed speed-up ideas such as gappy approximation methods to limit the number of computations involved in the Jacobian. We proposed and studied strategies for regularization to make Newton methods robust to the choice of the starting points. In particular, we proposed a global regularized Gauss-Newton algorithm for a composite function, which guarantees a fast rate of convergence. This algorithm is grounded in the fact that the hybrid reduced-order model we proposed is a composition of two functions: the external function is the representation of the studied model, which satisfies the zero residual property, and the internal function is the linear function whose matrix representation is the reduced basis. This formulation allows us to find a solution to the problem using the interior-point algorithm developed by our team (and used in the past by the Army in the modeling of wings for aerial vehicles) for constrained optimization problems, which have a wide range of applications relevant to the Army. Furthermore, we implemented an interval version of the Newton method (state of the art) for reduced problems (Interval Reduced Newton, which was new) and we also proposed and implemented the use of interval constraint solving techniques to tackle the reduced problems. This allowed us to guarantee convergence, handle uncertainty, and guarantee that the obtained results are correct.

3/ Uncertainty handling: Following the design of our IPOD approach and Interval Reduced Newton method for reduced problems, we designed and tested approaches to solve FOM with uncertainty, where uncertainty is modeled as intervals (e.g., intervals enclosing a constant – or constants – that are not known precisely or may vary). We now have a fully functional set of techniques for problems with uncertainty: given a FOM with uncertainty, we are able to design an IROM (Interval ROM), which in turn is used and solved using either Interval Newton or Interval Constraint Solving Techniques (ICST).

4/ Finally, we were able to model the FOM and ROM problems as constraint solving problems, which allowed us to design algorithms for predictions of future behavior and for mission control. We developed models and techniques to predict future behavior of given phenomena given observed

data (possibly with uncertainty). This is utterly important in Army applications as a reliable understanding of a developing situation can allow to take preventive or palliative action before the situation worsens. We were also able to demonstrate control capabilities: specifically, we designed a technique that is able to re-compute parameters of the dynamical system on the fly to meet new constraints (e.g., boundary conditions, behaviors to be avoided). We foresee that this will be particularly useful for mission control and for adapting missions on the fly. We are still actively working on this topic.

In short, we have contributed ideas for reduction and solution of the reduced problem, and most notably, we have extended approaches to handle uncertainty and be able to make predictions of future behavior.

What's next?

As a continuation of the work outlined above, I foresee that over the next 3 to 5 years, I will be exploring quantum mechanics applications to further challenge the techniques my team and I have developed for large nonlinear systems with uncertainty. I also have no doubt that I will be studying and integrating machine learning techniques to the reduction techniques I am currently using and developing, and using these for my joint work with Dr. Bistarelli on identifying bitcoin mixnets (or other mixers for other crypto-currencies).

1.2 Highlights of Research Successes and Impacts

Major Findings and Successes of the Multi-Criteria Decision Making Project

In this project, we studied the feasibility of using argumentation frameworks to model Multi-Experts Multi-Criteria Decision Making (ME-MCDM). Although our focus has clearly been to make new decisions consistent with what experts should have made, we realized that using an argumentation framework led us to two model options: one that would allow to make new decisions while following the experts' prior decisions rationales and another more suited to modeling voting systems. We decided to branch out our original research direction to pursuing both directions but kept more focus on the first option. In the aim of making decision, we defined a semantics that allows to remove, from the obtained argumentation network, decisions (potentially even experts) that are unfair or irrational.

Our findings were presented four times in 2013:

- at a research seminar at the University of Perugia in June 2013;
- at Numerical Computations: Theory and Algorithms, NUMTA'13, in Italy in June 2013 (<http://si.deis.unical.it/~yaro/numta2013/>);
- at the 2013 SACNAS National Conference in San Antonio in October 2013 (<http://sacnas.confex.com/sacnas/2013/webprogram/start.html>); and
- at the Graduate School Expo at UTEP in November 2013.

Three of these presentations (all but the seminar) were given by Joel Henderson, graduate student participating in the project. These opportunities helped him make significant progress in presenting

skills. He graduated in fall 2015.

Further findings of this project were presented at the Workshop on Argumentation, Rationality and Decision at the Imperial College in London, 18th-19th September 2014, and at the 8th International Workshop on Constraint Programming and Decision Making, CoProD'14, in Wurzburg, Germany on September 21st, 2014. This work resulted in the subsequent publications: [C47] Stefano Bistarelli, Martine Ceberio, Joel Henderson, Franceco Santini, "Using Argumentation Frameworks to promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making", in the Proceedings of the 2015 Italian Conference in Theoretical Computer Science, 2015; and [Ch22] Stefano Bistarelli, Martine Ceberio, Joel Henderson, Francisco Santini, Luciana Garbayo, "Abstract Argumentation Frameworks to Promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making", In: Martine Ceberio and Vladik Kreinovich (eds.), Constraint Programming and Decision Making: Theory and Applications, Springer Verlag, Berlin, Heidelberg, 2017.

Impact. This collaboration resulted in a strong partnership with Dr. Bistarelli (concretized by 8 visits in 5 years, 1 funded proposals, 3 more submitted) and with the University of Perugia, with whom UTEP signed an MOU recognizing our intention to work closely together. This allows researchers to go back and forth between the institutions to work together, but also students who can go and work on research with a co-advisor of the other institution. We are also currently finalizing the details of a student exchange program so that we can also have students taking part of their curriculum at the partner institution.

Major Findings and Successes of the Model-Order Reduction Project

The work conducted as a project within Stanford's Army High-Performance Computing Research Center (AHPARC) has led to several contributions. We started by proposing Reduced-Order Modeling approaches based on Wavelets, as an attempt to free the process from having to generate snapshots, which we argued would require too much knowledge of the field of interest. This resulted in publications and presentations (C40 and a few presentations at CoProD and posters at AHPARC).

However, the most noteworthy success from this project comes from the integration of uncertainty in the problems we had to solve, in a way that provided guaranteed results. We started by demonstrating that using uncertainty techniques (namely intervals in our case), we could fix some of the Reduced-Order Modeling we had tried to address with Wavelets: we proposed an interval version of POD, dubbed IPOD. This work was published and presented at several occasions (J25, C42, W10, A35, A28, A27).

We then showed that we could not only model problems with uncertainty, but we also were able to show how uncertainty could still be handled and quantified when solving the problem in its reduced size. This allowed us to propose two new uses of ROM: one to predict future behavior of an unfolding event based on sensed data (C53, C50), and one to estimate the values of a phenomenon's parameters to enforce (or avoid) specific behaviors (C52).

This work has also been presented as poster at AHPARC, as well as on numerous local seminars. I was the topic of a plenary talk at the international conference on guaranteed computing SCAN'16 in Uppsala, Sweden, in September 2016, and of a seminar talk at the University of Pierre and Marie Curie in Paris, in September 2017.

Impact. The work of Model-Order Reduction has allowed us to explore uncertainty quantification

in very challenging and yet practical settings (ROM and highly nonlinear problems). Our progress in this direction has allowed us to define new challenges, namely using ROM for predictions as well as for enforcing / excluding behaviors, all of which coming with guarantees, which is the highlight and main difference of our approach, when compared to non-guaranteed statistical or stochastic approaches. Our work has been recognized as demonstrated by publications and invitation to present. Its funding has also been renewed every year (4 times) since 2013. Finally, it allowed to train many students: 4 PhD students (one who defended in fall 2013, one to defend in fall 2017, and two still on-going), 2 post-doctoral researchers (one still in the position, and one who moved on to become an assistant professor), and many undergraduate students, 6 of whom spent one summer at Stanford for an REU.

Applications

My work over the last 5 years was certainly driven by my passion for new approaches to decision problems with uncertainty, but it was greatly enhanced by applications that did need such decision making techniques, forcing me to keep my work practical and relevant.

Specifically, I have worked on problems from the following main areas:

- Software engineering: using Argumentation Frameworks to automatically assess software packages (C35, C36, C37, C38, J18), designing algorithm to create minimal pairwise-covering test suites (A36)
- Misc. Engineering: applications driving our work in reduced-order modeling (A25, W10, C40, C42, C50, C52, C53, J25); interval constraints for underwater robots (C41, C43, C51, J21, J22, J23, J24)
- Biology (A37)
- Medicine: Modeling flu epidemic dynamics (A17, C39)
- Environmental Sciences (J16)

1.3 Summary of Impact

Over the past 5 years, I have further developed the work I had conducted before that into a strong research agenda with a lot of applications and applicability. The projects I have conducted have constituted a culmination of my prior work on optimization and decision making under uncertainty.

Because of the funding received during this period, my work had a significant impact on **students**, providing projects and funding to many of them, opening opportunities that they would not have been exposed to otherwise. As a result of this work, I was able to mentor two post-doctoral researchers (one still on-going and another one now a faculty in Mathematics at Saint Thomas University in Florida), two students obtained their Ph.D. in Computer Science and Computational Sciences respectively and one more, in Computational Sciences as well is about to defend his, two students obtained their Master's Degree in Computer Science (one of which is now still working with me on his Ph.D.), many undergraduate students were able to complete research experience for undergraduates in my lab (about 12) and/or at Stanford University (for the Army High-Performance

Computing Research Center Summer Institute for Undergraduate Research – 6 students). In addition to my own students, I was invited on the committee of a number of Ph.D. students at UTEP but was also asked to review a Ph.D. manuscript for a competition in Italy, and am currently a member of the Ph.D. committee of a student of computer science at the University of Pierre and Marie Curie in Paris, France.

My work on **decision making** has resulted in a strong on-going **collaboration with the University of Perugia**, in particular with Dr. Stefano Bistarelli and his team. Over the past five years, I have visited his lab 5 times for a total of about 1.5 month spent working together there. He also visited UTEP in 2016 and we had two other meetings at the occasion of conferences in 2014 and 2016. An MOU was signed in 2015 between the University of Perugia and UTEP to facilitate research exchanges between our institutions and a student exchange program is being finalized. New advances in **solving large problems with uncertainty** were also achieved, and was published in many venues (journals and conferences). In addition to many presentations locally by myself or my students, I was invited to present my work at the GAMM - IMACS International Symposium on Scientific Computing, Computer Arithmetic and Verified Numerical Computations SCAN'16 in Sweden in 2016 and at the University of Paris 6 in 2017. Additionally, on-going international collaboration took place during that time: one with Luc Jaulin from the **University of Western French Brittany** whose two students came to UTEP for research internships to complete their Master's degrees in 2014 and 2015; one with Salem Benferhat, from the **University of Artois (France)**, who visited Vladik Kreinovich and I at UTEP and with whom we have had since then on-going exchanges and collaboration.

Finally, I have continued my efforts in **organizing the annual International Workshop on Constraint Programming and Decision Making, CoProD**, started in fall 2008 as a satellite event of the 13th GAMM - IMACS International Symposium on Scientific Computing, Computer Arithmetic and Verified Numerical Computations SCAN'08, but this is now a team effort organized jointly by Vladik Kreinovich and myself. Together, we have also organized the **Annual Meeting of the North American Fuzzy Information Processing Society., NAFIPS** in fall 2016 at UTEP (we had already organized it once in 2011).

1.4 List of articles in refereed scholarly journals since 2012

Important note: In the lists below, the names of authors who were students at the time we wrote the article are followed by an “”. Also, the numbering of the articles is kept as shown in the detailed curriculum vitae to ensure consistency of references*

- J27 Martine Ceberio and Vladik Kreinovich, “Constraint Problems: Computability Is Equivalent to Continuity”, **International Journal of Intelligent Technologies and Applied Statistics (IJITAS)**, 2017, Vol.10, No.2, pp.21-40.
- J26 Martine Ceberio and Vladik Kreinovich, “A Modification of Backpropagation Enables Neural Networks to Learn Preferences”, **Journal of Uncertain Systems**, to appear.
- J25 Leobardo Valera* and Martine Ceberio, “Model-Order Reduction Using Interval Constraint Solving Techniques”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 84–103.
- J24 Anthony Welte*, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Avoiding Fake Boundaries in Set Interval Computing”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 137-148.

- J23 Anthony Welte*, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Computability of the Avoidance Set and of the Set-Valued Identification Problem”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 129-136.
- J22 Vladik Kreinovich, Martine Ceberio, and Quentin Brefort*, “In category of sets and relations, it is possible to describe functions in purely category terms”, **Eurasian Mathematical Journal**, 2015, Vol. 6, No. 2, pp. 90-94.
- J21 Quentin Brefort*, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Towards Fast and Reliable Localization of an Underwater Object: An Interval Approach”, **Journal of Uncertain Systems**, 2015, Vol. 9, No. 2, pp. 95-102.
- J20 Karen Villaverde, Olga Kosheleva, Martine Ceberio, “Computations under Time Constraints: Algorithms Developed for Fuzzy Computations can Help”. **Journal of Uncertain Systems**, 26(2), 138-145, 2013.
- J19 Olga Kosheleva, Martine Ceberio, “How Accurately Should We Write on the Board? When Marking Comments on Student Papers?”. **Journal of Uncertain Systems**, 6(2), 89-91, 2013.
- J18 Xiaojing Wang*, Martine Ceberio, Shamsnaz Virani, Angel Garcia*, and Jeremy Cummins*. “A Hybrid Algorithm to Extract Fuzzy Measures for Software Quality Assessment”. **Journal of Uncertain Systems**, 2013.
- J17 Vladik Kreinovich, Christelle Jacob*, Didier Dubois, Janette Cardoso, Martine Ceberio (2012). “Failure Analysis of a Complex System Based on Partial Information about Subsystems, with Potential Applications to Aircraft Maintenance”. **Journal of Applied and Computational Mathematics**, 11(2), 165-179.
- J16 Aline Jaimes*, Craig Tweedie, Vladik Kreinovich, and Martine Ceberio, “Scale-Invariant Approach to Multi-Criterion Optimization under Uncertainty, with Applications to Optimal Sensor Placement, in Particular, to Sensor Placement in Environmental Research”, **International Journal of Reliability and Safety**, 2012, Vol. 6, No. 1-3, pp. 188-203.

1.5 List of articles in conference proceedings since 2012

- C53 Leobardo Valera*, Angel Garcia*, Afshin Gholamy*, and Martine Ceberio, “Towards Predictions of Large Dynamic Systems’ Behavior using Reduced-Order Modeling and Interval Computations”, to be published in the proceedings of the **IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC 2017)**.
- C52 Leobardo Valera*, Angel Garcia*, and Martine Ceberio, “On-the-Fly Parameter Identification for Dynamic Systems Control, Using Interval Computations and Reduced-Order Modeling”. To be published in the proceedings of the **North American Fuzzy Information Processing Society Annual Conference 2017 (NAFIPS 2017)**.
- C51 Anthony Welte*, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Robust Data Processing in the Presence of Uncertainty and Outliers: Case of Localization Problems”, In the Proceedings of the **IEEE Series of Symposia in Computational Intelligence SSCI’2016**, Athens, Greece, December 6-9, 2016.

- C50 Leobardo Valera*, Martine Ceberio, “Using Interval Constraint Solving Techniques to Better Understand and Predict Future Behaviors of Dynamic Problems”. In the proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2016**.
- C49 Angel F. Garcia Contreras*, Martine ceberio, “Comparison of Strategies for Solving Global Optimization Problems Using Speculation and Interval Computations”. In the proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2016**.
- C48 Horacio Florez* and Martine Ceberio (2016). “A Novel Mesh Generation Algorithm for Field-Level Coupled Flow and Geomechanics Simulations”. In the Proceedings of **ARMA 16-305, 50th US Rock Mechanics / Geomechanics** Symposium held in Houston, TX.
- C47 Stefano Bistarelli, Martine Ceberio, Joel Henderson*, Franceco Santini*, “Using Argumentation Frameworks to promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making”, in the Proceedings of the **2015 Italian Conference in Theoretical Computer Science**, 2015.
- C46 Esquinca, A., Villa, E. Y., Hampton, E. M., Ceberio, M. C., Wandermurem, L. S.*, (2015). “Latinas’ resilience and persistence in computer science and engineering: Preliminary findings of a qualitative study examining identity and agency.” Proceedings of the 2015 **Frontiers in Education**.
- C45 Martine Ceberio, Vladik Kreinovich, Hung T. Nguyen, Songsak Sriboonchitta, and Rujira Ouncharoen, “What is the Right Context for an Engineering Problem: Finding Such a Context is NP-Hard”, Proceedings of the **IEEE Symposium Series on Computational Intelligence**, Cape Town, South Africa, December 7-10, 2015, pp. 1615-1620.
- C44 Salem Benferhat, Karim Tabia, Sylvain Lagrue, Vladik Kreinovich, and Martine Ceberio, “On the Normalization of Interval-Based Possibility Distributions”, Proceedings of the **Twenty-Eighth International Florida Artificial Intelligence Research Society Conference FLAIRS’28**, Hollywood, Florida, May 18-20, 2015, pp. 20-25.
- C43 Quentin Brefort*, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “If We Take Into Account that Constraints Are Soft, Then Processing Constraints Becomes Algorithmically Solvable”, Proceedings of the **IEEE Symposium on Computational Intelligence for Engineering Solutions CIES’2014**, Orlando, Florida, December 9-12, 2014, pp. 1-10.
- C42 Martine Ceberio, Leobardo Valera*, Olga Kosheleva, and Rodrigo Romero. “Model Reduction: Why It Is Possible and How It Can Potentially Help to Control Swarms of Unmanned Arial Vehicles”. In the Proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2015**.
- C41 Brefort, Q.*, Jaulin, L., Ceberio, M. C., Kreinovich, V. Y., (2014). “If We Take Into Account that Constraints Are Soft, Then Processing Constraints Becomes Algorithmically Solvable”. (pp. 1-10). Proceedings of the **IEEE Symposium on Computational Intelligence for Engineering Solutions**, Orlando, Florida SSCI’2014, December 9-12, 2014.
- C40 Miguel Argaez, Miguel Hernandez*, Leticia Velazquez, Martine Ceberio, Reinaldo Sanchez-Arias*, “Reduced-Order Modeling Using Orthogonal Wavelets”, in the proceedings of **IFORS Barcelona 2014**.

- C39 Paula A. Gonzalez-Parra*, Martine Ceberio, Sunmi Lee, Carlos Castillo-Chavez. “Optimal Control for a Discrete Time Influenza Model”. In the proceedings of the **Second Colombian Congress of Computational Biology and Bioinformatics (CCBCOL 2013)**.
- C38 X. Wang*, M. Ceberio, A. Garcia*. “Towards Fuzzy Method for Estimating Prediction Accuracy for Discrete Inputs, with Application to Predicting At-Risk Students”. Proceedings of the **Annual Conference of North American Fuzzy Information Processing Society (NAFIPS’2013)**, Alberta, Canada, June 2013.
- C37 X. Wang*, M. Ceberio, S. Virani, C. Del Hoyo*, and L. Gutierrez*. “Fuzzy measure extraction for software quality assessment as a multi-criteria decision-making problem”. Proceedings of the **2012 International Conference on Software Engineering Research and Practice**, Las Vegas, NV, July 2012.
- C36 X. Wang*, A. F. Garcia Contreras*, M. Ceberio, C. Del Hoyo*, L. C. Gutierrez*, and S. Virani. “Interval-based algorithms to extract fuzzy measures for software quality assessment”. Proceedings of the **Annual Conference of North American Fuzzy Information Processing Society (NAFIPS’2012)**, Berkeley, CA, August 2012.
- C35 Xiaojing Wang*, Angel Garcia Contreras*, Martine Ceberio, Christian Del Hoyo*, Luis Gutierrez*, “A Speculative Algorithm to Extract Fuzzy Measures from Sample Data”, Proceedings of the **2012 annual international conference of Fuzz-IEEE (FuzzIEEE’12)**.

1.6 Chapters in Scholarly Books and Monographs since 2012

- Ch22 Stefano Bistarelli, Martine Ceberio, Joel Henderson, Francisco Santini, Luciana Garbayo, “Abstract Argumentation Frameworks to Promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch21 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Optimizing $\text{pred}(25)$ Is NP-Hard”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch20 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Constraint Approach to Multi-Objective Optimization”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch19 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “From Global to Local Constraints: A Constructive Version of Bloch’s Principle”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch18 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Range Estimation under Constraints is Computable Unless There Is a Discontinuity”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.

- Ch17 Juan Carlos Figueroa Garcia, Martine Ceberio, and Vladik Kreinovich, “Algebraic Product is the Only t-Norm for Which Optimization Under Fuzzy Constraints is Scale-Invariant”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch16 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Towards a Physically Meaningful Definition of Computable Discontinuous and Multi-Valued Functions (Constraints)”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch15 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, “Peak-End Rule: A Utility-Based Explanation”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, to appear.
- Ch14 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Simplicity Is Worse Than Theft: A Constraint-Based Explanation of a Seemingly Counter-Intuitive Russian Saying”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 9-14.
- Ch13 Martine Ceberio and Vladik Kreinovich, “Continuous If-Then Statements Are Computable”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 15-18.
- Ch12 Aline Jaimes, Craig Tweedie, Tanja Magoc, Vladik Kreinovich, and Martine Ceberio, “Selecting the Best Location for a Meteorological Tower: A Case Study of Multi-Objective Constraint Optimization”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 61-66.
- Ch11 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, “Why Tensors?”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 75-78.
- Ch10 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, “Adding Constraints – A (Seemingly Counterintuitive but) Useful Heuristic in Solving Difficult Problems”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 79-84.
- Ch9 Vladik Kreinovich, Juan Ferret, and Martine Ceberio, “Constraint-Related Reinterpretation of Fundamental Physical Equations Can Serve as a Built-In Regularization” In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 91-96.
- Ch8 Paden Portillo, Martine Ceberio, and Vladik Kreinovich, “Towards an Efficient Bisection of Ellipsoids”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 137-142.
- Ch7 Uram Anibal Sosa Aguirre, Martine Ceberio, and Vladik Kreinovich, “Why Curvature in L-Curve: Combining Soft Constraints”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 175-180.

Ch6 Christian Servin, Martine Ceberio, Aline Jaimes, Craig Tweedie, and Vladik Kreinovich, “How to Describe and Propagate Uncertainty When Processing Time Series: Metrological and Computational Challenges, with Potential Applications to Environmental Studies”, In: Shyi-Ming Chen and and Witold Pedrycz (eds.), **Time Series Analysis, Modeling and Applications: A Computational Intelligence Perspective**, Springer Verlag, 2013, pp. 279-299.

1.7 List of articles in refereed Workshop Proceedings (W) and abstracts (A) since 2012

W10 Leobardo Valera, Martine Ceberio, “Model-Order Reduction Using Interval Constraint Solving Techniques.” Proceedings of the **7th International Workshop on Reliable Engineering Computing (REC2016)**. June 15-17, 2016, Ruhr University Bochum, Germany.

W9 Luis Gutierrez, Martine Ceberio, Vladik Kreinovich, Rebekah L. Gruver, Marianna Pena, Matthew J. Rister, Abraham Saldana, John Vasquez, Janelle Ybarra, and Salem Benferhat, “From Interval-Valued Probabilities to Interval-Valued Possibilities: Case Studies of Interval Computation under Constraints”, Proceedings of the **6th International Workshop on Reliable Engineering Computing REC’2014**, Chicago, Illinois, May 25-28, 2014.

A39 Angel F. Garcia Contreras, Martine Ceberio, and Vladik Kreinovich, “Plans Are Worthless but Planning Is Everything: A Theoretical Explanation of Eisenhower’s Observation”, in the Proceedings of the **10th International Workshop on Constraint Programming and Decision Making CoProd’2017**, El Paso, Texas, November 3, 2017, to appear.

A38 Angel F. Garcia Contreras, Martine Ceberio, and Vladik Kreinovich, “Why Convex Optimization Is Ubiquitous and Why Pessimism Is Widely Spread”, Proceedings of the **10th International Workshop on Constraint Programming and Decision Making CoProd’2017**, El Paso, Texas, November 3, 2017, to appear.

A37 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, “Attraction-Repulsion Forces Between Biological Cells: A Theoretical Explanation of Empirical Formulas”, Proceedings of the **10th International Workshop on Constraint Programming and Decision Making CoProd’2017**, El Paso, Texas, November 3, 2017, to appear.

A36 Leobardo Valera, Martine Ceberio, “Introduction to Pairwise Testing. Definition and Examples”. **47th Southeastern International Conference on Combinatorics, Graph Theory Computing (2016)**.

A35 Leobardo Valera, Martine Ceberio, “Interval Constraint Solving Techniques and Model-Order Reduction to Enhance the Solution of Dynamic Systems”. **2016 INFORMS Annual Meeting**.

A34 Chitta Baral, Martine Ceberio, and Vladik Kreinovich, “How Neural Networks (NN) Can (Hopefully) Learn Faster by Taking Into Account Known Constraints”, Proceedings of the Ninth International **Workshop on Constraints Programming and Decision Making CoProd’2016**, Uppsala, Sweden, September 25, 2016.

- A33 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, “When We Know the Number of Local Maxima, Then We Can Compute All of Them”, Proceedings of the **Ninth International Workshop on Constraints Programming and Decision Making** CoProd’2016, Uppsala, Sweden, September 25, 2016.
- A32 Martine Ceberio, Vladik Kreinovich, (2016). Preface to the special issue on uncertainty. (vol. 10). Journal of Uncertain Systems.
- A31 Ceberio, M. C., Kreinovich, V. Y., Nguyen, H. T., Sriboonchitta, S., Ouncharoen, R., (2015). “What is the Right Context for an Engineering Problem: Finding Such a Context is NP-Hard”. (pp. 136). Abstracts of the **IEEE Symposium Series on Computational Intelligence**, Cape Town, South Africa, December 7-10, 2015.
- A30 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Optimizing $\text{pred}(25)$ Is NP-Hard”, Proceedings of the **Eighth International Workshop on Constraints Programming and Decision Making** CoProd’2015, El Paso, Texas, November 6, 2015.
- A29 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Constraint Approach to Multi-Objective Optimization”, Proceedings of the **Eighth International Workshop on Constraints Programming and Decision Making** CoProd’2015, El Paso, Texas, November 6, 2015.
- A28 Leobardo Valera, Martine Ceberio, “Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction”. 8th International **Workshop on Constraint Programming and Decision Making**, El Paso, Nov. 2015.
- A27 Martine Ceberio, Miguel Argaez, Luis Gutierrez, Leobardo Valera. “Using Interval Constraint Solving Techniques to Solve Dynamical Systems”. **CORS/INFORMS 2015 Meeting**, Montreal, June 2015.
- A26 Miguel Argaez, Martine Ceberio, Leobardo Valera. “A Model Order Reduction for Solving Large-Scale Square Nonlinear Systems of Equations”. **CORS/INFORMS 2015 Meeting**, Montreal, June 2015.
- A25 Leobardo Valera, Martine Ceberio. “Using Regularization to Improve the Rate of Convergence in a Model-Order Reduction (MOR) Problem”. **22th International Symposium on Mathematical Programming**. Pittsburg, Pennsylvania, ISMP’2015, July 2015.
- A24 Martine Ceberio, Vladik Kreinovich, (2014). Preface to “Constraint Programming and Decision Making” in Constraint Programming and Decision Making. (pp. v-x). Berlin, Heidelberg: Springer Verlag.
- A23 Martine Ceberio, Vladik Kreinovich, (2014). Preface to the special issue on uncertainty. (3rd ed., vol. 8, pp. 163). Journal of Uncertain Systems.
- A22 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “From Global to Local Constraints: A Constructive Version of Bloch’s Principle”, Proceedings of the of the **Seventh International Workshop on Constraints Programming and Decision Making, Co-Prod’2014**, Wuerzburg, Germany, September 21, 2014.
- A21 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, “Range Estimation under Constraints is Computable Unless There Is a Discontinuity”, Proceedings of the of the **Seventh**

International Workshop on Constraints Programming and Decision Making, Co-Prod'2014, Wuerzburg, Germany, September 21, 2014.

- A20 Juan Carlos Figueroa Garcia, Martine Ceberio, and Vladik Kreinovich, "Algebraic Product is the Only t-Norm for Which Optimization Under Fuzzy Constraints is Scale-Invariant", Proceedings of the **Sixth International Workshop on Constraints Programming and Decision Making CoProd'2013**, El Paso, Texas, November 1, 2013, pp. 8-11.
- A19 Martine Ceberio, Olga Kosheleva, and Vladik Kreinovich, "Towards a Physically Meaningful Definition of Computable Discontinuous and Multi-Valued Functions (Constraints)", Proceedings of the **Sixth International Workshop on Constraints Programming and Decision Making CoProd'2013**, El Paso, Texas, November 1, 2013, pp. 22-26.
- A18 Olga Kosheleva, Martine Ceberio, and Vladik Kreinovich, "Peak-End Rule: A Utility-Based Explanation", Proceedings of the **Sixth International Workshop on Constraints Programming and Decision Making CoProd'2013**, El Paso, Texas, November 1, 2013, pp. 12-16.
- A17 Paula Gonzalez-Parra, Martine Ceberio, and Carlos Castillo Chavez. "Interior-Point Methods for a Multi-Group Discrete-Time Influenza Model". Presented at the **Mathematical Congress of the Americas 2013**, August 2013.
- A16 Joel Henderson, Stefano Bistarelli, Martine Ceberio (2013). "Multi-Experts Multi-Criteria Decision Making", In the Proceedings of **Numerical Computations: Theory and Algorithms International Conference**, Italy, June 2013.
- A15 Martine Ceberio, Vladik Kreinovich, (2012). "Preface to the special issue". (vol. 6, pp. 83). **Journal of Uncertain Systems**.
- A14 Ali Jalal-Kamali, Martine Ceberio, Vladik Kreinovich, (2012). "Constraint Optimization: From Efficient Computation of What Can Be Achieved to Efficient Computation of a Way to Achieve the Corresponding Optimum". Proceedings of the **Fifth International Workshop on Constraint Programming and Decision Making CoProD'12**, Novosibirsk, Russia, September 23, 2012.
- A13 MartineCeberio, Olga Kosheleva, Vladik Kreinovich, (2012). "Simplicity Is Worse Than Theft: A Constraint-Based Explanation of a Seemingly Counter-Intuitive Russian Saying". Proceedings of the **Fifth International Workshop on Constraint Programming and Decision Making CoProD'12**, Novosibirsk, Russia, September 23, 2012.

1.8 List of Edited Books since 2012

- B2 Martine Ceberio and Vladik Kreinovich (eds.), *Constraint Programming and Decision Making: Theory and Applications*, Springer Verlag, Berlin, Heidelberg, to appear, 2017.
- B1 Martine Ceberio and Vladik Kreinovich (eds.), *Constraint Programming and Decision Making*, Springer Verlag, Berlin, Heidelberg, 2014.

2 Evidence of Success in Securing Extramural Funding

As documented below, between 2012 and 2017, I have established a successful research agenda, mostly as PI for projects at the core of my research interests, as demonstrated by my funded efforts and the collaborations that took place. In addition to my funded projects, I pursued other ones, which were not funded but are reflected in what follows as evidence of my activities.

□ Total Grants and Contracts since 2012

Total funding is \$7,408,457 (**\$1,379,905** as PI).

- **Federal funding: \$390,905** as PI and \$5,517,552 for projects in which I am co-PI
- **Army funding: \$999,000** as PI and \$475,000 for projects in which I am co-PI
- **Industry funding: \$36,000** from Raytheon, for projects in which I am co-PI
- **University funds: \$25,000** from URI and two IDRs (IDR1 & IDR2)

2.1 Awarded Grants and Grants active during the 2012-2017 period

14. **ARMY RESEARCH LABORATORY through Stanford University's Army High Performance Computing Research Center– PI *HPC Modeling and Simulation of Underbody Blast Parameter Estimation Problems***, start: January 1, 2017, end: December 31, 2017. Amount: \$244,000.
13. **STEM Accelerator Fund: *CS1 Course Redesign***. Amount: \$8,500, Fall 2016.
12. **ARMY RESEARCH LABORATORY through Stanford University's Army High Performance Computing Research Center– PI *HPC Modeling and Simulation of Underbody Blast Parameter Estimation Problems***, start: January 1, 2016, end: December 31, 2016. Amount: \$225,000.
11. **Google CS Engagement Award: Ceberio, Martine (PI). *Revamping CS1 to increase retention***. Amount: \$5,000. (January 2015 – December 2015).
10. **ARMY RESEARCH LABORATORY through Stanford University's Army High Performance Computing Research Center– PI *HPC Modeling and Simulation of Underbody Blast Parameter Estimation Problems***, start: January 1, 2015, end: December 31, 2015. Amount: \$275,000.
9. **ARMY RESEARCH LABORATORY through Stanford University's Army High Performance Computing Research Center– PI *HPC Modeling and Simulation of Underbody Blast Parameter Estimation Problems***, start: January 1, 2014, end: December 31, 2014. Amount: \$250,000.
8. **NSF IUSE/PFE RED – Co-PI *IUSE/PFE:RED: Toward a Model of Change for Preparing a New Generation for Professional Practice in Computer Science***. July 2016 – June 2021. Amount: \$4,992,592.

7. **Raytheon – Co-PI** *Virtual Geocaching – STEM Student Software Application: Geocaching from Space*. September 1 to August 31, 2013. Amount: \$36,000.00.
6. **ARMY RESEARCH LABORATORY through Stanford University’s Army High Performance Computing Research Center– Co-PI** *HPC Modeling and Simulation of Underbody Blast Parameter Estimation Problems*, start: April 1, 2013, end: December 31, 2013. Amount: \$190,000.
5. **NSF Research on Gender – Co-PI** *Latinas in Computer Science and Engineering: A Qualitative*. September 15, 2012 – September 14, 2016 extended. Amount: \$524,960.00.
4. **American Association for the Advancement of Science WIRC MSIs – PI** *Predicting Experts’ Decisions and Disagreements using Argumentation Networks and Soft Constraints*. November 2012 – October 2013. Amount: \$19,472.00.
3. **UTEP Inter-Disciplinary Research fund – Co-PI** *Research on Identity and Participation in Science, Technology, Engineering, & Science (STEM)-IDR*, The University of Texas at El Paso, February 1, 2012 - January 31, 2013. Amount: \$20,000.00.
2. **UTEP Inter-Disciplinary Research fund – Co-PI** *IDR1: Interdisciplinary Research Group on Decision Making and Judgment*, The University of Texas at El Paso, Spring 2012 – Spring 2013. Amount: \$5,000.00.
1. **NSF CCF 0953339 – PI** *CAREER: Symbolic-Numeric Constraint-Based Solutions for Real-World Scientific Problems*, 01/2010 to **12/2016**. Amount: \$564,650 + additional \$32,000 REU supplement (2010, 2011, 2012).

2.2 Pending Grants

2. **Department of Homeland Security – Co-PI**. With Heidi Taboada (PI UTEP). *Center of Excellence for Cross-Border Threat Screening and Supply Chain Defense (CBTS & SCD)*. 2018 – 2023.
1. **ARMY RESERACH LABORATORY – Co-PI**. Radhakrishnan Balu (ARL PI). *ARL Computational & Information Sciences Directorate, Competitive Basic Research Program, Risk analysis (UQ)*. Amount: \$285,000 (October 2017 – September 2018).

2.3 Declined Grants

11. **European COST Action – Co-PI**. With S. Bistarelli (PI, University of Perugia, Italy). COST Action Proposal OC-2017-1-22146. *Argumentation and Intelligent Decisions in the largE’*.
10. **NSF MRI Program – Co-PI**. With T. Sarkodie-Gyan (PI UTEP). *MRI-Development: Development of an Intelligent Knowledge-based Condition-Monitoring System in Advanced Manufacturing*, Total amount: \$2,209,239 (September 2017 – August 2021).
9. **European COST Action – Co-PI**. With S. Bistarelli (PI, University of Perugia, Italy). COST Action Proposal OC-2016-2-21464. *Argumentation and Intelligent Decisions in the largE’*.

8. **NSF IUSE/PFE RED – Co-PI IUSE/PFE:RED: Toward a Model of Change for Preparing a New Generation for Professional Practice in Computer Science.** July 2015 – June 2020. Amount: \$4,992,592.00.
7. **Google Innovation Program – PI. Generating Minimal Constrained t -wise Covering Test Suites.** Amount: \$94,506.36 (submitted in: 2015).
6. **NSF – Co-PI. The Problem- Based Learning in Engineering Network (PBL in EN G Net): Scaffolding Design Problem Solving in Engineering Education to Foster Active Engagement for Enduring Understanding Education.** September 15, 2014 – September 15, 2017.
5. **NCWIT NEXT Award on Recruitment and Retention of Women in CS – Co-PI** (Submitted in: 2014).
4. **NSF Expeditions in Computing – USC Subcontract PI at UTEP.** with S. Sen(PI, USC). *Risk Analytics for a Data-powered Smart Grid.* Amount: \$818,180. (submitted in: 2014).
3. **NSF ERC – U.Michigan Subcontract PI at UTEP.** with A. Cohn (PI, U. Michigan). *Engineering Research Center for Data-Driven Re-Engineering of the Emergency Medicine System (DREEMS).*(submitted in: 2013).
2. **NSF REE – Co-PI.** With E. Mein (PI UTEP). *Retaining Hispanic Women in Engineering: An Examination of Social Networks, Identity Development, and Academic Success,* (submitted in: 2013).
1. **NSF Big Data Program – Co-PI.** with V. Kreinovich (PI UTEP). *BIGDATA: Mid-Scale: DCM: ESCE: DA: Quantum LEAP: Quantifying and Processing Heterogenous Uncertainty of Big Data: Methods and Algorithms that Enable Privacy* (submitted in: 2012).

3 Evidence of Community, Regional, National, or International Research

Collaboration is very important for me: at the local level (with colleagues and students), national, and international levels. I yearn for collaborations as often as possible, as an opportunity to mentor (students), be mentored (by more senior colleagues or by colleagues outside of my discipline), and seek innovation. This trend of my philosophy shows in my list of publications, with a long list of co-authors (as detailed below), as well as on the list of grant proposals I have been involved in over the last 8 years. I also have a few strong collaborations on organizations of international workshops and scientific sessions at international conferences. Finally, there are other collaborations that have not yet borne either proposals or publications but that are very active. I am listing all of these in what follows.

3.1 Co-authored Publications

All my publications were co-authored. Hereafter, I am listing the colleagues with whom I have co-authored articles. This list does not include students (publications with students will be listed in Subsection 4.3).

I co-authored articles with 5 international colleagues from 3 different institutions and countries, with 14 colleagues at the regional and national levels from 6 different institutions, and with 8

colleagues at UTEP from 7 different departments (3 colleges: Engineering, Science, and Education). Below is the list of all main non-students co-authors along with their affiliation and the number of publications co-authored.

Co-author	Affiliation	# Publ.
International		
Salem Benferhat	University of Artois, France	2
Stefano Bistarelli	Dep. of Mathematics and Computer Science University of Perugia, Italy	3
Juan C. Figueroa Garcia	Universidad Distrital Francisco José de Caldas, Colombia	2
Luc Jaulin	University of Bretagne Ouest, France	6
Francesco Santini	Dep. of Mathematics and Computer Science University of Perugia, Italy	2
National		
Carlos Castillo-Chavez	Arizona State University	2
Elaine Hampton	STEM Educational Consultants	1
Hung T. Nguyen	New Mexico State University	2
Christian Servin	El Paso Community College	1
Karen Villaverde	New Mexico State University	1
UTEP		
Miguel Argaez	Department of Mathematical Sciences	3
Alberto Esquinca	Department of Teacher Education	1
Juan Ferret	Department of Philosophy	1
Luciana Garbayo	Department of Philosophy	1
Olga Kosheleva	Department of Teacher Education	21
Vladik Kreinovich	Computer Science Department	32
Rodrigo Romero	Electrical and Computer Engineering Department	1
Craig Tweedie	Department of Biological Sciences	3
Elsa Villa	Center for Education Research and Policy Studies	1
Shamsnaz Virani	<i>formerly:</i> Systems Engineering <i>now at:</i> Worcester Polytechnic University	3

3.2 Joint Grant Proposals

I have also collaborated with colleagues on 23 of the 27 proposals I have submitted (12 of which were funded and 2 are still pending a decision). Below is the list of proposal collaborators (main PIs and co-PIs), along with their institution, the number of proposals written together that were funded (F), declined (D), or are still pending (P).

Collaborators	Institutions	# Prop. and F/D/P
Miguel Argaez	Dep. of Mathematical Sciences, UTEP	5 F
Rad Balu	ARL ALC Adelphi , MD	1P
Stefano Bistarelli	Dep. of Mathematics and Computer Science University of Perugia, Italy	2 D, 1 F
Amy Cohn	University of Michigan	1 D
Christina Convertino	Teacher Education Department, UTEP	1 D, 1 F
Scott Ferson	University of Liverpool , UK	1D
Ann Gates	Computer Science Department, UTEP	2 D, 1 F
Vladik Kreinovich	Computer Science Department, UTEP	1D
Erika Mein	Teacher Education Department, UTEP	1 D
Thompson Sarkodie-Gyan	Electrical and Computer Engineering Department, UTEP	1 D, 1 P
Suvrajeet Sen	University of Southern California	1 D
Heidi Taboada	Indus., Manuf., and Sys. Engineering Dept., UTEP	1P
Elsa Villa	Center for Education Research and Policy Studies, UTEP	2F, 2D

3.3 Joint Meeting Organization

Since 2012, I have organized a number of scientific sessions, workshops, and conferences. All of these were based on collaborations. The main events I organized since 2012 have been: the Annual Meeting of the North American Fuzzy Information Processing Society (NAFIPS'16), the annual International Workshop on Constraint Programming and Decision Making (CoProD, in Novosibirsk – Russia 2012, at UTEP 2013, in Wurzburg – Germany 2014, at UTEP 2015, in Uppsala – Sweden 2016, and at UTEP 2017). Here is a list of the main efforts I have conducted, along with my main collaborators for these efforts.

Workshops/Conf./Sessions	Collaborators	Institutions
NAFIPS'16	Vladik Kreinovich	Computer Science Department, UTEP
CoProD'12, '13, '14, '15, '16, '17	Vladik Kreinovich	Computer Science Department, UTEP
ACM SAC KRR'17, '18	Stefano Bistarelli Francesco Santini Eric Monfroy	Dep. of Mathematics and Computer Science University of Perugia, Italy University of Nantes, France

The proceedings of NAFIPS'16 were published and indexed by IEEE (<http://nafips.cs.utep.edu>). The proceedings for SAC KRR are to be published as the proceedings of the general conference ACM-SAC (<http://www.dmi.unipg.it/bista/organizing/KRsac2017/#organi> and <http://www.dmi.unipg.it/bista/organizing/KRRsac2018/>). The proceedings of CoProD are always provided at the meeting to all participants. However, extended versions of the work presented at CoProD have led to publishing two Springer books (see B1 and B2).

3.4 Other Collaborations

In addition to the above-mentioned collaborations, I have active collaborations with Luis Bravo and Simon Su from the **Army Research Laboratory at Aberdeen Proving Grounds** in Maryland. Our collaboration is concretizing in work that we are planning to present and publish, but it has just not been published yet.

4 Evidence of Involving Students

4.1 Students supported from extramural funding

Thanks to the funding I received but also through , I was able to support a number of students, ranging from undergraduate students to post-doctoral researchers. Below, I am highlighting the students I was able to support along with their major achievements in research.

- **Post-doctoral researchers (2):**

- **Reinaldo Sanchez Arias:** spring 2013 to summer 2014 – supported by **ARL AH-PCRC grant**.

Reinaldo contributed to Dr. Argaez and my work on reduced-order modeling using wavelets. In fall 2014, he was offered a position as an assistant professor of Mathematics at Wentworth Institute of Technology, Boston MA, and is now an assistant professor of Mathematics at St. Thomas University in Florida.

- **Horacio Florez:** fall 2015 to present – supported by **ARL AHPCRC grant**.

Horacio joined my research team at UTEP but is located at ARL ALC in Adelphi (MD) where he serves as a liaison with our collaborators from ARL. He works on reduced-order modeling and uncertainty quantification. Notable contributions of Horacio are as follows:

- Florez H.A. and Argaez M., 2016, “Applications and Comparison of Model-Order Reduction Methods based on Wavelets and POD”, in the Proceedings of NAFIPS 2016.

- Argaez M., Ceberio M., Florez H.A. and Mendez O., 2016, “A model reduction for highly non-linear problems using wavelets and Gauss-Newton method”, in the Proceedings of NAFIPS 2016.

- Florez H.A. and Ceberio M., 2016, “A Novel Mesh Generation Algorithm for Field-Level Coupled Flow and Geomechanics Simulations”, ARMA 16-305, 50th US Rock Mechanics / Geomechanics Symposium held in Houston, TX.

- Florez, H. A. and Ceberio, M. “Domain Decomposition Methods in Geomechanics”. 8th International Workshop on Constraint Programming and Decision Making (CoProD’2015), El Paso, Texas, Nov. 2015.

- **Ph.D. students (4):**

- **Luis Gutierrez:** fall 2013 to fall 2015 – supported by **NSF CAREER grant**.

Luis was a long-term student in my research group, who started as an undergraduate when he was only taking the Introduction to Computer Science course. Due to medical issues, he had to drop out of the PhD program in the fall 2015. His contributions while a PhD student in my group are as follows:

Presentations:

- El Paso, Texas, UTEP Graduate Research Expo, November 7 2013: “A constraint-based model for generating t-wise test suites”.
- El Paso, Texas, 14th Joint UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science, November 2 2013, Interval-Valued Probabilities to Interval-Valued Possibilities: Case Studies of Interval Computations under Constraints.
- San Antonio, Texas, SACNAS, October 3 - 6 2013, Constraint based model to generate t-wise test suites.
- El Paso, Texas, COURI Symposium, April 20 2013, Generating minimal t-wise constrained test suites.
- El Paso, Texas, 16th UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science, November 3, 2014: Validated Solutions of ordinary differential equations and prediction of behavior (poster).
- SIAM Seminar on Bash Scripting, February 2014.
- El Paso, Texas, Bio-Informatics Symposium: “Interval-Valued Probabilities to Interval-Valued Possibilities: Case Studies of Interval Computation under Constraints”. Luis C. Gutierrez, Salem Benferhat, Martine Ceberio, Vladik Kreinovich, Rebekah Gruver, Marianna Pena, Matthew J. Rister, Abraham Saldana, John Vasquez, and Janelle Ybarra (poster). April 2014.
- El Paso, Texas, Bio-Informatics Symposium: INCaS a new constraint solving toolbox. Luis C. Gutierrez, John Vasquez, Martine Ceberio (poster). April 2014.

Articles in which he was a major author:

- Gutierrez, Luis, Salem Benferhat, Martine Ceberio, Vladik Kreinovich, Rebekah Gruver, Marianna Pena, Matthew J. Rister, Abraham Saldana, John Vasquez, and Janelle Ybarra. “Interval-Valued Probabilities to Interval-Valued Possibilities: Case Studies of Interval Computation under Constraints”, 14th Joint UTEP/NMSU Workshop on Mathematics, Computer Science, and Computational Sciences (2013).
- Gutierrez, Luis C., Carlos Nieto, Francisco Zapata, and Martine Ceberio. “Constraint-based model to Generate wise Test Suites”, 2013 SACNAS National Conference (2013).
- Gutierrez, Luis C., Francisco Zapata, and Martine Ceberio. “Generating Minimal t-wise Constrained Test Suites”, COURI Symposium Abstracts Spring 2013 (2013).

- **Leobardo Valera:** fall 2014 to present – **supported by ARL AHPCRC grant and NSF CAREER grant.**

Leobardo has worked with me on integrating and quantifying uncertainty in our work on reduced-order modeling. He is set to defend his PhD dissertation in fall 2017. Below are some of his contributions:

Presentations, including posters:

- El Paso, Texas, 16th UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science, Reduced-Order Modeling
- November 3, 2014: AHPCRC BootCamp, “Using Wavelet Transformations for Reduced-Order Modeling”, DoD, Santa Cruz, California.
- Leobardo Valera and Martine Ceberio. How to use Constraint Solving Techniques (ICST) to Predict Future Behaviors of Dynamic Problems. Army High Performance Computing Research Center (AHPCRC), Annual Technical Review Meeting Stanford University, Santa Cruz, CA USA. March 2016.
- Leobardo Valera and Martine Ceberio. Handling Uncertainty and Large Dimensions in Nonlinear Systems of Equations using Interval Constraint Solving Techniques (ICST).

Army High Performance Computing Research Center (AHPCRC), Annual Technical Review Meeting Stanford University, Santa Cruz, CA USA. March 2016.

□ Leobardo Valera, Martine Ceberio and Horacio Florez, Handling Uncertainty and Large Dimensions in Nonlinear Systems of Equations using Interval Constraint Solving Techniques. Army High Performance Computing Research Center, Research Management Boarding Meeting, Stanford, CA, January 2016.

□ Handling Uncertainty and Large Dimensions in Nonlinear Systems of Equations using Interval Constraint Solving Techniques Army High-Performance Computing Research Center, Research Management Boarding Meeting, Stanford, CA, January 2016.

□ Introduction to Pairwise Testing. Definition and Examples, 17th Joint UTEP/NMSU Workshop on Mathematics, Computer Science, and Computational Sciences The University of Texas, November 2015.

□ Validated Solutions of ordinary Differential Equations and Prediction of Behavior. 15th Joint UTEP/NMSU Workshop on Mathematics, Computer Science and Computational Sciences The University of Texas. November 2014.

□ Using Wavelet Transformations for Reduced-Order Modeling. Army High Performance Computing Research Center (AHPCRC), Annual Technical Review Meeting Stanford University, Santa Cruz, CA USA. August 2014.

□ Leobardo Valera and Martine Ceberio. “Interval Constraint Solving Techniques and Model-Order Reduction to Enhance the Solution of Dynamic Systems”. INFORMS Annual Meeting. Nashville 2016.

□ Leobardo Valera, Martine Ceberio. Interval Constraint Solving Techniques and Model-Order Reduction to Enhance the Solution of Dynamic Systems. 19th Joint NMSU/UTEP Workshop on Mathematics, Computer Science, and Computational Sciences. El Paso, TX, November 2016.

□ Leobardo Valera and Martine Ceberio. Large Numerical Simulations: Needs, Challenges, Current Solutions How can Interval Computations help? NAFIPS 2016.

□ Leobardo Valera, Martine Ceberio. Reduced Interval Newton Method, 18th Joint UTEP/NMSU Workshop on Mathematics, Computer Science and Computational Sciences, New Mexico State University, Las Cruces, New Mexico, March 2016.

□ Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction, Constraint Programming and Decision Making (COPROD 2015), The University of Texas El Paso, November 2015.

Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction, 18th Joint UTEP/NMSU Workshop on Mathematics, Computer Science, and Computational Sciences The University of Texas, November 2015.

□ Using Regularization to Improve the Rate of Convergence in a Model-Order Reduction (MOR) Problem. Presented at the 22nd International Symposium on Mathematical Programming. Pittsburg, Pennsylvania, ISMP’2015, July 2015.

□ Using Regularization to Improve the Rate of Convergence in a Model-Order Reduction (MOR) Problem. The 17th Joint NMSU/UTEP Workshop on Mathematics, Computer Science, and Computational Sciences. New Mexico State University, Las Cruces, New Mexico, April 11, 2015.

Model-Order Reduction Using Cubic Spline Curve-Fitting. UTEP Graduate Student Expo. The University of Texas at El Paso, November 2014.

□ Model-Order Reduction Using Cubic Spline Curve-Fitting. 15th Joint UTEP/NMSU Workshop on Mathematics, Computer Science, and Computational Sciences. The University of Texas at El Paso, November 2014.

Honors and Awards:

□ Graduate Award for Academic and Research Excellence in Computational Science. UTEP

□ Banner Bearer at UTEP's Winter 2015 Commencement (No academic, probably it should be deleted)

□ Outstanding Paper Award. Joint Annual Conference of the North American Fuzzy Information processing Society NAFIPS'2015 and 5th World Conference on Soft Computing. For the paper: Martine Ceberio, Leobardo Valera, Olga Kosheleva, and Rodrigo Romero Model reduction: why it is possible and how it can potentially help to control swarms of Unmanned Aerial Vehicles (UAVs), Joint Annual Conference of the North American Fuzzy Information processing Society NAFIPS'2015 and 5th World Conference on Soft Computing, Redmond, Washington, August 17-19, 2015.

□ Outstanding Paper Award. Joint Annual Conference of the North American Fuzzy Information processing Society NAFIPS'2015 and 5th World Conference on Soft Computing. For the paper: Francisco Zapata, Octavio Lerma, Leobardo Valera. How to speed up software migration and modernization, Joint Annual Conference of the North American Fuzzy Information processing Society NAFIPS'2015 and 5th World Conference on Soft Computing, Redmond, Washington, August 17-19, 2015.

17/ Scholarship to attend the ACW conference.

Leo is about to graduate, in fall 2017.

- **Angel Garcia Contreras:** spring 2015 to present – supported by **NSF CAREER grant & STEM Accelerator program.**

Angel previously worked with me on his Master's thesis (see below). As a PhD student, he is focused on optimization techniques to handle dynamic systems with uncertainty. Below are some of his main contributions:

Presentations:

□ Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction, Constraint Programming and Decision Making (COPROD 2015), The University of Texas El Paso, November 2015.

□ Global Optimization via Speculation. Constraint Programming and Decision Making (COPROD 2015), The University of Texas El Paso, November 2015.

□ El Paso, Texas, 18th Joint UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science, November 2015, Insights into using continuous constrained optimization methods to solve black box mixed integer problems.

□ Comparison of Strategies for Solving Global Optimization Problems Using Speculation and Interval Computations. NAFIPS 2016.

□ Global Optimization via Speculation. UTEP NMSU Workshop Spring 2016.

□ Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction, Constraint Programming and Decision Making (COPROD 2015), The University of Texas El Paso, November 2015.

□ El Paso, Texas, 18th Joint UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science, November 2015, Insights into using continuous constrained optimization methods to solve black box mixed integer problems.

Additional notable experience:

□ Taught a programming course at Stanford's Army High-Performance Computing Research Center Summer Institute in summer 2015 and summer 2016.

- **Omeiza Olumoye:** summer to fall 2015 – supported by **NSF CAREER grant**. Omeiza is not one of my PhD students. However, I am part of his PhD committee and in 2015, he joined my research team to contribute to our work on optimization and intervals.

Presentation:

□ Poster on Interval Newton Methods, 17th Joint UTEP/NMSU Workshop on Mathematics, Computer Science, and Computational Sciences The University of Texas, November 2015.

- **Master’s students (6):**

- **Joel Henderson:** fall 2011 to summer 2014 – supported by **AAAS grant**. Joel completed his thesis on the topic of Multi-Criteria Multi-Agents Decision Making using Argumentation Frameworks. During his work with me on this topic, he presented his work at the following international conference: Numerical Computations: Theory and Algorithms International Conference, June 2013, in Italy. He now works at ARL White Sands.

- **Angel Garcia Contreras:** fall 2011 to fall 2014 – supported by **NSF CAREER grant**.

Before to enroll in the Ph.D. program, Angel completed his Master’s thesis with me. His work was in optimization using speculations. During his Master’s work, he presented at the following article: Garcia Contreras, A. F., Wang, X., Ceberio M., Bixler R., Gutierrez L., “Interval Optimization to Predict Software Quality Assessment Decisions”, at INFORMS OS’2012. He also presented several times at the UTEP/NMSU workshop. In particular he presented at the 14th Joint UTEP/NMSU Workshop on mathematics Computer Science, and Computational Science (November 2013): “Insights into using continuous constrained optimization methods to solve black box mixed integer problems”. Along with Joel Henderson (Master’s student), he also presented at SACNAS, October 3-6, 2013. In summer 2013, he worked with Patty Hough at Sandia National Lab in Livermore on thei DAKOTA project. internship at SANDIA Livermore in summer 2013.

- **Hima Kondepati:** fall 2014 – supported by **NSF CAREER grant**.

Hima joined my lab in fall 2014 as a new student to our program and looking for a topic. She was interested in optimization and I trained her in fall 2014 on this topic and on research methods. By the end of fall 2014, she had decided that she wanted to switch programs to follow more IT-oriented track, without research.

- **Troy McGarity:** summer 2015 to spring 2016, **Rebekah Gruver:** fall 2015, and **Salah Atiyeh:** fall 2015 – supported by **NSF CAREER grant**.

These three students in the Master’s of Software Engineering at UTEP contributed to my work on optimization and constraint solving by building a website (NumConSol) that allows to use the solver developed by my research students, hence allowing for broader dissemination. They also packaged our solver as standalone executables, tailored for Windows and Mac. They all graduated and are now working, respectively at HP, GoDaddy, and Exxon Mobil.

- **Under-graduate students (4):** The following undergraduate students were supported by funds external to UTEP.
 - **Cristian Ayub:** summer 2017 – supported by CAHSI (Computing Alliance for Hispanic-Serving Institutions).
 - **John Vasquez:** fall 2013 and spring 2014 – supported by NSF CAREER grant.
 - **Jesus Padilla:** summer 2017 – supported by CAHSI (Computing Alliance for Hispanic-Serving Institutions).
 - **Jason Holt:** fall 2014 – supported by NSF CAREER grant.

4.2 Students involved in research but not supported from extramural funding

In addition to the above-mentioned students, who were supported by extramural funding, I worked with the following students, who were either funded by jobs they already had or by scholarships, which they obtained to fund their work with me.

- **Ph.D. students (4):**
 1. **Paula Gonzalez Parra:** defended her Ph.D. in Computational Sciences in fall 2012. She worked on estimating best decisions to slow down and stop epidemics. She is now a professor of Mathematics at the University of Cali, Colombia.
 2. **Xiaojing Wang:** fall 2009 to spring 2013. Xiaojing worked on Multi-Criteria Decision Making using fuzzy measures. She supported herself with her job on campus, which she still holds, as a research associate at our Center for Institutional Evaluation, Research, and Planning (CIERP). She graduated in spring 2013 and obtained a Ph.D. in Computer Science.
 3. **Imran Abdullah:** joined my research lab in summer 2017. He is a Computational Sciences Ph.D. student and is currently supported by this program on campus. He is starting to work on predictions for large dynamical systems.
 4. **Francisco Zapata:** was a Ph.D. student of Vladik Kreinovich who joined my lab during a year prior to his graduation. He contributed to our work on pair-wise testing.
- **Under-graduate students (22):**
 1. **Luis Gutierrez:** spring 2010 to summer 2013. Luis joined my research team in spring 2010 as he was starting his B.S. degree studies at UTEP. As an undergraduate student, he worked on a variety of problems during his almost 4 years in my team as an undergrad. He attended a summer school on constraint programming and logic at the University of Perugia, Italy, in summer 2013. He presented at many local and regional symposium, as well as at a couple on international venues. He was supported by COURI starting in fall 2011 and until the end of his undergraduate studies.
 2. **Enrique Martinez:** spring 2014 to fall 2014. As a musician, Enrique worked on constraints and music. He left my group when he graduated.
 3. **Luis Alcantar:** fall 2014 to fall 2015. Luis was supported by COURI in summer 2015. He left my group shortly in spring 2016.

4. **Cristian Ayub:** since spring 2015. In addition to being supported by CAHSI (see above), he was supported every semester by either a scholarship of UTEP's Campus Office for Undergraduate Research Initiative (COURI) or by UTEP's Louis Stokes Alliance for Minority Participation (LSAMP – summer 2016). Until summer 2017, he worked on combinatorial testing using constraint programming. While working on this topic, he led a team of undergraduate research students in a NSF-funded COURI program called UTEP Lens of the Market: during this 6-month-long program, he and his peers worked on the marketability of their work on combinatorial testing and its applicability to real-world industry problems, such as transistor design. Since summer 2017, he has been studying quantum mechanics to identify ways to solve them using our team's tools for dynamic systems. Over his years in my team, he has presented several times (at least twice a year: at the COURI annual symposium and at the UTEP/NMSU workshop).
5. **Gabriel Max Felix:** summer 2015 to summer 2017. During his time in my team, Max was a very active student who worked on combinatorial testing. he was part of the team led by Cristian Ayub working on the Lens-of-the-Market project. He stopped attending regularly because of the constraints of his job on campus.
6. **Elsa Gonzalez:** fall 2015 to summer 2016. She was involved in the early work of Cristian Ayub on combinatorial testing.
7. **Raul Mena:** fall 2015 to summer 2016. He was involved in the early work of Cristian Ayub on combinatorial testing. Raul changed majors to Business and left our group in fall 2017.
8. **Miguel Zamudio:** since spring 2016. Miguel was part of the team led by Cristian Ayub working on the Lens-of-the-Market project. He is now moving to doing research on Machine Learning with Olac Fuentes, but is still participating in my lab.
9. **Phillip Hassoun:** since spring 2016. Phillip was selected to participate in Stanford's AHPCRC Summer Institute for undergraduates in 2016. He has worked on a variety of problems since joining my research team. Lately, he has been instrumental in porting our algorithms to a mobile device to demonstrate their ability to run on limited computational resources.
10. **Enrique Salcido:** since fall 2016. Enrique joined my research group as a member of the Lens-of-the-Market participant, in the team led by Cristian Ayub. He is a Math student and needed a team to participate in this program. After the end of the program, he asked to remain a member of my research group and has contributed to our work on optimization.
11. **Joseph Gutierrez:** since fall 2016. Joseph was originally a Mechanical Engineering student but he later (in spring 2017) changed his major to computer science. He worked in my team on robust optimization and was supported by COURI in summer 2017.
12. **Daniel Villa:** since spring 2017. Daniel was selected to participate in Stanford's AHPCRC Summer Institute for undergraduates in 2017. item **Jorge Quinones:** since fall 2017. Jorge is currently studying our work on dynamical systems.
13. **Jesus Padilla:** since spring 2017. Jesus has worked on dynamic systems. In summer 2017, he worked on time uncertainty and dynamic systems' behavior prediction. He is now implementing an interval constraint solver from scratch to be used on a mobile device.
14. **Sairy Cohen:** spring 2017. Sairy joined my research group in spring 2017. She was very active in her work on visualization of our numerical results and implementation of

optimization techniques. She left in summer 2017 to participate in a summer internship and has been busy since then.

15. **Alexa Cortes:** spring 2017. Alexa is a mechanical engineering student. She joined my group in spring 2017 but is no longer a member as she found it hard to combine with the constraints of her academic schedule.
16. **Stephanie Figueroa:** spring 2017. Stephanie joined my group in spring 2017. She is no longer a member as it was hard for her to combine taking classes, having a job on campus, and attending to research as well.
17. **Samuel Tinevra:** spring 2017. Samuel joined my group in spring 2017. He left in fall 2017 as he got a job off campus and finds it hard to combine his academic and professional constraints.
18. **Ricardo Alvarez Lopez:** since fall 2017. Ricardo is currently studying our work on dynamical systems.
19. **Jorge Quinonez:** since fall 2017. Jorge is currently studying our work on dynamical systems.
20. **Noemi Hernandez:** since fall 2017. Noemi actually is a former NEXUS high-school student intern in my lab. She spent summer 2017 in my lab as a high-school student and decided to join my team in the fall when she started her studies at UTEP. Noemi is currently working very actively with Ricardo and Jorge on our team's efforts on solving dynamic systems.

In addition to my "own research students", I also mentored students for whom I served as a committee member. The list of such students for the period starting in 2012 is as follows:

- **Chanel Perez**, fall 2014, in Geology at UTEP, work directed by Aaron Velasco;
- **Omeiza Olumoye**, since 2015 (expected graduation date: fall 2018), in Electrical and Computer Engineering at UTEP, directed by Thompson Sarkodie-Gyan;
- **Anastasia Volkova**, since fall 2016, graduated in fall 2017, in Computer Science at the University of Pierre and Marie Curie, France, directed by Christoph Lauter, Thibault Hilaire, and Jean-Claude Bajard;
- **Leticia Miranda Mojica**, since spring 2017, in Leadership Engineering at UTEP, directed by Meagan Kendall;
- **Nancy Avila**, since fall 2017, in Electrical and Computer Engineering at UTEP, directed by Homer Nazeran;
- **Esthela Gallardo**, since spring 2017, defended her proposal in summer 2017 (expected graduation date: Fall 2018), in Computer Science at UTEP, directed by Patricia Teller;
- **Paden Portillo** and **Oscar Chavez**, graduated in fall 2012, in Software Engineering (Master's).

I have also mentored visiting master's students from France:

- **Quentin Brefort** (spring and summer 2015) from ENSTA, France, directed by Luc Jaulin; and

- **Anthony Welte** (summer 2016) from ENSTA, France, directed by Luc Jaulin.

Finally, each summer, I have mentored high-school students who spent the summer as interns in my lab, not only learning how to code but also learning about our research and participating in our research via testing. In total, I have mentored about 20 high-school students in summer.

So in total, since 2012, I have worked closely with:

- **2 post-doctoral** researchers;
- **13 Ph.D. students:** 6 whom I directly advised, 2 of whom graduated and another one is about to (fall 2017); 1 whom I advised while he had joined my research team but whose actual advisor was Vladik Kreinovich; and another 6 Ph.D. students for whom I served as a committee member;
- **10 Master’s students:** 6 whom I directly advised, 5 of whom graduated; and another 2 whom I advised during their visit at UTEP (international visiting students) and 2 for whom I served as a committee member;
- **22 undergraduate students;** and
- about **20 high-school students.**

4.3 Articles co-authored with students

Many of my articles are co-authored with students. Below, I am listing the articles I co-authored with students of mine or with students that I was mentoring closely. The numbering is the same as appears on my CV.

- Ch22 Stefano Bistarelli, Martine Ceberio, Joel Henderson, Francisco Santini, Luciana Garbayo, “Abstract Argumentation Frameworks to Promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making: Theory and Applications**, Springer Verlag, Berlin, Heidelberg, pp. 7–20, 2017.
- Ch12 Aline Jaimes, Craig Tweedie, Tanja Magoc, Vladik Kreinovich, and Martine Ceberio, “Selecting the Best Location for a Meteorological Tower: A Case Study of Multi-Objective Constraint Optimization”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 61-66.
- Ch8 Paden Portillo, Martine Ceberio, and Vladik Kreinovich, “Towards an Efficient Bisection of Ellipsoids”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 137-142.
- Ch7 Uram Anibal Sosa Aguirre, Martine Ceberio, and Vladik Kreinovich, “Why Curvature in L-Curve: Combining Soft Constraints”, In: Martine Ceberio and Vladik Kreinovich (eds.), **Constraint Programming and Decision Making**, Springer Verlag, Berlin, Heidelberg, 2014, pp. 175-180.

- Ch6 Christian Servin, Martine Ceberio, Aline Jaimes, Craig Tweedie, and Vladik Kreinovich, “How to Describe and Propagate Uncertainty When Processing Time Series: Metrological and Computational Challenges, with Potential Applications to Environmental Studies”, In: Shyi-Ming Chen and and Witold Pedrycz (eds.), **Time Series Analysis, Modeling and Applications: A Computational Intelligence Perspective**, Springer Verlag, 2013, pp. 279-299.
- J25 Leobardo Valera and Martine Ceberio, “Model-Order Reduction Using Interval Constraint Solving Techniques”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 84–103.
- J24 Anthony Welte, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Avoiding Fake Boundaries in Set Interval Computing”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 137-148.
- J23 Anthony Welte, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Computability of the Avoidance Set and of the Set-Valued Identification Problem”, **Journal of Uncertain Systems**, 2017, Vol. 11, No. 2, pp. 129-136.
- J22 Vladik Kreinovich, Martine Ceberio, and Quentin Brefort, “In category of sets and relations, it is possible to describe functions in purely category terms”, **Eurasian Mathematical Journal**, 2015, Vol. 6, No. 2, pp. 90-94.
- J21 Quentin Brefort, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Towards Fast and Reliable Localization of an Underwater Object: An Interval Approach”, **Journal of Uncertain Systems**, 2015, Vol. 9, No. 2, pp. 95-102.
- J18 Xiaojing Wang, Martine Ceberio, Shamsnaz Virani, Angel Garcia, and Jeremy Cummins. “A Hybrid Algorithm to Extract Fuzzy Measures for Software Quality Assessment”. **Journal of Uncertain Systems**, 2013.
- J17 Vladik Kreinovich, Christelle Jacob, Didier Dubois, Janette Cardoso, Martine Ceberio (2012). “Failure Analysis of a Complex System Based on Partial Information about Subsystems, with Potential Applications to Aircraft Maintenance”. **Journal of Applied and Computational Mathematics**, 11(2), 165-179.
- J16 Aline Jaimes, Craig Tweedie, Vladik Kreinovich, and Martine Ceberio, “Scale-Invariant Approach to Multi-Criterion Optimization under Uncertainty, with Applications to Optimal Sensor Placement, in Particular, to Sensor Placement in Environmental Research”, **International Journal of Reliability and Safety**, 2012, Vol. 6, No. 1-3, pp. 188-203.
- C53 Leobardo Valera, Angel Garcia, Afshin Gholamy, and Martine Ceberio, “Towards Predictions of Large Dynamic Systems’ Behavior using Reduced-Order Modeling and Interval Computations”, to be published in the proceedings of the **IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC 2017)**.
- C52 Leobardo Valera, Angel Garcia, and Martine Ceberio, “On-the-Fly Parameter Identification for Dynamic Systems Control, Using Interval Computations and Reduced-Order Modeling”. To be published in the proceedings of the **North American Fuzzy Information Processing Society Annual Conference 2017 (NAFIPS 2017)**.

- C51 Anthony Welte, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “Robust Data Processing in the Presence of Uncertainty and Outliers: Case of Localization Problems”, In the Proceedings of the **IEEE Series of Symposia in Computational Intelligence SSCI’2016**, Athens, Greece, December 6-9, 2016.
- C50 Leobardo Valera, Martine Ceberio, “Using Interval Constraint Solving Techniques to Better Understand and Predict Future Behaviors of Dynamic Problems”. In the proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2016**.
- C49 Angel F. Garcia Contreras, Martine ceberio, “Comparison of Strategies for Solving Global Optimization Problems Using Speculation and Interval Computations”. In the proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2016**.
- C48 Horacio Florez and Martine Ceberio (2016). “A Novel Mesh Generation Algorithm for Field-Level Coupled Flow and Geomechanics Simulations”. In the Proceedings of **ARMA 16-305, 50th US Rock Mechanics / Geomechanics** Symposium held in Houston, TX.
- C47 Stefano Bistarelli, Martine Ceberio, Joel Henderson, Franceco Santini, “Using Argumentation Frameworks to promote Fairness and Rationality in Multi-Experts Multi-Criteria Decision Making”, in the Proceedings of the **2015 Italian Conference in Theoretical Computer Science**, 2015.
- C46 Esquinca, A., Villa, E. Y., Hampton, E. M., Ceberio, M. C., Wandermurem, L. S., (2015). “Latinas’ resilience and persistence in computer science and engineering: Preliminary findings of a qualitative study examining identity and agency.” Proceedings of the 2015 **Frontiers in Education**.
- C43 Quentin Brefort, Luc Jaulin, Martine Ceberio, and Vladik Kreinovich, “If We Take Into Account that Constraints Are Soft, Then Processing Constraints Becomes Algorithmically Solvable”, Proceedings of the **IEEE Symposium on Computational Intelligence for Engineering Solutions CIES’2014**, Orlando, Florida, December 9-12, 2014, pp. 1-10.
- C42 Martine Ceberio, Leobardo Valera, Olga Kosheleva, and Rodrigo Romero. “Model Reduction: Why It Is Possible and How It Can Potentially Help to Control Swarms of Unmanned Aerial Vehicles”. In the Proceedings of the **North American Fuzzy Information Processing Society Annual Conference, NAFIPS’2015**.
- C41 Brefort, Q., Jaulin, L., Ceberio, M. C., Kreinovich, V. Y., (2014). “If We Take Into Account that Constraints Are Soft, Then Processing Constraints Becomes Algorithmically Solvable”. (pp. 1-10). Proceedings of the **IEEE Symposium on Computational Intelligence for Engineering Solutions**, Orlando, Florida SSCI’2014, December 9-12, 2014.
- C39 Paula A. Gonzalez-Parra, Martine Ceberio, Sunmi Lee, Carlos Castillo-Chavez. “Optimal Control for a Discrete Time Influenza Model”. In the proceedings of the **Second Colombian Congress of Computational Biology and Bioinformatics (CCBCOL 2013)**.
- C38 X. Wang, M. Ceberio, A. Garcia. “Towards Fuzzy Method for Estimating Prediction Accuracy for Discrete Inputs, with Application to Predicting At-Risk Students”. Proceedings of the **Annual Conference of North American Fuzzy Information Processing Society (NAFIPS’2013)**, Alberta, Canada, June 2013.

- C37 X. Wang, M. Ceberio, S. Virani, C. Del Hoyo, and L. Gutierrez. “Fuzzy measure extraction for software quality assessment as a multi-criteria decision-making problem”. Proceedings of the **2012 International Conference on Software Engineering Research and Practice**, Las Vegas, NV, July 2012.
- C36 X. Wang, A. F. Garcia Contreras, M. Ceberio, C. Del Hoyo, L. C. Gutierrez, and S. Virani. “Interval-based algorithms to extract fuzzy measures for software quality assessment”. Proceedings of the **Annual Conference of North American Fuzzy Information Processing Society (NAFIPS’2012)**, Berkeley, CA, August 2012.
- C35 Xiaojing Wang, Angel Garcia Contreras, Martine Ceberio, Christian Del Hoyo, Luis Gutierrez, “A Speculative Algorithm to Extract Fuzzy Measures from Sample Data”, Proceedings of the **2012 annual international conference of Fuzz-IEEE (FuzzIEEE’12)**.
- W10 Leobardo Valera, Martine Ceberio, “Model-Order Reduction Using Interval Constraint Solving Techniques.” Proceedings of the **7th International Workshop on Reliable Engineering Computing (REC2016)**. June 15-17, 2016, Ruhr University Bochum, Germany.
- W9 Luis Gutierrez, Martine Ceberio, Vladik Kreinovich, Rebekah L. Gruver, Marianna Pena, Matthew J. Rister, Abraham Saldana, John Vasquez, Janelle Ybarra, and Salem Benferhat, “From Interval-Valued Probabilities to Interval-Valued Possibilities: Case Studies of Interval Computation under Constraints”, Proceedings of the **6th International Workshop on Reliable Engineering Computing REC’2014**, Chicago, Illinois, May 25-28, 2014.
- A39 Angel F. Garcia Contreras, Martine Ceberio, and Vladik Kreinovich, “Plans Are Worthless but Planning Is Everything: A Theoretical Explanation of Eisenhower’s Observation”, in the Proceedings of the **10th International Workshop on Constraint Programming and Decision Making CoProd’2017**, El Paso, Texas, November 3, 2017, to appear.
- A38 Angel F. Garcia Contreras, Martine Ceberio, and Vladik Kreinovich, “Why Convex Optimization Is Ubiquitous and Why Pessimism Is Widely Spread”, Proceedings of the **10th International Workshop on Constraint Programming and Decision Making CoProd’2017**, El Paso, Texas, November 3, 2017, to appear.
- A36 Leobardo Valera, Martine Ceberio, “Introduction to Pairwise Testing. Definition and Examples”. **47th Southeastern International Conference on Combinatorics, Graph Theory Computing** (2016).
- A35 Leobardo Valera, Martine Ceberio, “Interval Constraint Solving Techniques and Model-Order Reduction to Enhance the Solution of Dynamic Systems”. **2016 INFORMS Annual Meeting**.
- A28 Leobardo Valera, Martine Ceberio, “Using Interval Constraint Solving Techniques in Dynamic Systems Behavior Prediction”. **8th International Workshop on Constraint Programming and Decision Making**, El Paso, Nov. 2015.
- A27 Martine Ceberio, Miguel Argaez, Luis Gutierrez, Leobardo Valera. “Using Interval Constraint Solving Techniques to Solve Dynamical Systems”. **CORS/INFORMS 2015 Meeting**, Montreal, June 2015.
- A26 Miguel Argaez, Martine Ceberio, Leobardo Valera. “A Model Order Reduction for Solving Large-Scale Square Nonlinear Systems of Equations”. **CORS/INFORMS 2015 Meeting**, Montreal, June 2015.

- A25 Leobardo Valera, Martine Ceberio. “Using Regularization to Improve the Rate of Convergence in a Model-Order Reduction (MOR) Problem”. **22th International Symposium on Mathematical Programming**. Pittsburg, Pennsylvania, ISMP’2015, July 2015.
- A17 Paula Gonzalez-Parra, Martine Ceberio, and Carlos Castillo Chavez. “Interior-Point Methods for a Multi-Group Discrete-Time Influenza Model”. Presented at the **Mathematical Congress of the Americas 2013**, August 2013.
- A16 Joel Henderson, Stefano Bistarelli, Martine Ceberio (2013). “Multi-Experts Multi-Criteria Decision Making”, In the Proceedings of **Numerical Computations: Theory and Algorithms International Conference**, Italy, June 2013.

4.4 Presentations by students involved in research in national and international conferences

Of the articles listed in Subsection 4.3, the following were presented at conferences by one of the student authors: C53, C50, C49, C48, C47, C42, C39, C38, C37, C36, C35, A39, A38, A36, A35, A28, A25.

In addition to the presentation of the articles listed above, I catch every opportunity to put my students in the situation of presenting their work. For instance, I have my students present their work as often as practical at the regional UTEP-NMSU workshop (held twice a year either at UTEP or at NMSU – New Mexico State University). I also expose them to the national and international research by having them write reviews of articles and by involving them in the logistics of the conferences I organize: for instance, 4 of my students were major helpers at NAFIPS’2016 and all students in my lab usually help every other year when the workshop CoProD is held at UTEP.