Project title / Job position title:

PhD Fellowship in Estimation of Distribution Algorithms for Combinatorial Optimization Problems with Constraints

Research Project / Research Group Description.

Combinatorial optimization problems (COPs) are optimization problems characterized for having a finite search space. Classical examples are the travelling salesman problem, the quadratic assignment problem or the knapsack problem. All these problems have in common that they are NP-hard: there is no known polynomial algorithm able to solve all the instances. Therefore the scientific community has developed algorithms able to find good solutions in bounded computational time, they are called metaheuristics algorithms.

Estimation of Distribution Algorithms (EDAs) are a set of metaheuristics algorithms that belong to the Evolutionary Computation field. Contrary to Genetic Algorithms that use genetic operators such as crossover and mutation to generate new individuals, in EDAs a probability distribution is learnt from the selected individuals, which is later sampled to generate new promising individuals. EDAs have been successfully used in the solution of different real problems such as protein folding, flowshop scheduling problem, etc. In spite of that, there are still optimization problems where EDAs have not found outstanding results, one of these areas are COPs with constraints. This is due to the use of inappropriate probability models. Almost of application of EDAs to COPs with constraints learnt probability distribution in unbounded spaces and then modify the individuals at sampling time. In this way the learnt distribution does not account for the information in the selected individuals. In this PhD project we pursue the use of probability distributions for constraint spaces in the area of EDAs. Particularly we plan to use exponential distributions based on distances that can consider bounded spaces. The obtained algorithms will be applied in the solution of academic problems such as graph partitioning or number partitioning and finally to a real problem from a company. The project will be co-supervised with a researcher of the University of the Basque Country UPV/EHU.

Research Group: Machine Learning

The machine learning group at BCAM is composed by 3 PhD students, 4 Post-doc researchers and one research line leader. The researchers have a long story in the area of machine learning where they have published more than 100 journal ISI papers in the best journals in the field such as: Machine Learning, IEEE Trans. on Pattern Analysis and Machine Intelligence, Pattern Recognition, IEEE Trans. on Neural Networks and Learning Systems, etc. They have also carried out many research works in collaboration with companies in the application of machine learning methods to problems in medicine, weather, energy, bioinformatics, etc.
Job Position description.

The PhD student will meet regularly (every week) with the PhD supervisors. The work to be developed implies, reading, designing new algorithm, programming the algorithms and evaluating them in new problems. In addition to that, it is expected she/he to write scientific papers as well as to participate in conferences and workshops of the area. Finally, in order to complement her/his development a stay in an international prestigious research center will be carried out for a period of at least three months.

Group Leader:

- Full Name: Jose A. Lozano
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- Research group website: https://scholar.google.es/citations?user=lhzoWpwAAAAJ&hl=en&oi=ao
INPhINIT Offer:

INPhINIT targets the most motivated PhD candidates by addressing the research areas in which Spain excels: **Bio and Health Sciences, Technology, Physics, Engineering and Mathematics.** INPhINIT recruits per call **57 Early-Stage Researchers of any nationality**, who enjoy a **3-year employment contract at the Research Centre of their choice** among those selected and awarded by the Spanish Ministry of Economy and Competitiveness ("Severo Ochoa" centres of excellence and "Maria de Maeztu" units of excellence) and the Spanish Ministry of Health ("Carlos III centres of excellence"). In addition, researchers establish a **personal career development plan** including transnational, intersectoral and interdisciplinary mobility opportunities, and attend a full range of **complementary training courses and workshops.**  

"la Caixa" Foundation will **select international candidates.** Subsequently, the selected candidates, will propose the Research Centre and the predoctoral position in which he/she would like to do the research project. If there is agreement between the Centre, the supervisor (predoctoral researcher who presented the position) and the candidate, the fellowship will be awarded to the candidate.

Fellowship provisions:

- **3-years contract**
- **Funding per fellow:** 115.092 euros
  - **104.400 euros (34.800 euros per year)** including salary, employee social security contribution, income taxes and all compulsory employers’ contributions.
  - **10.692 euros (3.564 euros per year)** for research costs such as conferences and workshops attendance, short-stays, consumables and intellectual property costs, among others.
- **PhD Award of 7.500 euros** will be granted to researchers that submit their thesis within 6 months after the end of the fellowship.
- Complementary training programme:
  - Technology Transfer and Entrepreneurship workshops by Oxentia.
  - Professional and Career Development sessions by Vitae.
  - High – quality academic and industrial secondments.
  - Participation in outreach and social events.
How to Apply

1. Click in [https://hosts.lacaixafellowships.org/finder](https://hosts.lacaixafellowships.org/finder), click in RESEARCH CENTRE and choose “Basque Center for Applied Mathematics - BCAM”

2. Click in “SEARCH” and the displayable will list the positions offered
3. Click in the selected PhD Offer and click in “START THE APPLICATION”

4. The system will open a new window with the application website https://www.lacaixafellowships.org/index.aspx. Click in “Please register” for new applicants.
5. After the registration, the system will send to you the confirmation email and the link to access into the system. Now you are in the position to access into the application system. Please choose **INPhINIT: Doctorate in Spanish Research Centre of Excellence**

![Application System Screenshot](image)

6. Now you are in the position to fill the application form, upload the required documents and choose the project thesis. To choose the project thesis, click in "Studies to be Pursued", choose the centre and the position

![Application Form Screenshot](image)
Eligibility requirements

- At the publication date of the final list of selected candidates (29 May 2018), candidates must be in the first four years (full-time equivalent research experience) of their research careers and not yet have been awarded a doctoral degree.
- At the time of recruitment, candidates must comply with one of the following options:
  - To have completed the studies that lead to an official Spanish (or from another country of the European Higher Education Area) university degree awarding 300 ECTS credits, of which at least 60 ECTS credits must correspond to master level.
  - To have completed a degree in a non-Spanish university not adapted to the European Higher Education Area that gives access to doctoral studies. The verification of an equivalent level of studies to the ones mentioned above will be made by the university when the admission procedure starts.
- Mobility Rule: Candidates must not have resided or carried out their main activity (work, studies, etc.) in Spain for more than 12 months in the 3 years immediately prior to the publication date of the final list of selected candidates (29 May 2018). Short stays such as holidays will not be taken into account when calculating the mobility requirement.
- Demonstrable level of English (B2 or higher).

Evaluation and selection process

INPhINIT aims to recruit excellent Early-Stage Researchers with very solid theoretical backgrounds, with curiosity and ambition; with incipient skills to express themselves clearly and defend their ideas with creativity, independence and originality. Researchers may be focused on the academic side or be more industry-oriented. The evaluation criteria and scores defined to achieve this goal are:

PHASE 1 - REMOTE EVALUATION:
- Academic record and Curriculum Vitae (weight 50%): academic and/or professional curriculum in relation to the stage of the candidate's career; Motivation and statement of purpose (weight 30%): the originality, innovation and potential impact of the proposed project, and the choice of the Research Centre will be assessed;
- Letters of reference (weight 20%): reference letters supporting the candidacy will be assessed taking into account the specificity of the content with regard to the candidate's project as well as the profile of the people who sign them.

PHASE 2 - FACE-TO-FACE SELECTION:
- Candidate's potential (weight 40%): in order to have a general perception of the candidate’s potential, experts will pay attention to “soft” skills, ability to present easily a complex reasoning, team working; and capabilities such as
- Motivation and statement of purpose (weight 30%): experts will assess the impact of the project for the candidate and the society; project innovation, originality and feasibility; and candidate’s capabilities with regard to the scope of the project. Academic background and theoretical fundamentals (weight 30%): experts will assess the consistency of the candidate’s academic background and CV in the area chosen to carry out the PhD.

According to the number of applications received, there may be a pre-selection phase based on the final academic marks obtained for the Bachelor studies.