# SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

**The STSM applicant submits this report for approval to the STSM coordinator**

**Action number: CA16228**
**STSM title: Computing explanations for Game Theory approaches to MOO problems**
**STSM start and end date: 25/06/2018 to 29/06/2018**
**Grantee name: Luis Quesada**

## PURPOSE OF THE STSM/

Multi-Objective Optimization (MOO) is concerned with optimization problems involving more than one objective function to be optimized simultaneously. For a nontrivial MOO problem, no single solution exists that simultaneously optimizes each objective function. In such a case, the objective functions are said to be conflicting, and there exists a (possibly infinite) set of Pareto optimal solutions in the decision space. This set is known as the Pareto optimal frontier.
Many approaches based on Game Theory have been proposed for tackling MOO problems. In these approaches, each player is usually associated with one of the conflicting objectives. Each player follows a strategy whose aim is to maximise the satisfaction of the corresponding objective. This way, there is a link between the stability of the game and the Pareto optimal frontier of the MOO problem.
While most approaches that use Game Theory techniques have focussed on the quality of the solution obtained, not much effort has been put in explaining the solution computed. Our effort in this STSM was towards closing this gap.

## DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

**Day 01 (June 25th)**
Revision of the objectives of the STSM and discussion on the literature that should be covered during the visit.

**Day 02 (June 26th)**
Discussion on the work on "Extending the Notion of Preferred Explanations for Quantified Constraint Satisfaction Problems" and its relevance to multi objective optimisation

**Day 03 (June 27th)**
Discussion on approaches for computing inconsistencies among constraints on the parameters of an MCDA model and it relevance to Dynamic inconsistencies in the context of game theory.

**Day 04 (June 28th)**
Discussion of the paper "Nash Equilibria in Concurrent Games with Lexicographic Preferences" by Gutierrez et al and its relevance to multi-objective optimisation.

**Day 05 (June 29th)**
Discussion of the paper "Classes of multiojectives games possessing Pareto equilibria" by the Levaggi et al with the purpose of identifying ways of extending the lexicographic approach for handling preferences in concurrent games with Nash equilibria.

**DESCRIPTION OF THE MAIN RESULTS OBTAINED**

After discussing relevant literature, we defined the scope of our collaboration more precisely. The plan is to extend Gutierrez et al's lexicographic approach for handling preferences in concurrent games with Nash equilibria by adding a multi-criteria setting where the pay function associated with every agent is made dependent on a set of criteria.

The addition of multiple criteria per player make it complex [Q1] to elicit why is it not possible to satisfy one of the conflicting goals to a greater extent or [Q2] to find out how one can relax in a minimal way a subset of objectives to allow the other objectives to be satisfied to a greater extent, which gives room to the application of techniques to compute explanations.

**FUTURE COLLABORATIONS (if applicable)**

While progress was made during the visit, there is still a long way to go to turn this effort into a concrete result (e.g., a publication). We plan to continue this collaboration, and get our colleague in Oxford involved in this too. Our first step is to assess the implications on the complexity of the decision problem of deciding whether a given profile leads to a Nash equilibrium by extending the reduction to path finding considering the multicriteria case.