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A Review on Non-Linear Programming and Generalized Invexity

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Received: 11 December 2013 Accepted: 4 January 2014 Published: 15 January 2014

Abstract

Over past few years, the concept of NLPP and their related results based on generalized invexity has become one of the prominent and important areas of classical optimization. This paper presents a brief review on such problems and their respective results in game theory, continuous time programming, multivariable optimization, composite programming etc.

Index terms — non-linear programming, invexity, optimality, duality

1 Introduction

ptimization theory plays an important role in Science and Engineering. The concept of convexity and their generalizations have great significance in nonlinear programming. We deal with constrained optimization problems in which the essential constraints are defined by some parametric variational inequalities or parametric auxiliary systems. It has many important applications in many fields, such as engineering design, economic equilibria, transportation science, multilevel game, and mathematical programming itself. However, this kind of problems is generally difficult to deal with because its constraints fail to satisfy the standard Mangasarian, Mangasarian -Fromovitz constraint qualification (MFCQ) at any feasible point [20].

Since last two decades a lot of research has been done to study the first-order optimality conditions for NLPP ,such as Clarke (C), Mordukhovich (M), Strong(S), Bouligrand (B) stationarity conditions; see, e.g., [1][2][3][4][5][19][20]. And also various algorithms were studied for solving those NLP problems and have been proposed for enumerating various results by using different approaches, such as sequential quadratic programming approach, penalty function approach, relaxation approach, active set identification approach, composite multi-objective programming, continuous time programming, etc.; see, e.g., [9][10][11].

In this paper, we unify various results on first order and second-order optimality conditions for NLP by using generalized invexity and their classifications. In general, first order optimality conditions tell us how the first derivatives of the functions involved are related to each other at locally optimal solutions. However, for some feasible directions in the tangent cone such as the so-called critical directions, we cannot determine from the first derivative information alone whether the objective function increases or decreases in this direction. Therefore second-order optimality conditions examine the second derivative terms in the Taylor series expansions of the functions involved to see whether this extra information resolves the issue of increase or decrease in the objective function as well as a set of lagrange multipliers. Also, the second-order optimality conditions are concerned with the curvature of the socalled NLPP Lagrangian function in the critical directions. Moreover, second-order optimality conditions play important roles in convergence analysis for numerical algorithms, saddle points for game theoretic problems and the stability analysis for MPEC; see, e.g., [12][13][14][15][16][17][18].In recent times, many research observed and compared with the first-order optimality conditions, there is very little research done with the second-order optimality conditions for MPEC. Recently, Scheel and Scholtes [1] showed that S-stationary points satisfying the refined second-order sufficient optimality conditions are strictly and locally optimal and they derived a strong second-order necessary optimality condition under the MPEC strict MFCQ. Also, Izmailov [19] investigated second-order optimality conditions under the MPEC linear by using dependence constraint qualification (MPEC-LICQ).Further, Lei Guo and others studied second order conditions for equilibrium of saddle points. These results are further studied to scalar valued games to multiple objectives by using invexity coeffiecients.

In this paper, we unify various first and second order optimality conditions for MPEC in a similar manner. Note that, recently, several new constraint qualifications weaker than the LICQ and MFCQ have been introduced for standard nonlinear programming problems. We use these new constraint qualifications to derive some second-order optimality conditions for standard nonlinear programming problems and apply the obtained results to MPEC. We further study some MPEC variants of these new constraint qualifications, which are weaker than the MPEC-LICQ, and derive some second-order optimality conditions for MPEC in terms of S-and C-multipliers under these new MPEC Year 2014(D D D D D D D D)

a constraint qualifications. Moreover, we identify some relationships between various second-order optimality conditions for MPEC in terms of the classical NLPP multipliers and multipliers respectively. It is interesting to see that not all second-order optimality conditions in terms of the classical NLPP multipliers and S-multipliers are equivalent.

In addition, unlike the first-order conditions, the second-order conditions in terms of singular multipliers provide a solution but the significance may be different. This significance is observed in equilibrium of saddle points for multi objective NLPP and composite multi objective NLPP problems.

To unify these generalizations, we can use generalized invexity and their related properties. These results further generate different optimality and duality results by using the various conditions of univexity with the help of Mangasarian Constraint Qualification. This new set up has numerous applications in game theory, decision theory, cloud computing environment in generating first and second order optimality conditions for NLPP.

We consider a general NLPP for multi variable optimization as follows: minimize fi(x), i=1,2,??.,m subject to: gj (x)>0, j=1,2,?.,n hk (x)=0, k=1,2,??.., p.

Then the corresponding auxiliary function for the above NLPP is L(x) =?r fi(x) +? ?j gj(x) +? µkhk(x)

Where the langrange multipliers ? and µ have their usual meanings. These multipliers play a complementary role in most of NLPP problems. For instance, Clarke sub-differentials, Mangasarian constraint qualifications hold for such case. For this problem, the various generalized invexity concepts were studied and observed that the well known first and second order optimality conditions and duality results satisfied under this setting. These results have many important applications in game theory, decision making, cloud computing and so on. The Clarke sub-differentials are also hold for sufficient conditions [10]. And also, the constraint qualifications in [20,21] were studied for NLPP under this new setting.

2 II.

3 Conclusion

This survey is very use full for generating various results on mathematical programming and its related results. We develop many second order optimality and duality results for NLPP using generalized invexity and their unifications. The same results are further studied to equilibria of saddle points. Further , we explore different formulations for continuous time programming. [1]

Figure 1: A

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