Generalized Solutions of First Order PDEs: The Dynamical Optimization Perspective (Systems & Control: Foundations & Applications)

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Hamilton-Jacobi equations and other types of partial differential equa- tions of the first order are dealt with in many branches of mathematics, mechanics, and physics. These equations are usually nonlinear, and func- tions vital for the considered problems are not smooth enough to satisfy these equations in the classical sense. An example of such a situation can be provided by the value function of a differential game or an optimal control problem. It is known that at the points of differentiability this function satisfies the corresponding Hamilton-Jacobi-Isaacs-Bellman equation. On the other hand, it is well known that the value function is as a rule not everywhere differentiable and therefore is not a classical global solution. Thus in this case, as in many others where first-order PDE's are used, there arises necessity to introduce a notion of generalized solution and to develop theory and methods for constructing these solutions. In the 50s-70s, problems that involve nonsmooth solutions of first- order PDE's were considered by Bakhvalov, Evans, Fleming, Gel'fand, Godunov, Hopf, Kuznetzov, Ladyzhenskaya, Lax, Oleinik, Rozhdestven- ski1, Samarskii, Tikhonov, and other mathematicians. Among the inves- tigations of this period we should mention the results of S.N. Kruzhkov, which were obtained for Hamilton-Jacobi equation with convex Hamilto- nian. A review of the investigations of this period is beyond the limits of the present book. A sufficiently complete bibliography can be found in [58, 126, 128, 141].

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