Differential Inclusions: Set-Valued Maps and Viability Theory (Grundlehren der mathematischen Wissenschaften)

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A great impetus to study differential inclusions came from the development of Control Theory, i.e. of dynamical systems $x'(t) = f(t, x(t), u(t))$, $x(O)=xo$ "controlled" by parameters $u(t)$ (the "controls"). Indeed, if we introduce the set-valued map $F(t, x)= \{f(t, x, u)\}ueu$ then solutions to the differential equations (*) are solutions to the "differen tial inclusion" (**) $x'(t)EF(t, x(t))$, $x(O)=xo$ in which the controls do not appear explicitly. Systems Theory provides dynamical systems of the form $d\ x'(t)=A(x(t))\ dt\ (B(x(t))+ C(x(t))$; $x(O)=xo$ in which the velocity of the state of the system depends not only upon the $x(t)$ of the system at time t, but also on variations of observations state $B(x(t))$ of the state. This is a particular case of an implicit differential equation $f(t, x(t), x'(t)) = 0$ which can be regarded as a differential inclusion (**), where the right-hand side F is defined by $F(t, x)= \{vlf(t, x, v)=O\}$. During the 60's and 70's, a special class of differential inclusions was thoroughly investigated: those of the form $X'(t)E - A(x(t))$, $x\ (0) =xo$ where A is a "maximal monotone" map. This class of inclusions contains the class of "gradient inclusions" which generalize the usual gradient equations $x'(t) = -VV(x(t))$, $x(O)=xo$ when V is a differentiable "potential." 2 Introduction There are many instances when potential functions are not differentiable.

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