Backward Euler–Maruyama method for SDEs with multivalued drift coefficient

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We consider the numerical approximation of a multivalued SDE

$$\begin{cases} \mathrm{d}X(t) + f(X(t))\,\mathrm{d}t \ni g(t)\,\mathrm{d}W(t), & t \in (0,T], \\ X(0) = X_0, \end{cases}$$

where $f\colon \mathrm{R}^d \to 2^{\mathrm{R}^d}$ is maximal monotone, of at most polynomial growth, coercive and fulfills the condition

$$\langle f_v - f_z, z - w \rangle \leq \langle f_v - f_w, v - w \rangle,$$

for every $v, w, z \in \mathrm{R}^d$, $f_v \in f(v)$, $f_w \in f(w)$, and $f_z \in f(z)$ as proposed in [Nochetto, Savaré, Verdi, 2000]. Under these low regularity assumptions on the drift coefficient, we can prove well definedness of the backward Euler method as well as the strong convergence with a rate of $1/4$ if g lies in a suitable Hölder space. These results can be applied to possibly discontinuous drift coefficients.

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