Backward Euler–Maruyama method for SDEs with multivalued drift coefficient

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We consider the numerical approximation of a multivalued SDE

\[
\begin{aligned}
\text{d}X(t) + f(X(t)) \text{d}t \ni g(t) \text{d}W(t), & \quad t \in (0, T], \\
X(0) = X_0,
\end{aligned}
\]

where

\[ f : \mathbb{R}^d \to 2^{\mathbb{R}^d} \]

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 \( v, w, z \in \mathbb{R}^d \), \( f_v \in f(v), f_w \in f(w) \), 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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