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MA 473: Computational Finance Lab – X 09/04/2019

1. Consider the following Black-Scholes diffusion equation:

$$\begin{cases} dX(t) = \mu X dt + \sigma X dW(t) \\ X(0) = X_0. \end{cases}$$

   (a) Obtain the exact solution of the above SDE.

   (b) The values of the parameters are $\mu = 0.75$, $\sigma = 0.30$ and $X_0 = 307$, and $t \in (0, 1)$.

   (c) Solve the above SDE by the following methods:

      i. Runge-Kutta method of weak-order two and Strong-order one.

      ii. Taylor method of weak-order two and strong-order 1.5.

   (d) Plot the order of convergence in a loglog plot (Δt *vs. the mean error*).

2. Consider the following Langevin SDE:

$$\begin{cases} dX(t) = -\mu X(t) dt + \sigma dW(t) \\ X(0) = X_0. \end{cases}$$

   (a) The values of the parameters are $\mu = 10$, $\sigma = 1$ and $X_0 = 0$, and $t \in (0, 4)$.

   (b) Solve the above SDE by the following methods:

      i. Runge-Kutta method of weak-order two and Strong-order one.

      ii. Taylor method of weak-order two and strong-order 1.5.

   (c) Plot the order of convergence in a loglog plot (Δt *vs. the mean error*).