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## fd\_gauss\_downout

Input parameters:

- SpaceStepNumber  $N$
- TimeStepNumber  $M$
- Theta  $\frac{1}{2} \leq \theta \leq 1$

Output parameters:

- Price
- Delta

To obtain accurate prices the grid points is located on the barrier, where we impose Dirichlet boundary conditions.[there](#) In the american case we use the splitting methods. It seems that it converges very slowly.

**/\*Memory Allocation\*/**

**/\*Time Step\*/**

Define the time step  $k = \frac{T}{N}$ .

**/\*Space localisation\*/**

Define the integration domain  $D = [down, l]$  using the probabilistic estimate [there](#).

**/\*Space Step\*/**

Define the space step  $h = \frac{2l}{M}$ .

**/\*Peclet Condition\*/**

If  $|r - \delta|/\sigma^2$  is not small, then a more stable finite difference approximation is used. cf [there](#).

**/\*Lhs factor of theta scheme\*/**

Initialize the matrix  $M^h$  issued from the discretization of the operator  $A$  in the case of Dirichlet Boundary conditions.cf [there](#).

**/\*Rhs factor of theta scheme\*/**

Initialize the matrix  $N$  issued from the implicit method in the cases of Dirichlet conditions. [there](#)

**/\*Set up Gauss\*/**

This part concerns the factorization  $LU$  of the tridiagonal matrix  $M^h$ . The first loop initialize  $U$ , whereas the others initialize  $L$ .

**/\*Terminal value\*/**

Put the value of the payoff saved in  $Obst$  into a vector  $P$  which will be used to save the option value.

**/\*Dirichlet Boundary Condition\*/**

We set Dirichlet Boundary conditions on the barrier.

**/\*Finite difference Cycle\*/**

At any time step, described by the loop in the variable  $TimeIndex$ , we have to solve the system  $M^h v = NP$ .

**/\*Set rhs\*/**

Compute  $NP$  and save the result in the vector  $S$ .

**/\*Solve the system\*/**

We solve the system  $M^h v = S$  in two steps:

1. First loop consists in solving  $L\bar{v} = S$ . The result is saved in  $S$ .  
[there](#).
2. Second loop consists in solving  $Uv = \bar{v} = S$ . The result is saved in  $P$ .

**/\*Splitting for American case\*/**

For American options, we compare at each time step the solution of  $M^h v = NP$  saved in  $P$  with the payoff function saved in  $Obst$ . We save the result in  $P$  [there](#).

**/\*Price\*/**

One uses linear interpolation to find the option value corresponding to the initial stock price.

**/\*Delta\*/**

One uses linear interpolation to find the delta value corresponding to the initial stock price. If the initial stock price is close to barrier one uses one-sided second-order difference approximation

$$\frac{\delta u_h}{\delta x}(x_i) = \frac{1}{h^2}(-u_h(x_{i+2}) - 4u_h(x_{i+1}) - 3u_h(x_i))$$

**/\*Memory Desallocation\*/**