

writeup

Sumeng Wang

February 28, 2019

Problem 1

For $k = 1$:

stock prices	explicit	implicit	crank-nicolson	black-scholes	explicit error	implicit error	cn error
16	0.0001025	0.0001187	0.0001082	0.0001188	-0.0000163	-0.0000001	-0.0000106
15	0.0006715	0.0007274	0.0006881	0.0006346	0.0000370	0.0000928	0.0000535
14	0.0028162	0.0029954	0.0028959	0.0031075	-0.0002912	-0.0001121	-0.0002116
13	0.0144287	0.0146573	0.0144174	0.0136511	0.0007776	0.0010062	0.0007663
12	0.0549412	0.0556096	0.0552026	0.0524596	0.0024816	0.0031500	0.0027430
11	0.1656650	0.1655860	0.1650860	0.1715369	-0.0058719	-0.0059509	-0.0064509
10	0.4641260	0.4648750	0.4644210	0.4646945	-0.0005685	0.0001805	-0.0002735
9	1.0363600	1.0370000	1.0367700	1.0244281	0.0119319	0.0125719	0.0123419
8	1.8476600	1.8474500	1.8476500	1.8442686	0.0033914	0.0031814	0.0033814
7	2.8128500	2.8123000	2.8129400	2.8053574	0.0074926	0.0069426	0.0075826
6	3.7960300	3.7938800	3.7947400	3.8020578	-0.0060278	-0.0081778	-0.0073178
5	4.7797400	4.7270500	4.7286700	4.8019869	-0.0222469	-0.0749369	-0.0733169
4	5.7860500	4.8824200	4.8851800	5.8019867	-0.0159367	-0.9195667	-0.9168067

For $k = 3$:

stock prices	explicit	implicit	crank-nicolson	black-scholes	explicit error	implicit error	cn error
16	0.0001351	0.0001565	0.0001439	0.0001188	0.0000164	0.0000378	0.0000251
15	0.0006699	0.0007334	0.0006943	0.0006346	0.0000353	0.0000988	0.0000598
14	0.0028037	0.0029538	0.0028558	0.0031075	-0.0003038	-0.0001537	-0.0002517
13	0.0133190	0.0136322	0.0134011	0.0136511	-0.0003321	-0.0000189	-0.0002500
12	0.0494538	0.0498842	0.0494902	0.0524596	-0.0030058	-0.0025754	-0.0029694
11	0.1760470	0.1763860	0.1758840	0.1715369	0.0045101	0.0048491	0.0043471
10	0.4641530	0.4643270	0.4638730	0.4646945	-0.0005415	-0.0003675	-0.0008215
9	1.0435800	1.0437700	1.0435300	1.0244281	0.0191519	0.0193419	0.0191019
8	1.7983600	1.7983600	1.7985400	1.8442686	-0.0459086	-0.0459086	-0.0457286
7	2.8028200	2.8022500	2.8028900	2.8053574	-0.0025374	-0.0031074	-0.0024674
6	3.8044900	3.8022000	3.8030600	3.8020578	0.0024322	0.0001422	0.0010022
5	4.8218900	4.7595900	4.7612900	4.8019869	0.0199031	-0.0423969	-0.0406969
4	5.7929000	4.8604700	4.8632400	5.8019867	-0.0090867	-0.9415167	-0.9387467

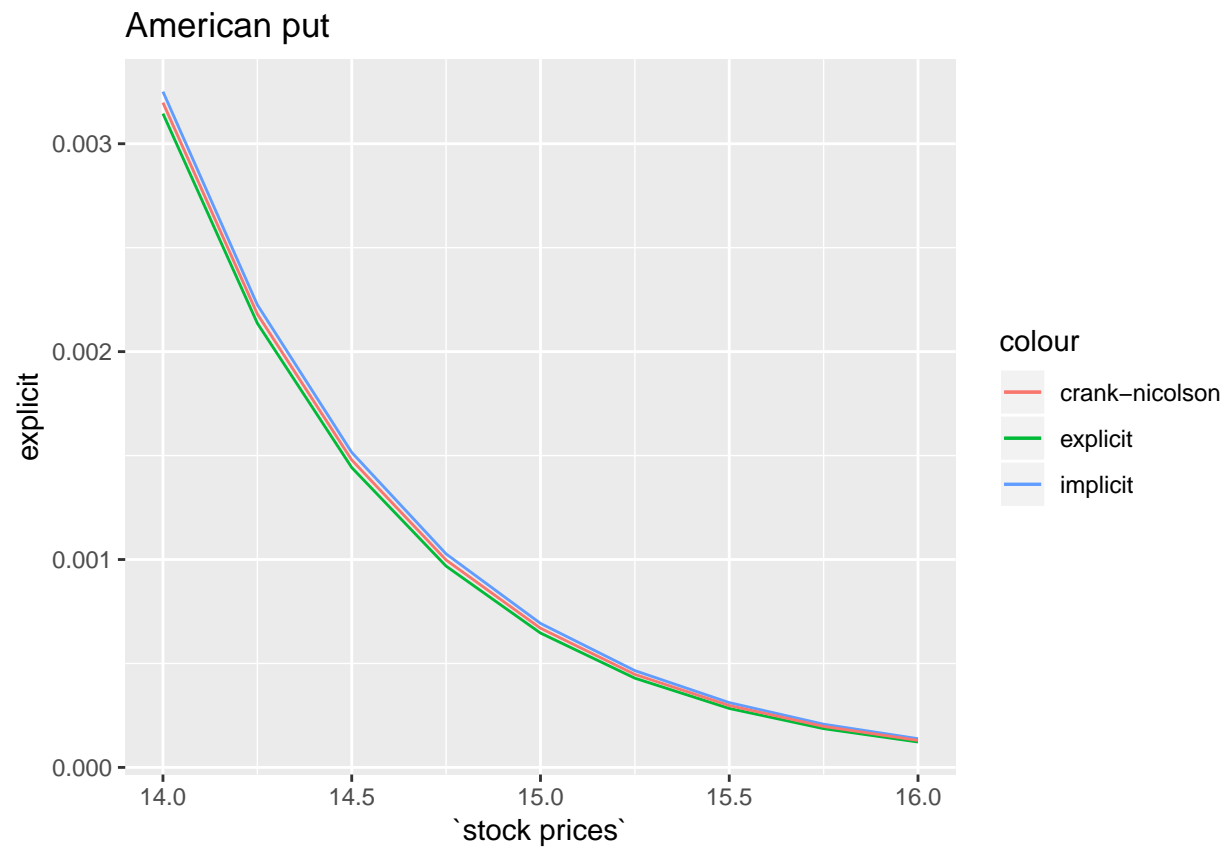
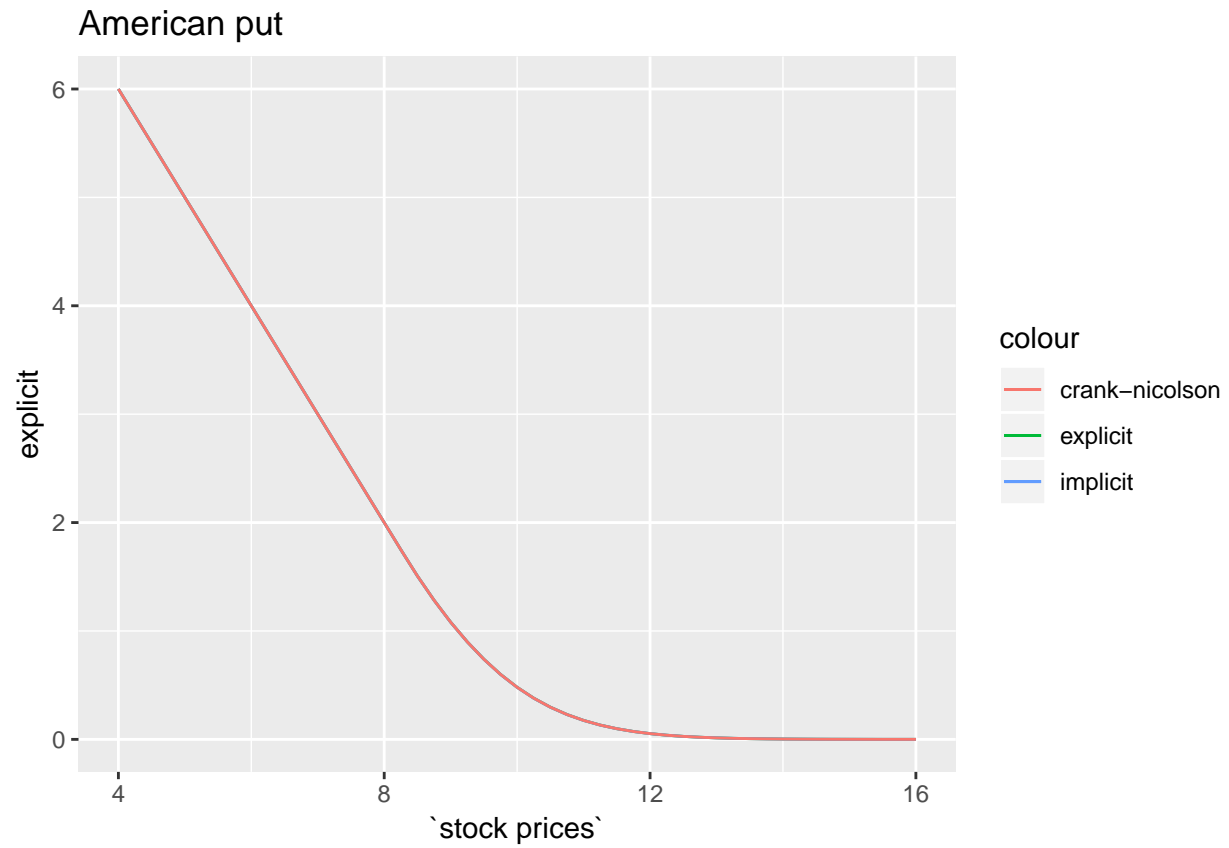
For $k = 4$:

stock prices	explicit	implicit	crank-nicolson	black-scholes	explicit error	implicit error	cn error
16	0.0001361	0.0001574	0.0001448	0.0001188	0.0000173	0.0000386	0.0000260
15	0.0005464	0.0006016	0.0005678	0.0006346	-0.0000882	-0.0000330	-0.0000667
14	0.0028708	0.0030224	0.0029233	0.0031075	-0.0002367	-0.0000851	-0.0001842
13	0.0121455	0.0124476	0.0122269	0.0136511	-0.0015056	-0.0012035	-0.0014242
12	0.0549823	0.0554157	0.0550086	0.0524596	0.0025227	0.0029561	0.0025490

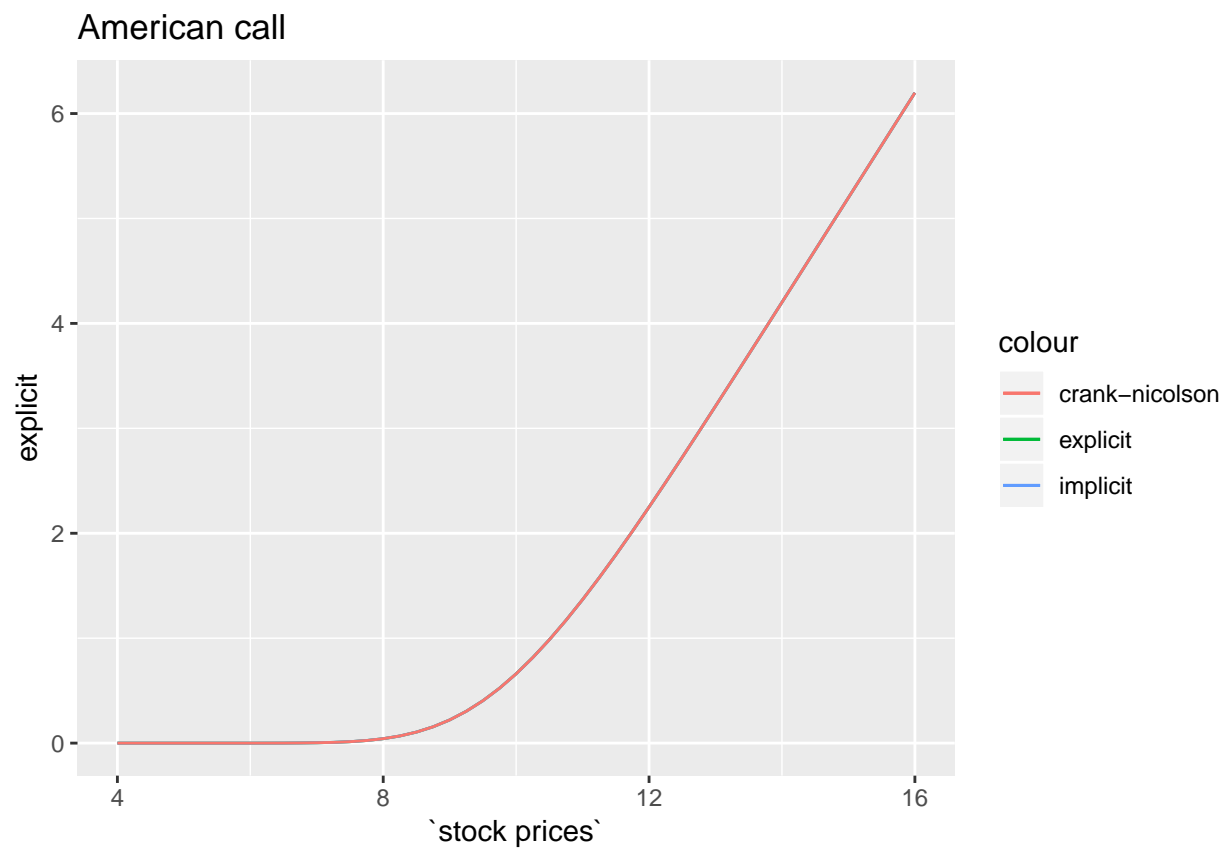
stock prices	explicit	implicit	crank-nicolson	black-scholes	explicit error	implicit error	cn error
11	0.1833650	0.1836970	0.1831930	0.1715369	0.0118281	0.0121601	0.0116561
10	0.4638780	0.4640520	0.4635980	0.4646945	-0.0008165	-0.0006425	-0.0010965
9	1.0363300	1.0365300	1.0362900	1.0244281	0.0119019	0.0121019	0.0118619
8	1.7821100	1.7821200	1.7822900	1.8442686	-0.0621586	-0.0621486	-0.0619786
7	2.8129200	2.8123500	2.8129900	2.8053574	0.0075626	0.0069926	0.0076326
6	3.8495000	3.8467500	3.8476300	3.8020578	0.0474422	0.0446922	0.0455722
5	4.8244500	4.7583700	4.7600900	4.8019869	0.0224631	-0.0436169	-0.0418969
4	5.7860400	4.8407300	4.8434900	5.8019867	-0.0159467	-0.9612567	-0.9584967

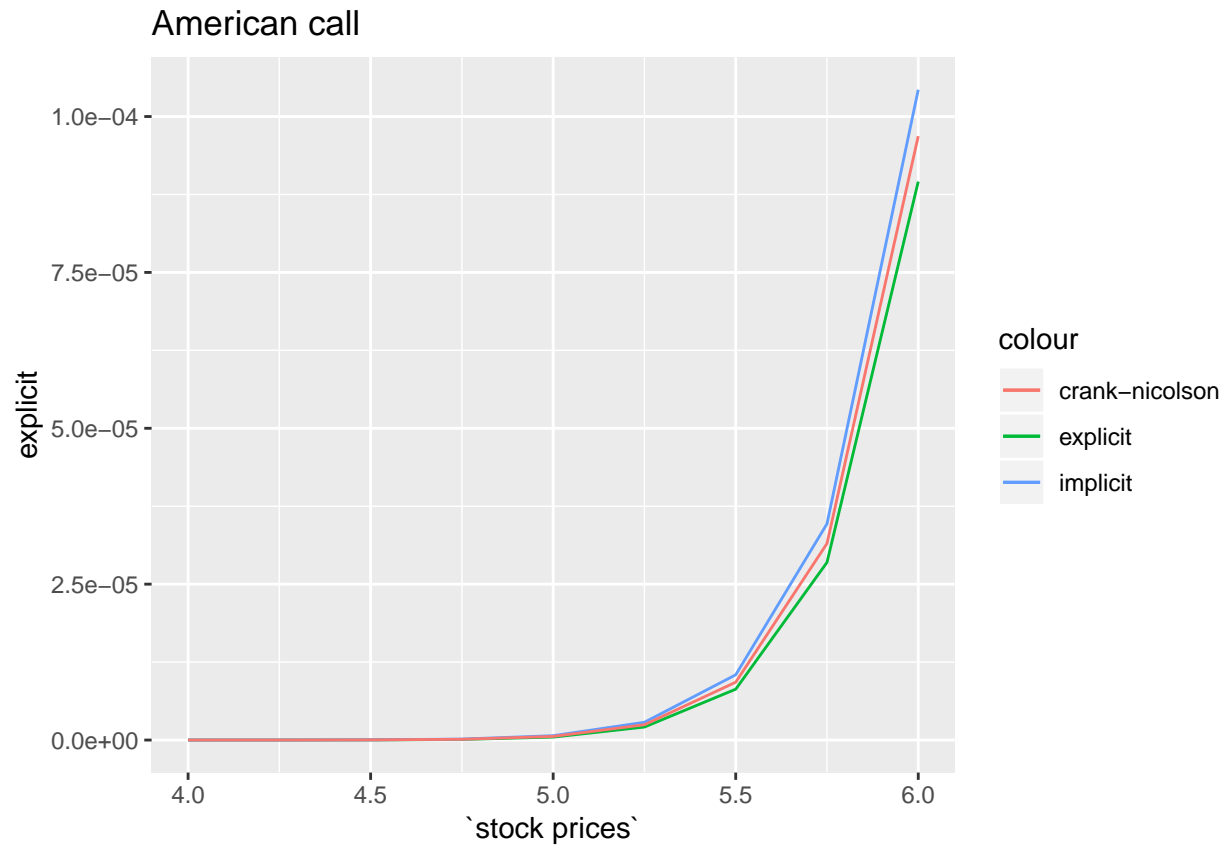
As a result, from the above 3 tables, we can see that all 3 methods are quite accurate when the stock price lies in the middle of the price range. In general, implicit performs better than other two methods when the price goes up from the middle point. And explicit method performs better than other two methods when the price goes down from the middle point.

Problem 2



If we plot the put option prices along with the whole price range, we cannot really see anything different. So let us only plot the prices in range of 14 to 16. As we can see from the second figure, the price of implicit method is the highest, while the price of explicit method is the lowest. And crank-nicolson lies between them.





The same findings also apply to the call option prices.