Project 7

MFE 405: Computational Finance

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This is a summary of the project for data visualisation, for detail implementation and result,

please refer to the print out of the program

Qn1, all implementation in C++

**Explicit Finite-Difference method:**

|  |  |  |  |
| --- | --- | --- | --- |
| Price | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.8017 | 5.80199 | -4.99829E-05 |
| 5 | 4.80183 | 4.80199 | -3.33195E-05 |
| 6 | 3.80195 | 3.80206 | -2.89317E-05 |
| 7 | 2.80462 | 2.80536 | -0.000263781 |
| 8 | 1.84357 | 1.84427 | -0.000379554 |
| 9 | 1.02501 | 1.02443 | 0.000566169 |
| 10 | 0.466006 | 0.464696 | 0.002819047 |
| 11 | 0.172229 | 0.171537 | 0.004034115 |
| 12 | 0.052905 | 0.0524596 | 0.008490343 |
| 13 | 0.0137246 | 0.0136507 | 0.005413642 |
| 14 | 0.00314309 | 0.00310847 | 0.011137312 |
| 15 | 0.000731843 | 0.000634385 | 0.153625953 |
| 16 | 0.000518862 | 0.000117774 | 3.405573386 |

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| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.80121 | 5.80199 | -0.000134437 |
| 5 | 4.80121 | 4.80199 | -0.000162433 |
| 6 | 3.80129 | 3.80206 | -0.000202522 |
| 7 | 2.80478 | 2.80536 | -0.000206747 |
| 8 | 1.84431 | 1.84427 | 2.16888E-05 |
| 9 | 1.02461 | 1.02443 | 0.000175707 |
| 10 | 0.464327 | 0.464696 | -0.000794068 |
| 11 | 0.171789 | 0.171537 | 0.001469071 |
| 12 | 0.0529175 | 0.0524596 | 0.008728622 |
| 13 | 0.0139156 | 0.0136507 | 0.019405598 |
| 14 | 0.00327371 | 0.00310847 | 0.053157984 |
| 15 | 0.00069426 | 0.000634385 | 0.094376443 |
| 16 | 0.00013879 | 0.000117774 | 0.178460441 |

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| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.8012 | 5.80199 | -0.00013616 |
| 5 | 4.8012 | 4.80199 | -0.000164515 |
| 6 | 3.80128 | 3.80206 | -0.000205152 |
| 7 | 2.80472 | 2.80536 | -0.000228135 |
| 8 | 1.84424 | 1.84427 | -1.62666E-05 |
| 9 | 1.02442 | 1.02443 | -9.76153E-06 |
| 10 | 0.464332 | 0.464696 | -0.000783308 |
| 11 | 0.172169 | 0.171537 | 0.003684336 |
| 12 | 0.0528479 | 0.0524596 | 0.007401886 |
| 13 | 0.0139581 | 0.0136507 | 0.022518992 |
| 14 | 0.00323025 | 0.00310847 | 0.03917683 |
| 15 | 0.00068398 | 0.000634385 | 0.078173349 |
| 16 | 0.00013313 | 0.000117774 | 0.130376823 |

**Implicit Finite-Difference method:**

|  |  |  |  |
| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.80121 | 5.80199 | -0.000134437 |
| 5 | 4.80121 | 4.80199 | -0.000162433 |
| 6 | 3.80129 | 3.80206 | -0.000202522 |
| 7 | 2.80475 | 2.80536 | -0.000217441 |
| 8 | 1.84408 | 1.84427 | -0.000103022 |
| 9 | 1.02466 | 1.02443 | 0.000224515 |
| 10 | 0.464875 | 0.464696 | 0.000385198 |
| 11 | 0.172039 | 0.171537 | 0.002926482 |
| 12 | 0.0529019 | 0.0524596 | 0.00843125 |
| 13 | 0.0139218 | 0.0136507 | 0.019859787 |
| 14 | 0.00323378 | 0.00310847 | 0.040312437 |
| 15 | 0.000680477 | 0.000634385 | 0.072656195 |
| 16 | 0.000132919 | 0.000117774 | 0.128593747 |

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| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.80121 | 5.80199 | -0.000134437 |
| 5 | 4.80121 | 4.80199 | -0.000162433 |
| 6 | 3.80129 | 3.80206 | -0.000202522 |
| 7 | 2.80478 | 2.80536 | -0.000206747 |
| 8 | 1.84431 | 1.84427 | 2.16888E-05 |
| 9 | 1.02461 | 1.02443 | 0.000175707 |
| 10 | 0.464327 | 0.464696 | -0.000794068 |
| 11 | 0.171789 | 0.171537 | 0.001469071 |
| 12 | 0.0529175 | 0.0524596 | 0.008728622 |
| 13 | 0.0139157 | 0.0136507 | 0.019412924 |
| 14 | 0.00327374 | 0.00310847 | 0.053167636 |
| 15 | 0.00069429 | 0.000634385 | 0.09442531 |
| 16 | 0.00013883 | 0.000117774 | 0.178740639 |

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| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.80121 | 5.80199 | -0.000134437 |
| 5 | 4.80121 | 4.80199 | -0.000162433 |
| 6 | 3.8013 | 3.80206 | -0.000199892 |
| 7 | 2.80481 | 2.80536 | -0.000196053 |
| 8 | 1.84441 | 1.84427 | 7.59108E-05 |
| 9 | 1.02437 | 1.02443 | -5.85692E-05 |
| 10 | 0.464052 | 0.464696 | -0.001385852 |
| 11 | 0.172012 | 0.171537 | 0.002769082 |
| 12 | 0.0528786 | 0.0524596 | 0.007987099 |
| 13 | 0.0140392 | 0.0136507 | 0.028460079 |
| 14 | 0.00328428 | 0.00310847 | 0.056558371 |
| 15 | 0.0007077 | 0.000634385 | 0.115574927 |
| 16 | 0.00014131 | 0.000117774 | 0.1998149 |

**Crank-Nicolson Finite Difference method:**

|  |  |  |  |
| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.8012 | 5.80199 | -0.00013616 |
| 5 | 4.8012 | 4.80199 | -0.000164515 |
| 6 | 3.80128 | 3.80206 | -0.000205152 |
| 7 | 2.80466 | 2.80536 | -0.000249522 |
| 8 | 1.84391 | 1.84427 | -0.000195199 |
| 9 | 1.02471 | 1.02443 | 0.000273323 |
| 10 | 0.465154 | 0.464696 | 0.000985591 |
| 11 | 0.172196 | 0.171537 | 0.003841737 |
| 12 | 0.0528718 | 0.0524596 | 0.007857475 |
| 13 | 0.0138403 | 0.0136507 | 0.013889398 |
| 14 | 0.00317942 | 0.00310847 | 0.022824734 |
| 15 | 0.000656768 | 0.000634385 | 0.035282991 |
| 16 | 0.000124879 | 0.000117774 | 0.060327407 |

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| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.8012 | 5.80199 | -0.00013616 |
| 5 | 4.8012 | 4.80199 | -0.000164515 |
| 6 | 3.80128 | 3.80206 | -0.000205152 |
| 7 | 2.80469 | 2.80536 | -0.000238829 |
| 8 | 1.84414 | 1.84427 | -7.04886E-05 |
| 9 | 1.02466 | 1.02443 | 0.000224515 |
| 10 | 0.464607 | 0.464696 | -0.000191523 |
| 11 | 0.171946 | 0.171537 | 0.002384325 |
| 12 | 0.0528871 | 0.0524596 | 0.008149128 |
| 13 | 0.0138342 | 0.0136507 | 0.013442534 |
| 14 | 0.00321958 | 0.00310847 | 0.035744273 |
| 15 | 0.00067058 | 0.000634385 | 0.057059987 |
| 16 | 0.00013067 | 0.000117774 | 0.109463888 |

|  |  |  |  |
| --- | --- | --- | --- |
| Price, | Pay Off | Black Scholes | Error In Percentage |
| 4 | 5.8012 | 5.80199 | -0.00013616 |
| 5 | 4.8012 | 4.80199 | -0.000164515 |
| 6 | 3.80128 | 3.80206 | -0.000205152 |
| 7 | 2.80472 | 2.80536 | -0.000228135 |
| 8 | 1.84424 | 1.84427 | -1.62666E-05 |
| 9 | 1.02442 | 1.02443 | -9.76153E-06 |
| 10 | 0.464332 | 0.464696 | -0.000783308 |
| 11 | 0.172169 | 0.171537 | 0.003684336 |
| 12 | 0.0528479 | 0.0524596 | 0.007401886 |
| 13 | 0.0139581 | 0.0136507 | 0.022518992 |
| 14 | 0.00323025 | 0.00310847 | 0.03917683 |
| 15 | 0.00068398 | 0.000634385 | 0.078173349 |
| 16 | 0.00013313 | 0.000117774 | 0.130376823 |

Comment:

In general when the put option is in the money and at the money, the error is very small using all of the three method. However, as the stock price goes further up, the option is way out of the money, the error starts to increase for all three method. Also because the option price is way too small (almost zero.)

Based on the data, the error also reduces for Implicit and Crank Nicolson methods in general. But that is not the case for Explicit Finite-Difference method. This might have to do with unconditional convergence for Implicit and Crank Nicolson methods.