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# 9.2.2 Example: Accuracy of Forward Euler simulation of coffee cooling

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MO2.4

MO2.6

MO2.7

Let's consider the error for the Forward Euler simulation of coffee cooling. Figure 9.1 shows that the error decreases by about a factor of 10 for a factor of 10 decrease in  $\Delta t$  from 50 to 5 minutes. This would seem to indicate a first order ( $p = 1$ ) method since the error seems proportional to  $\Delta t$ .

To see more certainly that Forward Euler is  $p = 1$ , we plot the maximum error ( $e_{\max}$ ) versus a range of  $\Delta t$  in Figure 9.2. This plot is done using a log-log scale because the slope then is directly the observed order of accuracy. To see that this is true, recall that the definition of the order of accuracy says that,

$$e_{\max} = O(\Delta t^p)$$

(9.4)

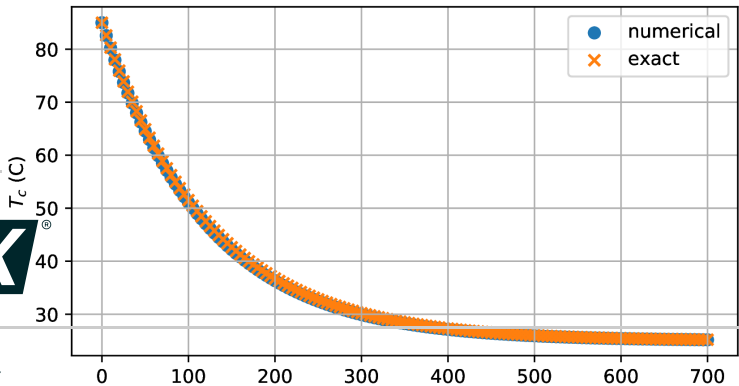
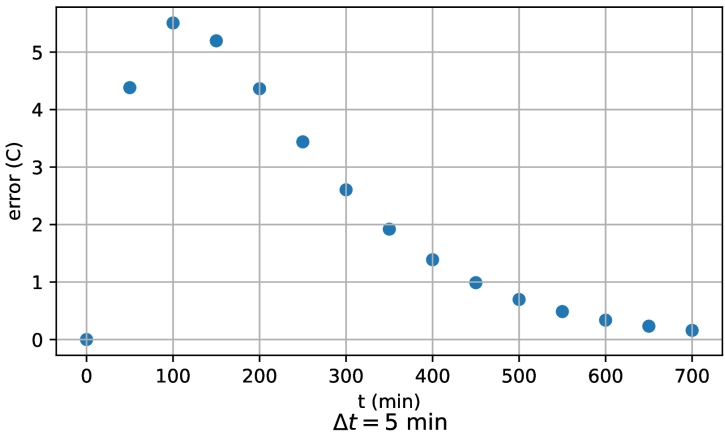
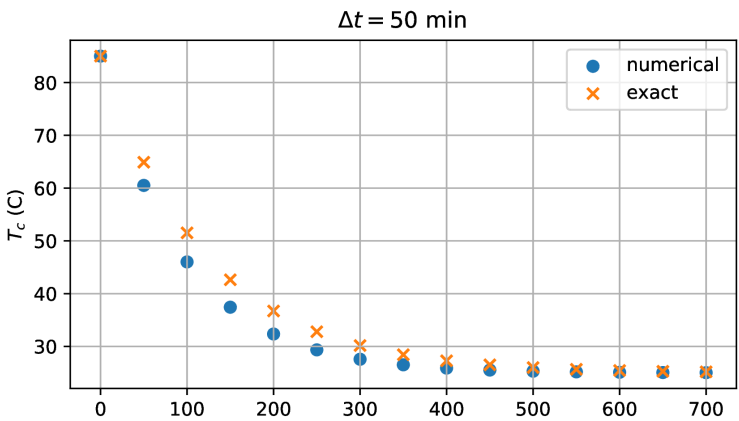
$$\log e_{\max} = O(\log(\Delta t^p))$$

(9.5)

$$\Rightarrow \log e_{\max} = O(p \log \Delta t)$$

(9.6)

Thus,  $p$  is the slope of the  $\log e_{\max}$  versus  $\log \Delta t$  plot. As can be seen in Figure 9.2, the slope is 1.

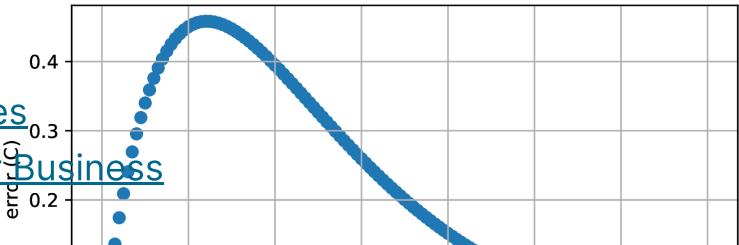


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