5DV005, Fall 2018, Lab session 1

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Contents

1 The time and the place

Our first lab session will take place on

Wednesday, November 7st, 2018, (kl. 13.00-16.00), Room MA416-426.

2 Setting the MATLAB path correctly

1. Change directory to `5dv005ht18` and launch `MATLAB` using the command `matlab &`.
2. Update `MATLAB`'s search path to include the folders

   ```
   5dv005ht18/matlab
   5dv005ht18/exercises
   ```

   and all their subfolders. Save the path definition into the file `5dv005ht18/pathdef.m`

Always launch `MATLAB` from the directory `5dv005ht18`. This ensures that the search path is set correctly for each session.

3 The problems

Problem 1 Within MATLAB do:

1. Issue the command `help bal`. This prints a summary of the MATLAB files contained in the folder `bal`. These files are for solving problems in external ballistics, i.e. fire control of artillery.

2. Issue the command `help range_rk1` and read through the documentation in detail.

3. Execute the minimal working example `range_rk1_MWE1`.

Remark 1 The function `range_rk1` demonstrates the standard that is expect from you! In particular, all your codes must contain the call sequence, a complete description of all input and output variables, as well as a minimal working example. Moreover, all code must contain frequent and helpful comments. Software which does not adhere to this standard will not be accepted.

Problem 2 Copy the script `lab1/scripts/l1p2.m` into `lab1/work/my_l1p2.m`. Your task is to modify `my_l1p2.m` so that it produces the output shown in Figure ?? and renders the graphics shown in Figure ??. These are the `MATLAB` commands which you will need: `fprintf`, `plot`, `axis equal`, `xlabel`, `ylabel`, `grid`, `axis`, `print`.

```
Flag    Range (meters)    TOI (seconds)
  1       16844.662          66.33
  1       14998.963          81.57
```

Figure 1: The output of `l1p2` after completion.

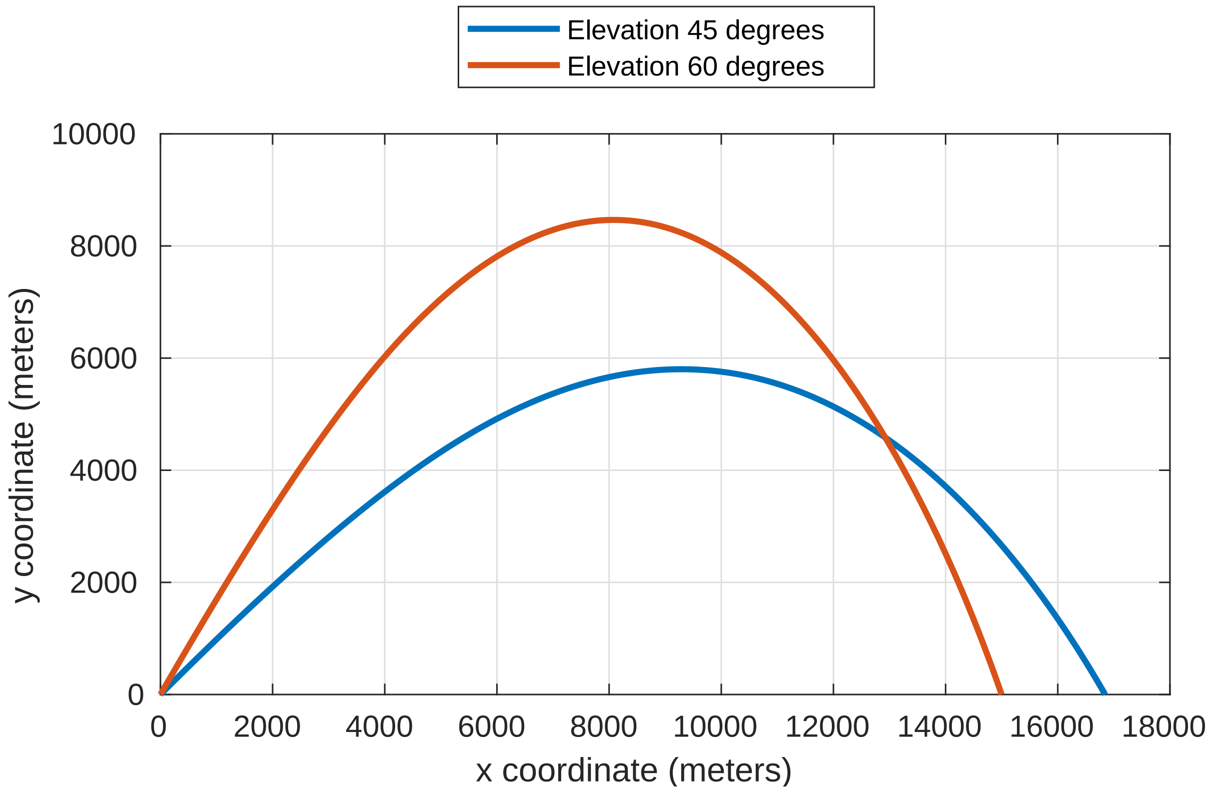

Figure 2: The trajectory of a two shells fired at using elevations of 45 degrees and 60 degrees

Remark 2 In general, I recommend that you export figures from MATLAB at `.eps` files. You can convert the file `fig.eps` to `.pdf` format using the command `ps2pdf -DEPSCrop fig.ps`. This crops the white space and produces a file called `fig.pdf`.

Problem 3 As demonstrated during yesterday's lecture the problem of computing a sum of positive numbers

$$s = \sum_{i=1}^{m} a_i$$

is substantially more complicated than it would appear! This exercise illustrates highlights the problem and shows how calculate an upper bound for the error.

1. Copy the script `lab1/scripts/l1p3.m` to `lab1/work/my_l1p3.m`.
2. Edit `my_l1p3` so that it uses `simple_sum` to compute

   $$s = \sum_{i=1}^{m} \frac{1}{i}, \quad m = 2^{22}$$

   using single/double precision and ascending/descending order, a total of 4 different calculations.
3. Edit `my_l1p3` so that compute the error associated with each value of s. An exceedingly accurate value of the true sum s can be obtained using double precision and the function `kahan_sum`.
4. Copy function `simple_sum` to `lab1/work/my_simple_sum`.
5. Edit `my_simple_sum` to include the computation of a running error bound E_b, such that

   $$|s - \hat{s}| \leq E_b, \quad E_b = \mu u$$

   where s is the true value of the sum, $\hat{s}$ is computed value of s and u is the unit roundoff, see [?], Section 4.3, Algorithm 7. Be mindful of the fact that $u = 2^{-24}$ in single precision and $u = 2^{-53}$ in double precision.
6. Edit `my_l1p3` so that it displays the running error bound right next to the actual error.
7. Verify that the absolute value of the error is bounded by the running error bound.
8. Which order of summation is the most accurate?