Differential equations

Computational practicum

Tasks

Week 06

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Task details

Textbook

- **Elementary Differential Equations**
  by *William F. Trench*.
  Brooks/Cole Thomson Learning, 2001.
  http://ramanujan.math.trinity.edu/wtrench/texts/TRENCH_FREE_DIFFEQ_I.PDF

Reference Material

- **Java: a beginner's guide. 6th edition.**
  by Herbert Schildt.
  Oracle Press.
  https://doc.lagout.org/programmation/Java/Java_%20A%20Beginner%27s%20Guide_%20Create%2C%20Compile%2C%20and%20Run%20Java%20Programs%20Today%20%286th%20ed.%29%20%5BSchildt%202014%5D%20%28badly%20formatted%29.pdf
- **JavaFX. Getting Started with JavaFX.**
  by Oracle.
  Release 8.
  https://docs.oracle.com/javase/8/javafx/JFXST.pdf.

Computer Resources

- **Java** compatible compiler & IDE
  (e.g. Netbeans & JavaFX Scene Builder)
- Spreadsheets editor
  (e.g. Google Sheets)

Grading criteria

- software application and report – 30 points

Final date of submission and live-grading

- **End of 12th week**

Grading scenario

- PDF-report (**5-7 pages**), containing your exact solution, source code and screenshots of numerical investigations, submitted to the Moodle.
- Live-session after the second practice test on 10th week

Additional rules

- Students who did not submit a report or was not presence on live-session without legal excuse (e.g., documented medical) may try pass it **not later than in one week with 30% deduction** from the grade for this deliverable.

Task

Initial value problem (IVP)
with an interesting interval:

$$\begin{cases} y' = \mathrm{f}(x, y) \\ y(x_0) = y_0 \\ x \in [x_0; X] \end{cases}$$

- For your own variant of the task realize in your favorite programming language (e.g. Java)
  - *Euler's method,*
  - *improved Euler's method,*
  - *Runge-Kutta method*

  in your own software application.
- Using this application construct corresponding approximation of the solution of a given initial value problem (provide the possibility of changing of the initial conditions).
- Realize the exact solution of an IVP in your application.
- Provide data visualization capability (charts plotting) in the user interface of your application (e.g. using the JavaFX).
- Investigate the convergence of these numerical methods on different grid sizes (provide the possibility of changing of the number of grid steps).
- Compare approximation errors of these methods plotting the corresponding chart for different grid sizes (provide the possibility of changing of the range of grid steps).

Variants

Var. №	$f(x,y)$	x_0	y_0	X
1	$-y-x$	0	1	10
2	$-2y+4x$	0	0	3
3	$\frac{4}{x^2}-\frac{y}{x}-y^2$	1	3	4
4	$1+y(2x-1)/x^2$	1	1	10
5	$\cos x-y$	1	1	9.5
6	$\sin x+y$	0	1	12/5
7	$-x+\frac{y(2x+1)}{x}$	1	3	18.2
8	y^2/x^2-2	1	1	10.2
9	$\frac{y}{x}+\frac{x}{y}$	1	1	2.3
10	$\frac{1}{2}\sin 2x-y\cos x$	0	1	5.2
...				

Var. №	$f(x,y)$	x_0	y_0	X
11	$e^{-\sin x} - y\cos x$	0	1	9.3
12	$xy^2 + 3xy$	0	3	5.5
13	$\sin^2 x + y\,\mathrm{ctg}\,x$	1	1	3
14	$y^4\cos x + y\,tg\,x$	0	0	9
15	$3xe^x - y(1-\frac{1}{x})$	1	0	5
16	$2yx + 5 - x^2$	0	1	3
17	$(1-2y)e^x + y^2 + e^{2x}$	-5	2	0
18	$xy^{3/2} + xy$	1	4	7.8
19	$2y^{1/2} + 2y$	0	1	9
20	$x^3y^4 - y/x$	1	0.5	5
21	$y^2e^x - 2y$	1	1	10
22	$y^4cos(x) - ytg(x)$	0	1	8
23	$y^2e^x + 2y$	1	0.5	7
24	$y^4cos(x) + ytg(x)$	0	1	9.5
25	$xy^2 - 3xy$	0	2	6.4