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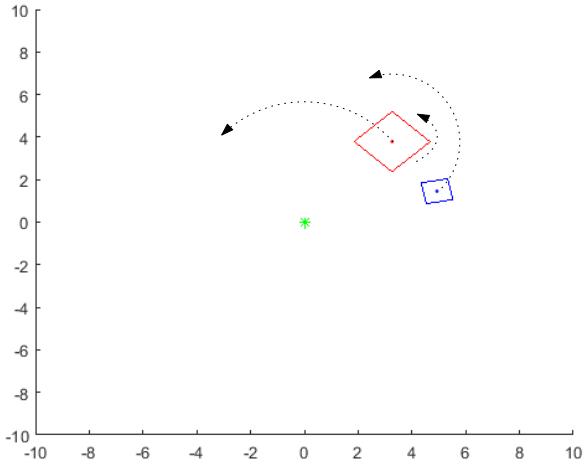
Basics of Computer Graphics: Exercise Set

Goal: The aim of this exercise is to implement an animation of Sun, Earth and Moon.



Task 1 Implement the following two auxiliary methods

(1) $p_{\texttt{new}}$ = `rotate_around_point(`$p_{\texttt{old}}$`, a, b,` ϕ`)`

Input:

- a point p_{old} represented via homogeneous coordinates
- numbers a, b and an angle ϕ (in radians)

Output: homogeneous coordinates of the point obtained by rotating p_{old} around the point $[a, b]$ by ϕ

Test cases:

- `rotate_around_point([2,5 ,1], 6, 9, pi/2)` gives [10, 5, 1]
- `rotate_around_point([-2 ,8 ,1], 5, 7, pi)` gives [12, 6, 1]

(2) [$p1_{\texttt{new}}$, $p2_{\texttt{new}}$, $p3_{\texttt{new}}$, $p4_{\texttt{new}}$] =
`rotate_tuple(`$p1_{\texttt{old}}$, $p2_{\texttt{old}}$, $p3_{\texttt{old}}$, $p4_{\texttt{old}}$, `a, b,` ϕ`)`,

which applies the rotation described in (1) to each of the 4 input-points separately.

Task 2 Complete the program `earth_sun1` (which can be found on moodle) to run an animation of an Earth (modelled by a point) orbiting a Sun (modelled by an asterisk in the origin).

Task 3 Adapt the program `earth_sun1` such that the Earth is represented by a red square with a mark in its center. Name your program `earth_sun2`.

Question: Does the Earth (square) rotate (spin) around its center in your implementation? If yes, what is its rotation period and its rotation direction?

Remark: For better inspection of the spinning properties, color one of earth's sides black!

Task 4 Modify `earth_sun2` such that the Earth spins around its center (independent of the orbital motion). Name the resulting program `earth_sun3`.

Question: How do you chose earth's spinning angular velocity in relation the one for earth's orbit around the sun?

Task 5 Adapt `earth_sun3` such that it also contains the Moon (represented by a square with a mark in its center) which

- orbits the Earth, and
- spins about its center.

Name the resulting program `earth_sun_moon`.

Question: How do you chose the Moon's rotation period and its spinning angular velocity in relation the period of the earth's orbit around the sun to obtain realistic properties?

Task 6 (optional) Add further (not necessarily realistic) objects/movements to your system; e.g.

- use the orbital and spinning parameter (including its *direction*) for Venus and determine the duration of a day on Venus (=time span from noon to noon). You find the corresponding parameters on wikipedia!
- a second moon
- a square around the 'sun-asterisk' spinning on its center
- another planet orbiting and/or spinning in the opposite direction