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Game Technology
Winter Semester 2016/2017

Exercise 9

For bonus points upload your solutions until **Saturday, January 21, 2017, 9:50**

General Information

- The exercises may be solved by teams of up to three people.
- The solutions have to be uploaded to the Git repositories assigned to the individual teams.
- **The submission date (for practical and theoretical tasks) is noted on top of each exercise sheet.**
- If you have questions about the exercises write a mail to game-technology@kom.tu-darmstadt.de or use the forum at https://www.fachschaft.informatik.tu-darmstadt.de/forum/viewforum.php?f=557

P9 Practical Tasks: Physics (5 points)

In this exercise, the overall task is to build a simple version of “Marbellous”. The extended physics code which handles collisions between the ball and the triangle mesh are provided for the most parts.

The code is provided for you, your task is to fill out the respective functions. The code can be found at https://github.com/TUDGameTechnology/Exercise9.git

Please remember to push into a branch called “exercise9”.

P9.1 Triangle-Sphere-Intersection (2 points)

In `Collision.h`, you can find the source code for the SAT intersection test for triangles and spheres. (Note that the remaining code is an optimized version of the test). Provide the code for the functions `IsSeparatedByA`, `IsSeparatedByB` and is `IsSeparatedByC` which should be true iff the axis from the vertex a, b or c to the sphere is a separating axis.

P9.2 Sphere-Box-Intersection (3 points)

(See also the theoretical task.) Implement your box-sphere-intersection algorithm. Use it to detect when the ball has reached the goal area. Play the provided sound when the goal area is reached.

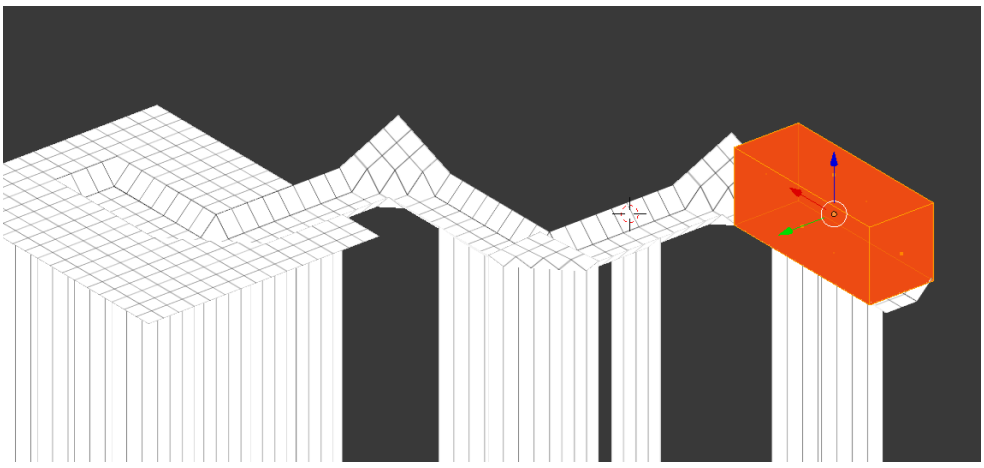
The goal is a box (rectangular cuboid) that is centered at the point (x, y, z) = (-46, -4, 44). The full extents of the sides of the box are approximately (10.6, 4.4, 4.0). The box is not rotated and therefore aligned to the global coordinate system.

T9.2 Theoretical Task: Physics (5 points)

T9.1 Sphere-Box-Intersection (1 point)

Research a method for intersection between a box and a sphere or derive your own.

Describe the chosen intersection test and write it down in pseudocode.



T9.2 Torque (2 points)

We have a sphere that is positioned at the origin (0, 0, 0) and has a radius of $\sqrt{2}$ units. We apply a force with the vector f = (-1, 0, 1) at point p = (1, 0, 1).

a) Write down the formula for computing the torque t. **(0.5 points)**

b) Use the formula to compute the actual torque. **(1 point)**

c) A second force is applied simultaneously to the first one. Force f_2 = (1, 1, 0), applied at point p_2 = (0,0,-1). Calculate the overall torque of the sphere resulting from f and f_2. **(0.5 points)**

T9.3 Separating Axis (2 Points)

Consider the following situation with a rectangle and a triangle. The rectangle is not rotated.

Provide an axis that is a separating axis for these two objects and show formally why your axis is separating the objects, using the definition from the lecture.

Specify the separating axis by providing a point and a normal direction.

Note: You may of course make a diagram to help you visualize the exercise, but answers using only diagrams are not counted.

Rectangle (not rotated)	
Center	$\begin{pmatrix}\mathbf{5}\\\mathbf{6}\end{pmatrix}$
Edge Lengths	$\begin{pmatrix}\mathbf{3}\\\mathbf{3}\end{pmatrix}$
(Vertices)	$\{\begin{pmatrix}\mathbf{3.5}\\\mathbf{4.5}\end{pmatrix},\begin{pmatrix}\mathbf{6.5}\\\mathbf{4.5}\end{pmatrix},\begin{pmatrix}\mathbf{3.5}\\\mathbf{7.5}\end{pmatrix},\begin{pmatrix}\mathbf{6.5}\\\mathbf{7.5}\end{pmatrix}\}$
Triangle	
Vertices	$\{\begin{pmatrix}\mathbf{6}\\\mathbf{3}\end{pmatrix},\begin{pmatrix}\mathbf{8}\\\mathbf{5}\end{pmatrix},\begin{pmatrix}\mathbf{8}\\\mathbf{3}\end{pmatrix}\}$

Axis	
Point	
Normal	