Prof. Dr.-Ing. Ralf Steinmetz
Multimedia communications Lab

Dipl. Inf. Robert Konrad
Polona Caserman, M.Sc.

Game Technology
Winter Semester 2017/2018

Exercise 9

For bonus points upload your solutions until **Tuesday, January 9th, 2018, 13:29**

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 Theoretical Task: Physics 2 (5 points)

T9.1 Sphere-Plane-Collision (2 points)

Consider the situation below, which gives you information about the current state of a sphere and an immovable plane. You can disregard gravity for this exercise.

Plane: $\boldsymbol{d} = \mathbf{1}, \boldsymbol{n} = \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \\ \mathbf{0} \end{pmatrix}$

Circle: $\text{radius} = \mathbf{3}, \text{position} = \begin{pmatrix} \mathbf{5} \\ \mathbf{2} \\ \mathbf{1} \end{pmatrix}, \text{velocity} = \begin{pmatrix} \mathbf{-0.5} \\ \mathbf{1} \\ \mathbf{1} \end{pmatrix}$

a) Calculate the following values. Please include your calculations.

   Distance (sphere center to plane):

   Collision normal:

   Penetration depth:

   Separating Velocity:

b) Are the sphere and the plane colliding? Explain your answer.

c) Should we apply some collision response? Explain your answer. (You don't need to specify which collision response, if any is required).

T9.2 Separating Axis (3 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	