# Due Date

This assignment must be completed and submitted via Moodle before end-of-day on Friday during Week 8 (Spring Semester) or Week 6 (Summer Semester).

# Objectives

The objectives for this project are four-fold:

* To implement a simple game object manager.
* To implement a simple mesh manager.
* To implement cloning of game objects.
* To implement two unique behaviors.

# Description

For this project, you have been provided with a set of header files (.h) that specify the interface for six new modules. You are responsible for creating the associated source files (.c) and implementing the functionality, as outlined in the header files and the lecture notes.

One of the new modules is a game state that will be used to implement an Asteroids clone across Projects 4 & 5. The four game states created during previous projects should remain in the project and must be accessible from the Asteroids game state.

# Files

NOTE: You may not change the public interface of the header files (.h) that have been provided, except as expressly directed in the instructions below. Should you modify these header files in any way, exercise extreme caution, as adding, removing, or modifying the public interface will result in a penalty to your project grade.

FOR EXAMPLE: The Animation, Physics, Sprite, SpriteSource, Transform, GameObjectManager and MeshManager structures must all be declared in their associated .c files, not the .h files. Exposing the internal implementation of these modules by declaring the structures in the .h files will result in a penalty to your project grade.

The Behavior structure may be declared publicly in the .h file, as it will be used to implement pseudo-inheritance in Project 5.

Animation.h

* This header file has been updated to include the function, AnimationClone. This function should perform a shallow copy of all member variables of the original object
  + Hint: It is possible to copy all members of a structure from one variable to another, in the following manner (this is a shallow copy):
    - \*animation = \*other
  + After an Animation component is cloned, it’s ‘parent’ pointer must be updated to point at the newly cloned game object. This step should be performed within GameObjectAddAnimation

Behavior.h

* This header file declares the public interface for creating and updating behaviors.
* In Project 5, the base Behavior structure will be used to create “derived” behavior structures for specific game objects. For now, the Spaceship and Bullet behaviors will use only the base Behavior structure.
* The function, BehaviorUpdate, should implement a finite-state machine (FSM), as follows:
  + Validate the behavior pointer.
  + If the behavior state is changing (stateCurr != stateNext),
    - Call the onExit() function, *iff* (“if and only if”) it exists.
    - Set stateCurr = stateNext
    - Call the onInit() function, *iff* it exists.
  + Call the onUpdate function, *iff* it exists.

Physics.h

* This header file has been updated to include the function, PhysicsClone. This function should perform a shallow copy of all member variables of the original object.
* This header file has been updated to include the functions, PhysicsGetRotationalVelocity & PhysicsSetRotationalVelocity. These functions should get and set a new rotational velocity variable that you must add to the Physics structure. For example, this new variable might be defined as:
  + float rotationalVelocity;

Physics.c

* The function, PhysicsUpdate, must be modified to add the rotational velocity to a game object’s Transform ‘rotation’ every game loop. For example, (in pseudocode):
  + rotation += rotationalVelocity \* dt

Sprite.h

* This header file has been updated to include the function, SpriteClone. This function should perform a shallow copy of all member variables of the original object.

Sprite.c

* The function, SpriteRead, must be modified to handle meshes, as follows:
  + After reading frameIndex and alpha from the stream, read a token that represents the name of a mesh
  + Call MeshManagerBuild(), passing the name of the mesh
  + Call SpriteSetMesh(), passing the created mesh

Transform.h

* This header file has been updated to include the function, TransformClone. This function should perform a shallow copy of all member variables of the original object

Stream.h

* This header file has been updated to include the function, StreamReadHex. This function should read a single hexadecimal integer (“%x”) from the stream

Mesh.h

* This header file has been updated to include the function, MeshRead. This function should construct an AEGfxVertexList object using data read from a file, as follows:
  + Read a token from the stream
  + If the token == “Mesh” (Hint: use strncmp() for this purpose)
    - Call AEGfxMeshStart()
    - Read an integer from the stream; this is the number of vertices to be read
    - For each vertex to be read,
      * Read two floats (or a Vector2D), indicating the vertex position
      * Read one hexadecimal integer, indicating the vertex color
      * Read two floats (or a Vector2D), indicating the vertex UV values
      * Call AEGfxVertexAdd(), passing the read values
    - Call AEGfxMeshEnd() and return the resultant pointer

MeshManager.h

* This header file declares the public interface for creating and freeing meshes. See the information below and in the header file comments for additional, detailed instructions on the implementation of the .c file.
* There is no need to make any changes to this file for Project 4. However, there is a sample structure that should be incorporated into MeshManager.c. You are free to change the contents of this structure within the .c file as long as you do not change the public interface.
* The contents of the MeshManager structure may not be accessed directly anywhere outside of MeshManager.c. The public interface provides everything necessary for this project.

MeshManager.c

* MeshManagerBuild
  + Construct a path name (folder and file name) using meshName, for example:
    - char pathName[FILENAME\_MAX] = "";
    - sprintf\_s(pathName, \_countof(pathName), "Data/%s.txt", meshName);
  + Call StreamOpen(), passing the pathname
  + If the stream was opened successfully,
    - Call MeshRead() to construct a mesh using data read from the file
    - Call MeshManagerAdd(), a new private function, passing the created mesh
    - Close the stream
    - Return the created mesh

GameObject.h

* This header file has been updated to include the function, GameObjectClone. This function should perform a deep copy of the ‘name’ member variable, a shallow copy of the isDestroyed variable (see below) and create cloned copies of any attached components.
  + Hint: Use the GameObjectAdd functions to attach the cloned components to the newly cloned game object
* This header file has been updated to include the functions, GameObjectIsDestroyed and GameObjectDestroy. These functions should get and set a new member variable that indicates when the game object should be destroyed. For example, this new variable might be defined as:
  + bool isDestroyed
* The header file has been updated to include the function, GameObjectIsNamed. This function should compare the name of the game object with the name passed as a parameter. If the two names are equal, then the function should return true; otherwise false
* This header file has been updated to include the functions, GameObjectGetBehavior and GameObjectAddBehavior. These functions should get and set a new member variable that stores a behavior component. For example, this new variable might be defined as:
  + BehaviorPtr behavior;

GameObject.c

* GameObjectAddBehavior
  + This function must also store the game object pointer in the behavior’s ‘parent’ member variable, as follows:
    - BehaviorSetParent(behavior, gameObject);
* GameObjectRead
  + This function must be updated to create behaviors and add them to the game object
    - If the token “BehaviorSpaceship” is encountered,
      1. Call BehaviorSpaceshipCreate()
      2. Call BehaviorRead(), passing the created behavior
      3. Call GameObjectAddBehavior(), passing the created behavior
    - If the token “BehaviorBullet” is encountered,
      * Repeat steps 1 – 3, above, calling BehaviorBulletCreate() instead
* GameObjectUpdate
  + This function must be modified to call BehaviorUpdate.
    - Note: The order of the update calls will become important in Project 6. Give some thought to the order that you update each of the components. This will be discussed further during future lectures

GameObjectManager.h

* This header file declares the public interface for managing lists of game objects. The current implementation will utilize two lists, one containing active game objects and another contain game object archetypes
* These two lists can be fixed-length arrays (minimum size of 100 entries) or dynamically-sized linked lists

GameObjectManager.c

* The following private variables will be required:
  + static GameObjectManager gameObjectActiveList;
  + static GameObjectManager gameObjectArchetypes;

Engine.c

* This module must be updated to include calls to the GameObjectManager, as shown below. Give careful consideration of where each of these function calls must be placed
  + In EngineInit(), add a call to GameObjectManagerInit().
  + In EngineUpdate(), add calls to GameObjectManagerUpdate() and GameObjectManagerDraw() *before* SystemDraw().
  + In EngineShutdown(), add a call to GameObjectManagerShutdown().

GameStateTable.c/.h

* Modify these files to add a new game state, ‘GsAsteroids’.
* Set the game state’s name to “Asteroids”.
* Set GsInitial = GsAsteroids.

GameObjectFactory.c

* You must make the following changes to this file for Project 4:
  + GameObjectFactoryBuild:
    - The function is being changed to accept the name of a game object, rather than the path to the data file. As a result, before opening the data file, the game object’s name must be combined with the file path information, as follows:
      * char pathName[FILENAME\_MAX] = "";
      * sprintf\_s(pathName, \_countof(pathName), "Data/%s.txt", objectName);
    - The function is also being changed to make use of the Archetype game object list. The code should now behave as follows:
      * If objectName is NULL
        + Return NULL
      * Call GameObjectManagerGetArchetype to see if an archetype of the requested game object already exists
      * If the archetype does not exist,
        + Construct the file pathname
        + Open the data file for streaming
        + If the stream was opened successfully,

Read a token

If the token == “GameObject”

Call GameObjectCreate to create a new archetype

Call GameObjectRead

Call GameObjectManagerAddArchetype, passing the new archetype game object

* + - * If the archetype existed or was created successfully,
        + Clone the archetype
        + Return the cloned game object

GameStateLevel1.c

* You must make the following changes to this file for Project 4:
  + GameStateLevel1Init:
    - Change the strings passed to GameObjectFactoryBuild() to:
      * "PlanetBounce"
      * "Monkey"
      * "MonkeyLivesText"
  + GameStateLevel1Update:
    - If the ‘3’ key is *triggered*, change the game state to “GsAsteroids”.

GameStateLevel2.c

* You must make the following changes to this file for Project 4:
  + GameStateLevel2Init:
    - Change the string passed to GameObjectFactoryBuild() to:
      * "SpaceshipHoming"
  + GameStateLevel2Update:
    - If the ‘3’ key is *triggered*, change the game state to “GsAsteroids”.

GameStateDemo.c

* You must make the following changes to this file for Project 4:
  + GameStateDemoUpdate:
    - If the ‘3’ key is *triggered*, change the game state to “GsAsteroids”.

GameStateSandbox.c

* You must make the following changes to this file for Project 4:
  + GameStateSandboxUpdate:
    - If the ‘3’ key is *triggered*, change the game state to “GsAsteroids”.

GameStateAsteroids.c/.h

* You will need to create these files and add them to the project.
  + Hint: Use the existing GameStateStub.c & .h files as examples.
* You must make the following changes to this file for Project 4:
  + GameStateAsteroidsLoad:
    - Call MeshManagerInit().
  + GameStateAsteroidsInit:
    - Create a “Spaceship” game object by calling GameObjectFactoryBuild() with the parameter, "Spaceship"
    - If the game object was created successfully,
      * Call GameObjectManagerAdd() to add the created game object to the game object manager
    - Set Alpha Engine’s background color to black (0,0,0).
    - Set Alpha Engine’s blend mode to blend.
  + GameStateAsteroidsUpdate:
    - If the ‘1’ key is *triggered*, change the game state to GsLevel1
    - If the ‘2’ key is *triggered*, change the game state to GsLevel2
    - If the ‘3’ key is *triggered*, restart the current level
    - If the ‘9’ key is *triggered*, change the game state to GsSandbox
    - If the ‘0’ key is *triggered*, change the game state to GsDemo
  + GameStateAsteroidsShutdown:
    - Call GameObjectManagerShutdown()
      * Note: This causes all active game objects and game object archetypes to be freed.
    - Call MeshManagerFreeAll().
      * Note: This causes all loaded meshes to be freed.

BehaviorSpaceship.h

* This header file declares the public interface for creating and updating behaviors associated with a spaceship game object. See the information below for detailed instructions on the implementation of the .c file.

BehaviorSpaceship.c

* Create an enum with the following entries:
  + cSpaceshipInvalid = -1
  + cSpaceshipIdle
  + cSpaceshipThrust
* Add the following private constants:
  + static const float spaceshipAcceleration = 150.0f;
  + static const float spaceshipSpeedMax = 500.0f;
  + static const float spaceshipTurnRateMax = PI / 1.5f;
  + static const float spaceshipWeaponCooldownTime = 0.034f;
  + static const float spaceshipWeaponBulletSpeed = 750.0f;
* Add the following private function declarations:
  + static void BehaviorSpaceshipUpdateRotation(BehaviorPtr behavior, float dt);
  + static void BehaviorSpaceshipUpdateVelocity(BehaviorPtr behavior, float dt);
  + static void BehaviorSpaceshipUpdateWeapon(BehaviorPtr behavior, float dt);
  + static void BehaviorSpaceshipSpawnBullet(BehaviorPtr behavior);
* BehaviorSpaceshipCreate:
  + Calloc the memory for a Behavior structure.
  + If the memory was allocated successfully,
    - Set stateCurr = cSpaceshipInvalid
    - Set stateNext = cSpaceshipInvalid
    - Set the onInit, onUpdate, and onExit functions
* BehaviorSpaceshipInit:
  + This function may remain empty.
  + Use UNREFERENCE\_PARAMETER() to fix the warning.
* BehaviorSpaceshipUpdate:
  + Add a switch statement with the expression, (behavior->stateCurr)
  + Add a case for cSpaceshipIdle
    - Call BehaviorSpaceshipUpdateRotation.
    - Call BehaviorSpaceshipUpdateWeapon
    - If ‘VK\_UP’ is *pressed* (being held down),
      * Set next behavior state = cSpaceshipThrust
  + Add a case for cSpaceshipThrust
    - Call BehaviorSpaceshipUpdateRotation.
    - Call BehaviorSpaceshipUpdateVelocity.
    - Call BehaviorSpaceshipUpdateWeapon
    - If ‘VK\_UP’ is NOT *pressed*,
      * Set next behavior state = cSpaceshipIdle
* BehaviorSpaceshipExit:
  + This function may remain empty.
  + Use UNREFERENCE\_PARAMETER() to fix the warning.
* BehaviorSpaceshipUpdateRotation:
  + If ‘VK\_LEFT’ is *pressed*,
    - Set the physics component’s rotation velocity = spaceshipTurnRateMax
  + Else If ‘VK\_RIGHT’ is *pressed*,
    - Set the physics component’s rotation velocity = -spaceshipTurnRateMax
  + Else
    - Set the physics component’s rotation velocity = 0
* BehaviorSpaceshipUpdateVelocity:
  + Get the transform and physics components from the behavior’s parent game object
  + Verify that the pointers are valid
  + Get the transform component’s ‘rotation’
  + Get a unit vector in direction of ‘rotation’
    - Hint: There is a Vector2D function for this
  + Get the physics component’s ‘velocity’
  + Calculate the new velocity:
    - velocity = velocity + direction of rotation \* spaceshipAcceleration \* dt
    - Note: Try using the Vector2DScaleAdd function for this
  + Calculate the ‘speed’ of this new velocity
    - Hint: speed = length(new velocity)
  + If the speed > spaceshipSpeedMax, then limit the speed:
    - velocity = velocity \* (spaceshipMaxSpeed / speed)
  + Set the physics component’s new velocity
* BehaviorSpaceshipUpdateWeapon:
  + If the behavior timer > 0,
    - Decrement the behavior timer by ‘dt’.
    - If the behavior timer < 0,
      * Set the behavior timer = 0
  + If spacebar (‘ ‘) is *pressed*,
    - If behavior timer <= 0
      * Call BehaviorSpaceshipSpawnBullet
      * Set behavior timer = spaceshipWeaponCooldownTime
* BehaviorSpaceshipSpawnBullet:
  + Call GameObjectFactoryBuild to build a new ‘Bullet’ object
    - NOTE: The ‘objectName’ parameter is case-sensitive!
  + If the Bullet was cloned successfully
    - Get the spaceship’s position and rotation.
    - Set the *cloned* bullet’s position and rotation.
    - Get a unit vector in direction of the spaceship’s ‘rotation’.
    - Set the bullet’s velocity = direction \* spaceshipWeaponBulletSpeed
    - Add the cloned bullet to the game object manager’s active list.

BehaviorBullet.h

* This header file declares the public interface for creating and updating behaviors associated with bullet game objects. See the information below for detailed instructions on the implementation of the .c file.

BehaviorBullet.c

* Create an enum with the following entries:
  + cBulletInvalid = -1
  + cBulletIdle
* Add the following private function declaration:

static void BehaviorBulletUpdateLifeTimer(BehaviorPtr behavior, float dt);

* BehaviorBulletCreate
  + Calloc the memory for a Behavior structure.
  + If the memory was allocated successfully,
    - Set stateCurr = cBulletInvalid
    - Set stateNext = cBulletInvalid
    - Set the onInit, onUpdate, and onExit functions
* BehaviorBulletInit
  + This function may remain empty.
  + Use UNREFERENCE\_PARAMETER() to fix the warning.
* BehaviorBulletUpdate
  + Add a switch statement with the expression, (behavior->stateCurr)
  + Add a case for cBulletIdle
    - Call BulletBehaviorUpdateLifeTimer.
* BehaviorBulletExit
  + This function may remain empty.
  + Use UNREFERENCE\_PARAMETER() to fix the warning.
* BehaviorBulletUpdateLifeTimer()
  + If the behavior timer > 0,
    - Decrement the behavior timer by ‘dt’.
    - If the behavior timer <= 0,
      * Call GameObjectDestroy(), passing the behavior’s ‘parent’ pointer.

# Submission Requirements

* The project must build cleanly, with no errors or warnings.
* Once the assignment has been completed, create a submission .zip file by performing the following steps:
  + Select the following files and folders:
    - “AE” folder
    - “Assets” folder
    - “Data” folder
    - “Source” folder
    - Project4.sln
    - Project4.vcxproj
    - Project4.vcxproj.filters
  + Right-click on one of these files and select the option:
    - “Send to” -> “Compressed (zipped) folder”
  + The resultant .zip file **must not** include any of the following Visual Studio generated folders and files:
    - Folders: “Debug”, “Release”, “ipch”
    - Files (\*.db, \*.sdf, \*.opendb)
  + Rename the resultant .zip file using the following naming convention:
    - CS230SU22<section letter>\_<Login ID>\_Project4.zip
      * Example: CS230SU22A\_john.doe\_Project4.zip
* Upload the submission .zip file via the Moodle page for your CS230 section (A or B)
* It is your responsibility to ensure that the project was submitted properly. Once the submission has been uploaded, it is ***highly recommended*** that you verify that the submission process was completed successfully by performing the following steps:
  + Return to the home Moodle page for your section (A or B)
  + Click on the assignment submission link
  + Download the .zip file to your computer
  + Unzip the contents of the .zip file into an empty folder
  + Open the Visual Studio solution file
  + Clean and rebuild the project
  + Verify that the program runs correctly (within Visual Studio is fine)

# Assignment Grading Guidelines

* A -25% penalty will be applied for each week or portion of a week that the project is submitted late.
* A -10% penalty will be applied to any submissions that are performed incorrectly (e.g. incorrect .zip format, submitting extraneous files, etc.)
* A -10% penalty will be applied to any submissions that do not conform to the naming convention specified in the Submission Requirements section.