Autodesk Maya
modeling, animation, scripting
and C++ programming
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Cours ENSIMAG, Ingénierie de l’Animation 3D
Goals

• Discover a professional tool in 3D production
  • Practical implementation of theoretical concept
    • cf: “Synthèse d’images”, “Visualisation scientifique 3D »
  • Gain experience on a software that is a reference in the digital media industry

• Learn the role of programmers in 3D workflows
  • To cooperate with artists and engine programmers
  • Developing tools
    • Scripts (MEL / Python)
    • Plug-ins C++ (hot reload system)
Organization & Evaluation

• Introduction to Maya (6h)
• Development project (9h)
• Evaluation (3h)
  • Attendance
  • Results
  • + clean source code for bonus points?
3D Programming

• Different software categories
  • Libraries
    • Low level: OpenGL, DirectX, CUDA, OpenCL
    • Higher level: Qt, OpenACC, Boost.Compute
  • Engines
    • Rendering, Animation, Physics, All-in-One..
  • Artist software
    • General purpose: 3ds Max, Maya, Blender
    • Rendering: Mental Ray, Mitsuba, Lightwave
    • Animation: MotionBuilder, Houdini, Cinema 4D,
    • Modeling: Rhinoceros, ZBrush, Mudbox
3D Programming

• Different language levels
  • CPU
    • APIs C/C++ dedicated to 3D or computation: OpenGL, DirectX
      • Delegation to GPU though drivers or emulation on CPU depending on the hardware.
    • Libraries, engines, software APIs
  • GPGPU (GPU for Computation)
    • Low level (specific language): Compute Shaders
    • Mid level (C++ & specific language): CUDA, OpenCL
    • High level (C++): Nvidia PhysX, Havok Game Dynamics
  • GPU (for Graphics)
    • Specific language (between C and assembly): shaders
      • Depends on target platform: NVIDIA, ATI now AMD, PlayStation, Xbox
      • ex: GLSL, HLSL, CG, PSSL
3D Programming in the Digital Media Industry

• Animation Studios
  • Maya and 3ds Max are the reference
  • Proprietary suites are used in the biggest studios (Disney, DreamWorks, Pixar)
    • ex: Disney’s Tonic tool for hair modeling & simulation
3D Programming in the Digital Media Industry

• Game Studios
  • Most studios use Maya or 3ds Max
  • Tools are often proprietary as well as file formats (to protect assets)
    • ex: EA’s, Blizzard’s and Riot’s file formats
  • Assets are used by the 3D engine of an end-user software
    • Implies the use of proprietary solutions to store geometries, animations, particle emitters...
      • ex: Valve provides the workflow standards of their game Dota2 to freelancers
        http://www.dota2.com/workshop/
3D Programming in the Digital Media Industry

- Extended workflow

![Diagram showing workflow and software tools used in 3D programming.](attachment:image.png)
Autodesk Maya

- Interactive application for:
  - Modeling
    - Polygons, NURBS, Subdivision, Texture placement
  - Animation
    - keyframe, skeleton, physics
  - Rendering
    - Interactive (real-time visu.), off-line (ray-tracing)
- Open software architecture (script and C++)
- Multi-platform (formats, script and code)
- Nice Documentation support (F1)
Project summary

• Development of a tool related to animation
  • Specific deformation technique: Green Coordinates

• 4 languages will be addressed
  • Maya Embedded Language (MEL) Script
  • Maya Python Script
  • Python using Maya API
  • C++ using Maya’s C++ API
    • Integrating the algorithm into Maya’s core mechanics
But first!

You will discover and manipulate this software a bit.

(Artists have around 6 months of full-time training to use it properly, so don’t expect to be experts at the end of this course.)
Maya Interface
Maya’s software architecture

- MEL / Python
- C++ API
- Interface
- DG (Nodes & Attributes)
- DAG (Scene Graph)
MEL (Maya Embedded Language)

• create/edit objects, query/set attributes
  • geometry, animation, computation nodes

• Algorithm
  • control flow, data structures, procedures

• GUI (Maya own programming widgets)
  • input handling
Maya API C++

• Programmable nodes
  • input: geometry[], float[], time, etc
  • output: geometry[], float[], color[], etc
    Exemples : shaders, skinning

• Custom File I/O

• Custom tools (3D HCI widgets)
  • access to OpenGL context of interactive view

• Stand-alone application
  • use Maya API but no need for Maya Interface
  • open Maya binary files
Maya programming books

• Complete Maya Programming, D. Gould, Morgan Kaufmann
  • for MEL script and C++
  • two volumes
Maya Learning tools

• A nice set of tutorials
  • See Maya Documentation “Getting Started” through Help
• Additional tutorials and content from Autodesk Creative Suite
  • Should be installed on your computer
Maya and 3D on the web

- [www.autodesk.com](http://www.autodesk.com)
  - FREE version for student
- [www.creativecrash.com](http://www.creativecrash.com)
  - great source of scripts and plug-ins (mostly free), for Maya and others
- [www.turbosquid.com](http://www.turbosquid.com)
  - A lot of models (some free ones)