



13th Summer School on **SCIENTIFIC VISUALIZATION**

Blender

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BLENDER FOUNDATION

BLENDER

<http://www.blender.org>

<http://www.blender.org/features/demo-reels/>

<http://www.blender.org/features/projects/>



<http://gooseberry.blender.org/>





BLENDER HISTORY

“Blender is a free and open-source 3D computer graphics software product used for creating animated films, visual effects, art, 3D printed models, interactive 3D applications and video games. Blender's features include 3D modeling, UV unwrapping, texturing, rigging and skinning, fluid and smoke simulation, particle simulation, soft body simulation, sculpting, animating, match moving, camera tracking, rendering, video editing and compositing. It also features a built-in game engine.”

[http://en.wikipedia.org/wiki/Blender_\(software\)](http://en.wikipedia.org/wiki/Blender_(software))



BLENDER HISTORY

“The Dutch animation studio Neo Geo and Not a Number Technologies (NaN) developed Blender as an in-house application. The primary author was Ton Roosendaal, who previously wrote a ray tracer called Traces for Amiga in 1989. The name Blender was inspired by a song by Yello, from the album Baby.

Rosendaal founded NaN in June 1998 to further develop and distribute the program.

... The Blender Foundation initially reserved the right to use dual licensing, so that, in addition to GNU GPL, Blender would have been available also under the Blender License that did not require disclosing source code but required payments to the Blender Foundation. However, they never exercised this option and suspended it indefinitely in 2005.[5] Currently, Blender is solely available under GNU GPL.

Suzanne

... As a sort-of easter egg, a last personal tag, the artists and developers decided to add a 3D model of a chimpanzee. It was created by Willem-Paul van Overbruggen (SLiD3), who named it Suzanne after the orangutan in the Kevin Smith film Jay and Silent Bob Strike Back.

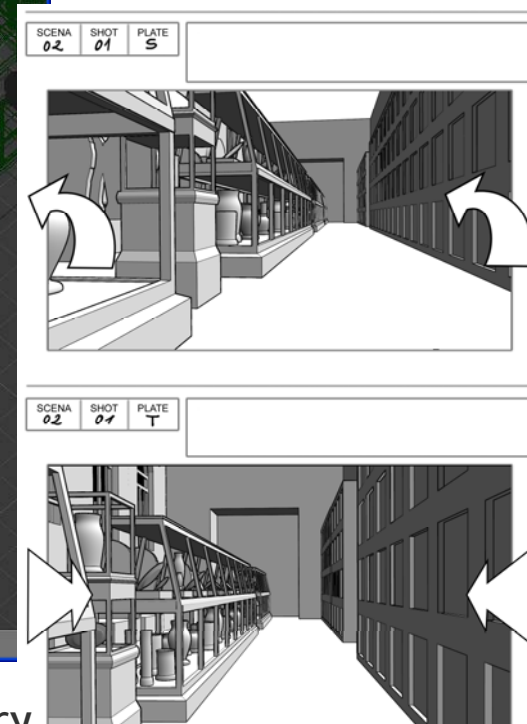
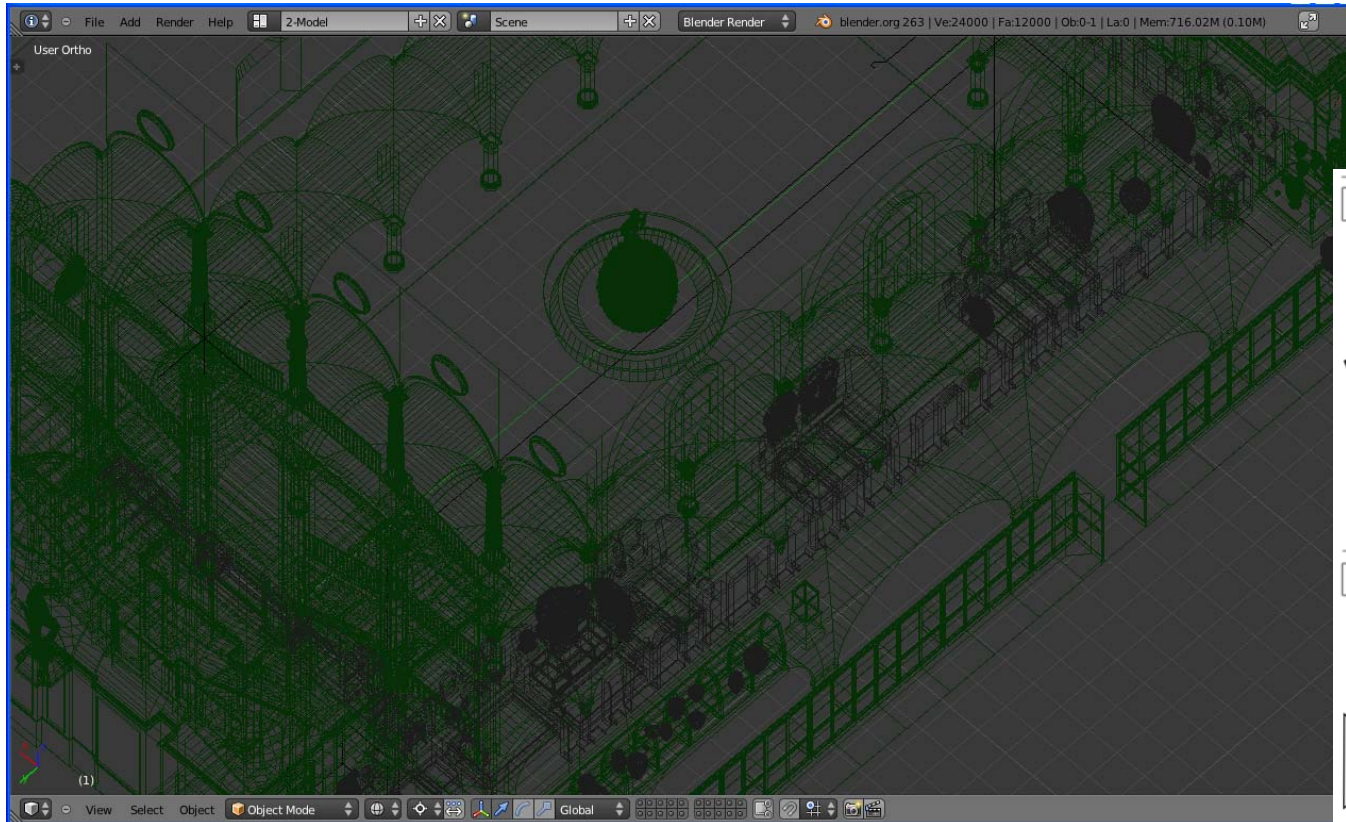
Suzanne is Blender's alternative to more common test models such as the Utah Teapot and the Stanford Bunny. A low-polygon model with only 500 faces, Suzanne is often used as a quick and easy way to test material, animation, rigs, texture, and lighting setups, and is also frequently used in joke images[citation needed]. Suzanne is still included in Blender. The largest Blender contest gives out an award called the Suzanne Awards.”

[http://en.wikipedia.org/wiki/Blender_\(software\)](http://en.wikipedia.org/wiki/Blender_(software))



BLENDER - CINECA APPLICATIONS

- SCENE:



Apa the Etruscan and 2700 years of Bolognese History
(in ACM SIGGRAPH ASIA 2011, Posters and Sketches Proceedings, Hong Kong, 2011)

BLENDER - CINECA APPLICATIONS



Summer
School on
SCIENTIFIC
VISUALIZATION

- RENDER:



Apa the Etruscan and 2700 years of Bolognese History

(in ACM SIGGRAPH ASIA 2011, Posters and Sketches Proceedings, Hong Kong, 2011)

<http://www.cineca.it/it/video/apa-alla-scoperta-di-bologna-i-primi-minuti-del-cartoon-3d>



Basis of Modeling



SCENE

The scene includes points, lines and polygons that exist inside a three dimensions space defined by X, Y, Z axis.

In order to compose a scene is necessary:

- define 3D object geometry - OBJECT MODELING
- define texture and material of all objects - SHADING AND TEXTURING
- define scene light for realistic final render - LIGHTING
- realize frame (RENDERING) or export created models in format file for real time navigation



OBJECT MODELING

- 3D models created with Blender
- 3D models created with others software and imported in Blender
- 3D models from laser scanner

software to manage point clouds
<http://meshlab.sourceforge.net/>

- 3D models from photographs

software to create models from photographs
<http://www.photomodeler.com>

<http://www.arc3d.be/>



OBJECT MODELING

Example of imported models in Blender:

-terrain created with osgdem

<http://openscenegraph.sourceforge.net/documentation/OpenSceneGraph/doc/osgdem.html>

-building with the software City Engine

<http://www.esri.com/software/cityengine>





OBJECT MODELING

3D MODELS

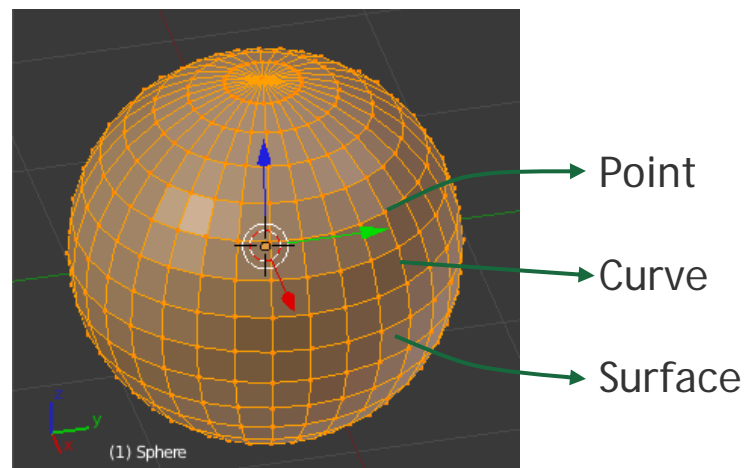
3D MODELS

a representation of 3D OBJECTS by using points connected each others by curves that define surfaces like triangles, quadrilaterals or other type.

A number of polygons linked together is called polymesh (mesh) and so can define a 3D object.

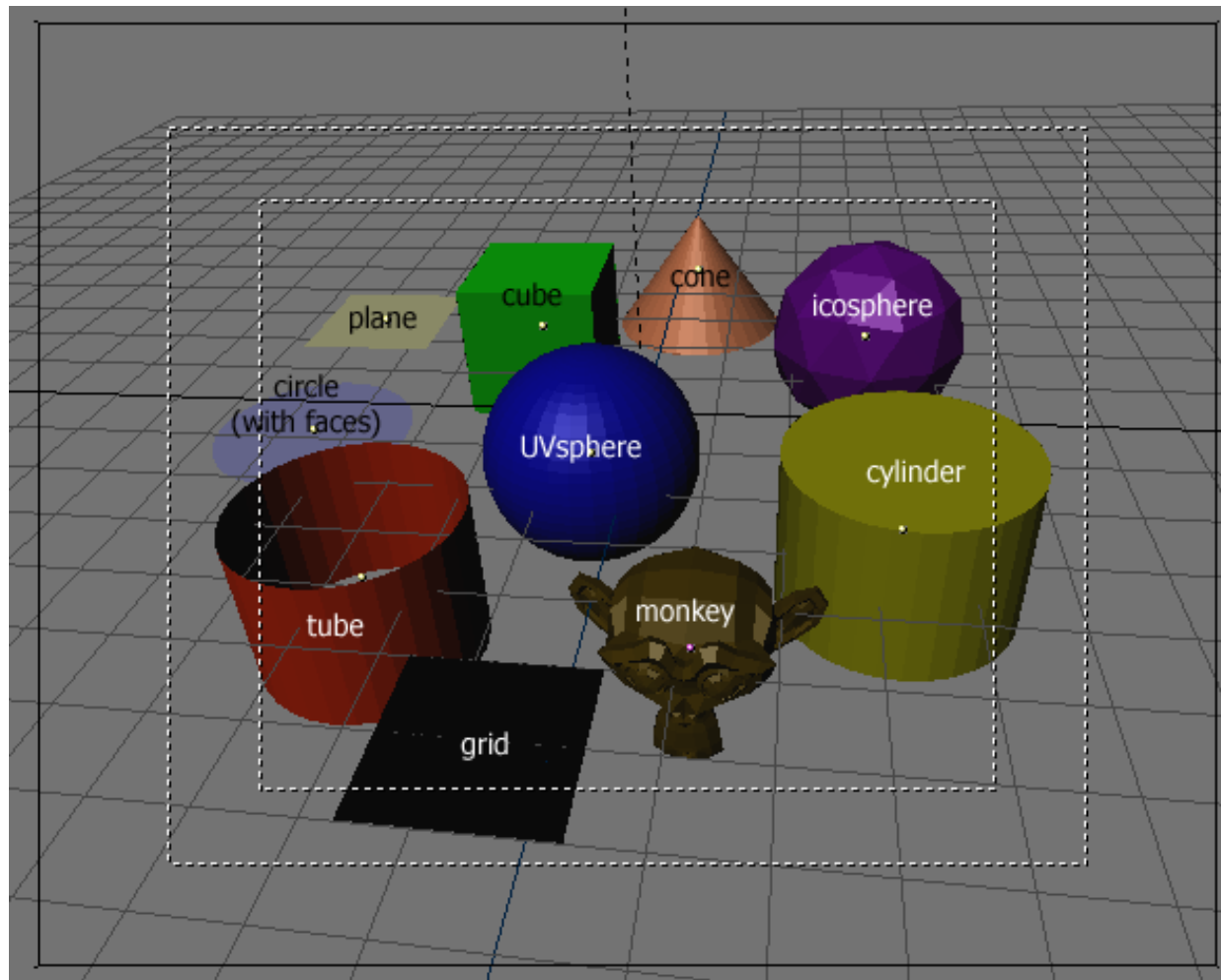
The coordinates are the geometric information, while the way in which the faces are made from the vertices are the topological information.

→ The set of faces is called Mesh.





BLENDER MESH PRIMITIVES





OBJECT MODELING

- Box modeling

Suited for simple and organic shapes

Starting from simple Mesh type objects (i.e. cube, sphere, ...) by changing vertices, edges and/or polygons 3D complex object can be created

- Spline modeling

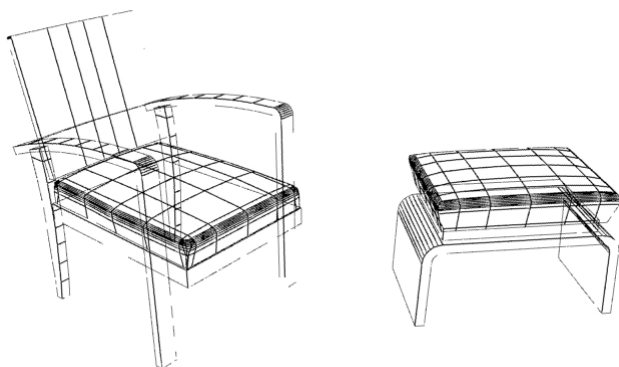
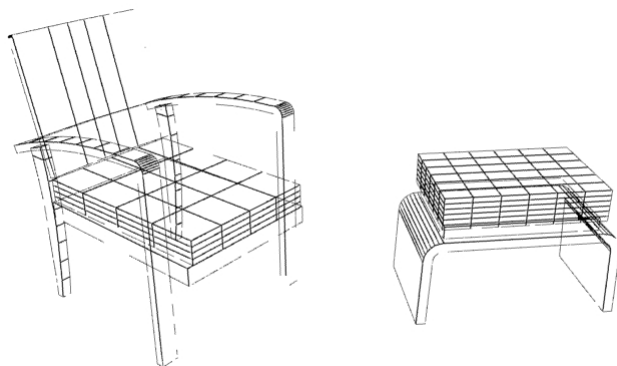
Suited for the design and mechanical models

Starting from a 2D Spline, like a building's plant, with specific operations like extrusion it is possible to obtain 3D object



OBJECT MODELING

Example of BOX MODELING from "MUVI", house of the Thirties

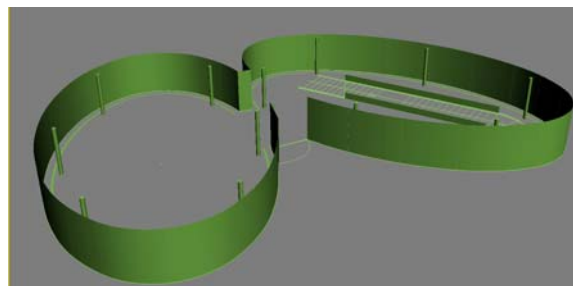
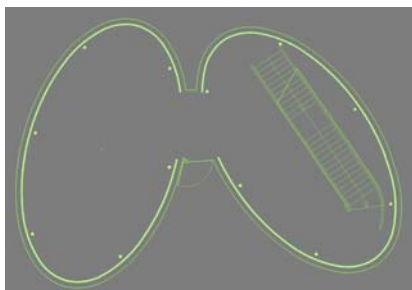




OBJECT MODELING

Example of SPLINE MODELING, extruded surface:

surface created by extending a curve along a direction.



Example of extruded surface from "MUVI", house of the Thirties:

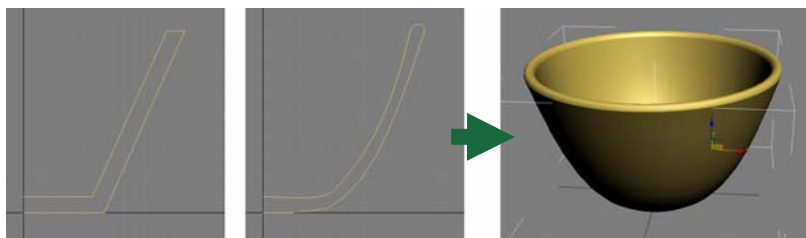




OBJECT MODELING

Example of SPLINE MODELING, revolved surface:

surface created using a simple curve, which is rotated about an axis to define a shape.



Example of revolved
surface from "MUVI",
house of the Thirties:





SHADING

Each object must be better identified with its own material.

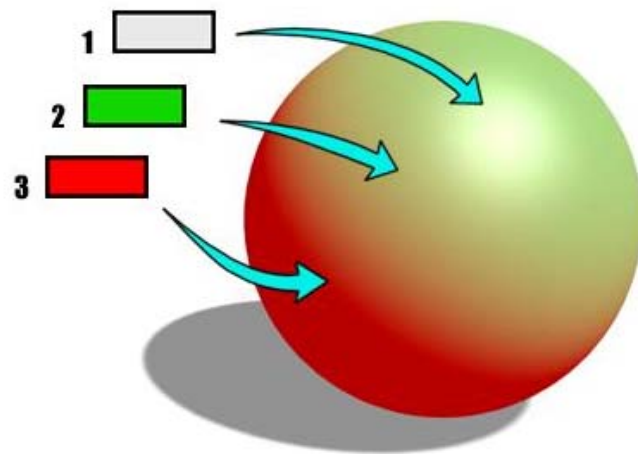
In particular, the material must be defined with different attribute and properties, which identify the material behavior to light.

The shadow and the light parts make an object appear three-dimensional, other information, such as transparency, refraction, roughness or smoothness, give more information of objects.

The following are lighting components:

- Ambient (3), color of the shaded part of the material that is still affected by the indirect light;
- Diffuse (2), color of the part directly affected by the light;
- Specular (1), color of the part of a glossy object.

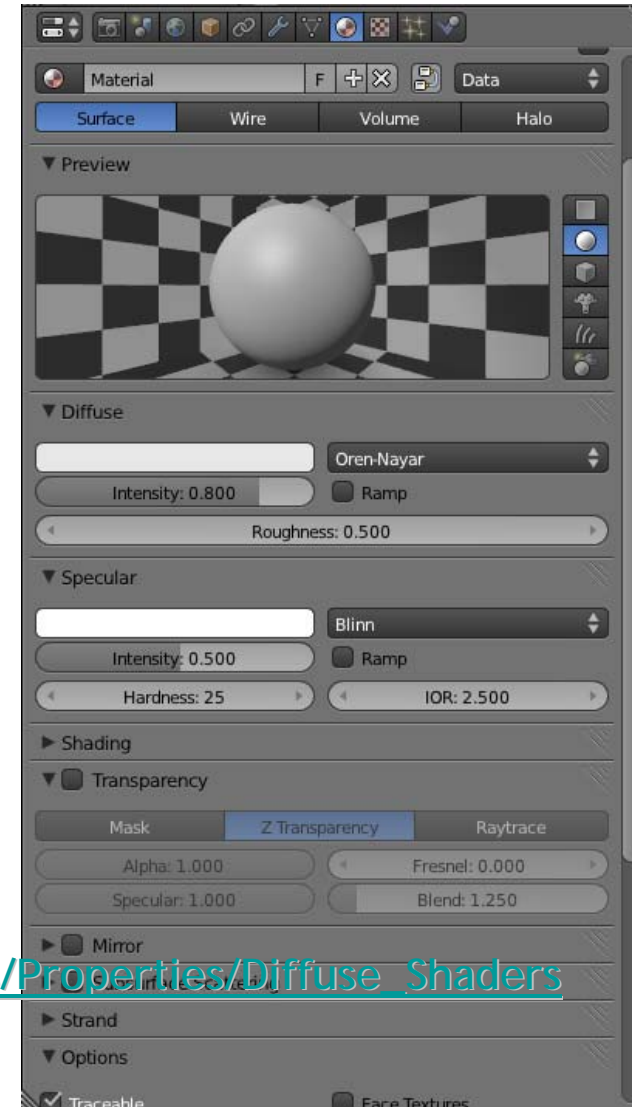
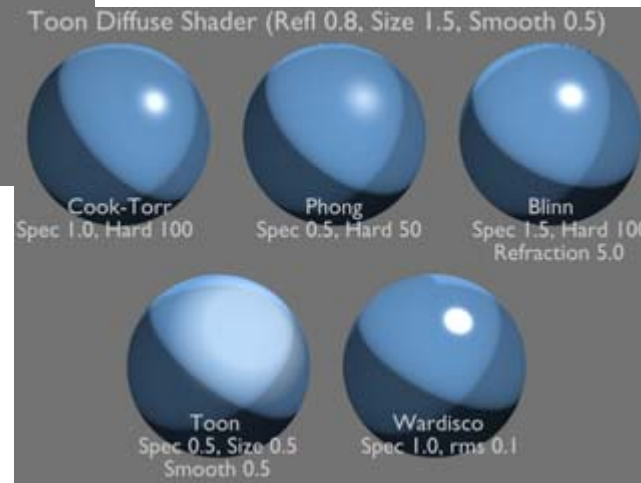
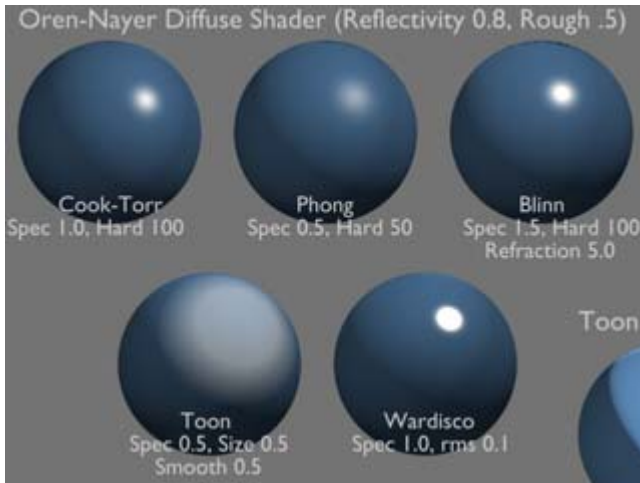
In reality,
Ambient and Diffuse
are the same color!





SHADING

Examples of Blender shading:



http://wiki.blender.org/index.php/Doc:2.4/Manual/Materials/Properties/Diffuse_Shaders

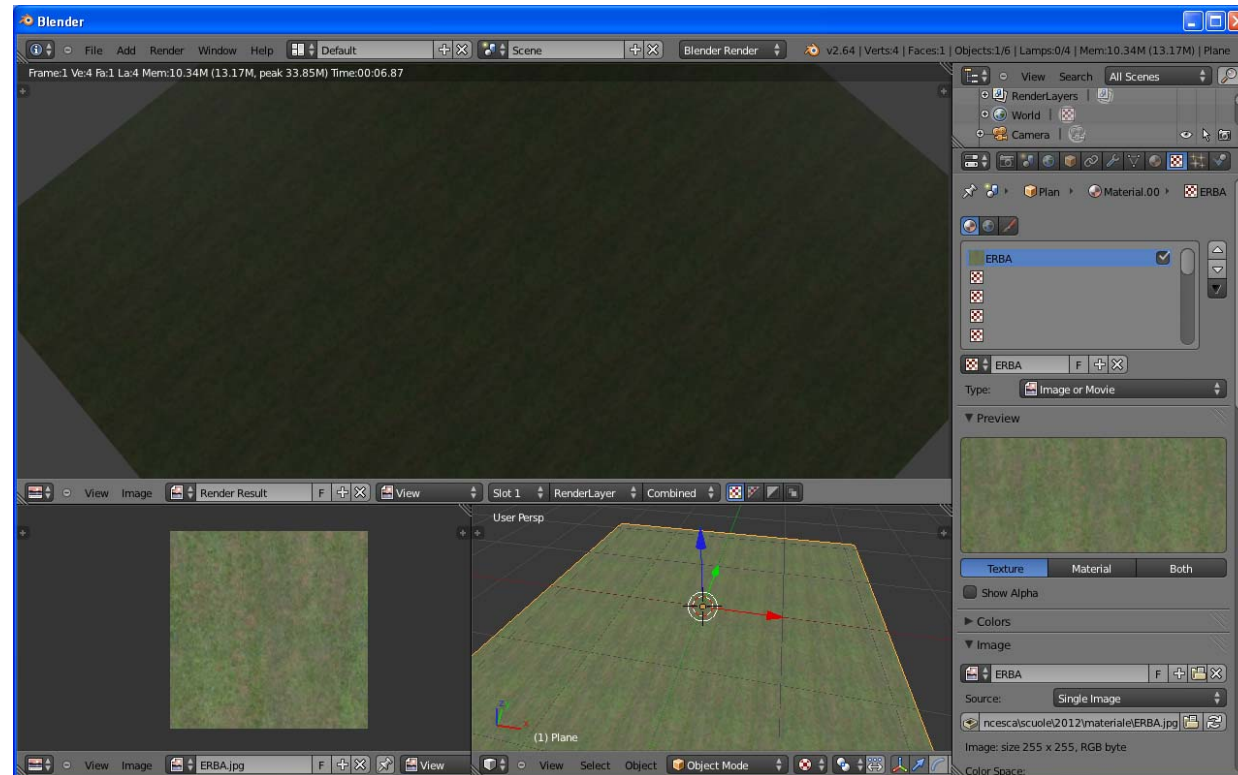


TEXTURING

Example of texture bitmap



The texture must be elaborated in order to have continuity up-down and left-right to be able to be repeated it over the entire object without discontinuity.



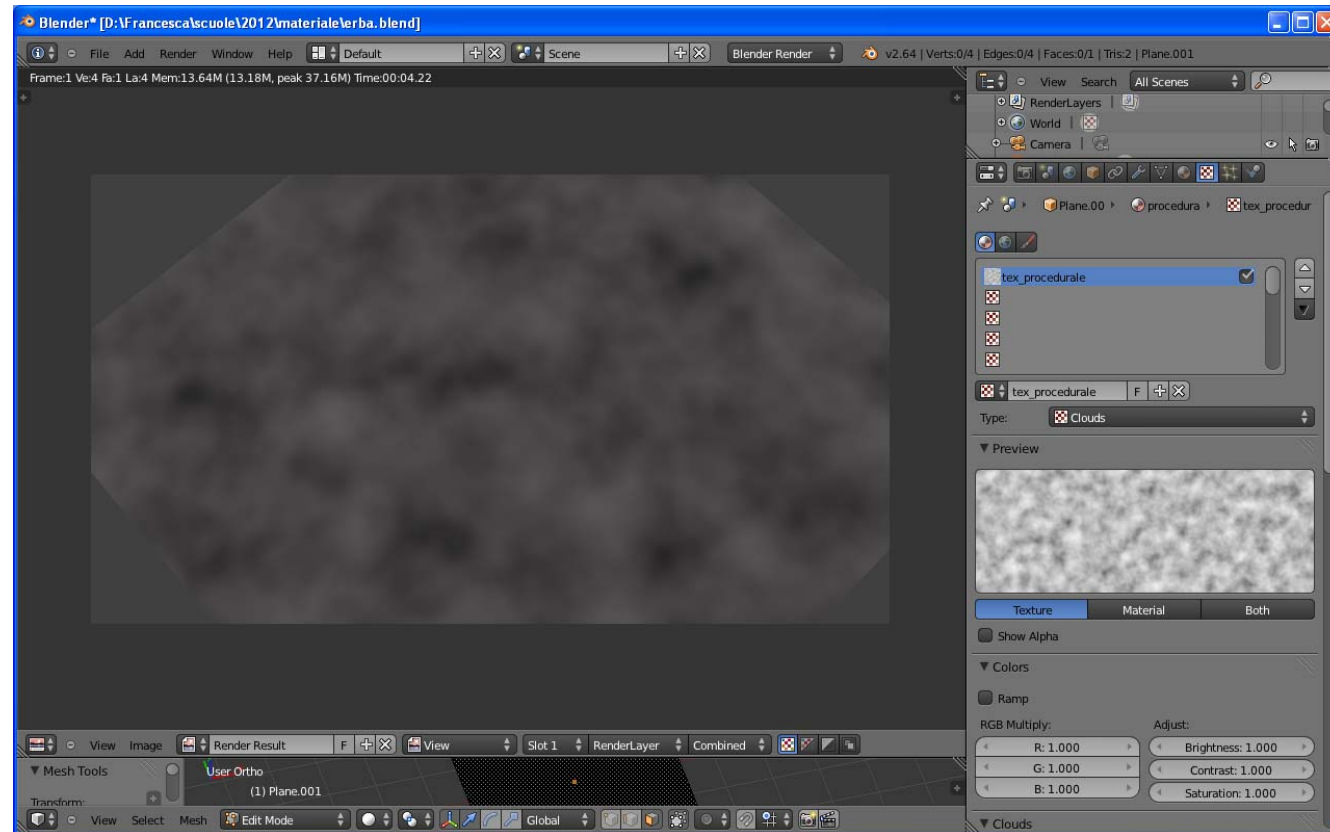
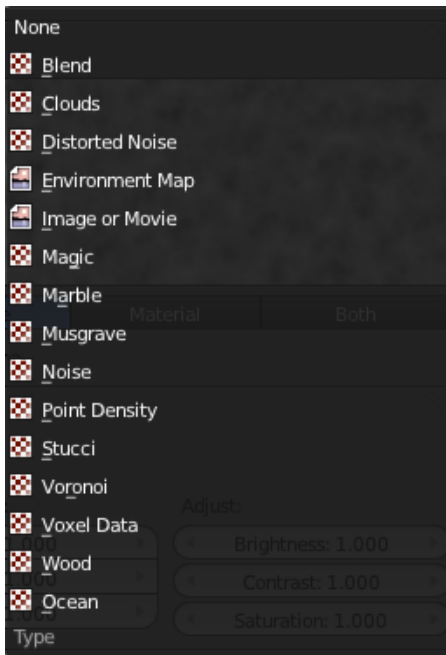


TEXTURING

Procedural texture

a computer-generated image created using an algorithm in order to create a realistic representation of natural elements.

Blender procedural texture:

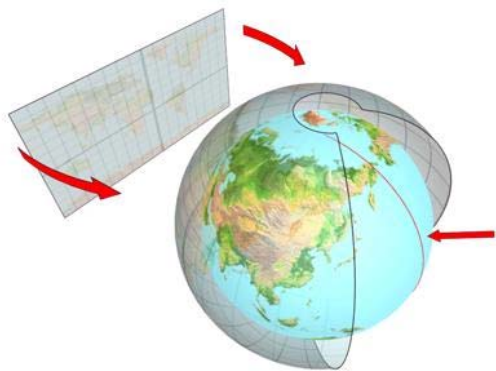




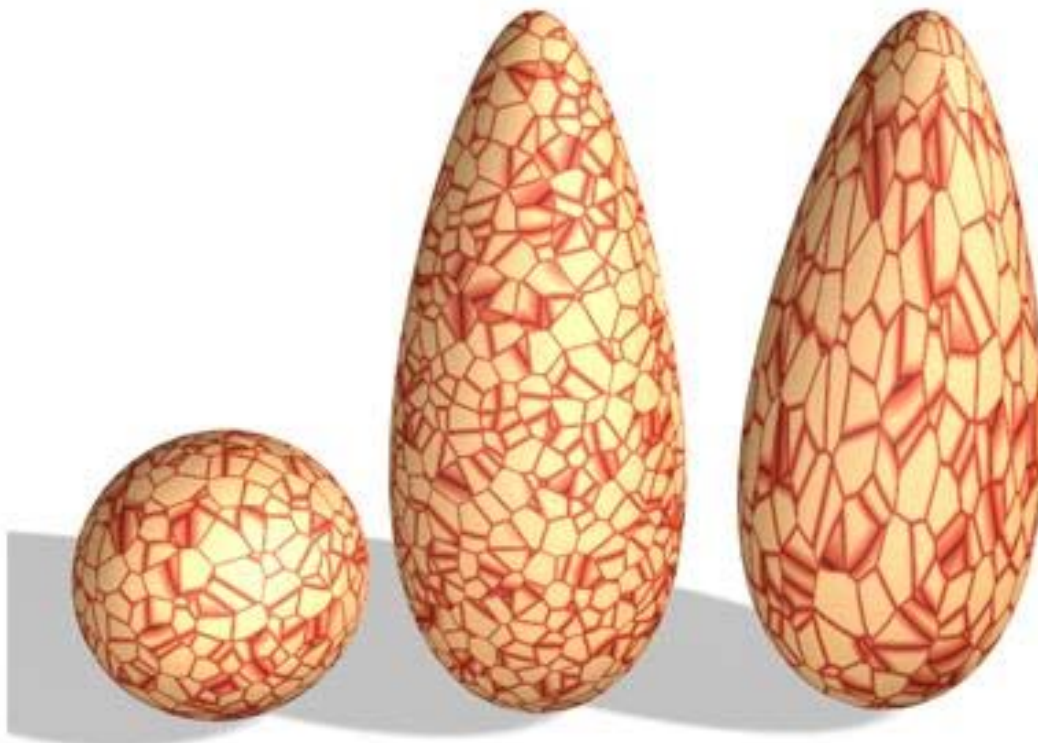
TEXTURING

In order to correctly apply a texture must be set up texture coordinates, that define how is visualize on a object:

- projection method,
- orientation,
- repetition.



Example of a spheric projection





SHADING/TEXTURING

Example from "MUVI", house of the Thirties





SHADING/TEXTURING

Example from "MUVI", house of the Eighties





LIGHTING

Lighting is a necessary step and is recommended even before the definition of the materials, in this way (with neutral material for all objects in the scene) can be better valuated the effect of the lights.

Below three general types of light that can be used:

- **Omni** (points of light that emit in all directions);
- **Spot** (cones of light used for simulate lamps or projectors);
- **Direct** (cylinders of light, usually used to simulate sunlight).

Each light can be customized by location and illumination intensity parameters, like decay, color, ...

For real-time navigation is useful to develop the textures so that they contain lighting and rendering information through a procedure called Render to Texture:

shadows and multi-texture are compacted into a single texture.



RENDERING

The set of operations required to transform a three-dimensional model (all 3D objects in the scene and their properties) in a two-dimensional visual representation (bitmap), depending on the view parameters and the type of the chosen mode of visual presentation .

By using algorithms that allow to make the effects of **Global Illumination** it is possible to achieve realistic effects of the scene.

GLOBAL ILLUMINATION definition:

It is a method (algorithm) of computation for light calculation in the scene which, takes in to account the light bounces from the neighboring surfaces, along with the normal illumination of direct lights. In Other words GI calculates the Indirect light also, thus it makes the renders more photo-realistic.



RENDERING

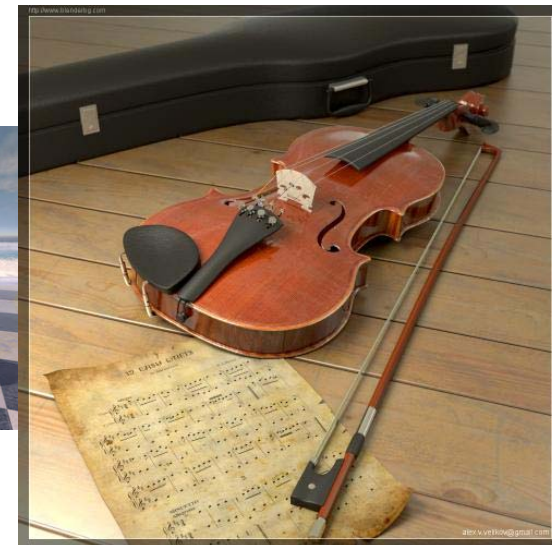
YafaRay

<http://www.yafaray.org/>



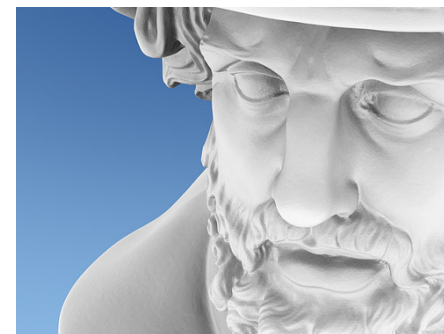
LuxRender

<http://www.luxrender.net/>



Aqsis Renderer

<http://www.aqsis.org/>





REAL TIME - RENDER TO TEXTURE

Render to Texture

This operation allows to precompute light and shadow information on the individual objects, necessary for real-time navigation.





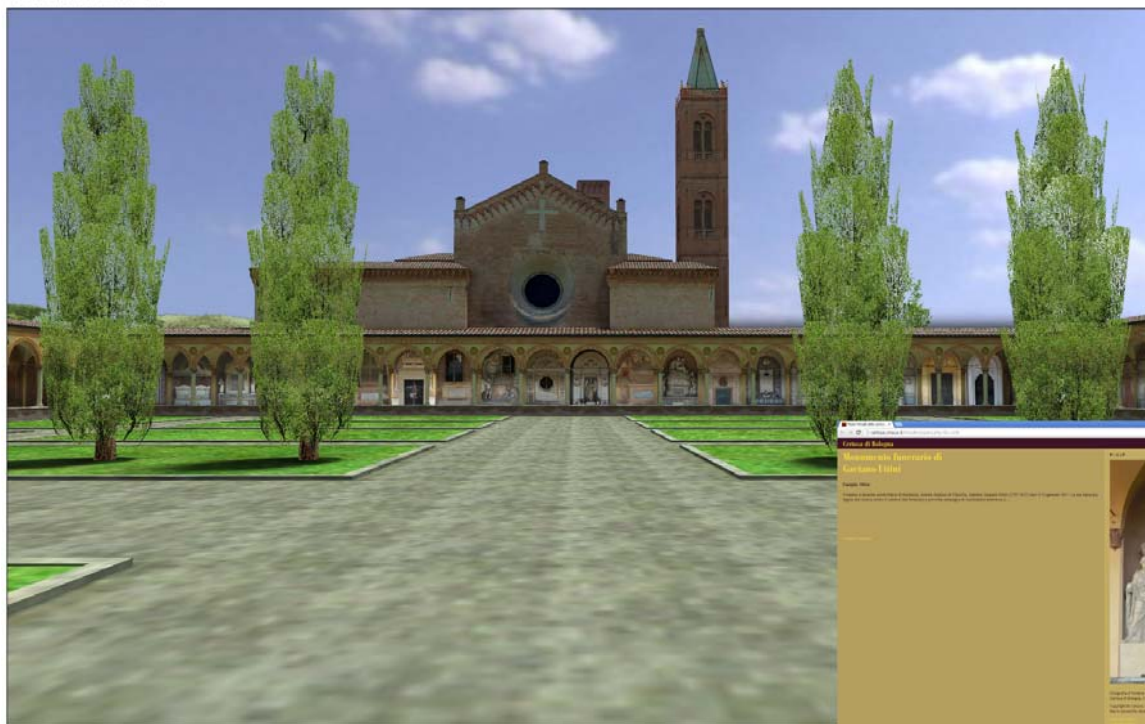
WEB

By exporting models in format x3d it is possible to put the model in a html page and navigate it freely (<http://www.x3dom.org/>).

https://hpc-forge.cineca.it/files/visit_3Dmodels/public/ChiostroIII_X3D/ChiostroIII.html

MUSEO VIRTUALE DELLA CERTOSA: Chiostro III

Prove di navigazione del modello in x3d.



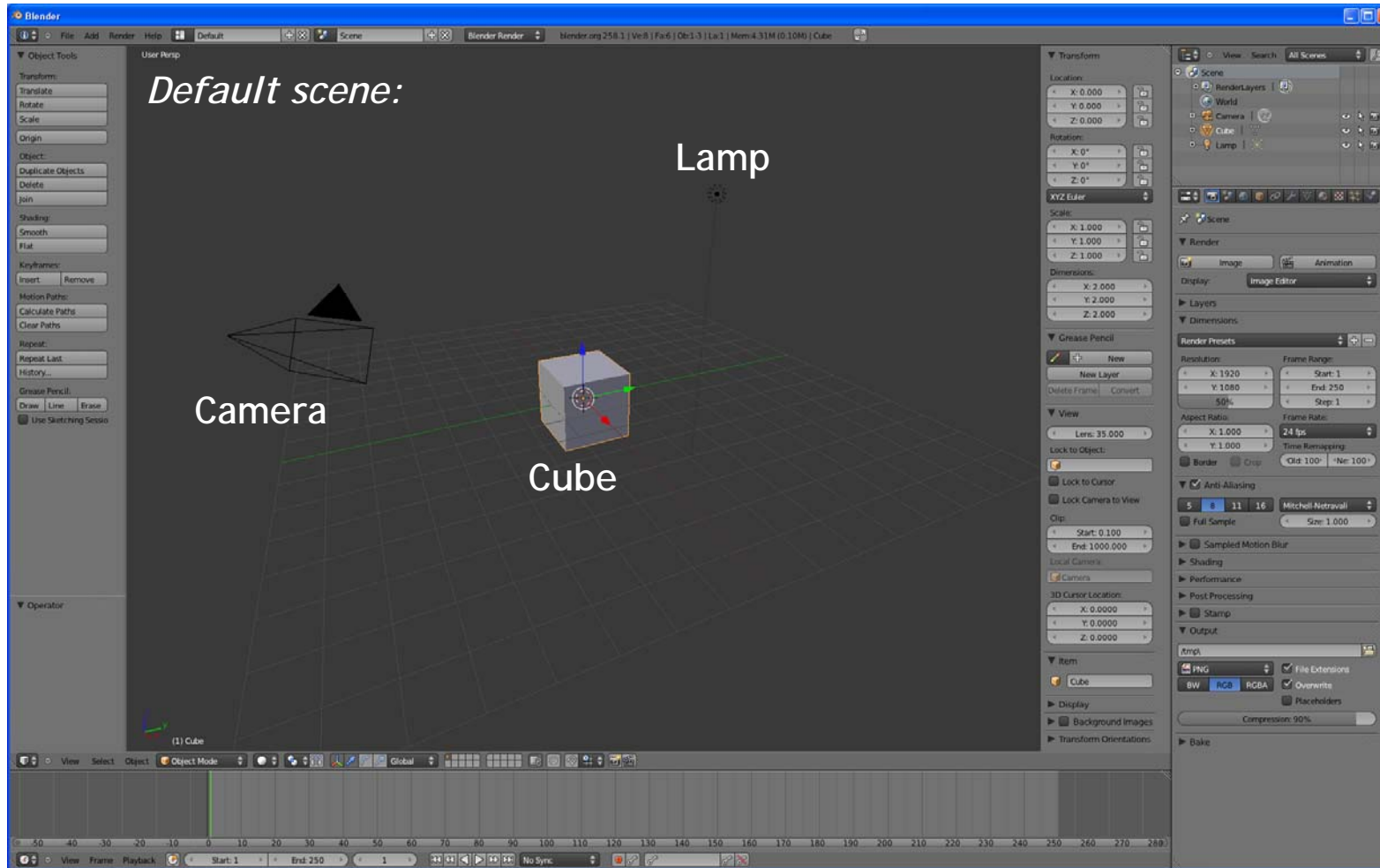
Lato EST Tomba Ulivi Inizio lato SUD Lato SUD Lato SUD-OVEST Lato OVEST Lato NORD-OVEST Lato NORD Centro Chiostro Percorso





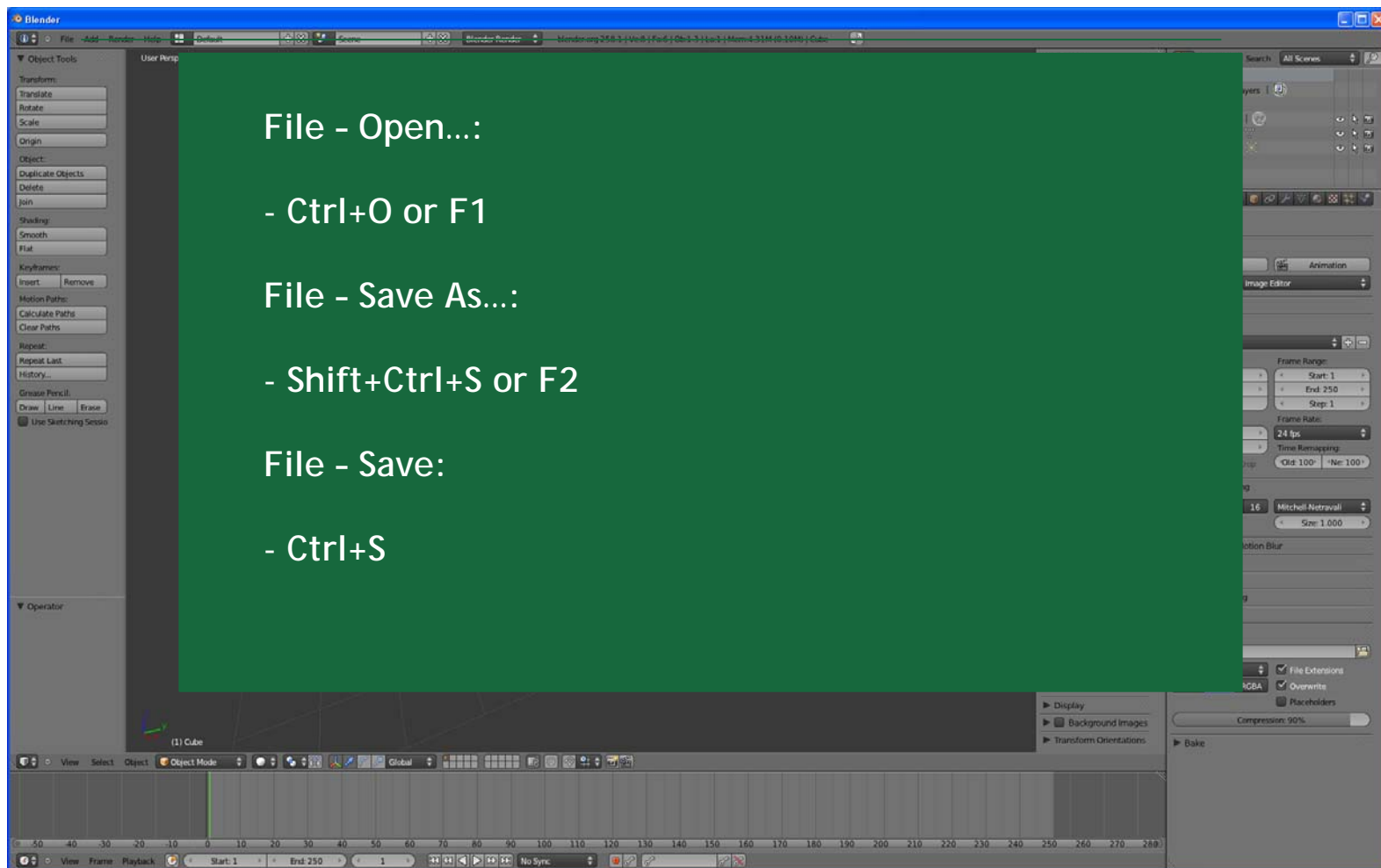
Blender

INTERFACE

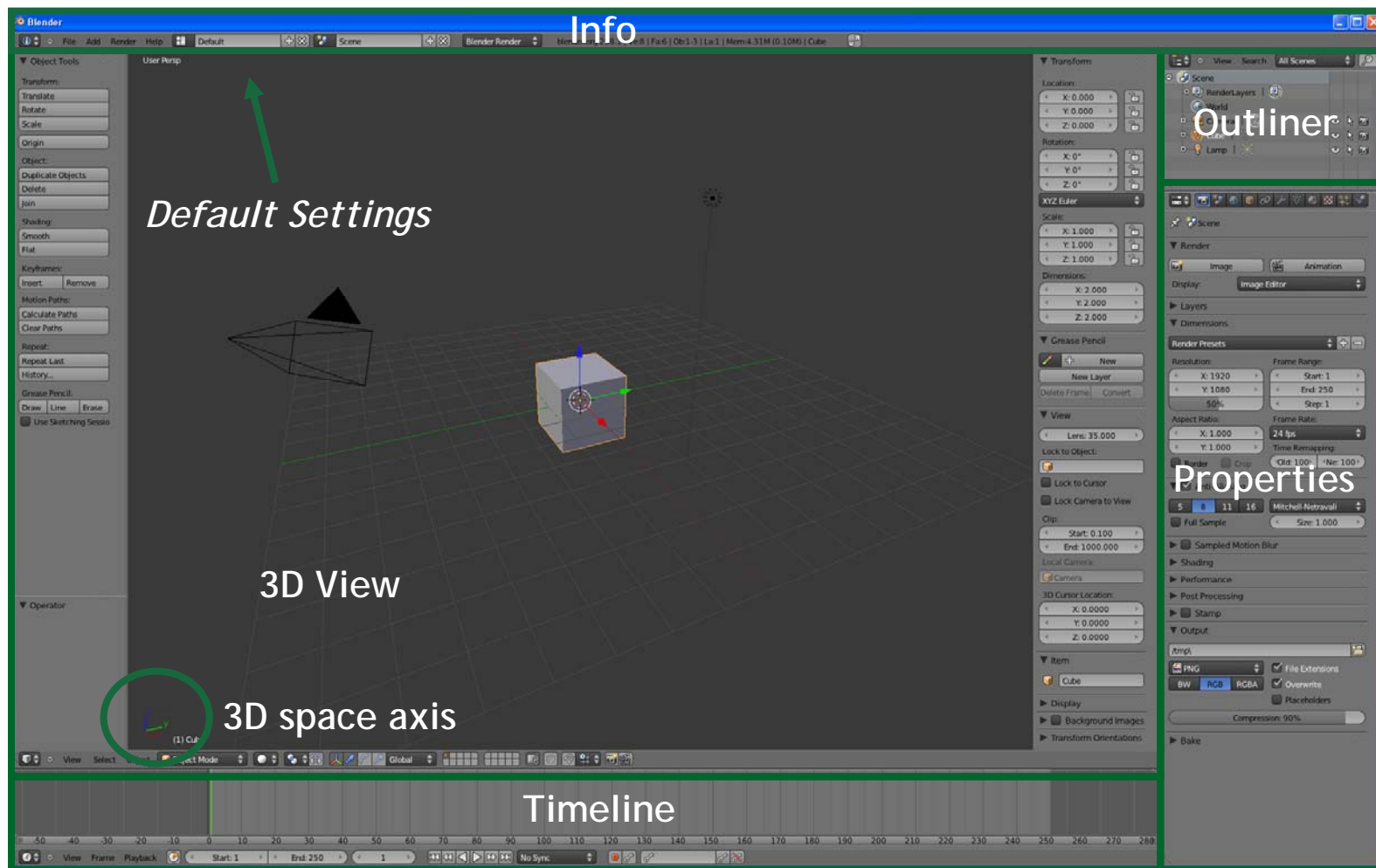




INTERFACE



INTERFACE





INTERFACE - USER PREFERENCES

Import/Export modules

Modules of import or export different file format can be chosen in the User Preferences window and let them visible in the Info window (File - Import, Export)

The screenshot shows the Blender 2.58.3 interface with the User Preferences window open to the Add-Ons tab. The 'Import/Export modules' section is highlighted, showing a list of modules that can be enabled or disabled. The 3D Viewport shows a cube in Object Mode. The right-hand side of the interface shows the Properties panel with the Render tab selected.

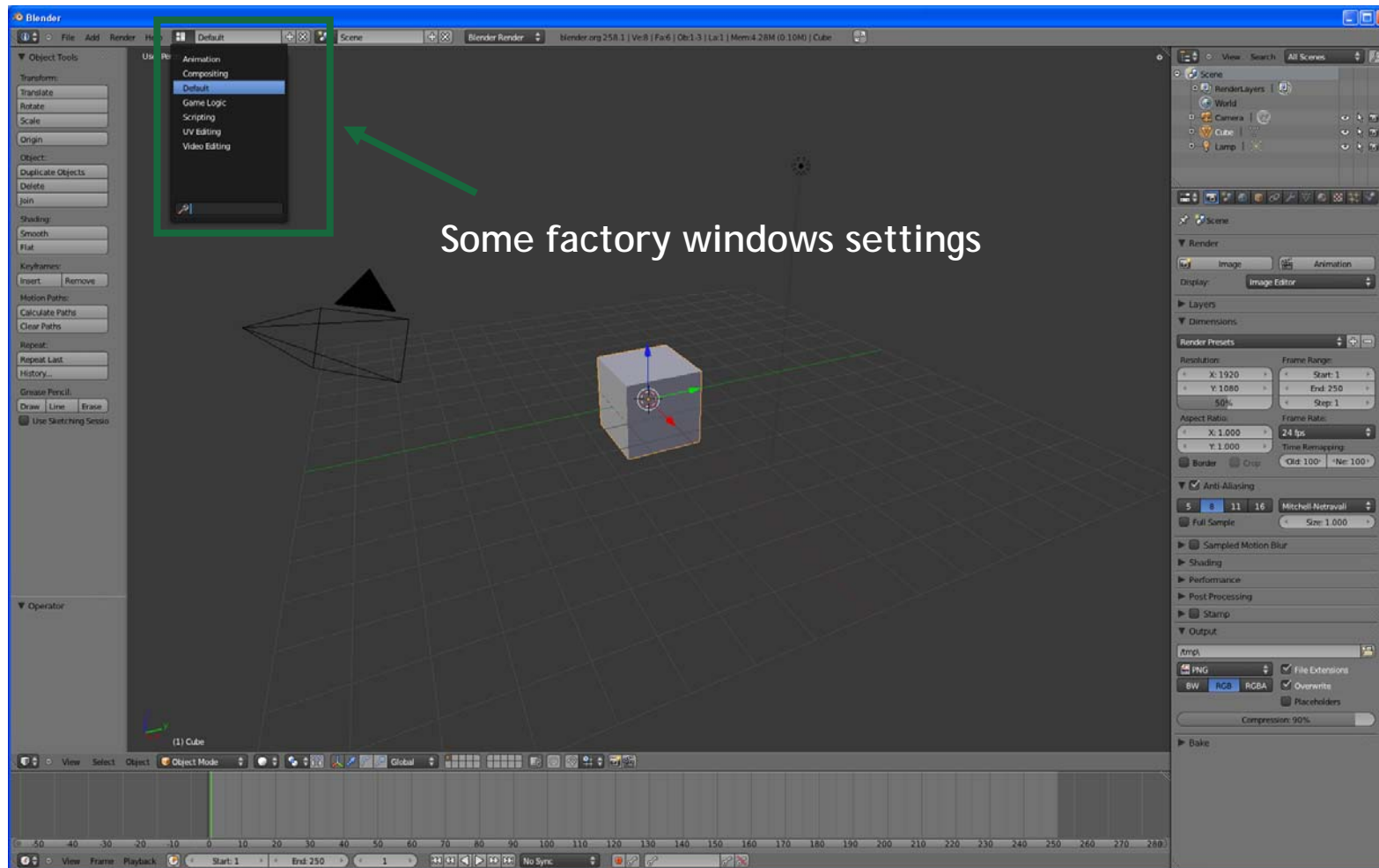


SHORTCUT

Combinations of keys that are used for a lot of commands (keyboard and/or mouse) instead of using tool bar, faster in the modeling stage.



INTERFACE



Some factory windows settings

INTERFACE



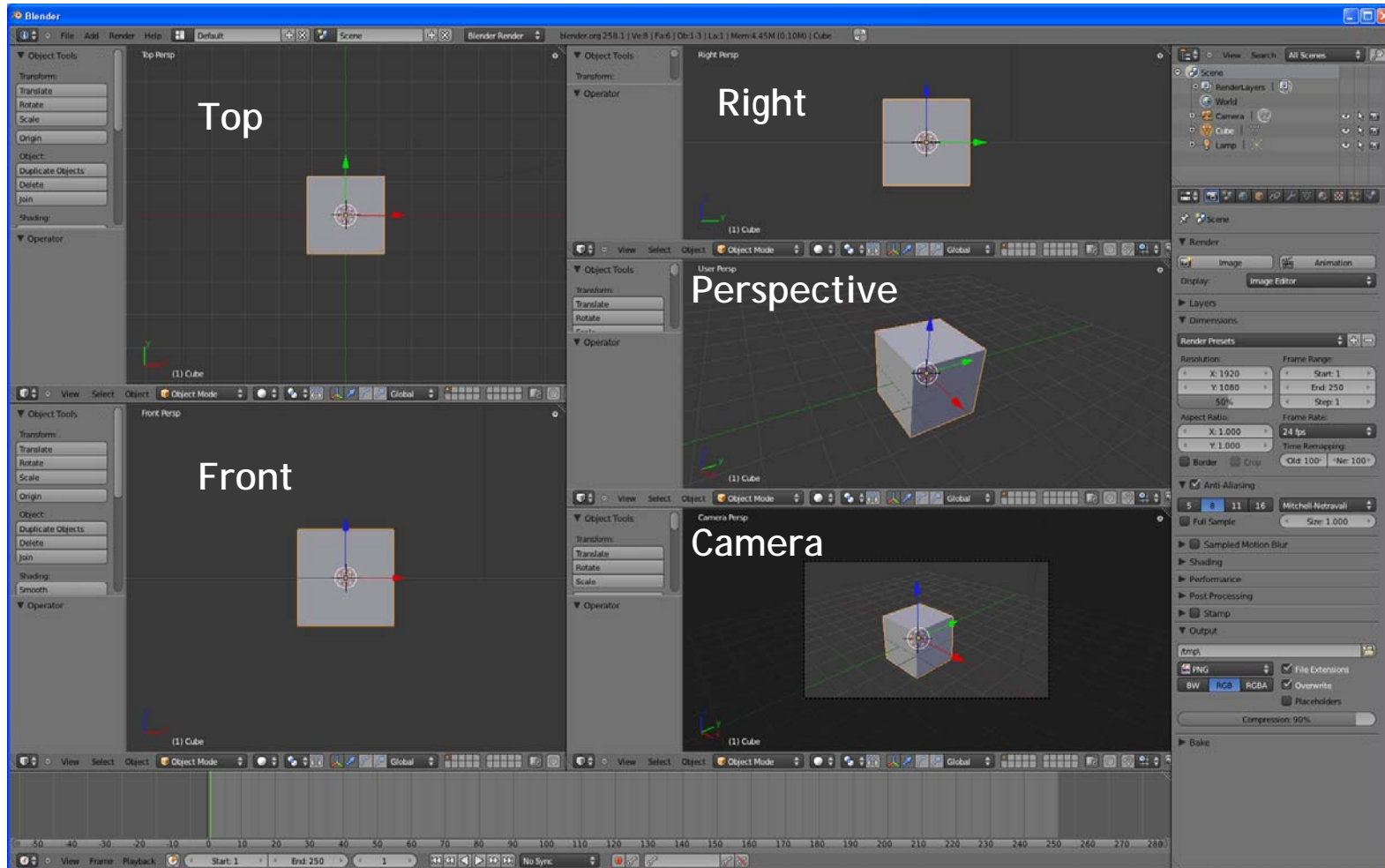
Drag the windows corner when highlighted

By putting mouse on window border will appear a double arrow, with click right button mouse it is possible to chose between:

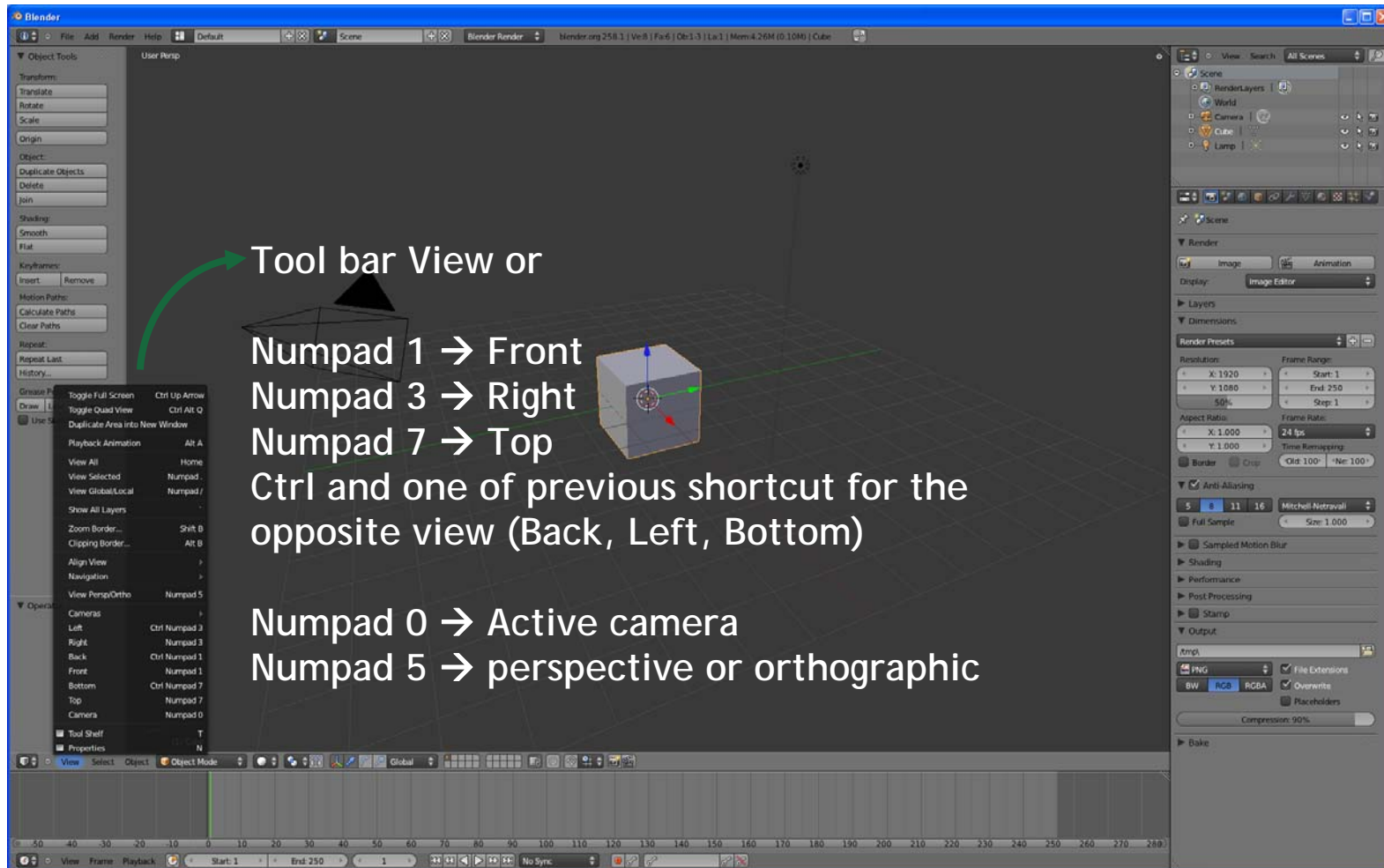
- SPLIT → split selected area into new windows
- JOIN → join selected areas into new window

Area Options
Split Area
Join Area

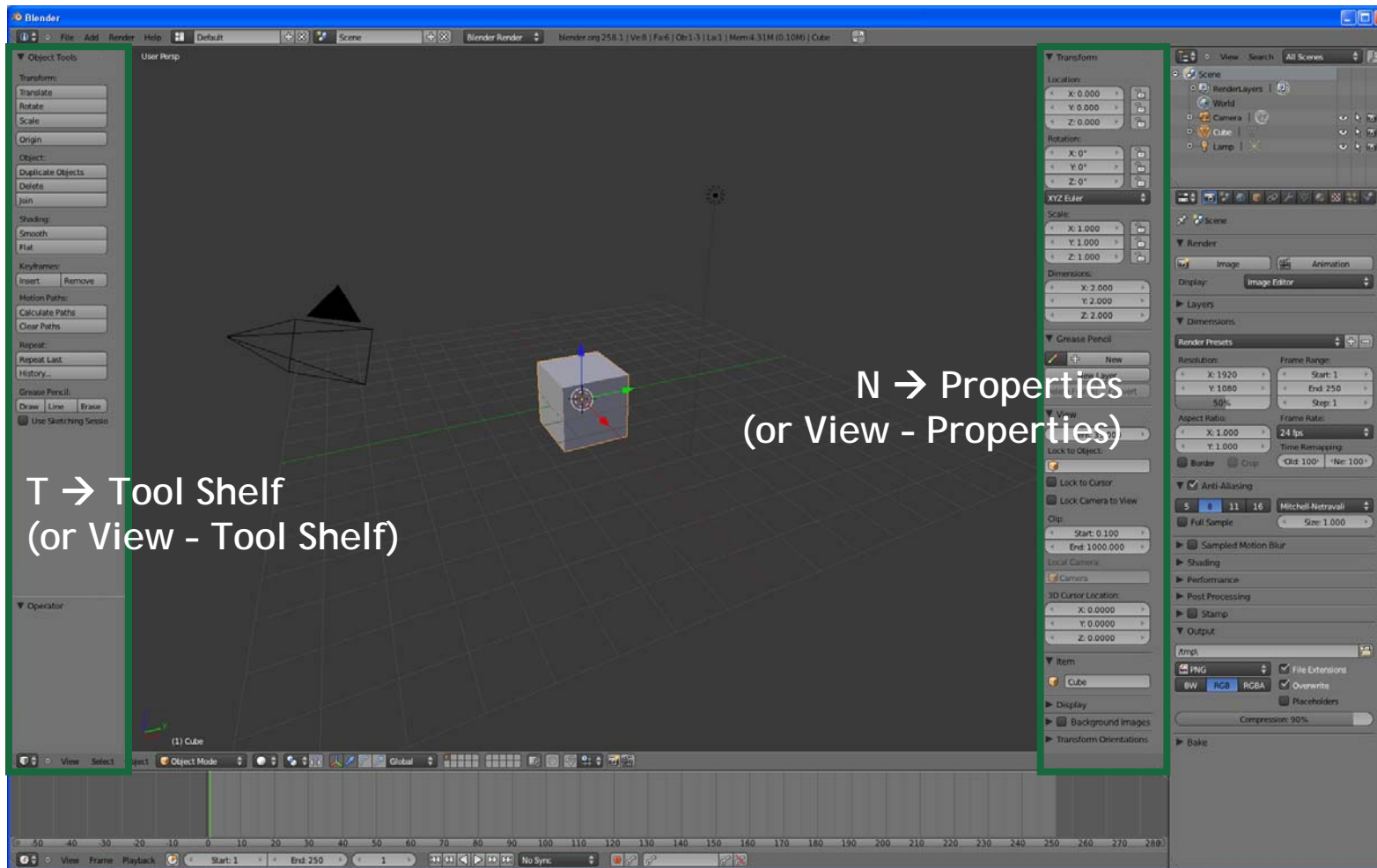
INTERFACE



INTERFACE



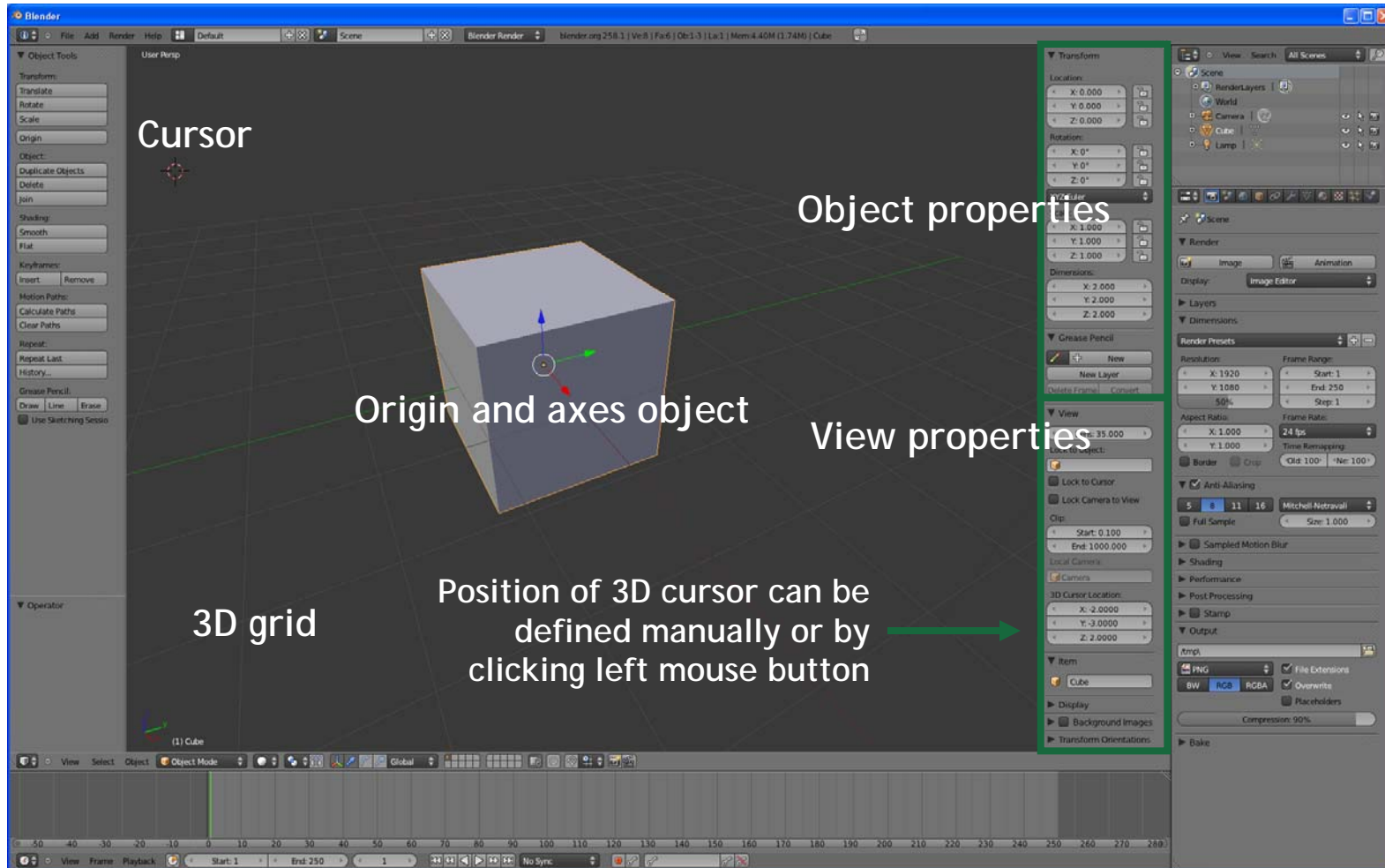
INTERFACE



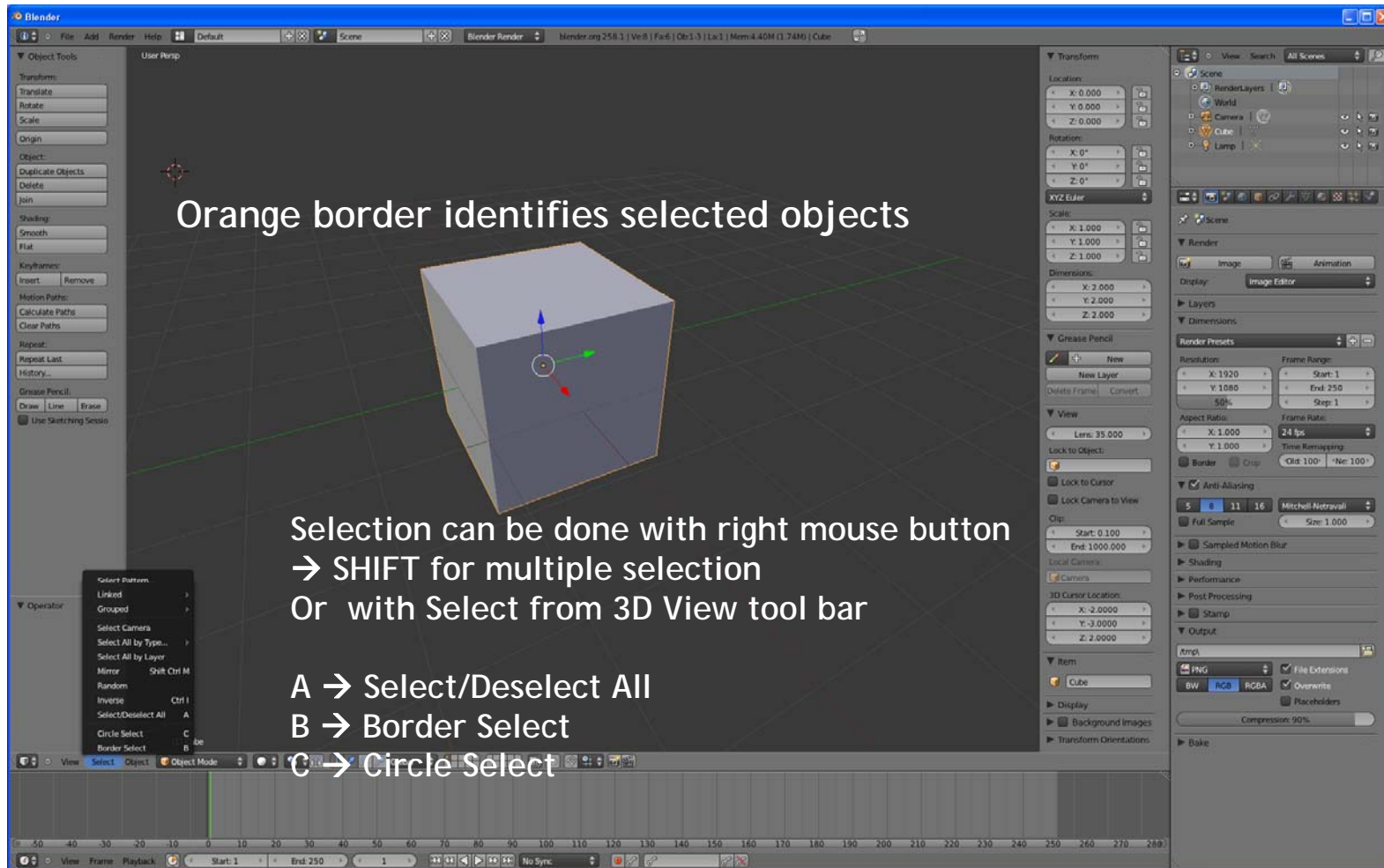
N → Properties
(or View - Properties)

T → Tool Shelf
(or View - Tool Shelf)

INTERFACE



INTERFACE



SHIFT + G → similar selection

LAYER



M → to move selected objects from a layer to another

Shift+click on layer → to visualize more layer at the same time

Only objects on visible layers are rendered.

The image shows the Blender 2.79 interface. In the center, a 3D scene contains a sphere, a cube, a cylinder, and a cone. A 'Move to Layer' dialog box is open, showing a grid of layer icons. A green arrow points from the text 'M →' to the dialog box. Another green arrow points from the text 'Shift+click on layer →' to the layer icons in the dialog. A third green arrow points from the text 'Only objects on visible layers are rendered.' to the 'Cone' object in the 3D view. The right-hand side of the interface shows the 'Render' and 'Layers' panels. The 'Layers' panel shows a grid of layer icons, with the 'Cone' layer highlighted. The 'Render' panel shows various rendering options like resolution, frame range, and anti-aliasing.



INTERFACE

UNDO:

- Ctrl+Z

REDO:

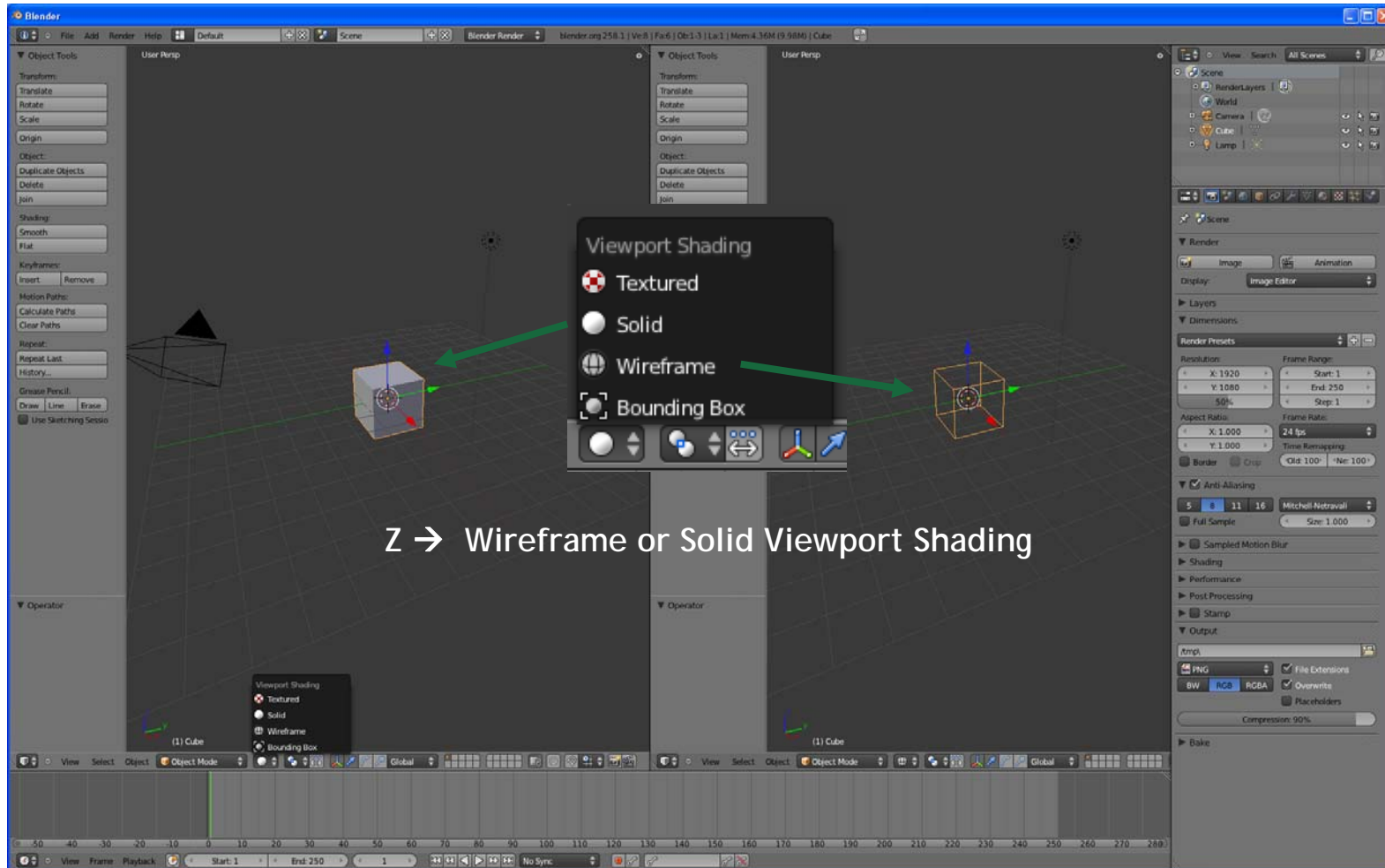
- Shift+Ctrl+Z

HISTORY:

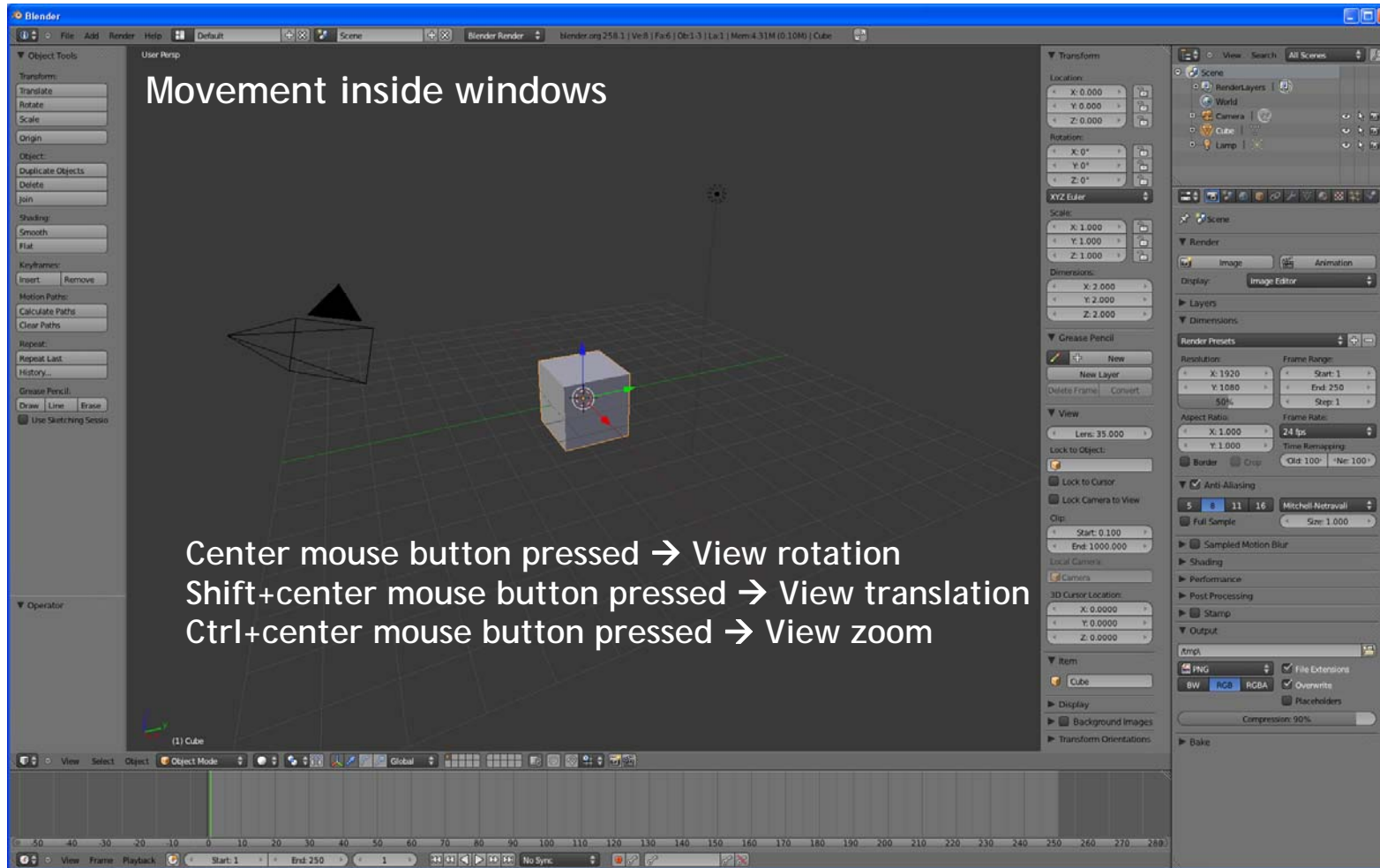
- Ctrl+Alt+Z

All action are visualized and it is possible to choose from which action restart modeling

INTERFACE



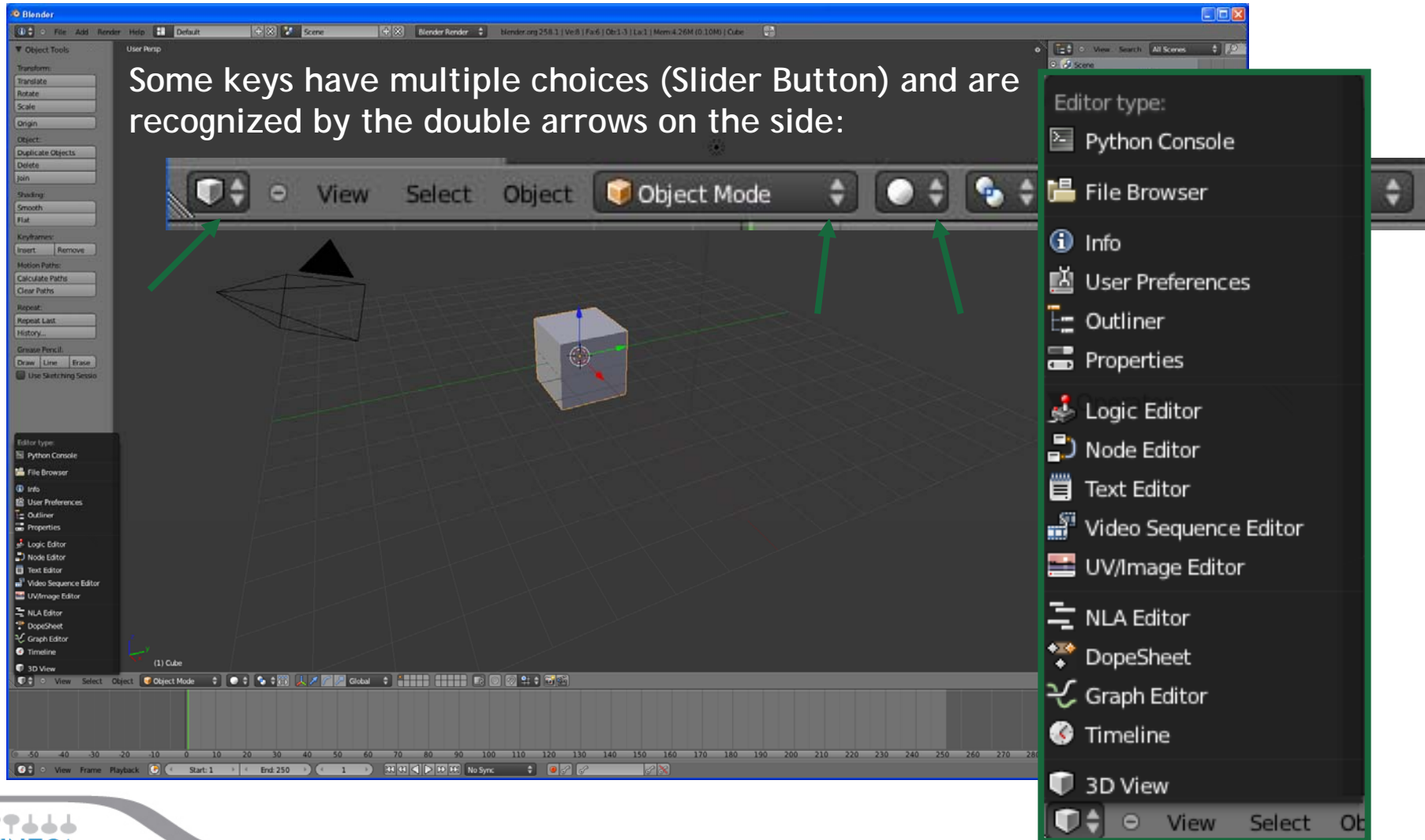
INTERFACE





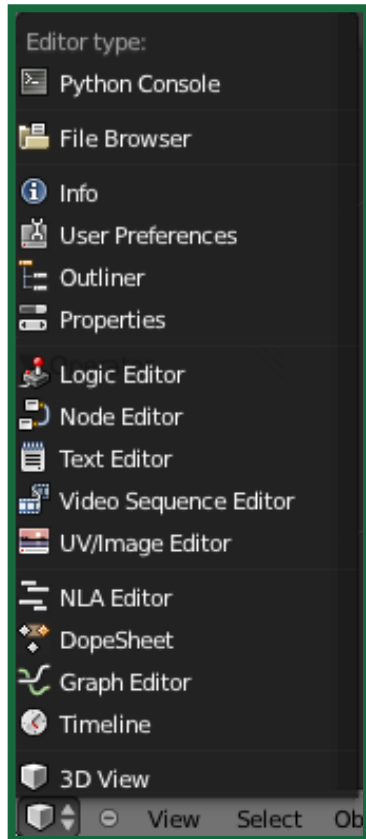
INTERFACE

Some keys have multiple choices (Slider Button) and are recognized by the double arrows on the side:





INTERFACE



PYTHON CONSOLE - to directly use python in Blender

FILE BROWSER - used to organize, load and save files

INFO - provides information and options for managing files, windows and engines

USER PREFERENCES - customize Blender to your work style and computer

OUTLINER - helps you find and organize your objects

PROPERTIES - shows the several attributes of the currently selected object

LOGIC EDITOR - a game logic editing window

NODE EDITOR - allows you to use nodes for texturing, materials and compositing

TEXT EDITOR - keep notes and documentation about your project, and write Python scripts

VIDEO SEQUENCE EDITOR - assemble video sequences into a film strip

UV/IMAGE EDITOR - an image editor with advanced UV management tools

NLA EDITOR - manage non-linear animation action sequences

DOPE SHEET - combine individual actions into action sequences

GRAPH EDITOR - manage animation keys (and drivers) and inter/extrapolation of these

TIMELINE - controls for animation playback

3D VIEW - a graphical view of your scene



PYTHON CONSOLE

Blender v2.68 | Verts:8 | Faces:6 | Tris:12 | Objects:1/3 | Lamps:0/1 | Mem:9.38M (0.11M) | Cut

Object Tools: Transform (Translate, Rotate, Scale), Object (Duplicate Objects, Delete), Operator

View: User Persp

Render: Render, Anim, Play, Displa, Image Editor

Dimensions: Resolution (1920, 1080, 50%), Frame Ranges (Start: 1, End: 250, Frame: 1), Aspect Ratio (1.000), Frame Rate (24 fps, Time Rema)

Anti-Aliasing: 5 8 1116 Mitchell, Full Sa (1.000), Sampled Motion Bl

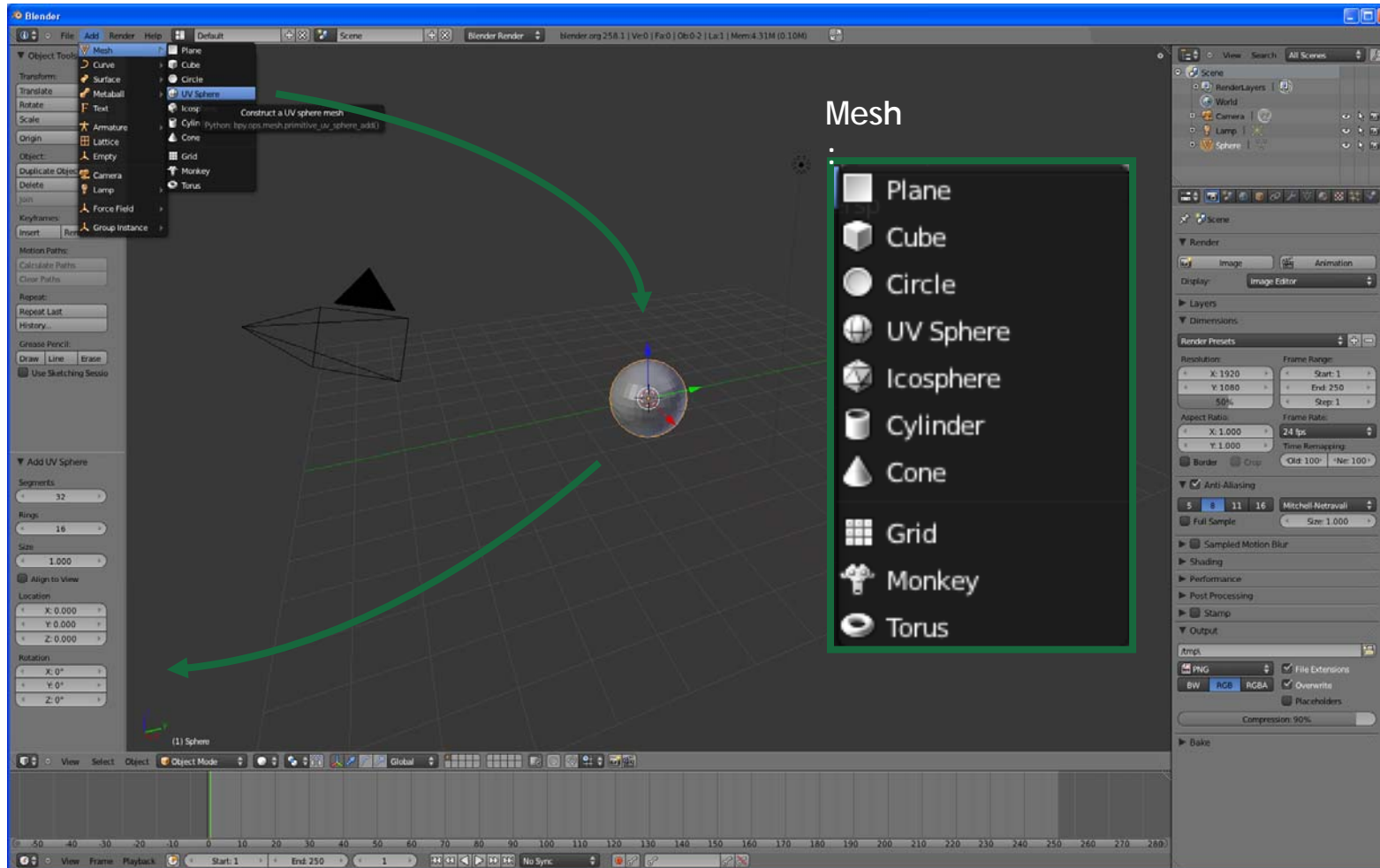
Shading, Performance, Post Processing, Freestyle, Stamp, Output

```
Command history: up/down Arrow
Cursor: Left/Right Home/End
Remove: Backspace/Delete
Execute: Enter
Autocomplete: Ctrl-Space
Zoom: Ctrl +/-, Ctrl-Wheel
Builtin Modules: bpy, bpy.data, bpy.ops, bpy.props, bpy.types, bpy.context, bpy.utils, bgl, blf, mathutils
Convenience Imports: from mathutils import *; from math import *
Convenience Variables: C = bpy.context, D = bpy.data

>>> import bpy
>>> for i in bpy.data.objects:
...     print(i)
...
<bpy_struct, Object("Camera")>
<bpy_struct, Object("Cube")>
<bpy_struct, Object("Lamp")>

>>> |
```


ADD MESH



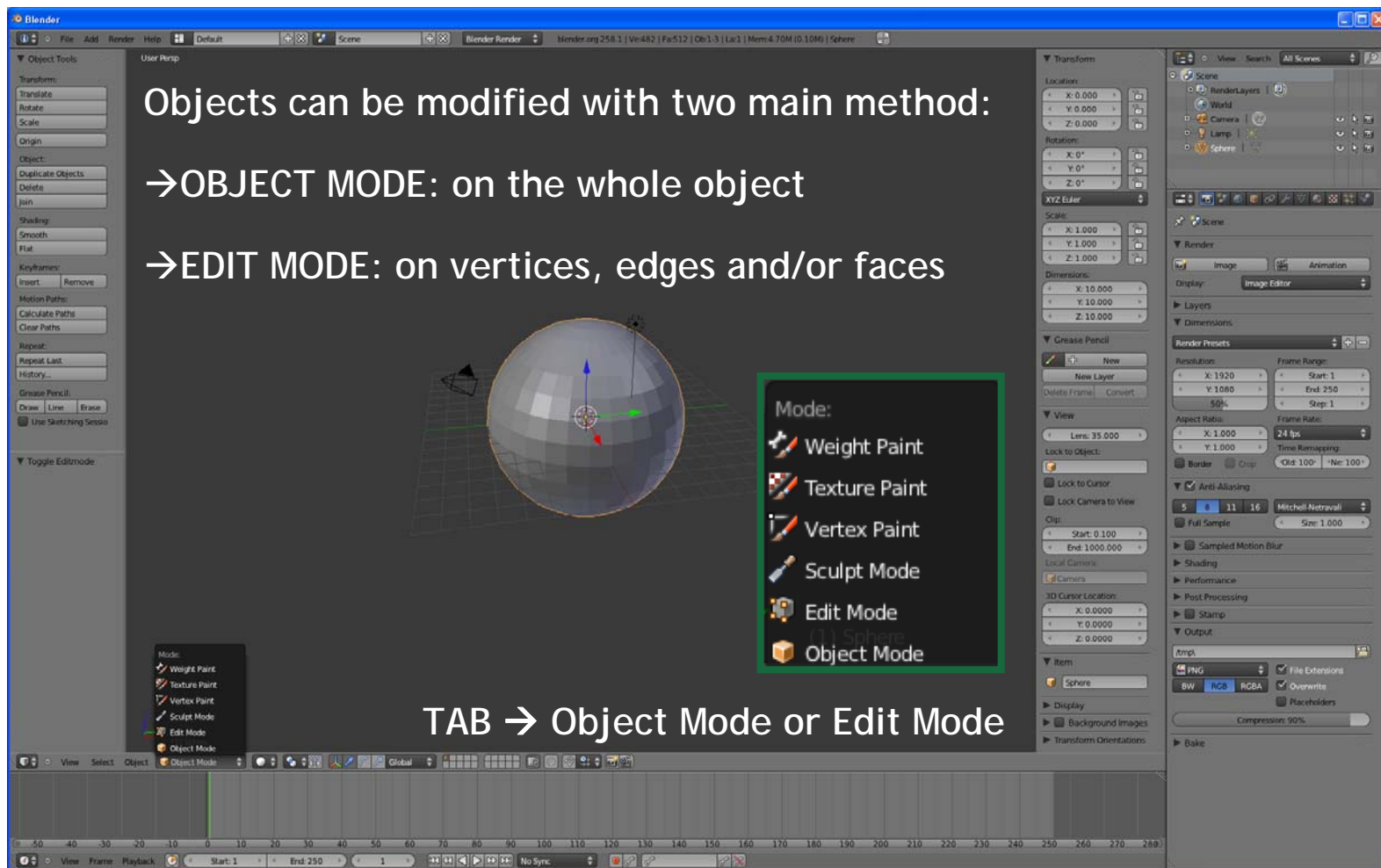


MODIFY OBJECTS

Objects can be modified with two main method:

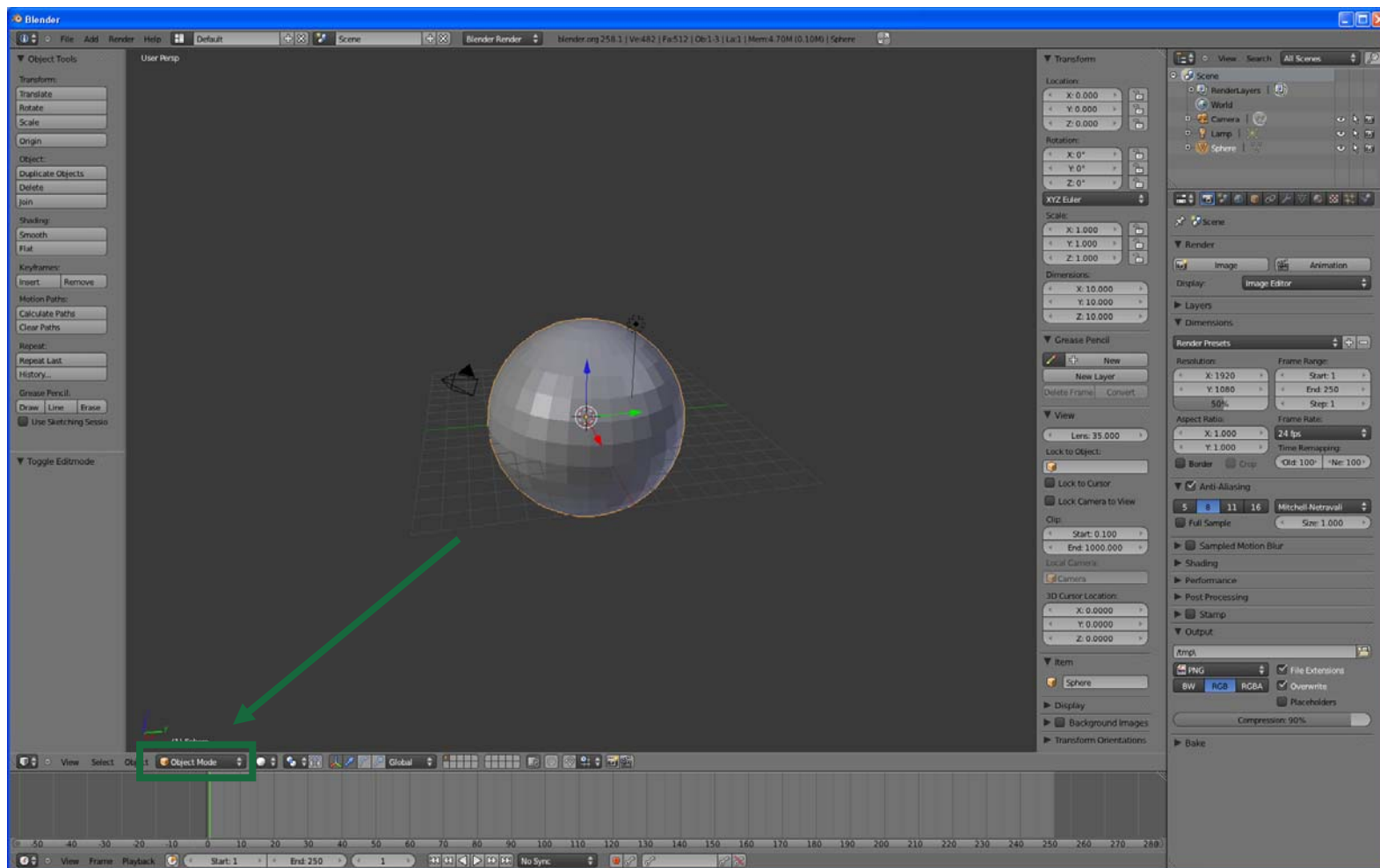
→ OBJECT MODE: on the whole object

→ EDIT MODE: on vertices, edges and/or faces

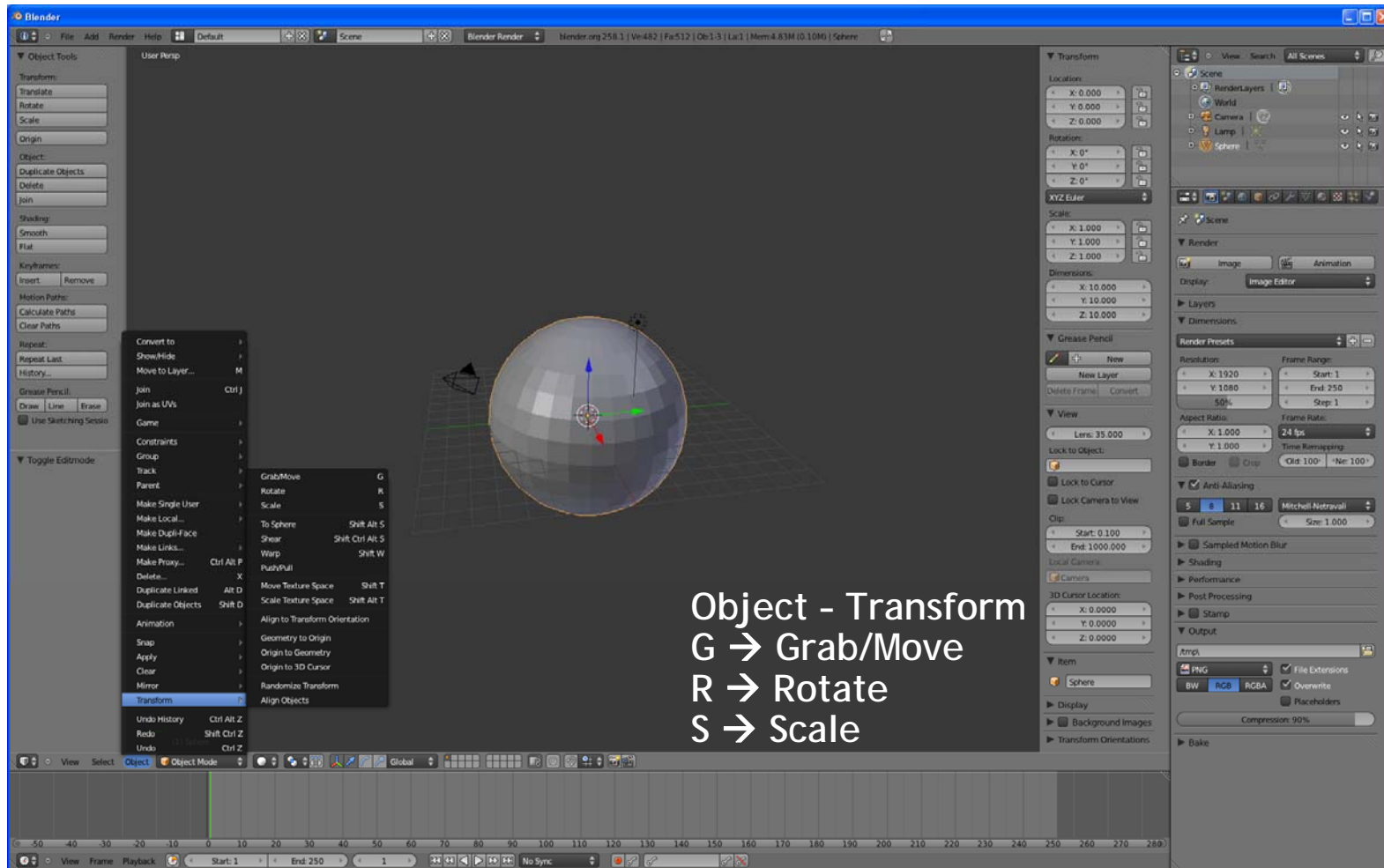


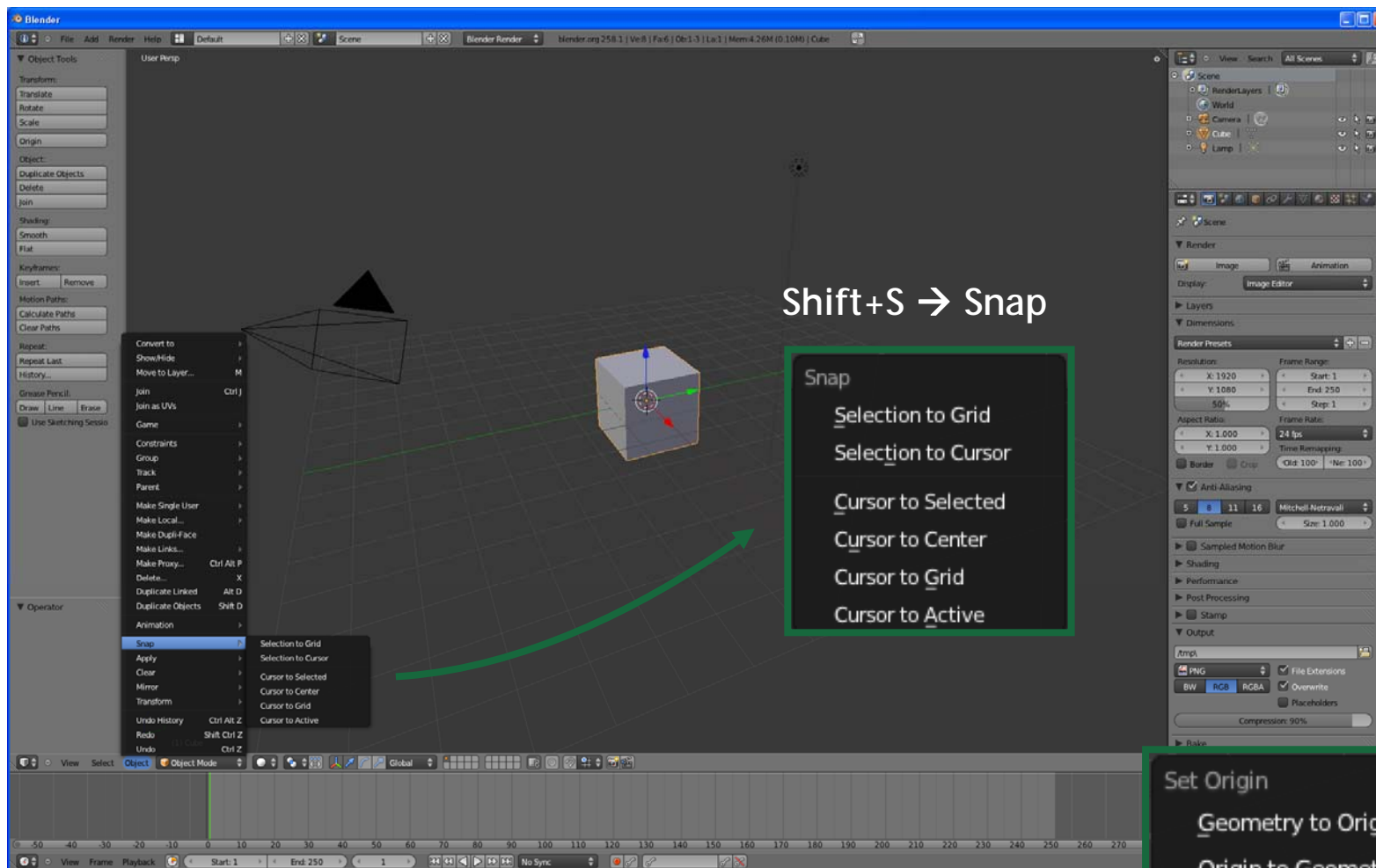


OBJECT MODE



OBJECT MODE





Shift+S → Snap

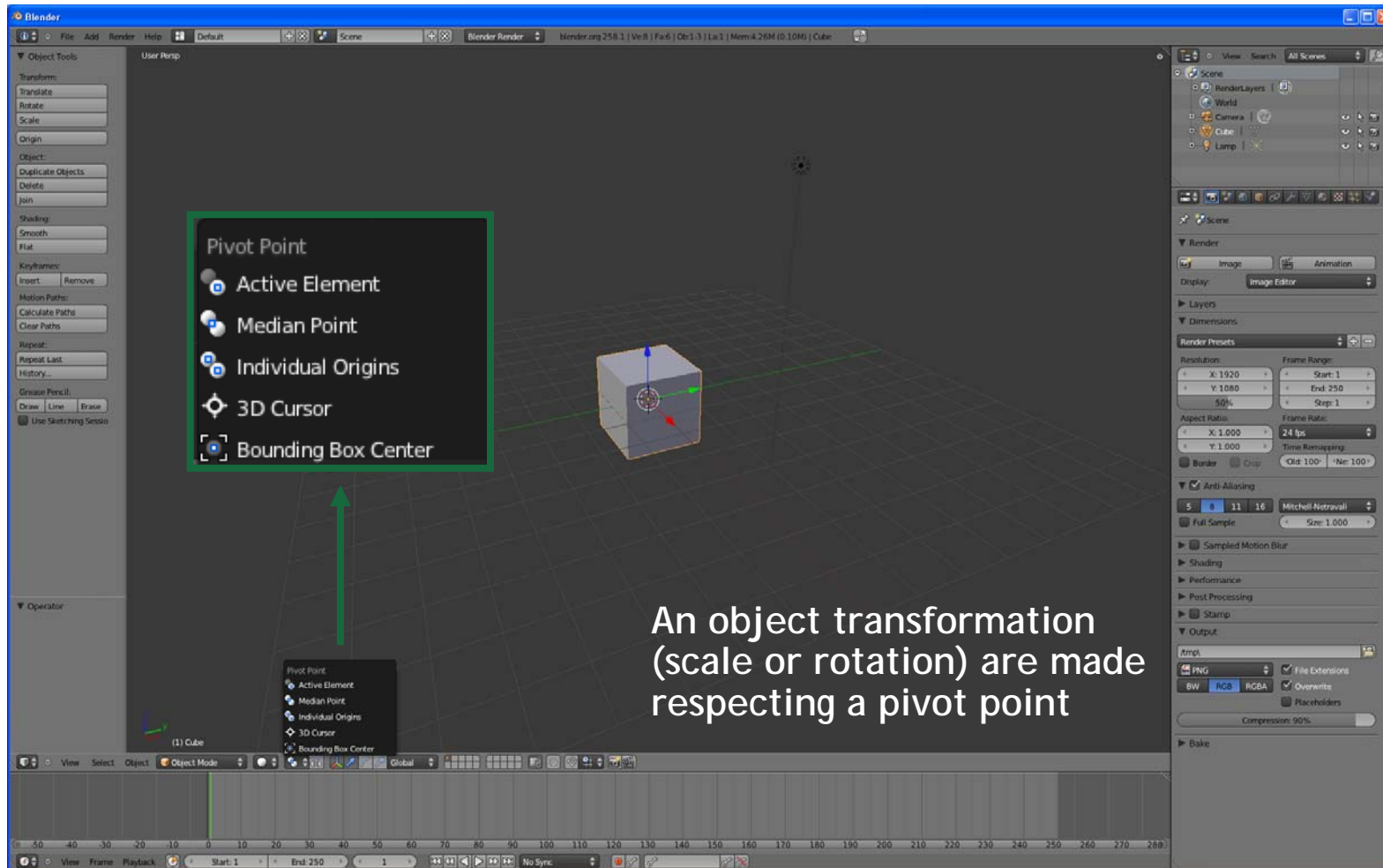
- Snap
- Selection to Grid
- Selection to Cursor
- Cursor to Selected
- Cursor to Center
- Cursor to Grid
- Cursor to Active

- Set Origin
- Geometry to Origin Shift Ctrl Alt C
- Origin to Geometry Shift Ctrl Alt C
- Origin to 3D Cursor Shift Ctrl Alt C

SHIFT + CTRL + ALT + C → set origin

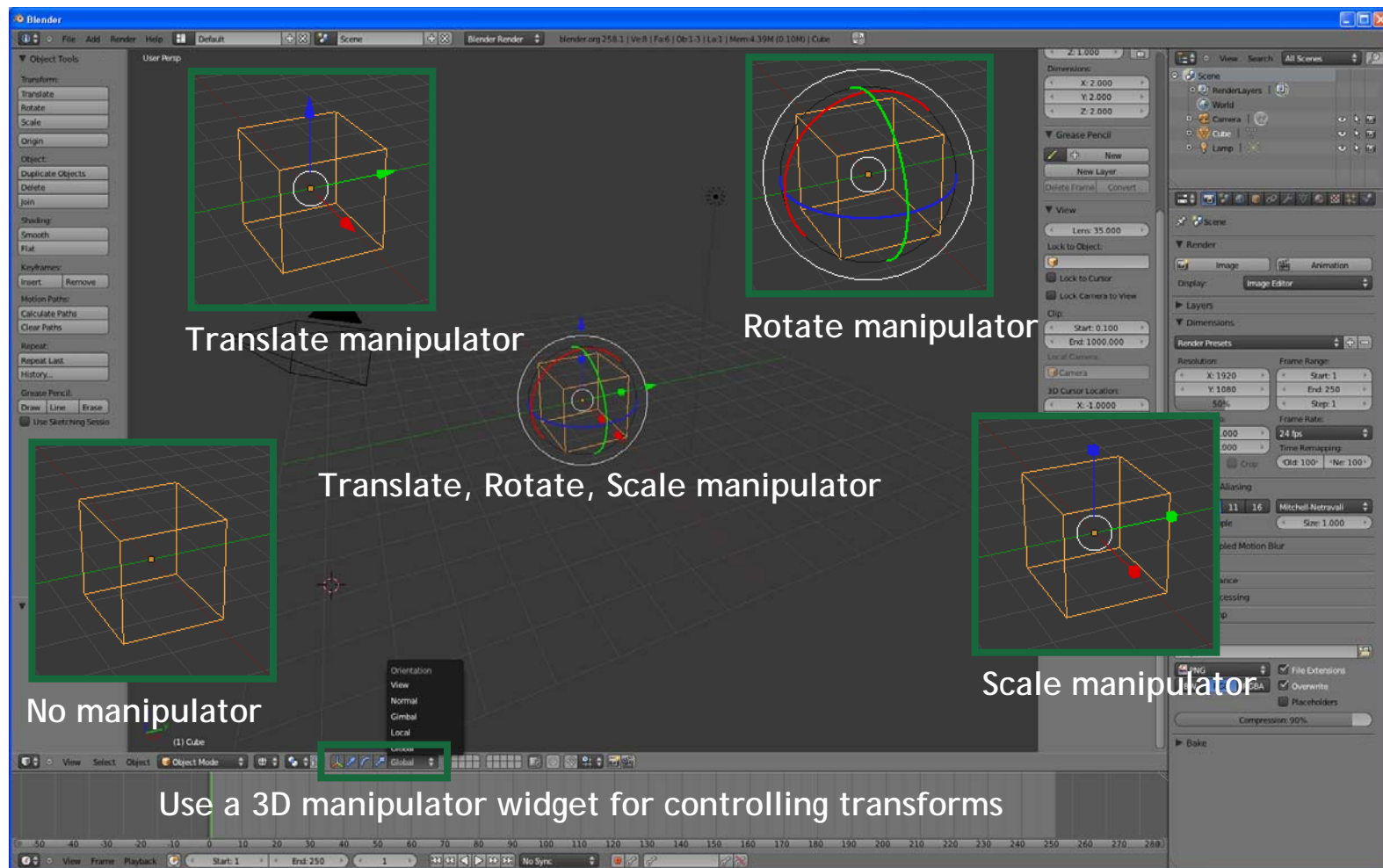


PIVOT POINT



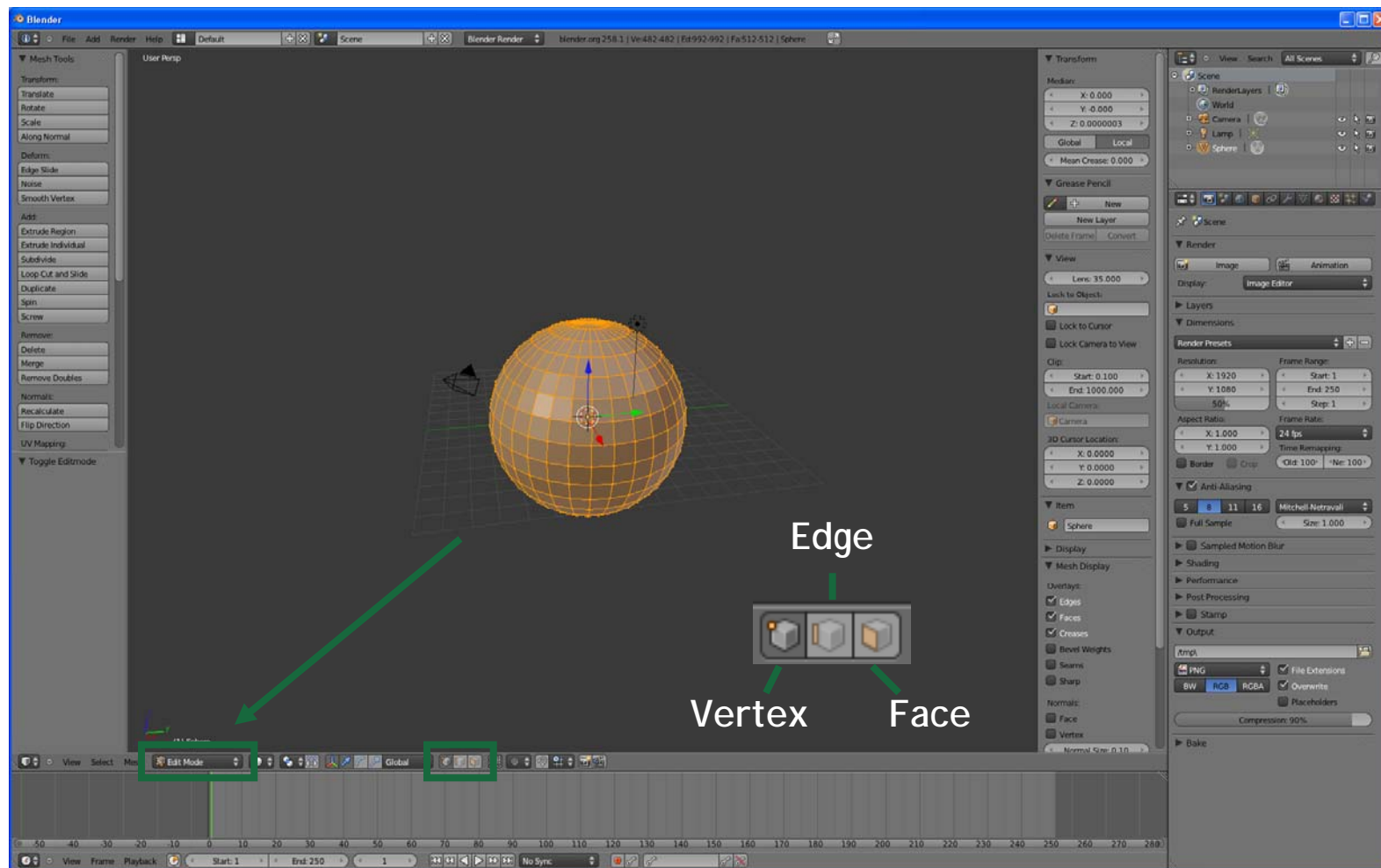


3D MANIPULATOR





EDIT MODE



EDIT MODE



Mesh - Transform
G → Grab/Move
R → Rotate
S → Scale



EDIT MODE

- Show/Hide
- Proportional Editing Falloff
- Proportional Editing
- AutoMerge Editing
- Normals
- Faces
- Edges
- Vertices
- Delete... X
- Add Duplicate Shift D
- Extrude Individual
- Extrude Region E
- UV Unwrap...
- Snap
- Mirror
- Transform
- Undo History Ctrl Alt Z
- Redo Shift Ctrl Z
- Undo (1) Sphere Ctrl Z

Mesh Edit Mode

- Recalculate Outside Ctrl N
- Recalculate Inside Shift Ctrl N
- Flip Normals

- Flip Normals
- Make Edge/Face F
- Fill Alt F
- Beautify Fill Shift Alt F
- Solidify
- Sort Faces
- Make F-gon
- Clear F-gon
- Quads to Tris Ctrl T
- Tris to Quads Alt J
- Edge Flip Shift Ctrl F
- Shade Smooth
- Shade Flat
- Rotate Edge CW
- Rotate UVs
- Mirror UVs
- Rotate Colors
- Mirror Colors

- Make Edge/Face F
- Subdivide
- Mark Seam
- Clear Seam
- Mark Sharp
- Clear Sharp
- Rotate Edge CW
- Rotate Edge CCW
- Edge Slide
- Edge Crease Shift E
- Edge Loop
- Edge Ring
- Loop to Region
- Region to Loop

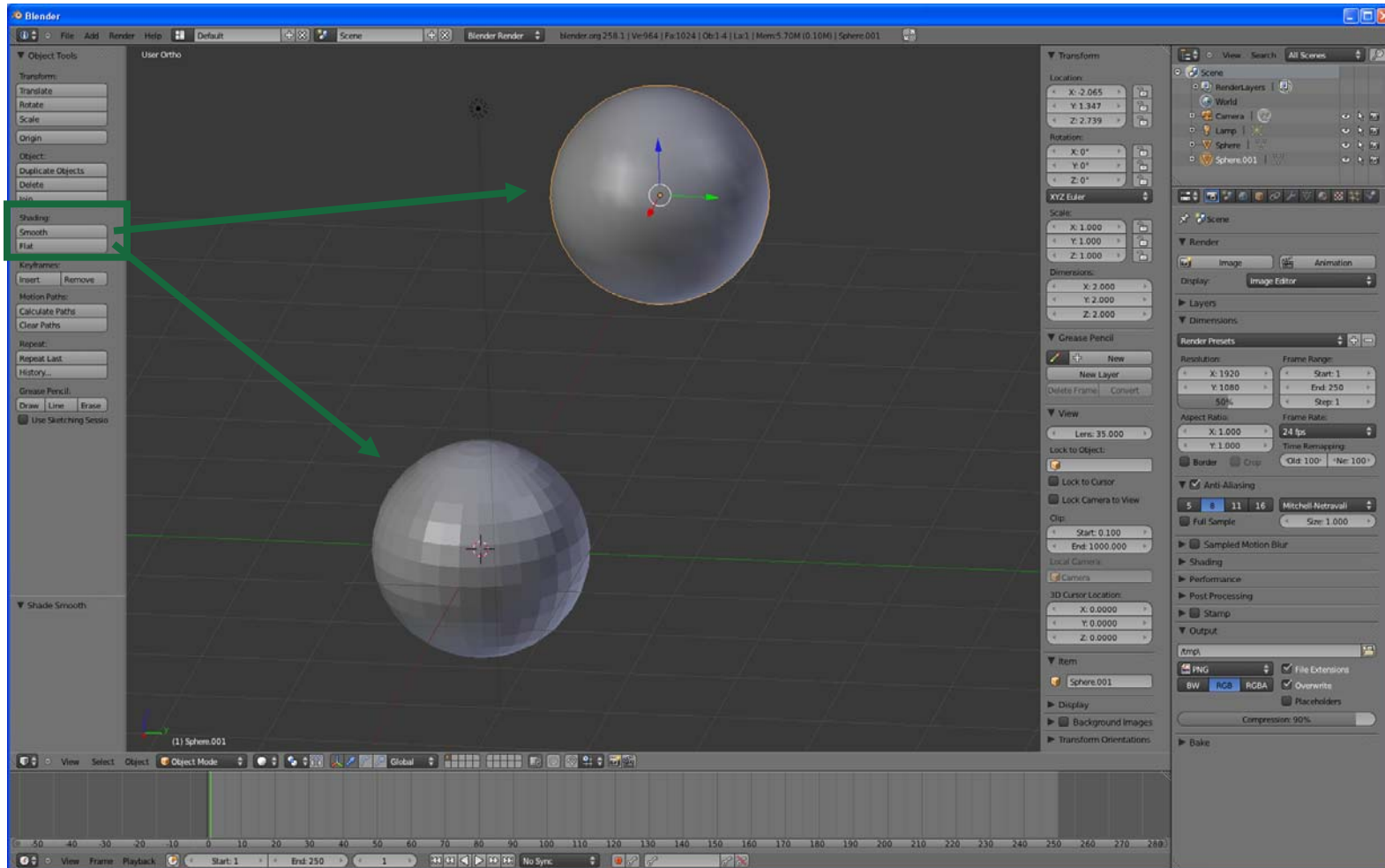
- Merge Alt M
- Rip V
- Split Y
- Separate P
- Smooth Vertex
- Remove Doubles
- Vertex Sort
- Vertex Randomize
- Select Vertex Path
- Blend From Shape
- Blend Vertex Group
- Shape Propagate
- Vertex Groups
- Hooks

Ctrl+F

Ctrl+E

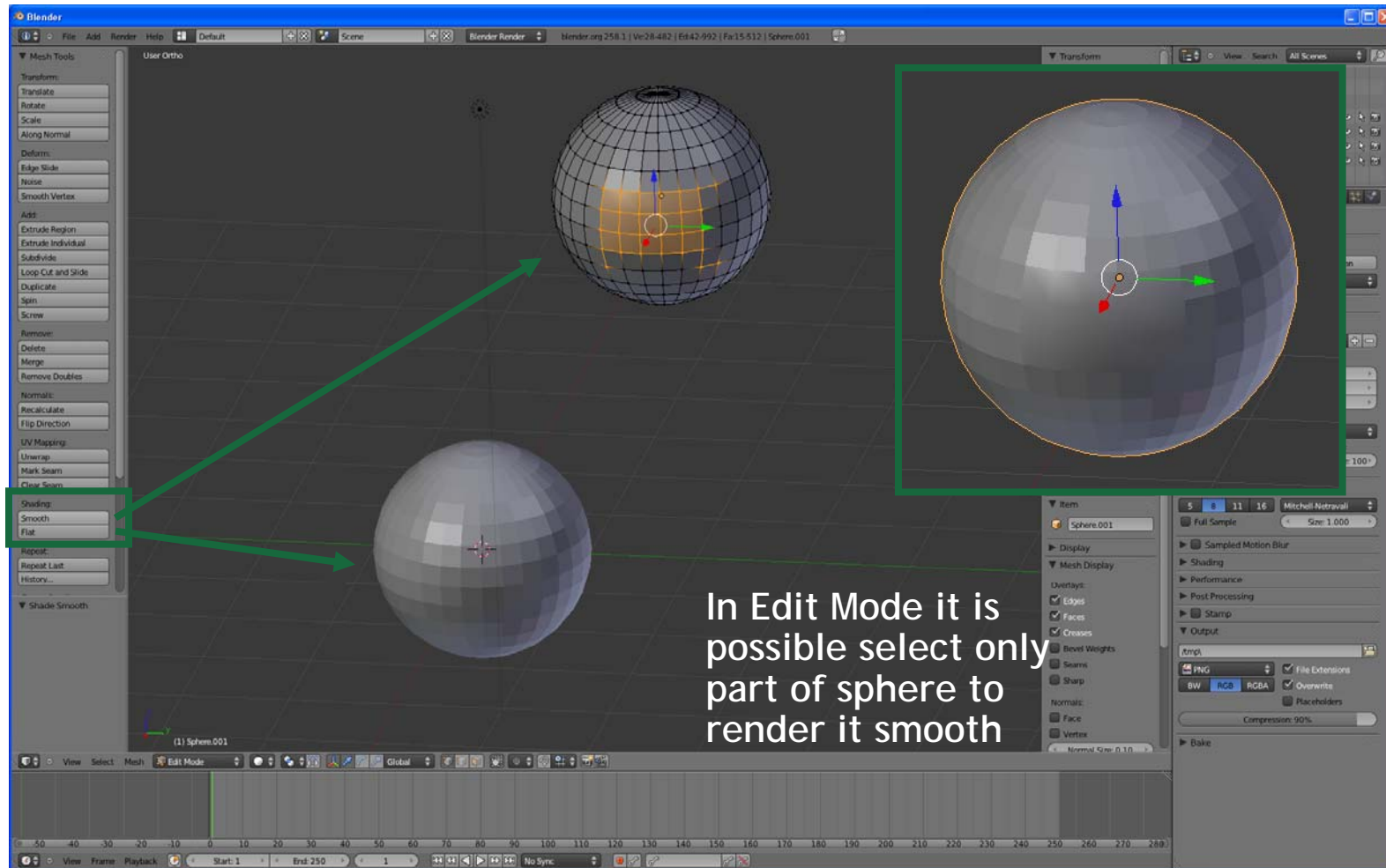
Ctrl+V

OBJECT MODE - SMOOTH SHADING



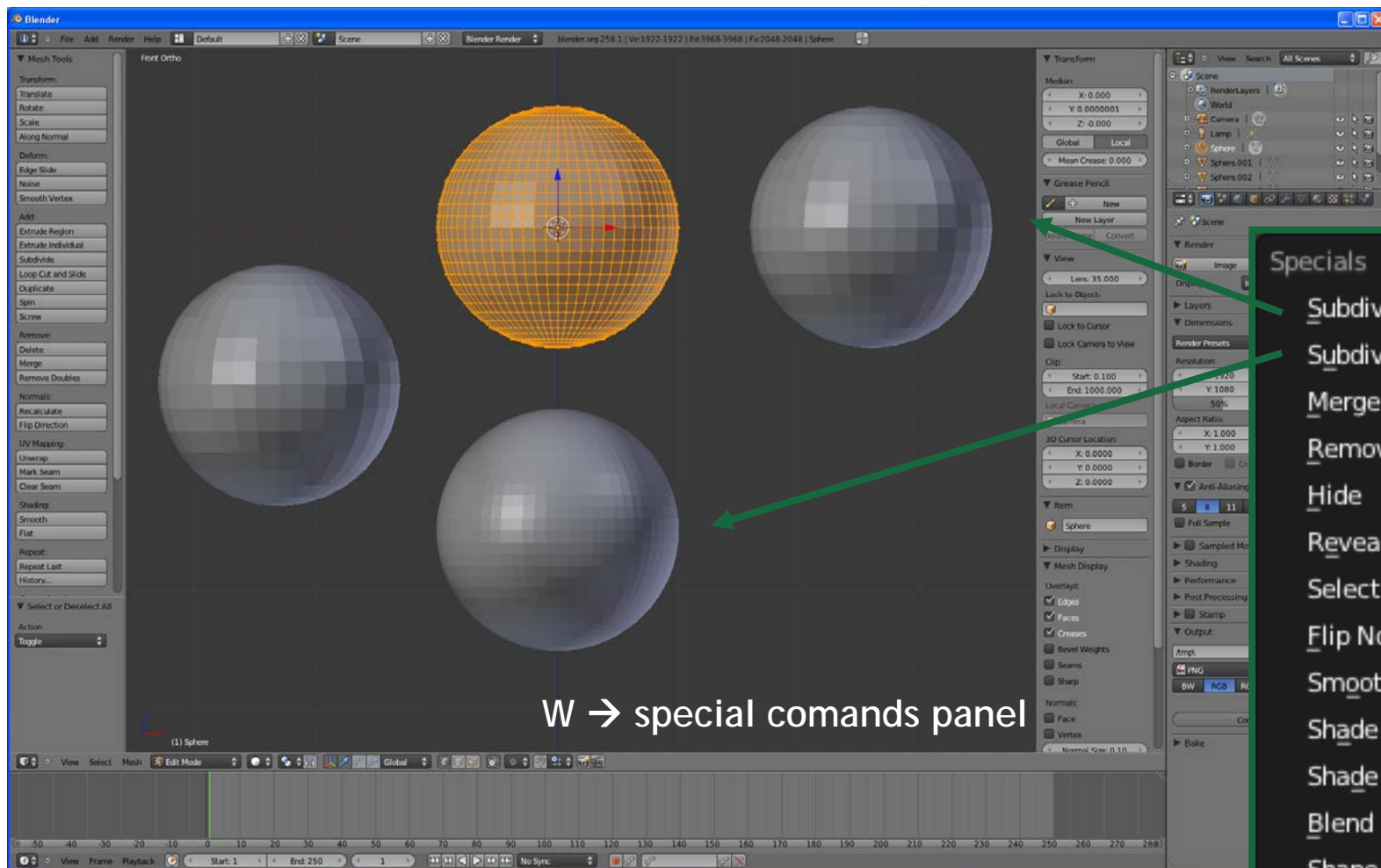


EDIT MODE - SMOOTH SHADING





EDIT MODE - FACES - SUBDIVIDE

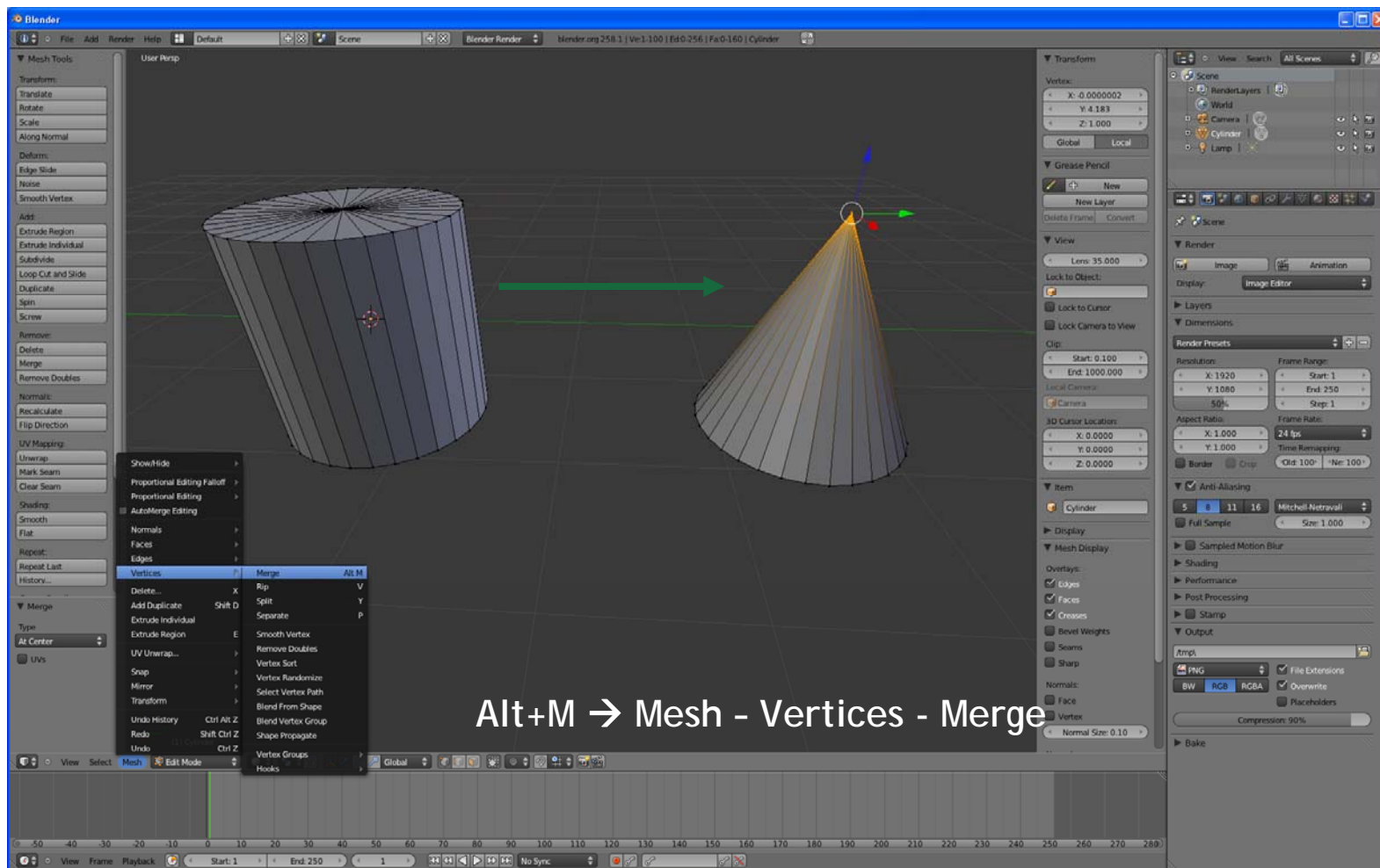


W → special comands panel

- Specials
- Subdivide
- Subdivide Smooth
- Merge... Alt M
- Remove Doubles
- Hide H
- Reveal Alt H
- Select Inverse Ctrl I
- Flip Normals
- Smooth
- Shade Smooth
- Shade Flat
- Blend From Shape
- Shape Propagate
- Select Vertex Path

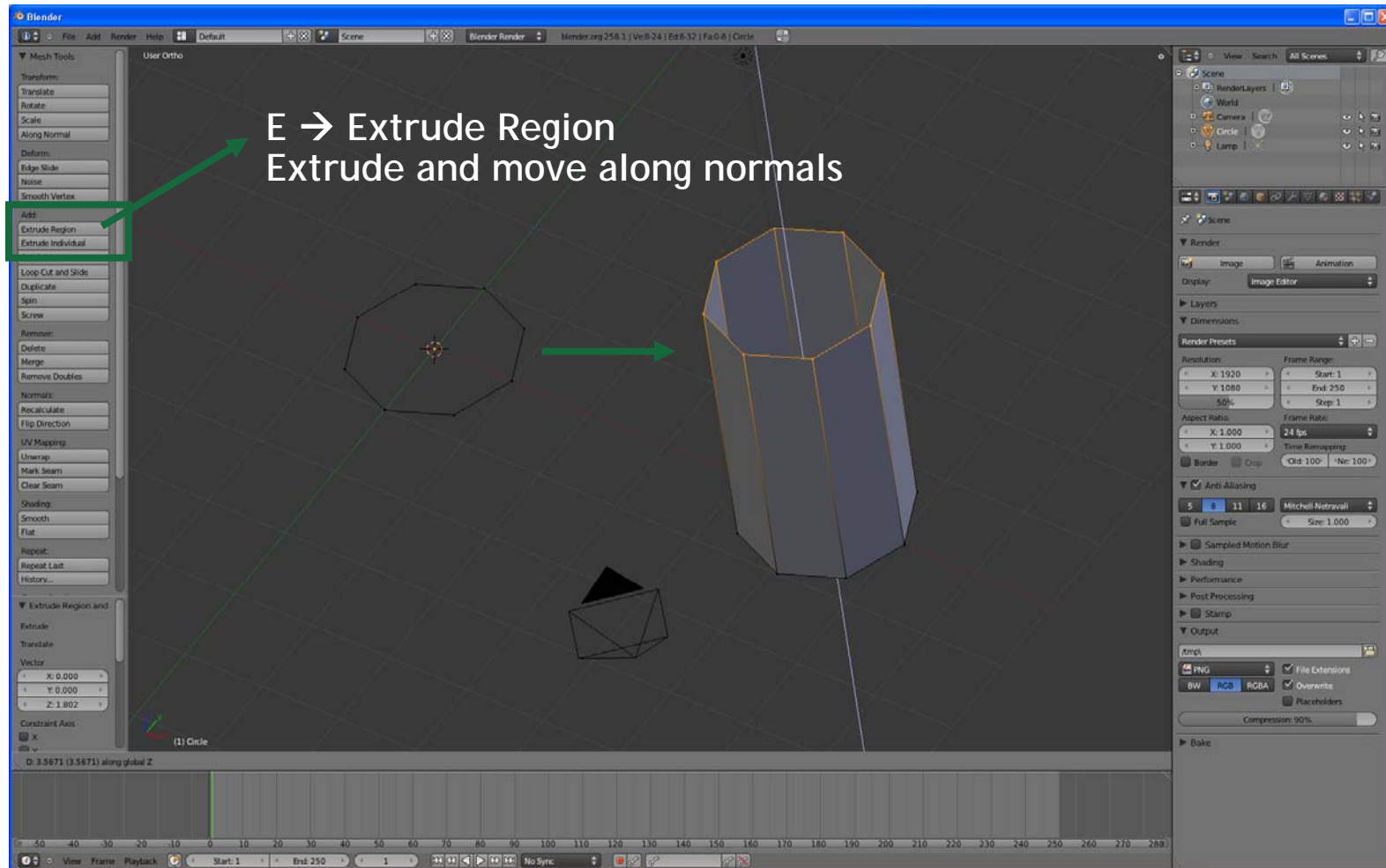


EDIT MODE - VERTEX - MERGE



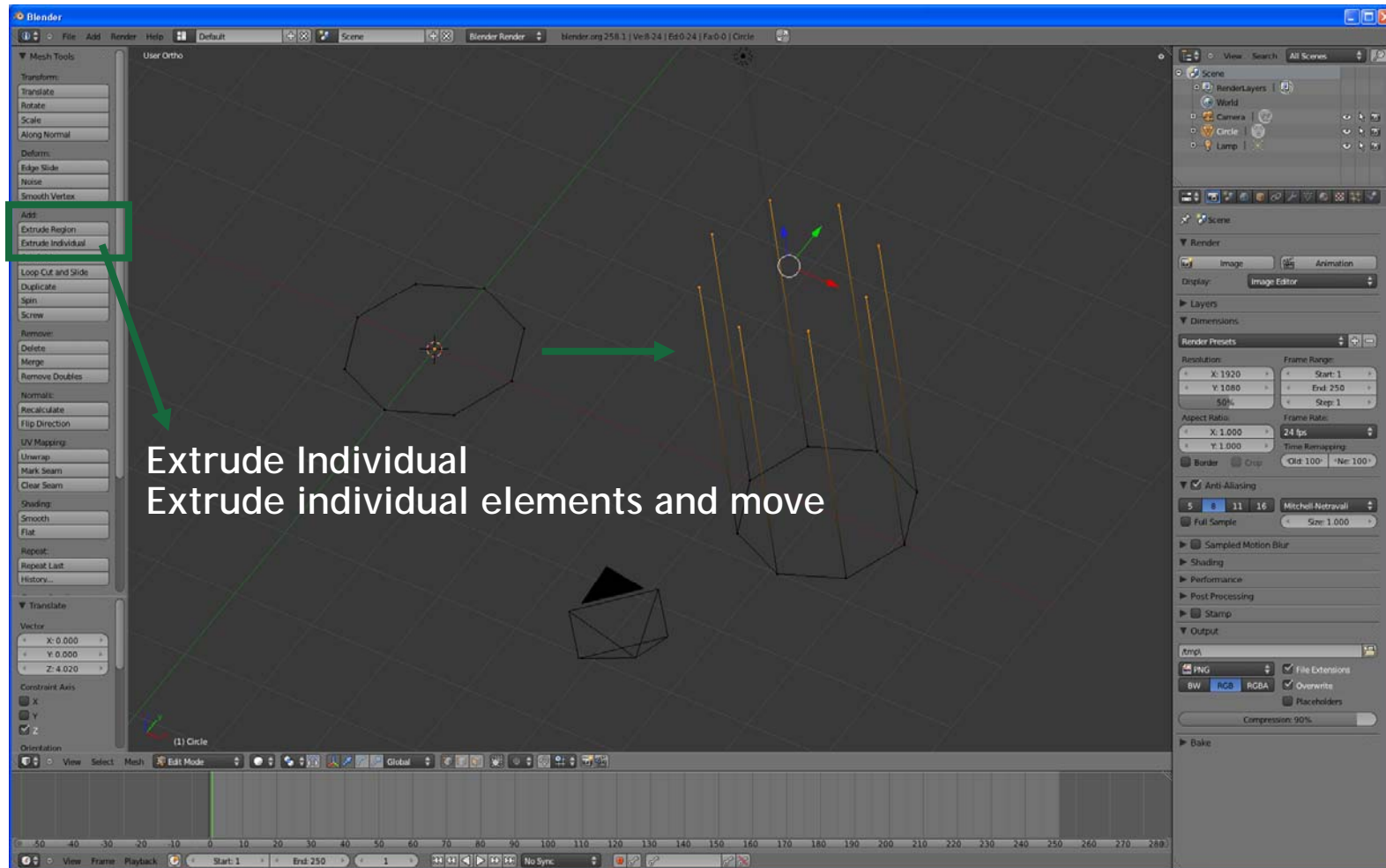


EDIT MODE - EXTRUDE





EDIT MODE - EXTRUDE





EDIT MODE - SPIN

Blender interface showing the Spin tool in Edit Mode. The left panel displays the Spin tool settings:

- Steps: 24
- Degrees: 360.000
- Center: X: 0.000, Y: 0.000, Z: 0.000

The main viewport shows a circle being spun into a bowl shape. A green box highlights the Spin parameters, and a green arrow points to the resulting bowl. A 3D rendering of the bowl is shown in the bottom right corner.

Spin parameters



EDIT MODE - KNIFE

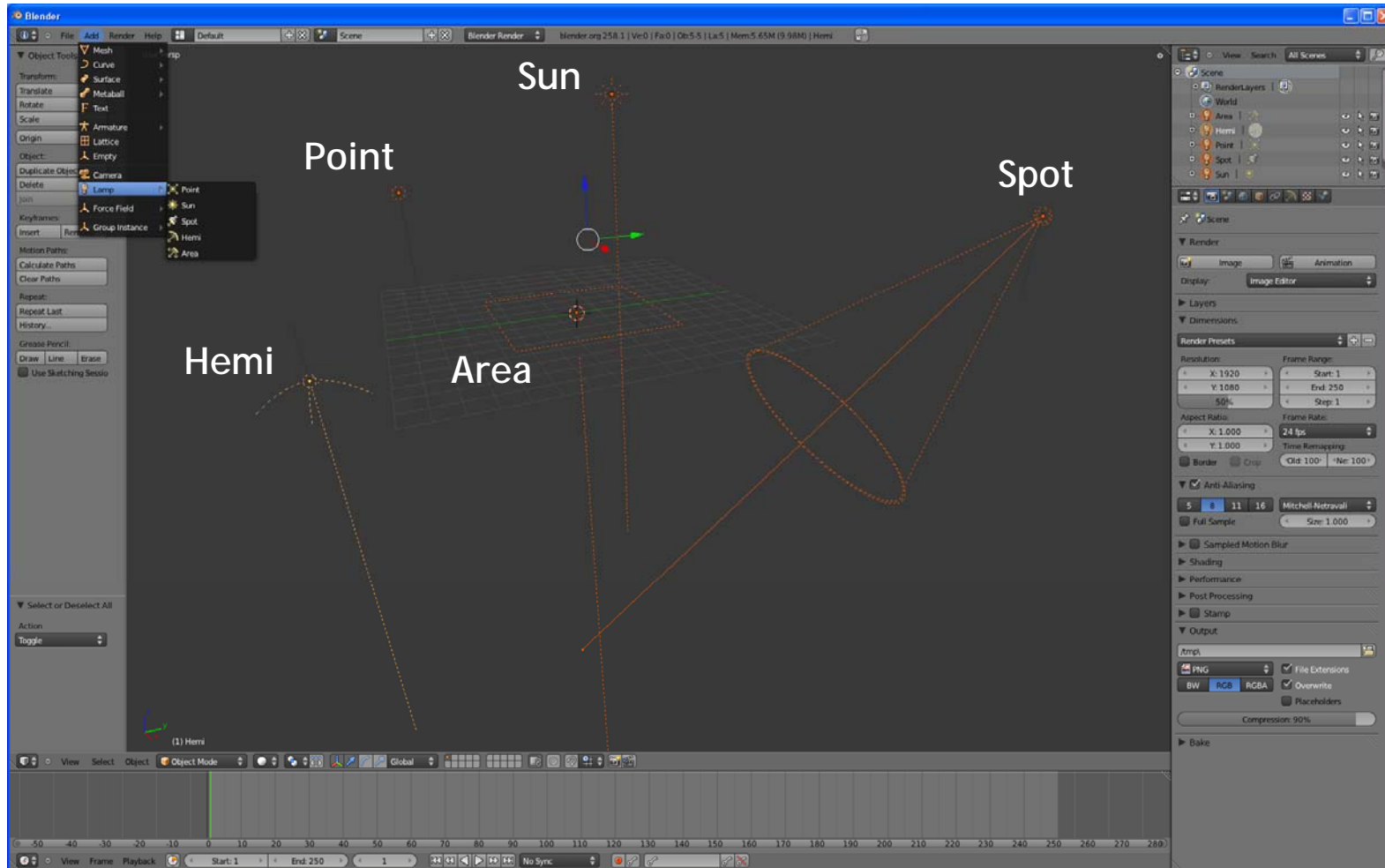
Options:

- Left mouse button to define cut lines
- Return/Spacebar to confirm
- ESC or right mouse button to cancel
- E for a new cut
- Ctrl to turn on midpoint snap
- Shift to ignore snap
- C to turn on angle constrain
- Z to turn on cut through

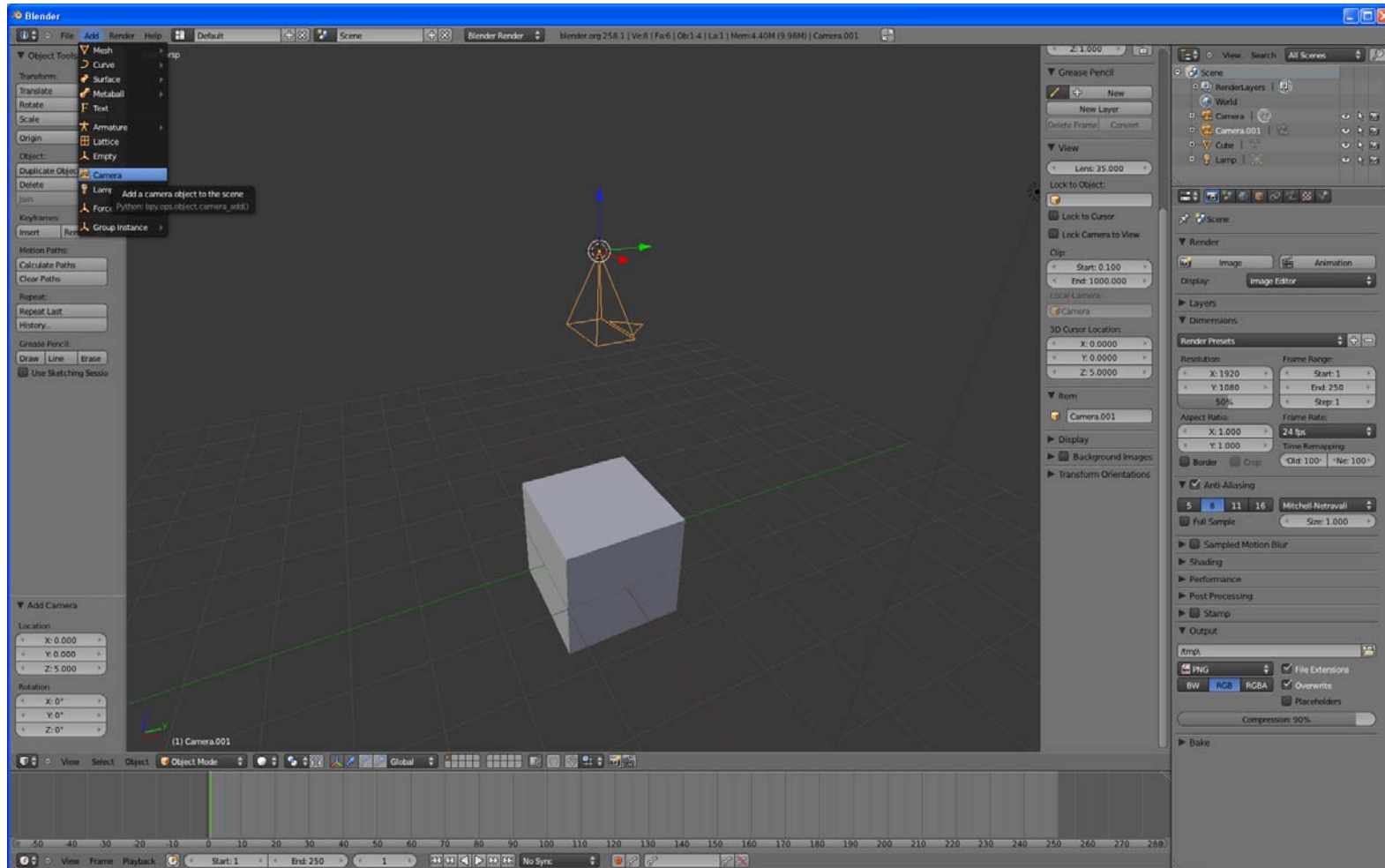
Knife (K)

LMB: define cut lines, Return/Spacebar: confirm, Esc or RMB: cancel, E: new cut, Ctrl: midpoint snap (Off), Shift: ignore snap (Off), C: angle constrain (On), Z: cut through (On)

ADD LAMP



ADD CAMERA





PROPERTIES



Render

Scene

World

Object

Object Constraints

Modifiers

Object Data

Material

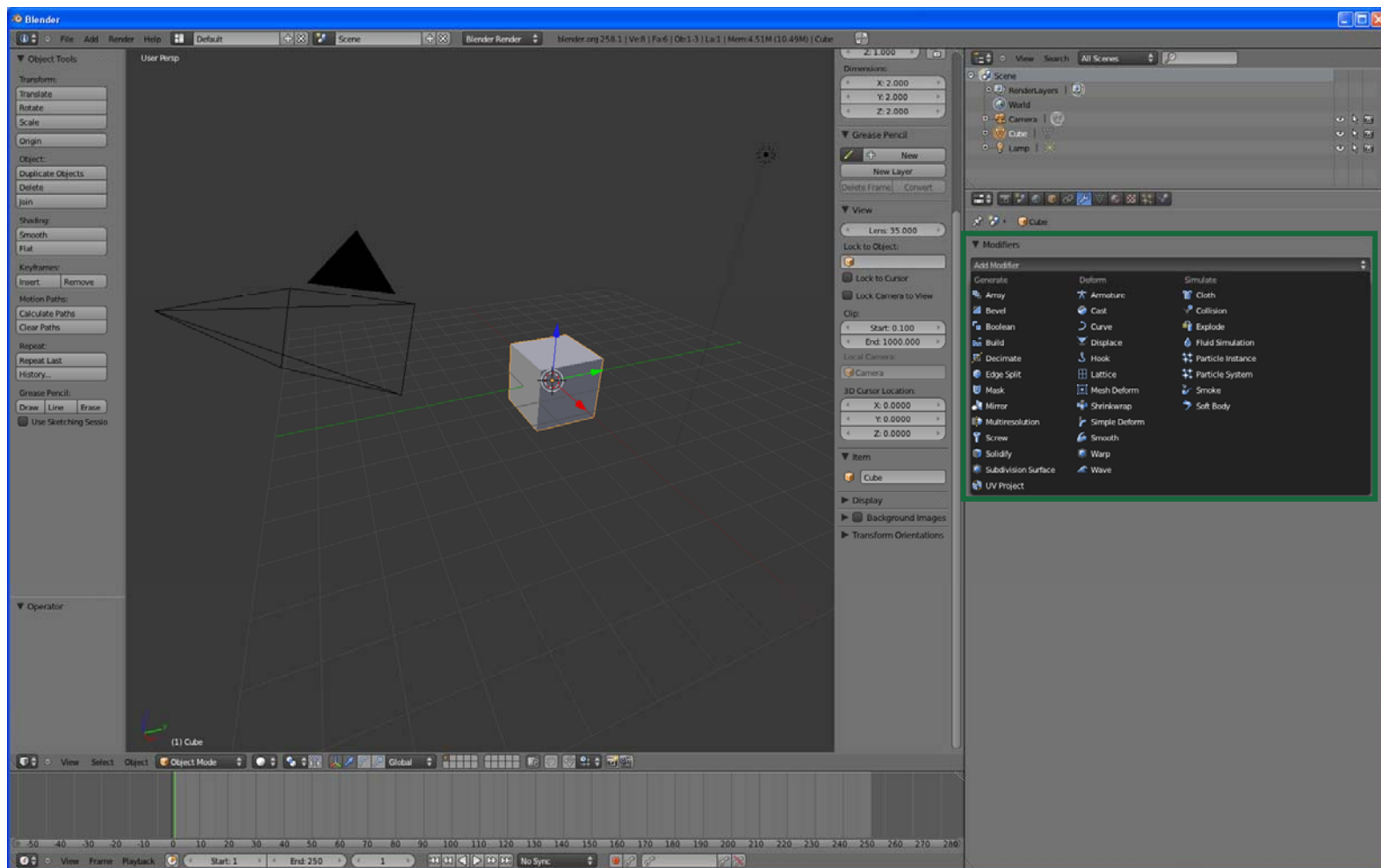
Texture

Particles

Physics

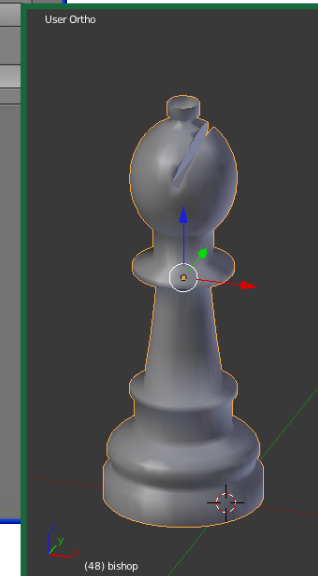
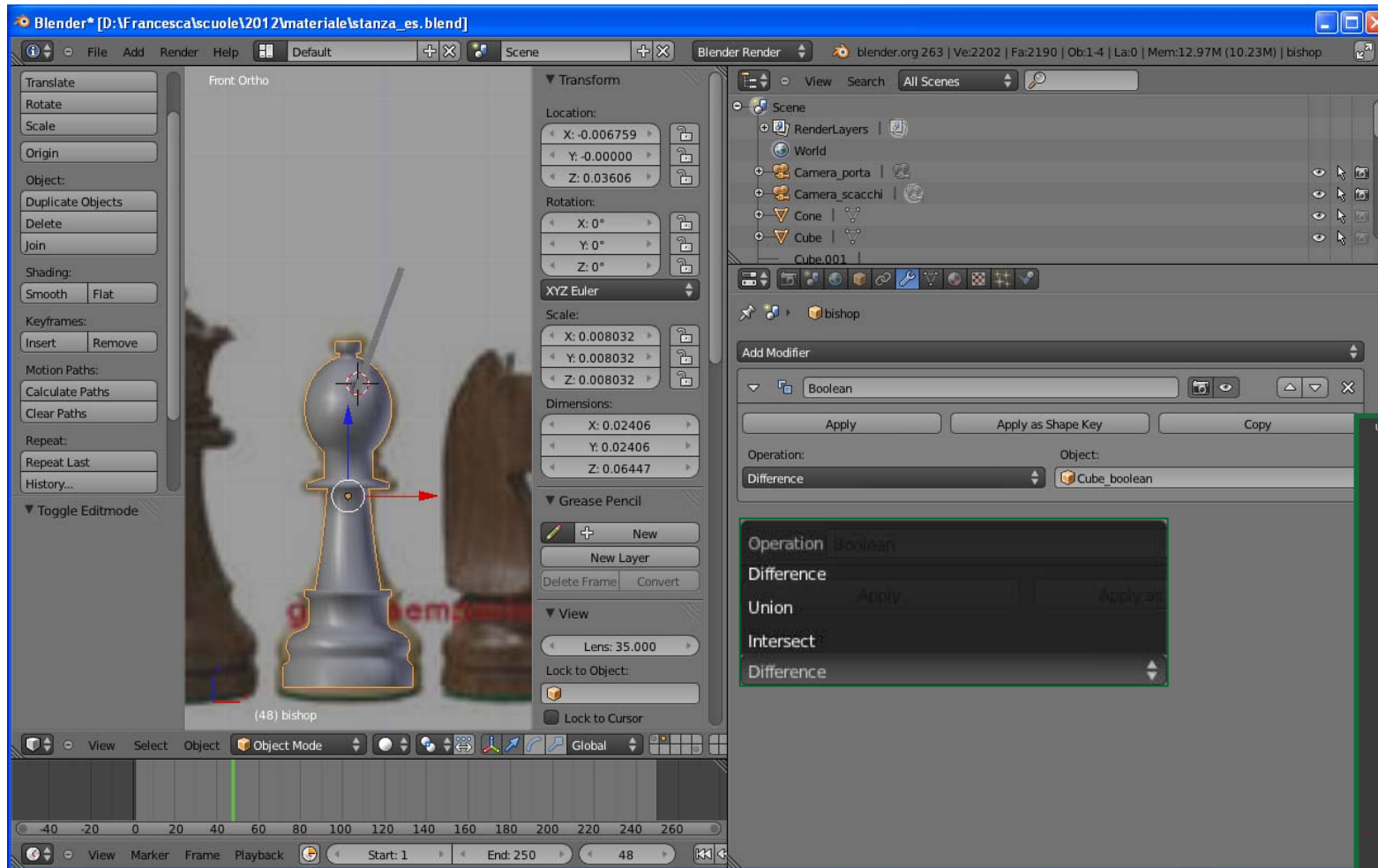


PROPERTIES - MODIFIERS



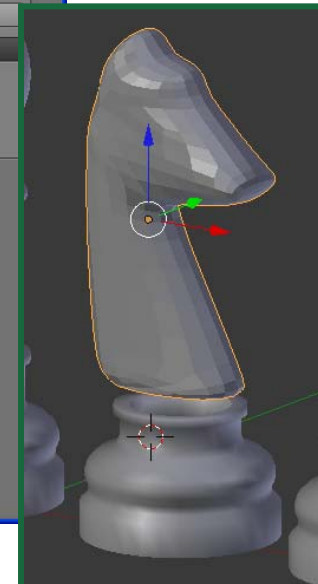
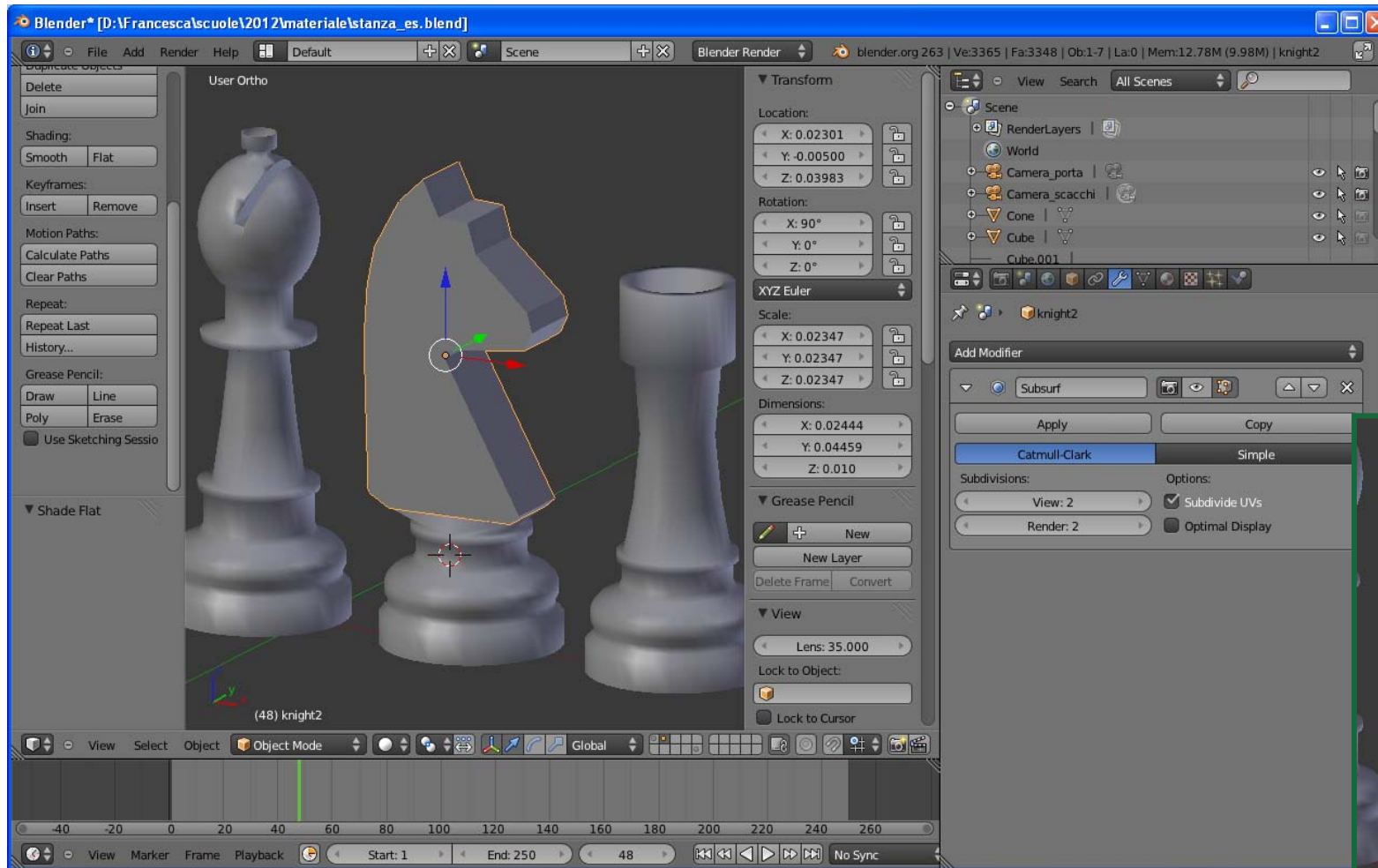


MODIFIERS - BOOLEAN



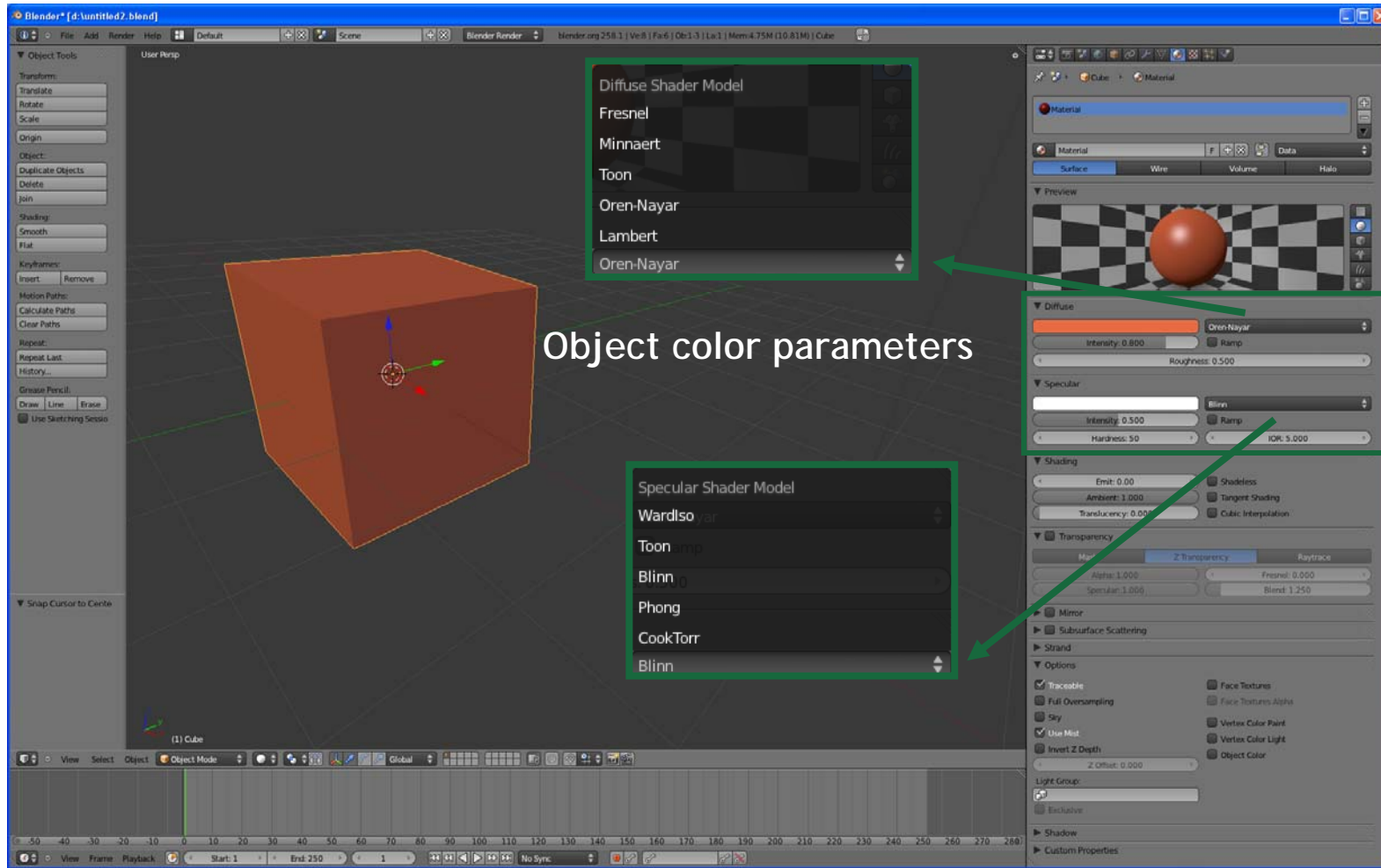


MODIFIERS - SUBDIVISION SURFACE





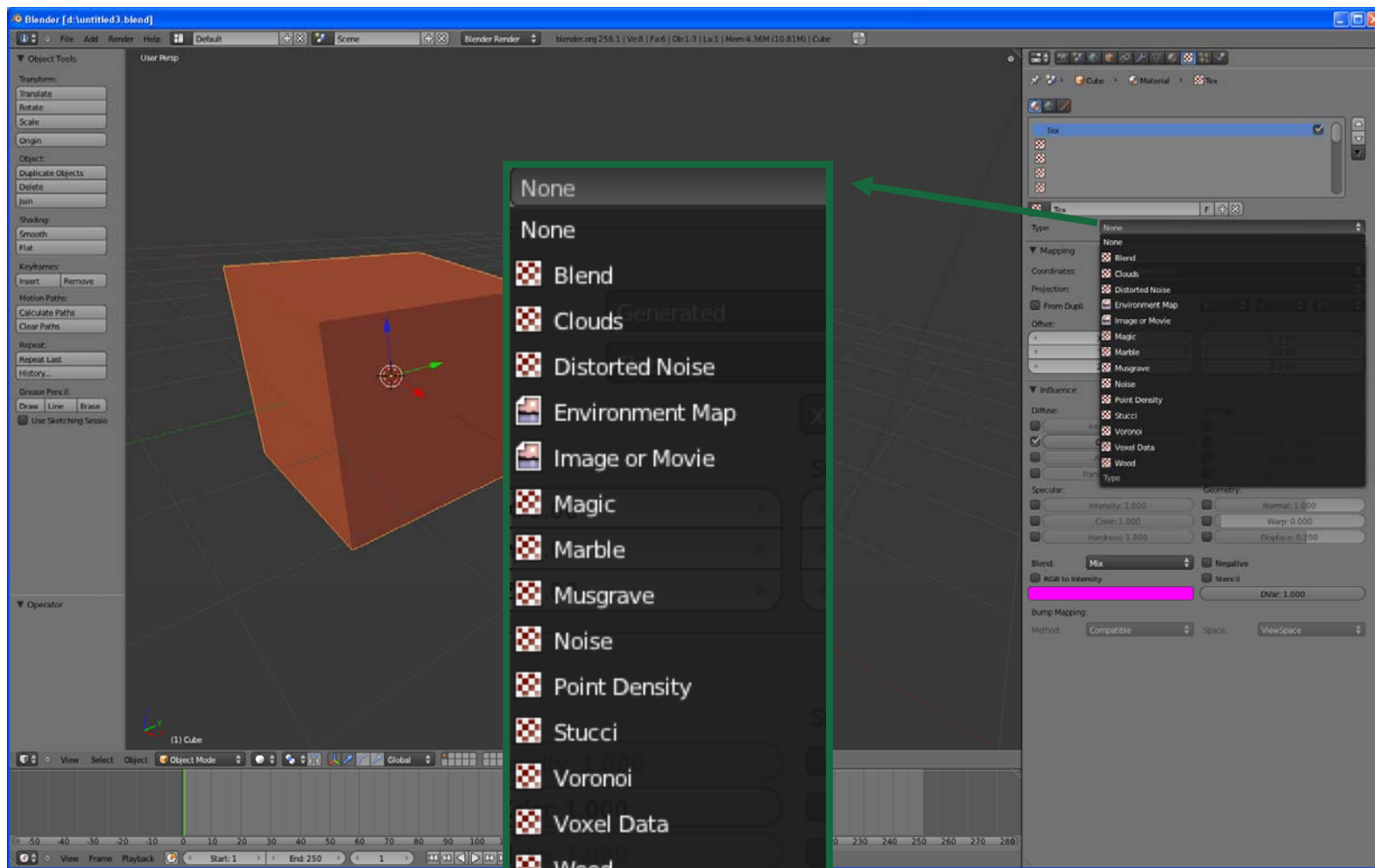
PROPERTIES - MATERIAL



http://wiki.blender.org/index.php/Doc:Manual/Materials/Properties/Diffuse_Shaders



PROPERTIES - TEXTURE





PROPERTIES - MATERIAL

The image displays the Blender 2.58.1 interface in Object Mode. The main 3D viewport shows a scene with a sphere, a cube, and a cylinder. The Properties panel on the right is set to the Material tab, showing the 'Transparency' section. A green box highlights the 'Transparency' section in the Properties panel, and another green box highlights a zoomed-in view of the 'Transparency' section at the bottom of the screen. A green arrow points from the zoomed-in view back to the Properties panel.

Transparency

Mask **Z Transparency** Raytrace

Alpha: 0.200 Fresnel: 0.000

Specular: 1.000 Blend: 1.250



PROPERTIES - MATERIAL

The image shows the Blender 2.58.1 interface with a material editor. The material is a Mirror material. The Mirror section is highlighted with a green box, showing the following properties:

- Mirror
- Reflectivity: 0.500
- Fresnel: 0.000
- Blend: 1.250
- Depth: 2
- Max Dist: 0.000
- Gloss: Amount: 1.000
- Threshold: 0.005
- Samples: 18
- Anisotropic: 1.000
- Fade To: Sky

The background shows a 3D scene with a green sphere, a yellow cylinder, and a red cube. The material editor on the right shows the material properties for the selected object.

PROPERTIES - RENDER



The screenshot shows the Blender 2.48.1 interface with the Render Properties panel open. The central 3D viewport displays a yellow cube with a grid texture. The Render Properties panel on the right is annotated with green boxes and text:

- Render:** A green box highlights the 'Render' section, with 'F12' and 'Ctrl+F12' annotations above it.
- Image resolution:** A green box highlights the 'Resolution' section, with 'Image resolution' text overlaid. The resolution is set to X: 1920 and Y: 1080.
- Output format file:** A green box highlights the 'Output' section, with 'Output format file' text overlaid. The format is set to PNG.

At the bottom right, a dark grey box contains the text 'Render F3 → to save render' and a small 3D render of the yellow cube.



PROPERTIES - RENDER

Two open source rendering engines included in Blender:

Blender Internal, fast biased engine, for animation and cartoon rendering of scenes, which we used for the production of Apa;

Blender Cycles, new unbiased engine, in development since 2011, with a propensity for photorealism. The engine manages the actual light bounce and limits the use of tricks for creating realistic lighting on stage, thus creating convincing effects with less effort. This engine should be optimized to achieve optimal results for animation and needs more computational power, but thanks to the Cineca computing resources and to the implementation of the new RenderFarm, it will be an affordable choice for future productions.



LINK

→Official website:

- <http://www.blender.it>
- <http://www.blender.org>

→Library:

- <http://www.blendswap.com/>
- <http://matrep.parastudios.de/>

→Documentation:

- http://wiki.blender.org/index.php/Main_Page
- <http://www.blendermagazineitalia.it/>
- http://en.wikibooks.org/wiki/Blender_3D:_Noob_to_Pro