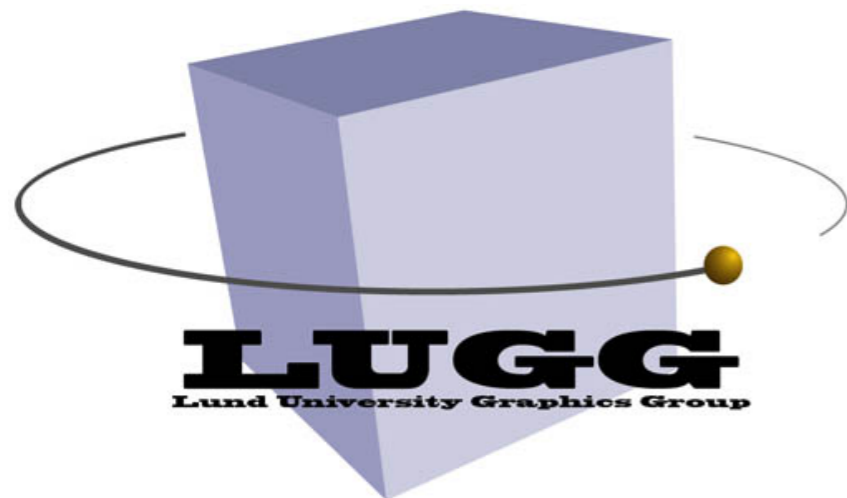EDAN35 HIGH PERFORMANCE COMPUTER GRAPHICS

Anti-aliasing

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Project

- Assignments are over, let's look at the project

- Should be done in a group of 2

- Each group writes a 2-4 page report

  - Check out LaTeX style on web page or use something similar

  - Make sure report includes references for web pages, papers, or other references used

- Submit a short video with report highlighting features of the project

- Final presentation includes a competition

- Total project corresponds to 3 points (3 weeks of work x 2 people)

- Project will be graded out of 10, and is worth 30% of final mark

- Finish by 2020-12-14, 13:00, Wednesday before last lecture

3D Graphics Project

- A chance to be creative

- A chance to create something that can be shown to potential employers (i.e. game company)

- For example :

  - Games (keep the mechanics simple, 2D)

  - Demo using 3D graphics algorithm

  - Graphical User Interface (GUI)

  - Tool (drawing tool)

  - Check out previous year's projects on the web page

- Performance is not too important

  - But optimization is good, write about it in your report

- Formulate project, and get it approved

  - A long paragraph description of what your project will do, due Monday, 28th

- What is the best project?

  - A jury (with participants from industry) decides ...

3D Graphics Projects

- SSAO
- Fur rendering
- Terrain Rendering
- Fire
- POM
- NPR - Outlines, hatching
- Temporal Anti-Aliasing
- Ray Tracing
- On web page look at :
  - Links
  - Previous years page
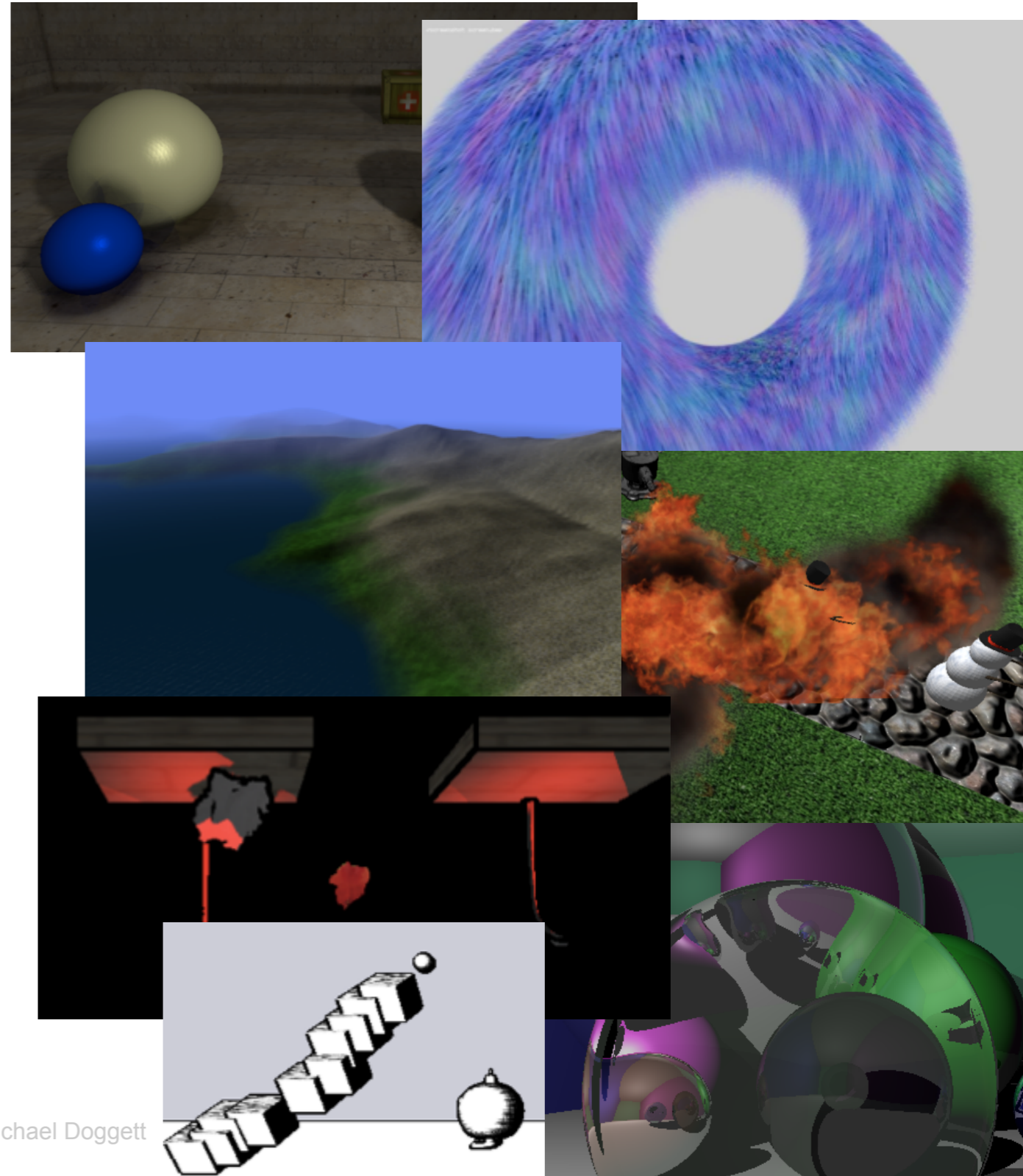
3D Graphics Projects

- Use Ray Tracer from Assignment 1

- Use Bonobo from Assignment 2

- For presentation/competition we provide a PC

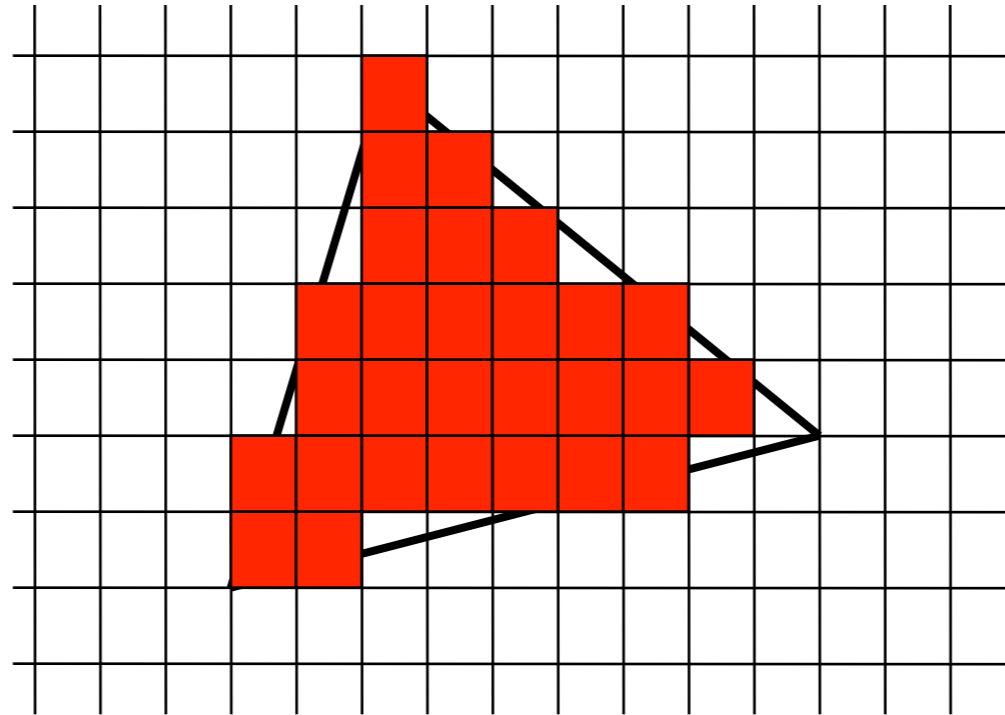 - or bring your own laptop

  - ~2 minute presentation

Back to the Graphics Pipeline
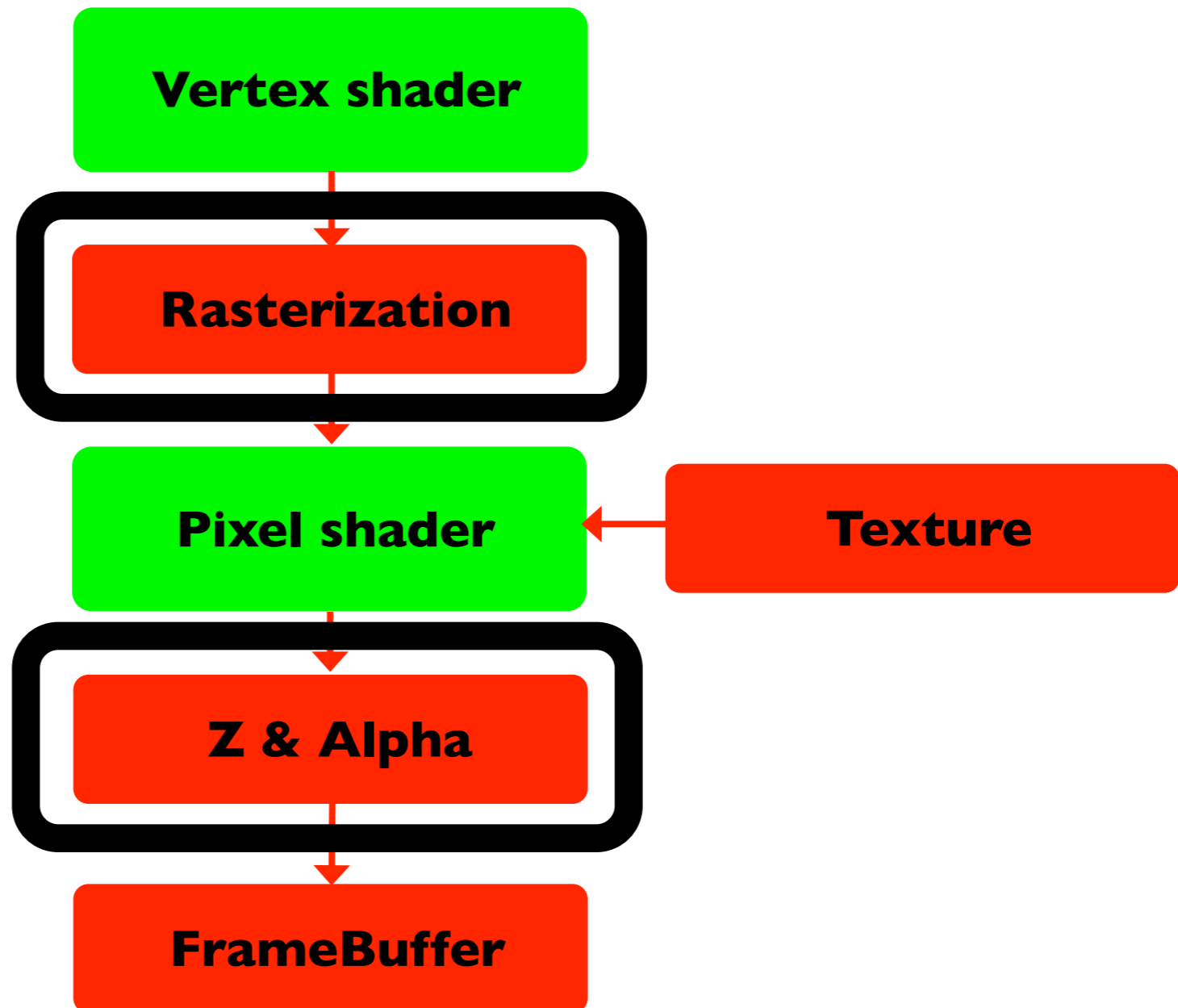
Anti-aliasing overview

- Sampling and reconstruction

- Supersampling

- Sampling Patterns

- Multisampling

- Screen Space, Resolve Pass AA

- Temporal AA

Aliasing

- When rasterizing we get jagged edges
  - sometimes called "jaggies"
  - can look bad when animated
- Anti-aliasing is used to smooth out edges

Sampling

- Computer Graphics does a lot of :

  - Sampling, filtering and reconstruction

- Many objects are continuous, spheres, triangles

  - but are discretized by sampling

Sampling Theory

- Sampling Theorem

  - A signal can be reconstructed from its samples without loss of information, if the original signal has no energy in frequencies at or above ½ the sampling frequency.

- The minimum rate at which it must be sampled is the Nyquist frequency.
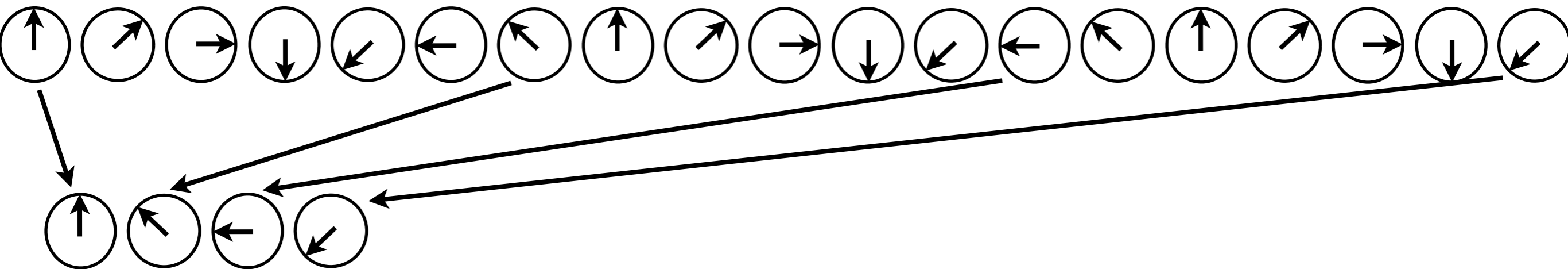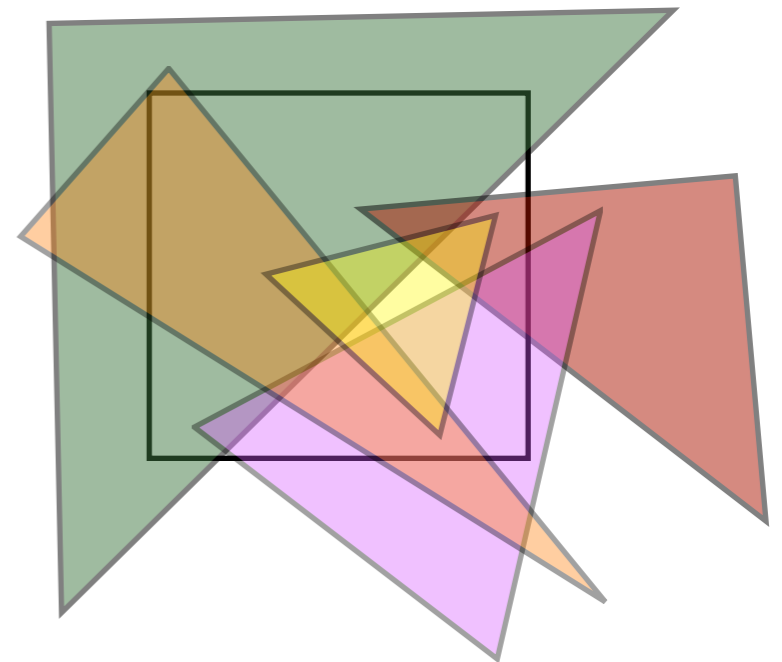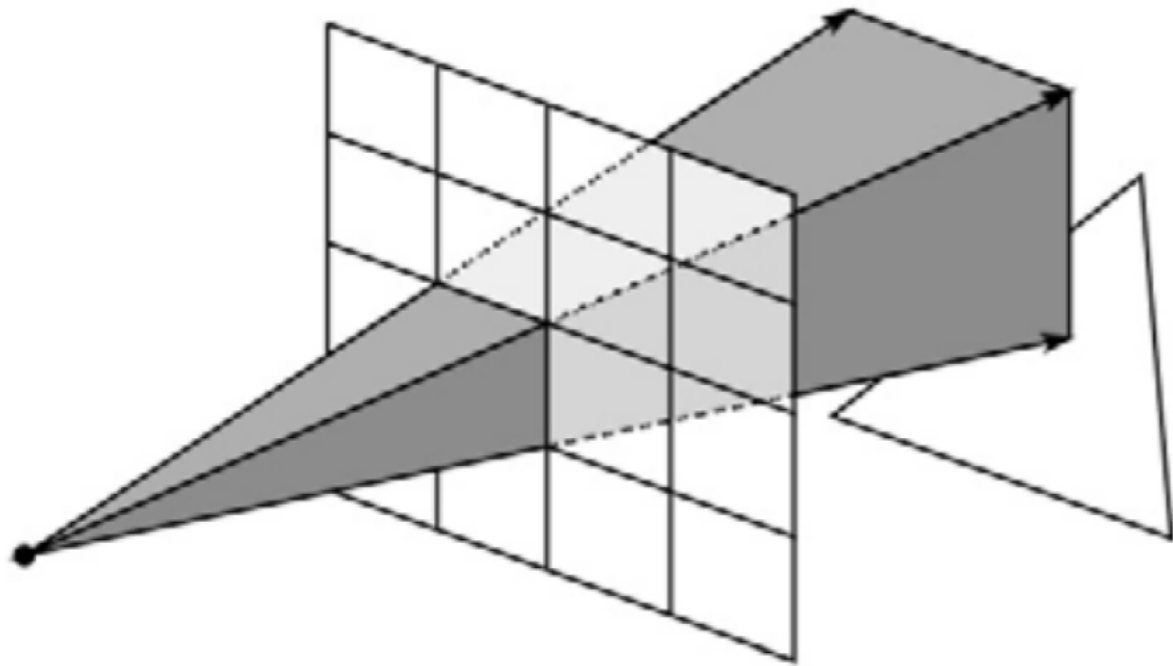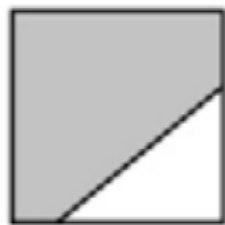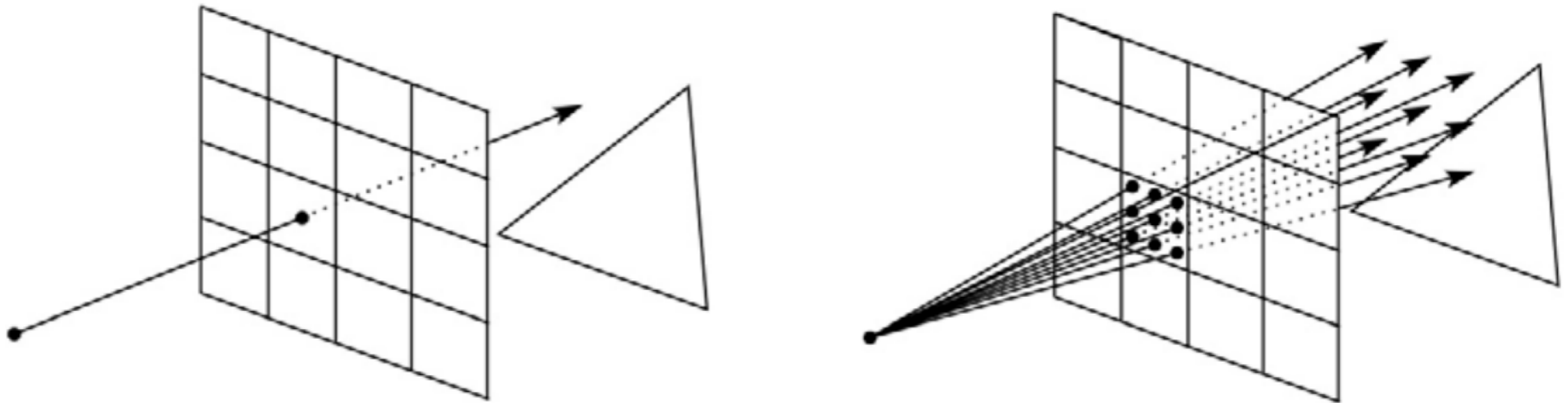
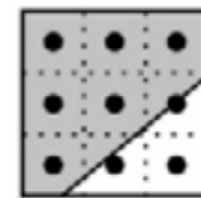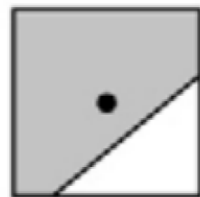# Calculate everything that is in a pixel

- Calculate area of triangle that covers pixel

- Divide by total area and multiply by color

- But this becomes complex ...

Reduce aliasing by increasing samples

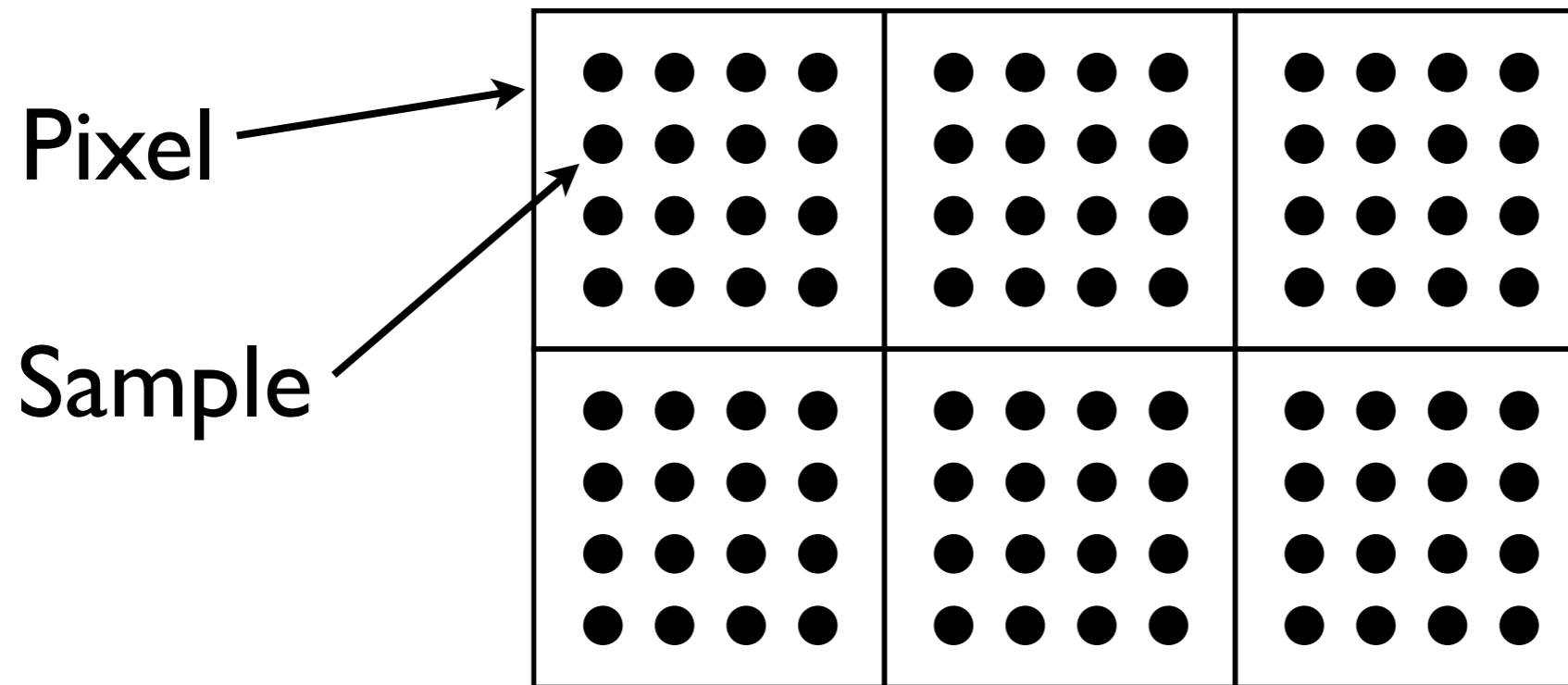- So instead we sample in the center of the pixel

- To antialias we increase the number of samples in the pixel

Supersampling

Pixel

Sample

- Super Sampling AntiAliasing (SSAA)
  - Render at 4x resolution in X and Y
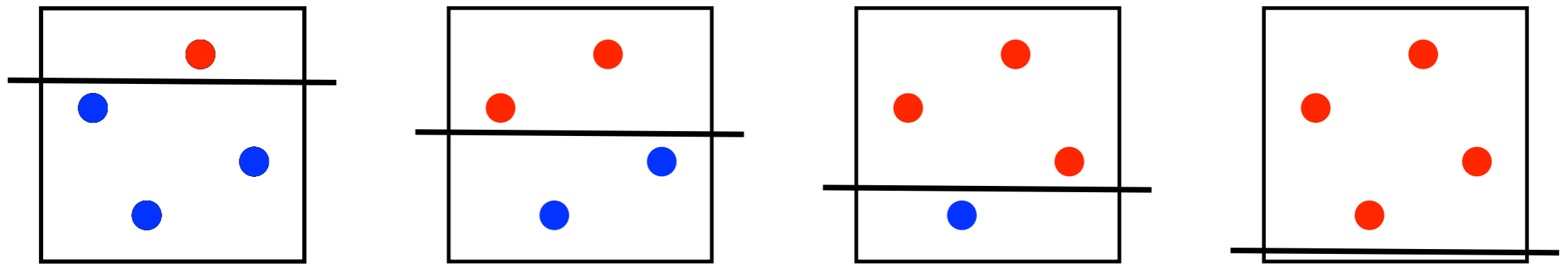 - Average 4x4 pixels to get final color

Sampling Patterns
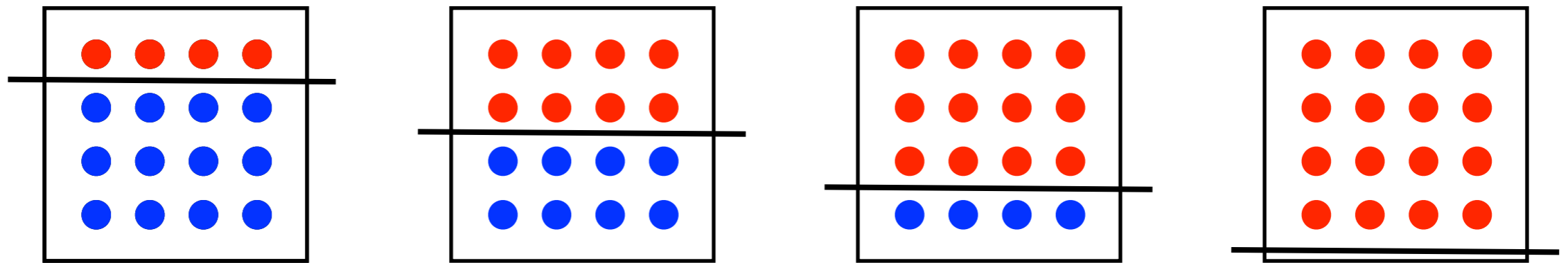
Only 4 different shades of red for 16 samples!

- Grid (Uniform Sampling)
  - Works well on diagonal lines
 - Not efficient on near horizontal and vertical lines

Sampling Patterns

Now 4 different shades of red for 4 samples!

- Rotated Grid Super sampling (RGSS)

  - Rotate a grid to improve horizontal and vertical

  - Diagonal lines not as well covered, but average is much better

  - Important feature is no two samples on same horizontal or vertical line (called n-rooks pattern)

Multisample AA (MSAA)
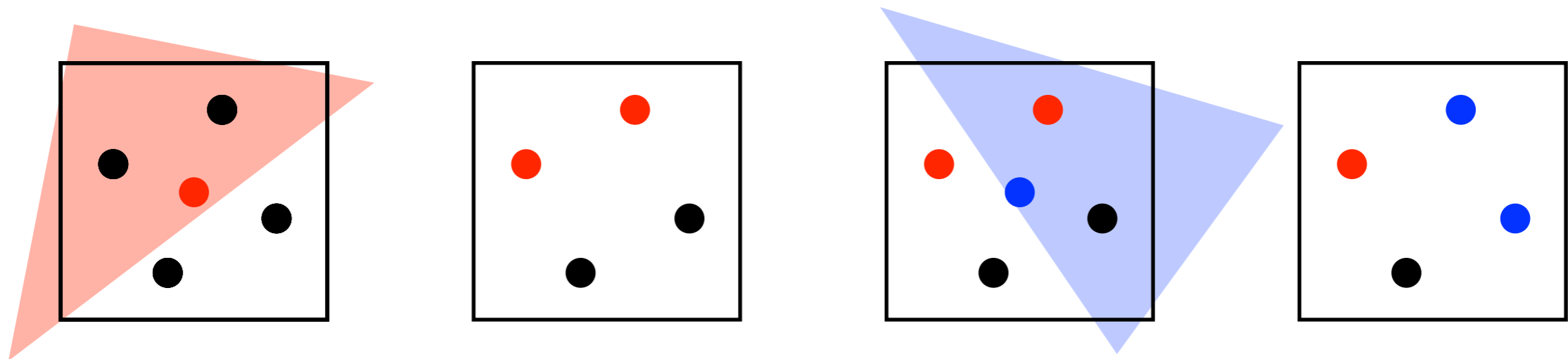
- Computing the color using a shader at every sample is expensive
- So only compute color at one sample, but compute depth at all samples
- Write color to every sample that passes the Z test
  - Store colors at up to 4 positions (RGSS)
- Still have to store the total number of Z/Color samples at each pixel
  - Since some triangles only cover some samples
- Implemented in hardware

Extending MSAA

- Compute color at more than one sample

- i.e. 16 depth samples, 2 or 4 color samples

- NVIDIA Coverage Sample AA

- AMD Enhanced Quality AA

Screen Space (Resolve Pass) AA

- Post-processing AA

- Purely software/shader based

- Many approaches (27)

  - all use deferred shading color buffer pixels

- The basic idea is :

  - Detect colors that are different

  - Construct a silhouette

  - Filter colors based on constructed silhouette

- For more see the SIGGRAPH 2011 course, "Filtering Approaches for Real-Time Anti-Aliasing"

Morphological Anti-Aliasing

MLAA rule # 1 (out of 2)

silhouette segments start/end at edges of pixels at which horizontal and vertical separation lines intersect
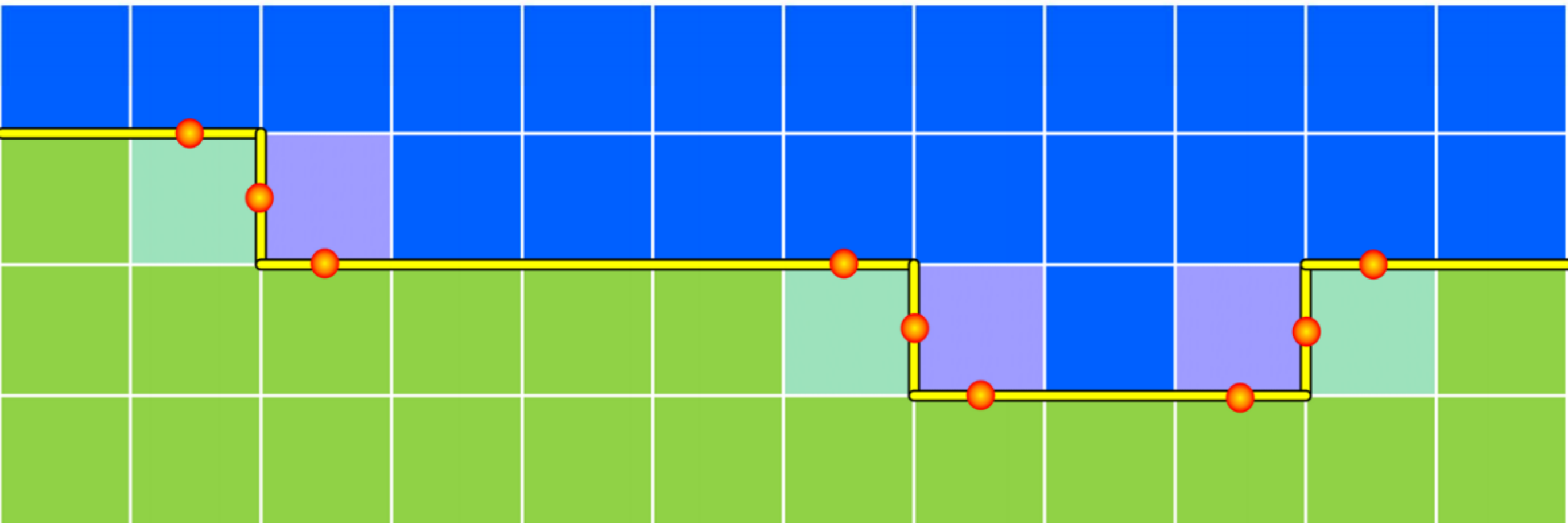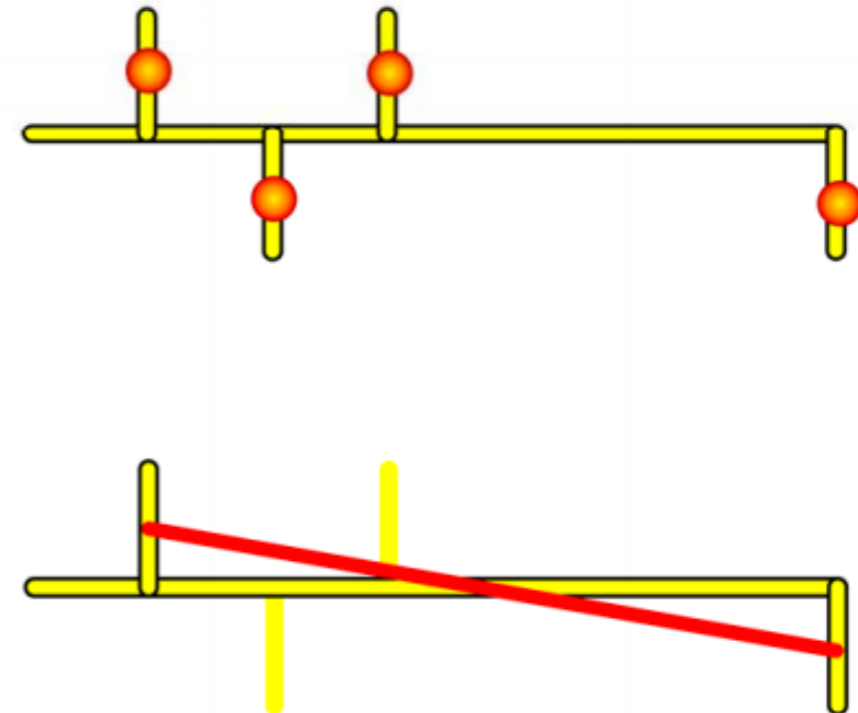
Morphological Anti-Aliasing

MLAA rule # 2

for each separation line

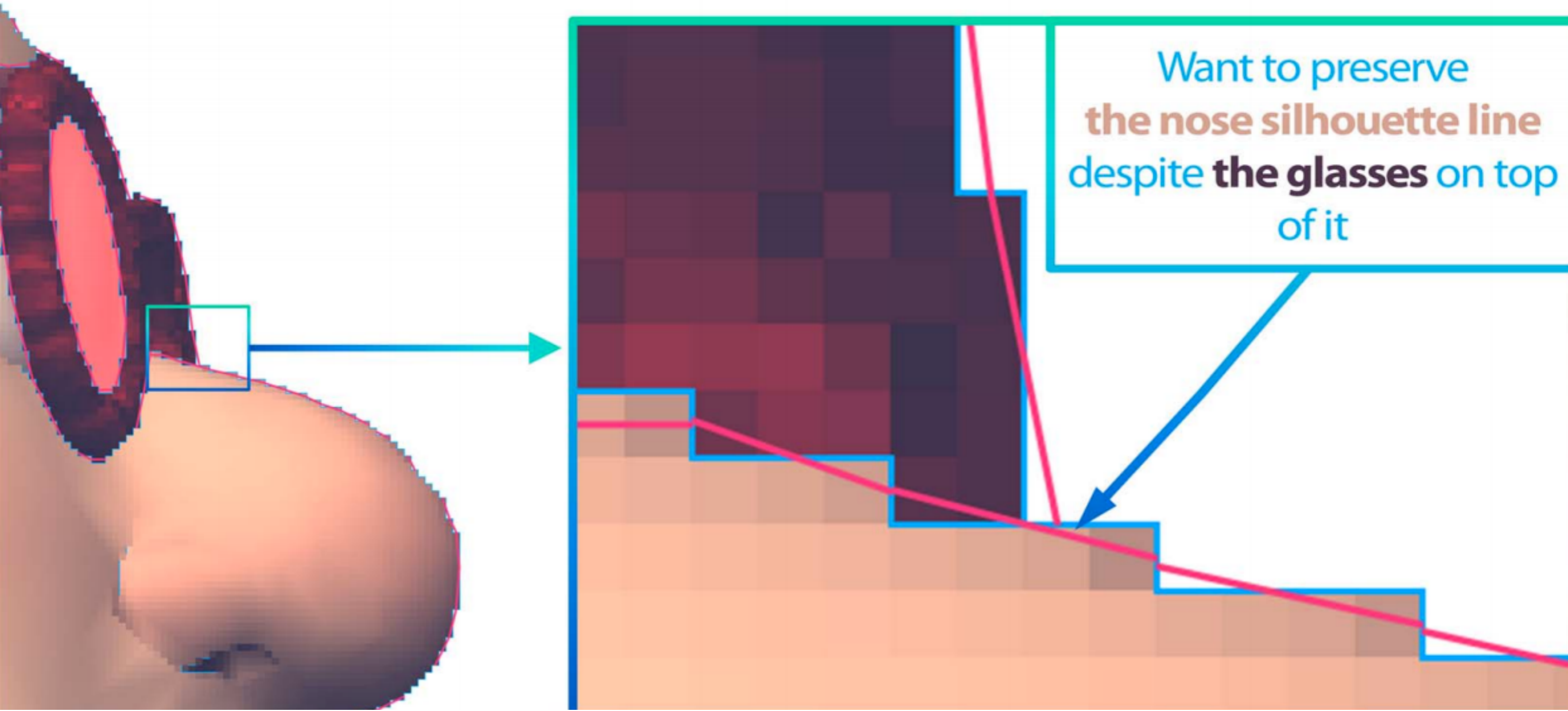- look at all start/end points on adjacent orthogonal lines

- choose the longest segment

Morphological Anti-Aliasing

image courtesy Alexander Reshetov, Morphological Anti-Aliasing http://iryoku.com/aacourse/downloads/03-Morphological-Anti-Aliasing.pdf

Morphological Anti-Aliasing

image courtesy Alexander Reshetov, Morphological Anti-Aliasing http://iryoku.com/aacourse/downloads/03-Morphological-Anti-Aliasing.pdf
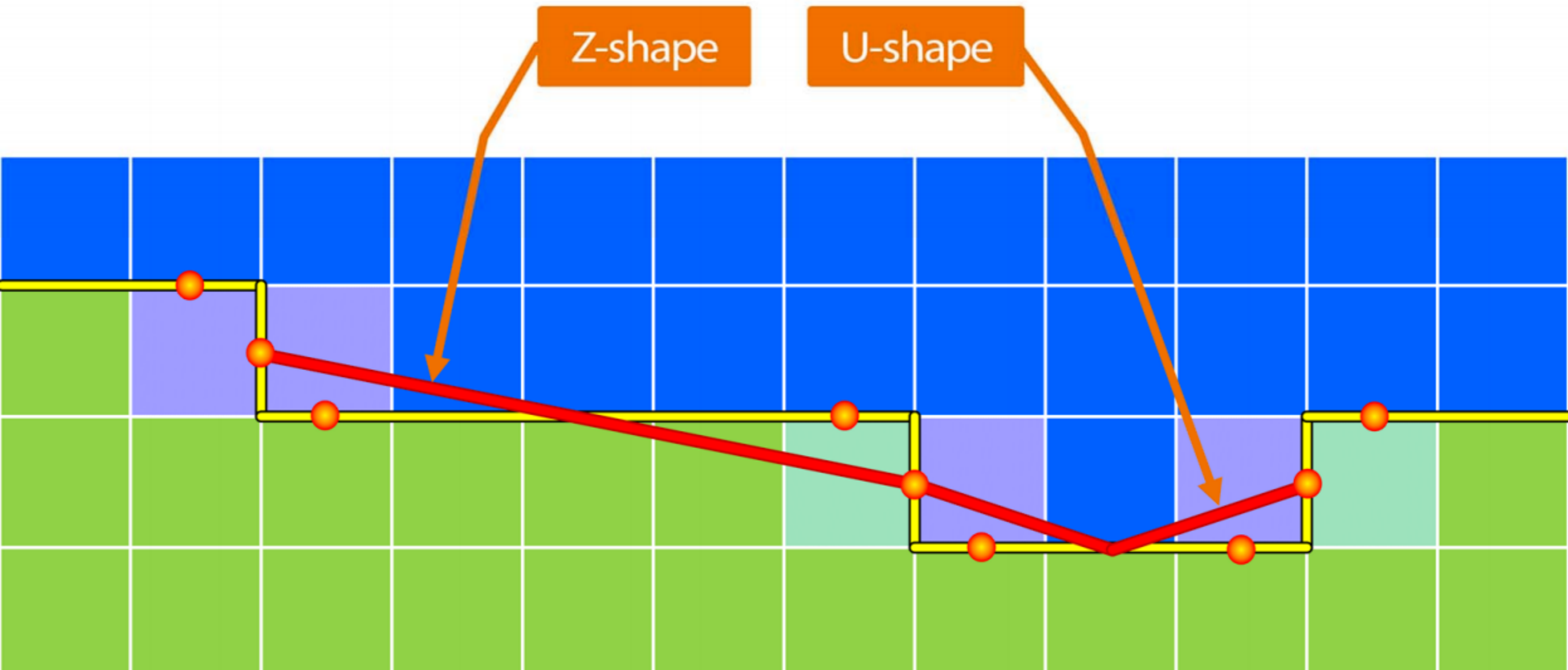
Morphological Anti-Aliasing
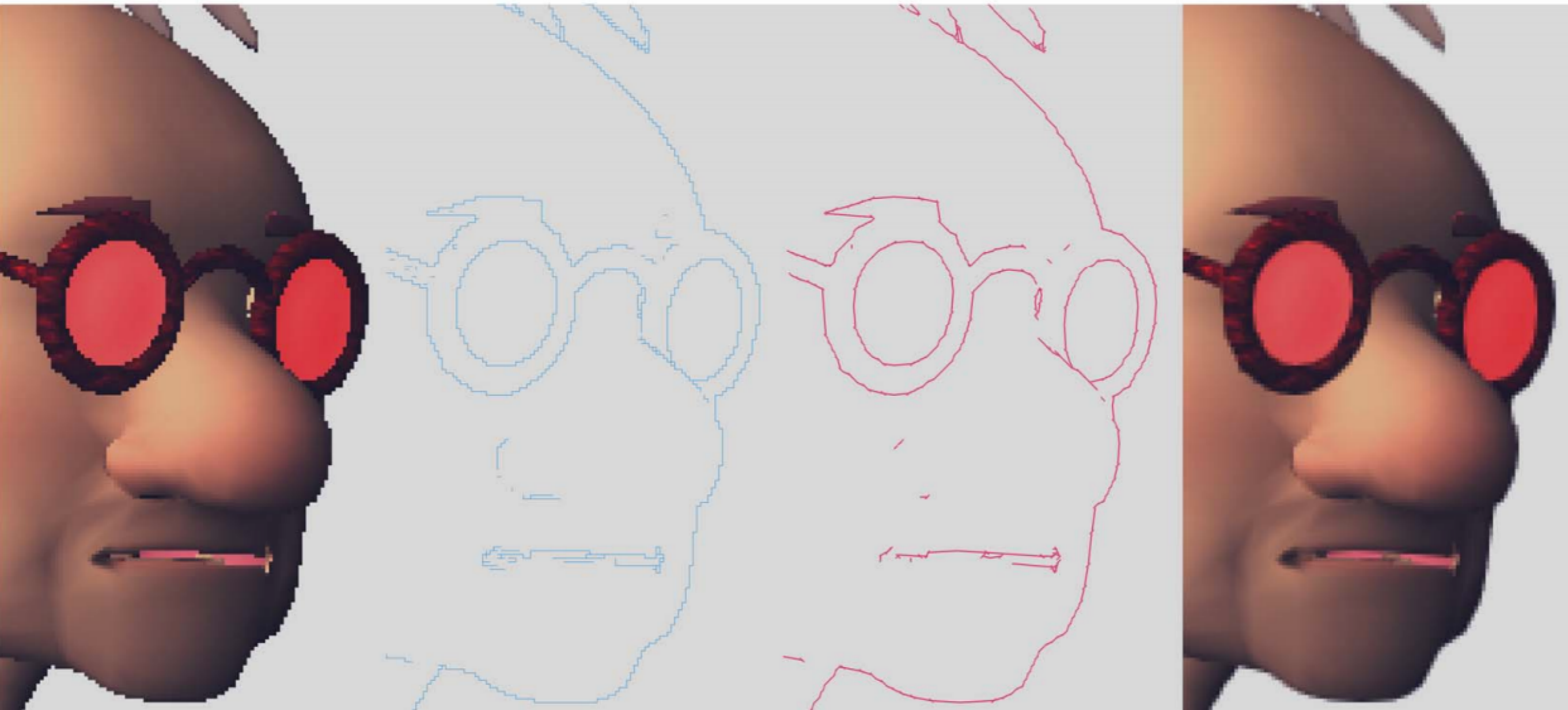
Original   Separation lines   Reconstructed silhouette   AA image

image courtesy Alexander Reshetov, Morphological Anti-Aliasing http://iryoku.com/aacourse/downloads/03-Morphological-Anti-Aliasing.pdf

MLAA on PS3

Original

MLAA

image courtesy Tobias Berghoff and Cedric Perthuis, http://iryoku.com/aacourse/downloads/06-MLAA-on-PS3.pdf

Directionally Localized Anti-Aliasing (DLAA)

image courtesy Dmitry Andreev, http://iryoku.com/aacourse/downloads/12-Anti-Aliasing-from-a-Different-Perspective-(DLAA).pdf

Temporal Antialiasing

Previous — Reproject → Current
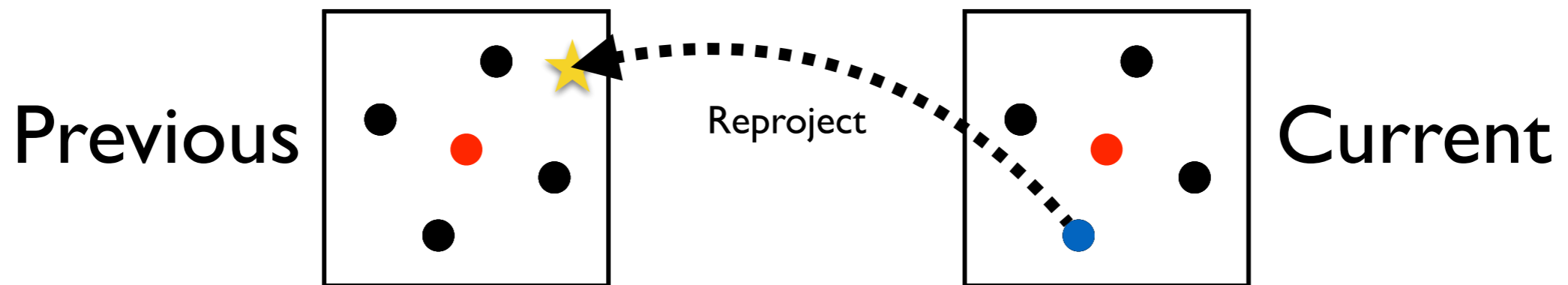
- Create new sample in current pixel

- Reproject current pixel into previous frame

  - Use motion vectors

  - Sample history buffer (previous frame's pixels)

  - Validate history sample for changes in occlusion, etc

- Blend history color with new sample

AI/DL/Neural Network AA

- Train a NN with high quality images from games

- Use low-res image, G-Buffer, motion vectors, etc as input to NN

- Also used for upscaling

- Nvidia Deep Learning Super Sampling (DLSS)

- AMD FidelityFX Super Resolution (FSR)

- Intel Xe Super Sampling (XeSS)