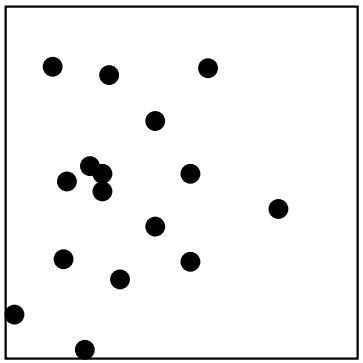
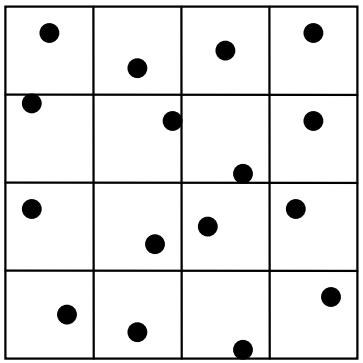
CS 563 Advanced Graphics
Poisson Disk Sampling

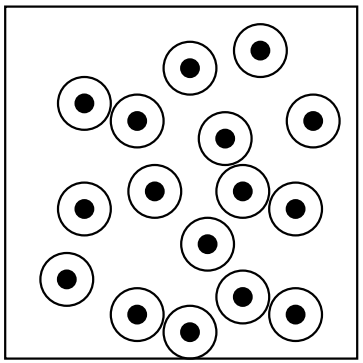
by Emmanuel Agu

Non-Uniform Sampling - Patterns

- Poisson
  - Pick ***n*** random points in sample space
- Uniform Jitter
  - Subdivide sample space into n regions
- Poisson Disk
  - Pick n random points, but not too close



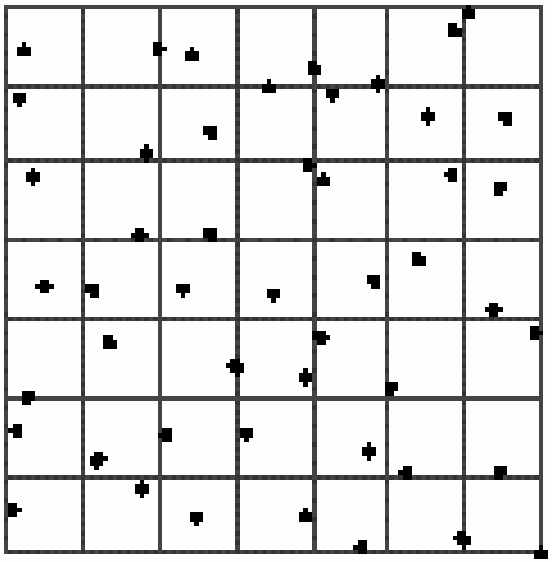




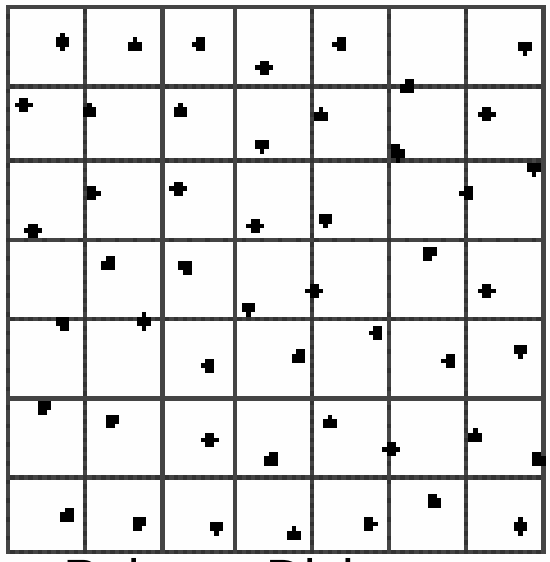
Best-Candidate Sampling

- Jittered stratification
  - Randomness (inefficient)
  - Clustering problems
  - Undersampling (“holes”)
- Stratified, Low Discrepancy Sequences
  - Still (visibly) aliased
- “Ideal”: Poisson disk distribution
  - too computationally expensive
- Best candidate sampling - approximation to Poisson disk

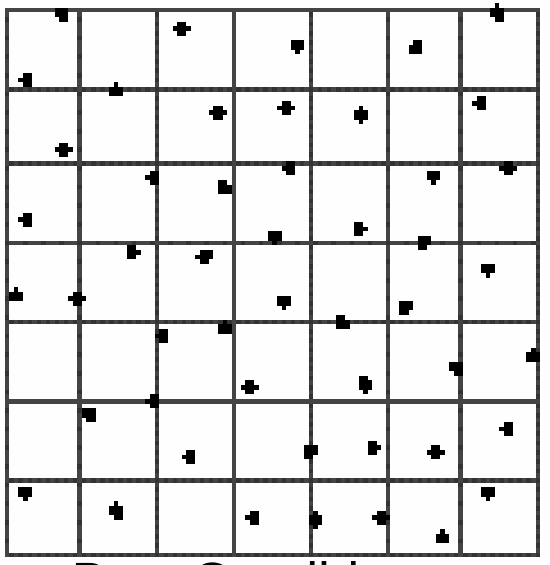
Best-Candidate Sampling



Jittered



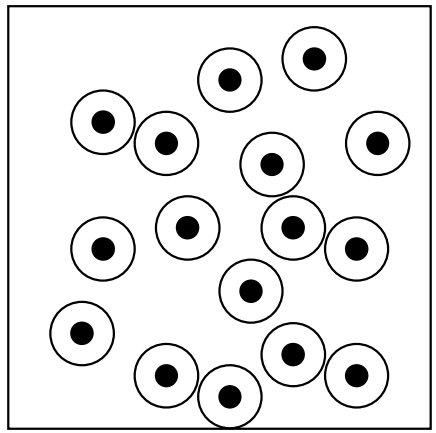
Poisson Disk



Best Candidate

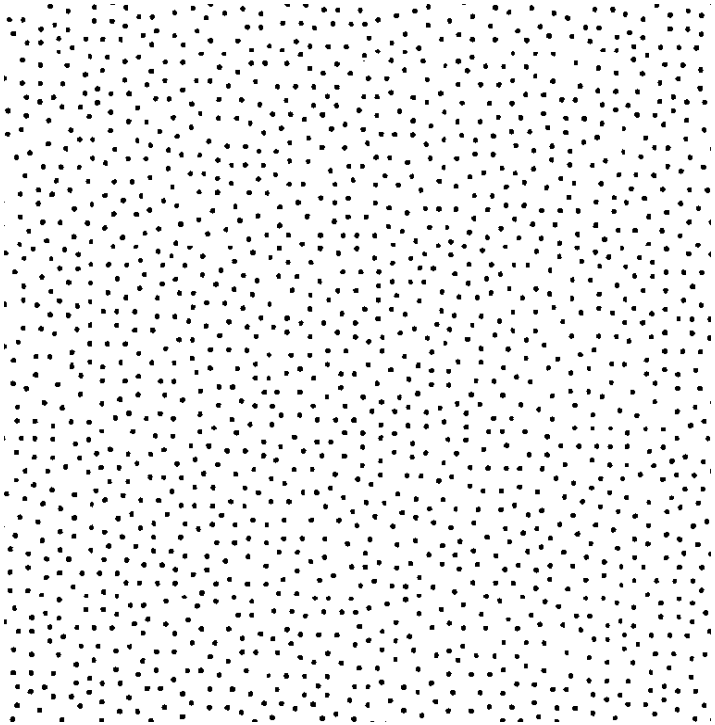
Poisson Disk

- Comes from eye structure of – rods and cones
- Dart Throwing
- No two points are closer than a threshold
- Very expensive – time consuming
- Compromise – Best Candidate Sampling
  - Don Mitchell
  - Generates many ***potential*** candidates randomly, only insert ***farthest one*** to all previous samples.
  - Compute “tilable pattern” offline that is reused by tiling the image plane (translating and scaling).
  - Toroidal topology – paste on toroid
  - Affects distance between points on top to bottom

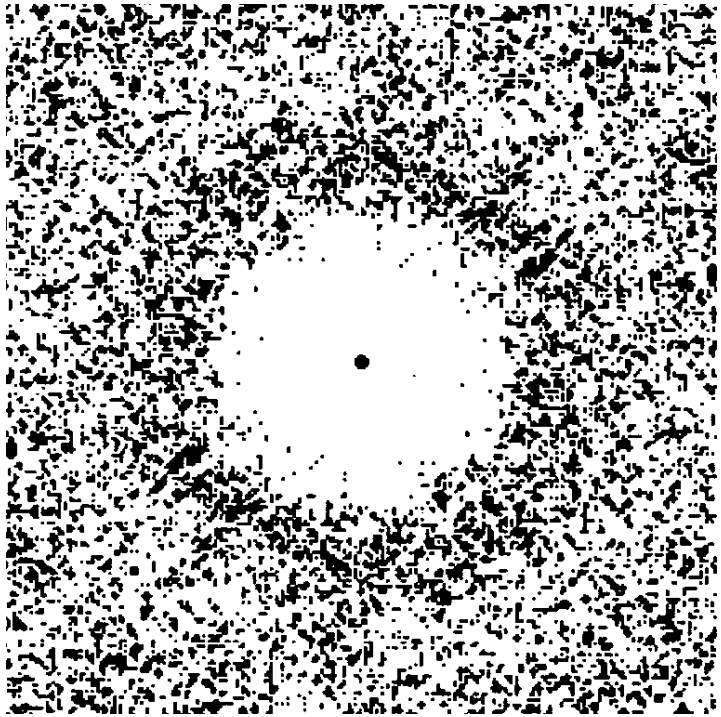


Poisson Disk Sampling

- Spectral characteristics:
  - **Poisson:** completely uniform (white noise). High and low frequencies equally present
  - **Poisson disc:** Pulse at origin (DC component of image), surrounded by empty ring (no low frequencies), surrounded by white noise



Spatial Domain



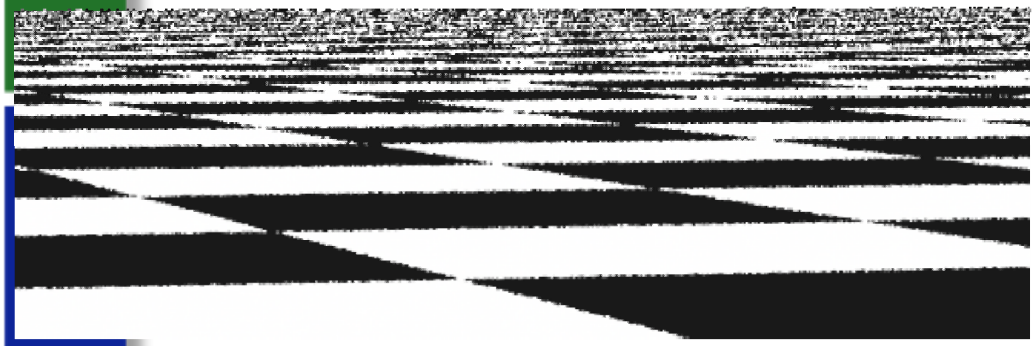
Fourier Domain

Poisson Disk algorithm

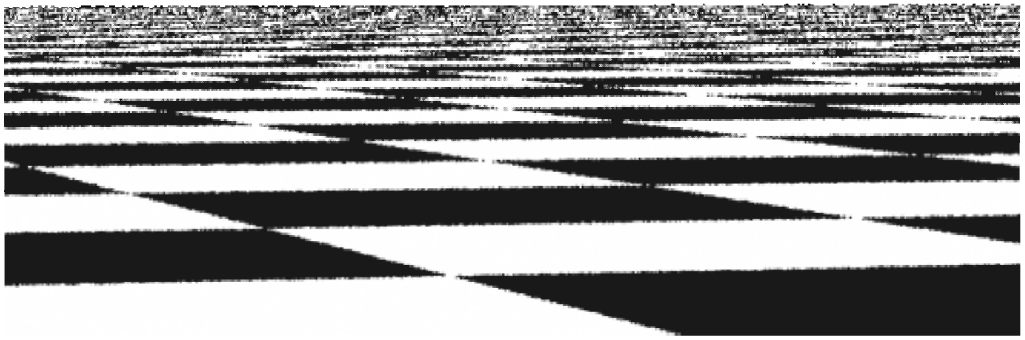
```
i ← 0
while i < N
  x_i ← unit()                                  Throw a dart.
  y_i ← unit()
  reject ← false
  for k ← 0 to i − 1                            Check the distance to all other samples.
    d ← (x_i − x_k)^2 + (y_i − y_k)^2
    if d < (2r_p)^2 then                        This one is too close—forget it.
      reject ← true
      break
    endif
  endfor
  if not reject then                            Append this one to the pattern.
    i ← i + 1
  endif
endwhile
```

Texture

Jitter with 1 sample/pixel



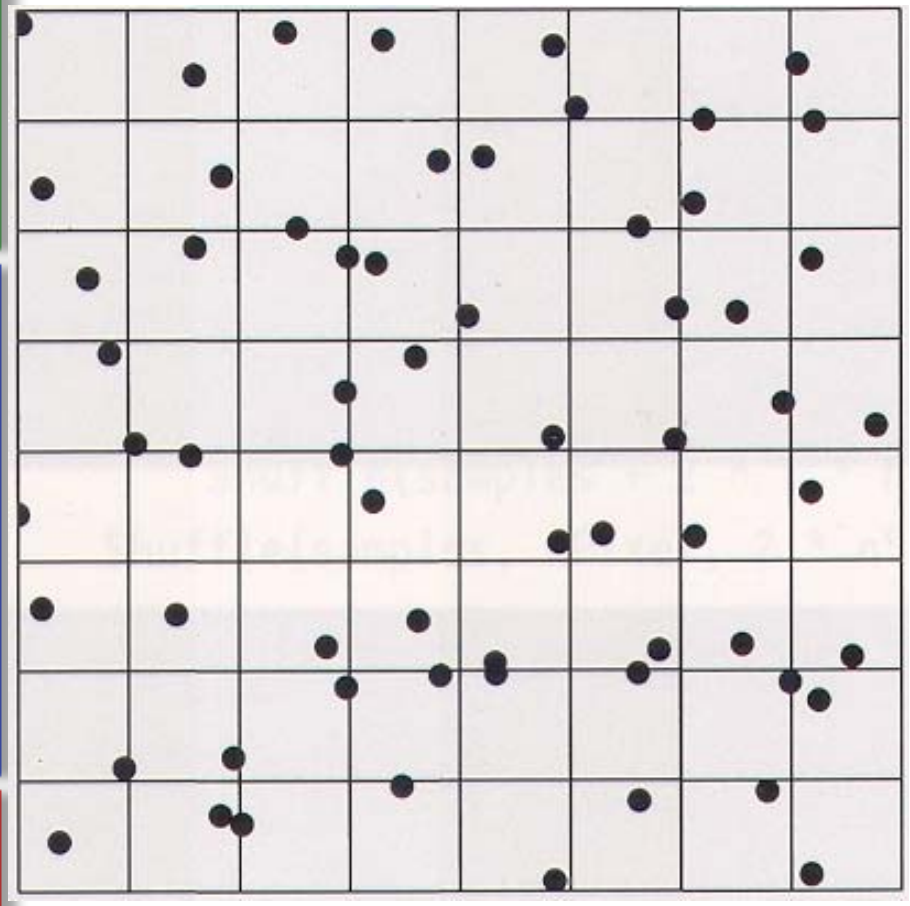
Best Candidate with 1 sample/pixel



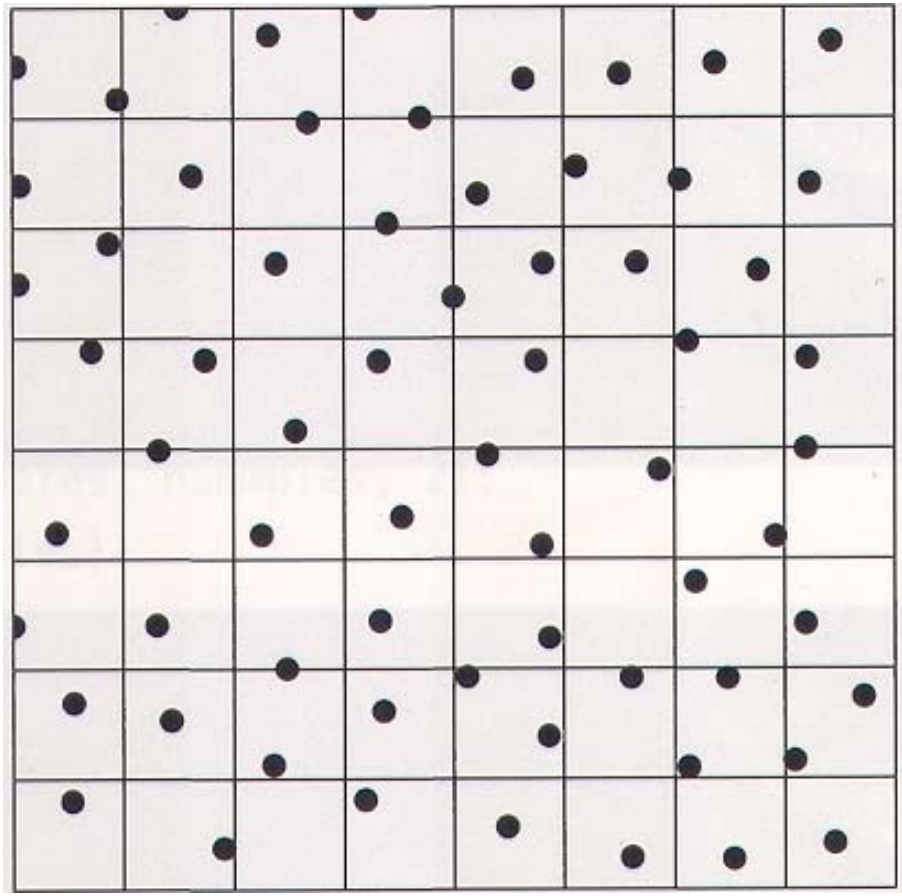
Jitter with 4 sample/pixel

Best Candidate with 4 sample/pixel

Best candidate sampling



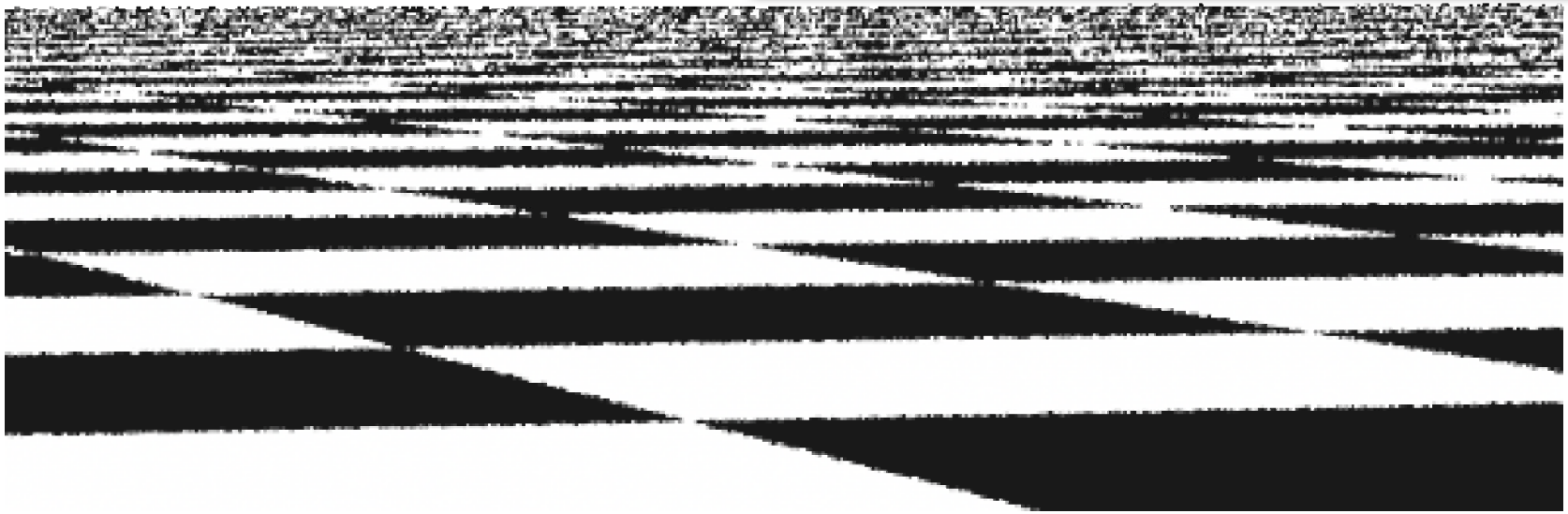
stratified jittered



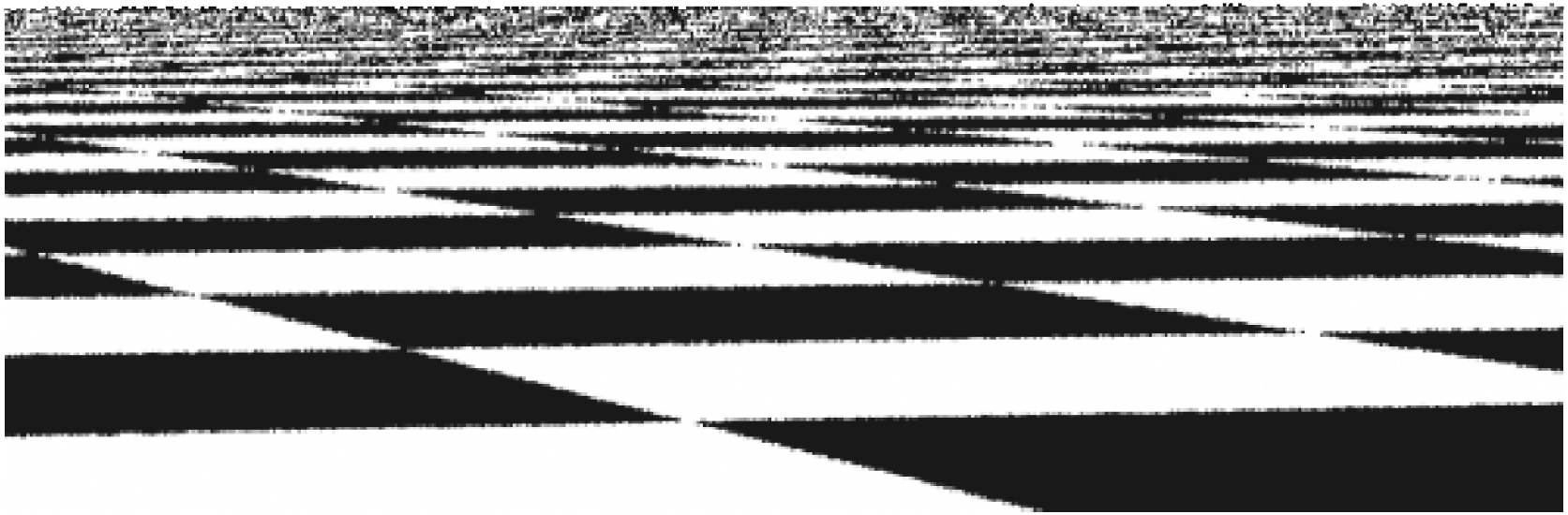
best candidate

It avoids holes and clusters.

Best candidate sampling

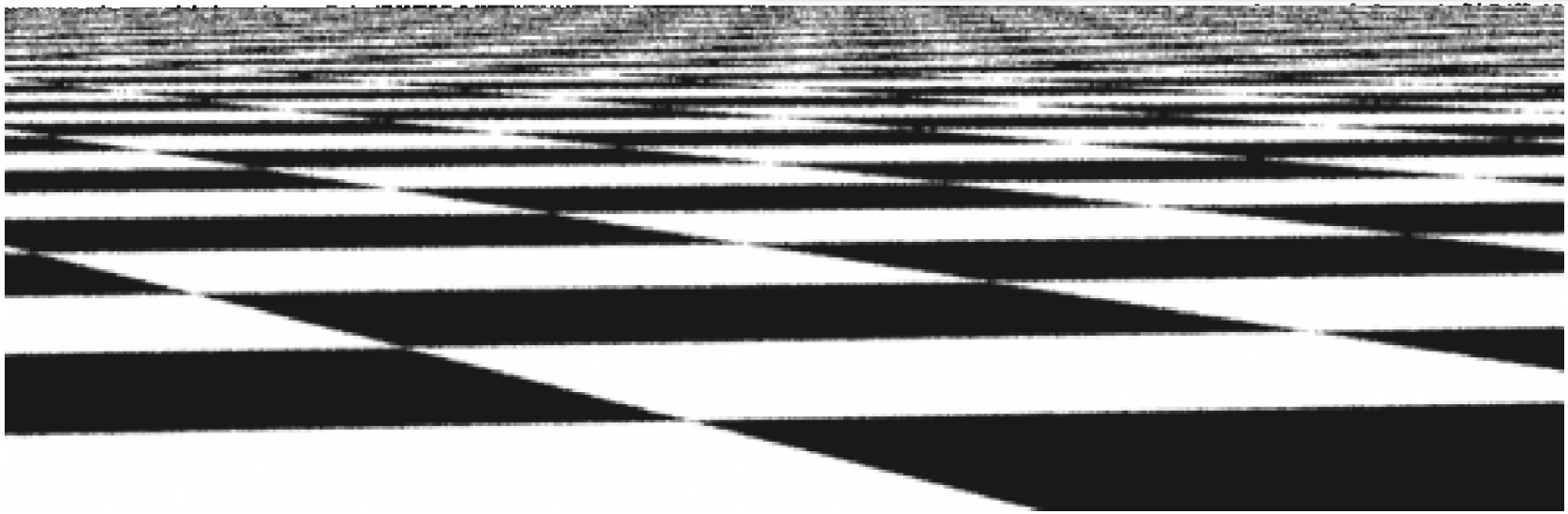


stratified jittered, 1 sample/pixel



best candidate, 1 sample/pixel

Best candidate sampling



stratified jittered, 4 sample/pixel

best candidate, 4 sample/pixel

Poisson Disk Recent Developments

- Daniel Dunbar , Greg Humphreys, A spatial data structure for fast Poisson-disk sample generation, ACM SIGGRAPH 2006, Boston, Massachusetts

  SIGGRAPH VIDEO Quicktime version

- Parallel Poisson disk sampling by Li-Yi Wei, SIGGRAPH 2008
- Youtube video Quicktime version

- Jones, T. R. 2006. Efficient generation of poisson-disk sampling patterns. journal of graphics tools 11, 2, 27--36.

References

- Yung-Yu Chuang, Image Synthesis, class slides, National Taiwan University, Fall 2005
- Rick Parent, 782: Advanced 3D Image Generation
- Pat Hanrahan, CS 348B, Spring 2005 class slides