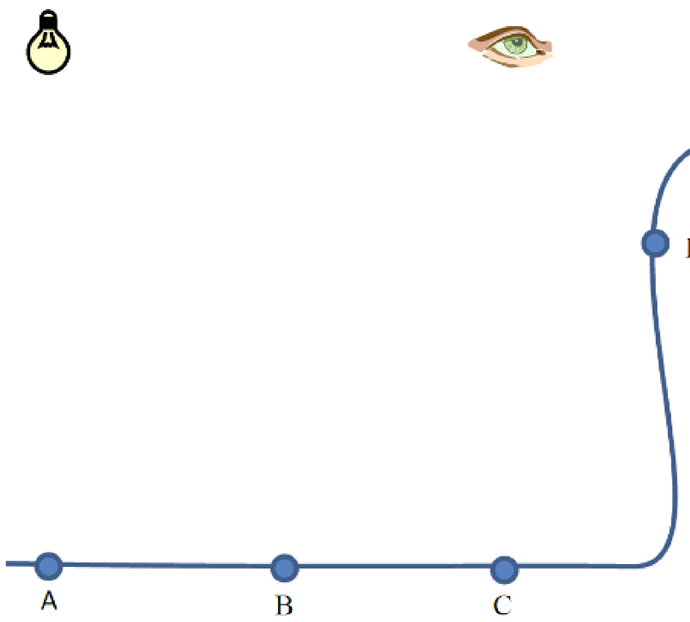
Lighting

For the following questions, please refer to the 2-D scene depicted in this figure.



Which point (A, B, C or D) reflects the most diffuse light using the Phong reflection model?

- (a) Point A
- (b) Point B
- (c) Point C
- (d) Point D

Which point (A, B, C or D) reflects the most specular light using the Phong reflection model?

- (a) Point A
- (b) Point B
- (c) Point C
- (d) Point D

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Week 6: Feb 21	Rendering: Shading	Lecture Video Basic Shading PDF Game Design: Stardew Valley PDF

When Do We Do the Shading Calculation?

Shading can be done at different stages of the rendering process...what we call the process depends on when the shading calculation occurs. Match the correct label to each of these three algorithms

```
For each light:
  For each object affected by the light:
      framebuffer += object * light
```

- (a) Deferred Shading
- (b) Single Pass Lighting
- (c) Deferred Lighting
- (d) Multi-pass Lighting

```
For each object:
  Render to multiple targets
For each light:
  Apply light as a 2D postprocess
```

- (a) Single Pass Lighting
- (b) Deferred Shading
- (c) Deferred Lighting
- (d) Multi-pass Lighting

```
For each object:
  Render mesh, applying all lights in one shader
```

- (a) Deferred Lighting
- (b) Multi-pass Lighting
- (c) Single Pass Lighting
- (d) Deferred Shading

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Week 6: Feb 23	Rendering: Shading & Materials	Lecture Video Shading Worksheet PDF Deferred Shading PDF UE5 Materials PDF

Deferred Complexity

Suppose we render a scene with n_L lights and n_T polygons. Which function best describes the algorithmic complexity of rendering when using *deferred shading*.

- ○ (a) $O(n_L \times n_T)$
- ○ (b) $O(n_T^{n_L})$
- ○ (c) $O(n_L + n_T)$
- ○ (d) $O(n_L^{n_T})$

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Deferred Shading Drawbacks

Which of the following effects are non-performant when implemented with deferred shading?

- ☐ (a) A full-scene directional light source
- ☐ (b) Ambient Occlusion
- ☐ (c) Transparency
- ☐ (d) Multi-Sample Anti-Aliasing (MSAA)
- ☐ (e) The Blinn-Phong reflection model

Select all possible options that apply.

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Light Volumes

When using *deferred shading* one opimization is to render a *light volume* mesh enclosing the world space that the light hits, and only shade the pixels that within that light volume. Assuming the light volume is convex and does not intersect the near or far clip planes, which of the following is true?

- ○ (a) Backfacing polygons should be culled.
- ○ (b) Backfacing polygons should be rendered.
- ○ (c) The light volume is not large enough.
- ○ (d) None of the above are true.

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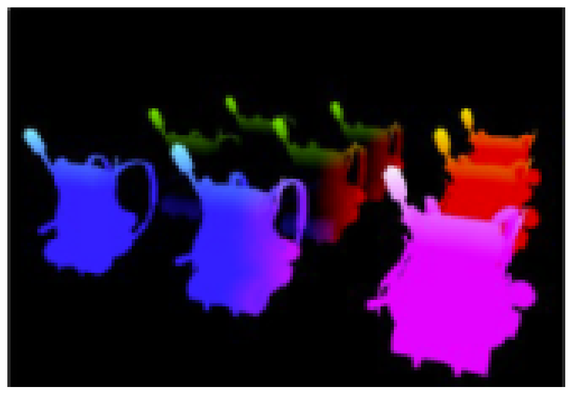
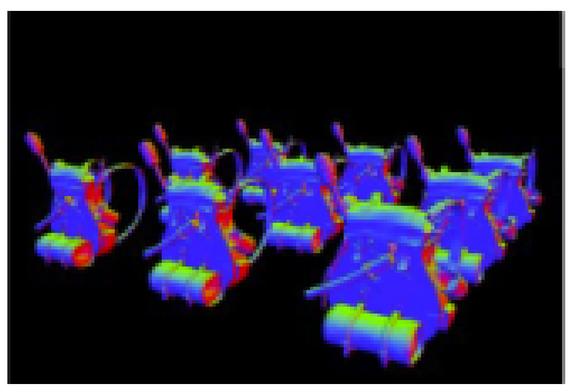
Week 6: Feb 23	Rendering: Shading & Materials	Lecture Video Shading Worksheet PDF Deferred Shading PDF UE5 Materials PDF

Geometry Buffers for Deferred Shading

Deferred shading uses geometry buffers to store information needed for a final lighting computation over a scene. Each image below is a geometry buffer that stores a different kind of data. Match each image to the label that most likely describes the kind of data in the buffer.

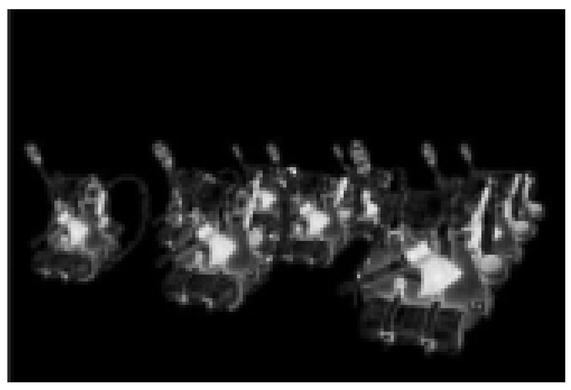


- [ ] (a) Albedo (Diffuse Material)
- [ ] (b) Specular Material
- [ ] (c) Normals
- [ ] (d) Position
- [ ] (e) Light Intensity



- [ ] (a) Normals
- [ ] (b) Specular Material
- [ ] (c) Position
- [ ] (d) Albedo (Diffuse Material)
- [ ] (e) Light Intensity

- [ ] (a) Position
- [ ] (b) Normals
- [ ] (c) Albedo (Diffuse Material)
- [ ] (d) Specular Material
- [ ] (e) Light Intensity



- [ ] (a) Specular Material
- [ ] (b) Normals
- [ ] (c) Position
- [ ] (d) Light Intensity
- [ ] (e) Albedo (Diffuse Material)

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Week 6: Feb 23	Rendering: Shading & Materials	Lecture Video Shading Worksheet PDF Deferred Shading PDF UE5 Materials PDF

Perspective Projection 1 1

Suppose a camera is at (0,0,0) of a coordinate system, looking down the negative Z axis. The view plane is at $z = -15$, and a point P is at $(6, 12, -1)$. P is projected onto the view plane using the perspective projection. What is the Y coordinate of the projected point on the view plane?

$Y =$ number (rtol=0.01, atol=1e-08)

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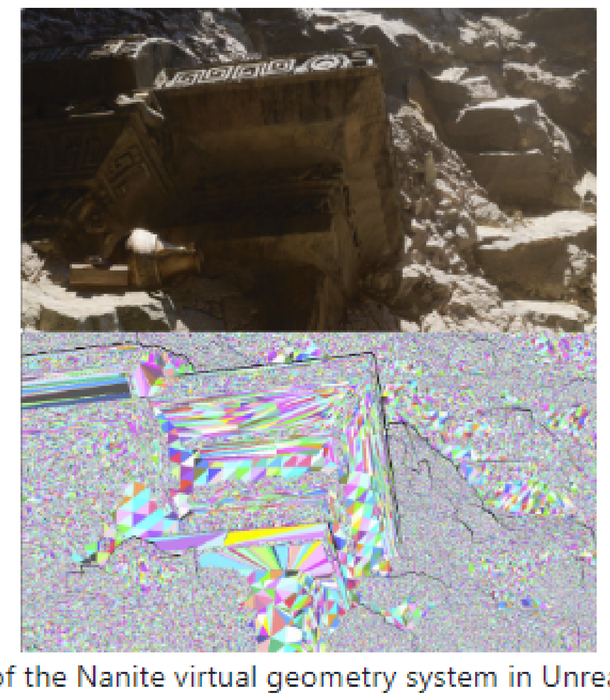
Week 5: Feb 14	Rendering: Projection	Recorded Video Projection PDF **HW1 Assigned** PrairieLearn HW1 Hints PDF

Nanite Facts



Which of the following are true of the Nanite virtual geometry system in Unreal Enghine 5?

- [ ] (a) In Nanite all triangles are processed using hardware rasterization on the GPU.
- [ ] (b) Nanite uses software rasterization, which means triangles are rasterized by the CPU of a computer system.
- [ ] (c) Nanite uses a software visibility buffer to do hidden surface removal.
- [ ] (d) Nanite Micropoly rasterization is very similar to that used in REYES, Pixar's first renderer from the 1980 used in Star Trek II: The Wrath of Khan.
- [ ] (e) For a triangle mesh, Nanite builds a level-of-detail hierarchy using the quadric error metric.

Select all possible options that apply.

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Week 7: Feb 28	Rendering: UE5 Nanite	**HW1 Due** PrairieLearn Lecture Video UE5 Nanite Example YouTube UE5 Virtual Geometry PDF

Week 10: Mar 21	Game AI	**No Lecture** **Pre-Recorded Videos:** UE5 Rasterization PDF Game AI History PDF Waypoints PDF

Non-Player Character Actions

Which AI technique is most often used to drive the actions of non-player characters in video games?

- ○ (a) Neural Nets
- ○ (b) Decision Trees
- ○ (c) A*
- ○ (d) Sense Simluation

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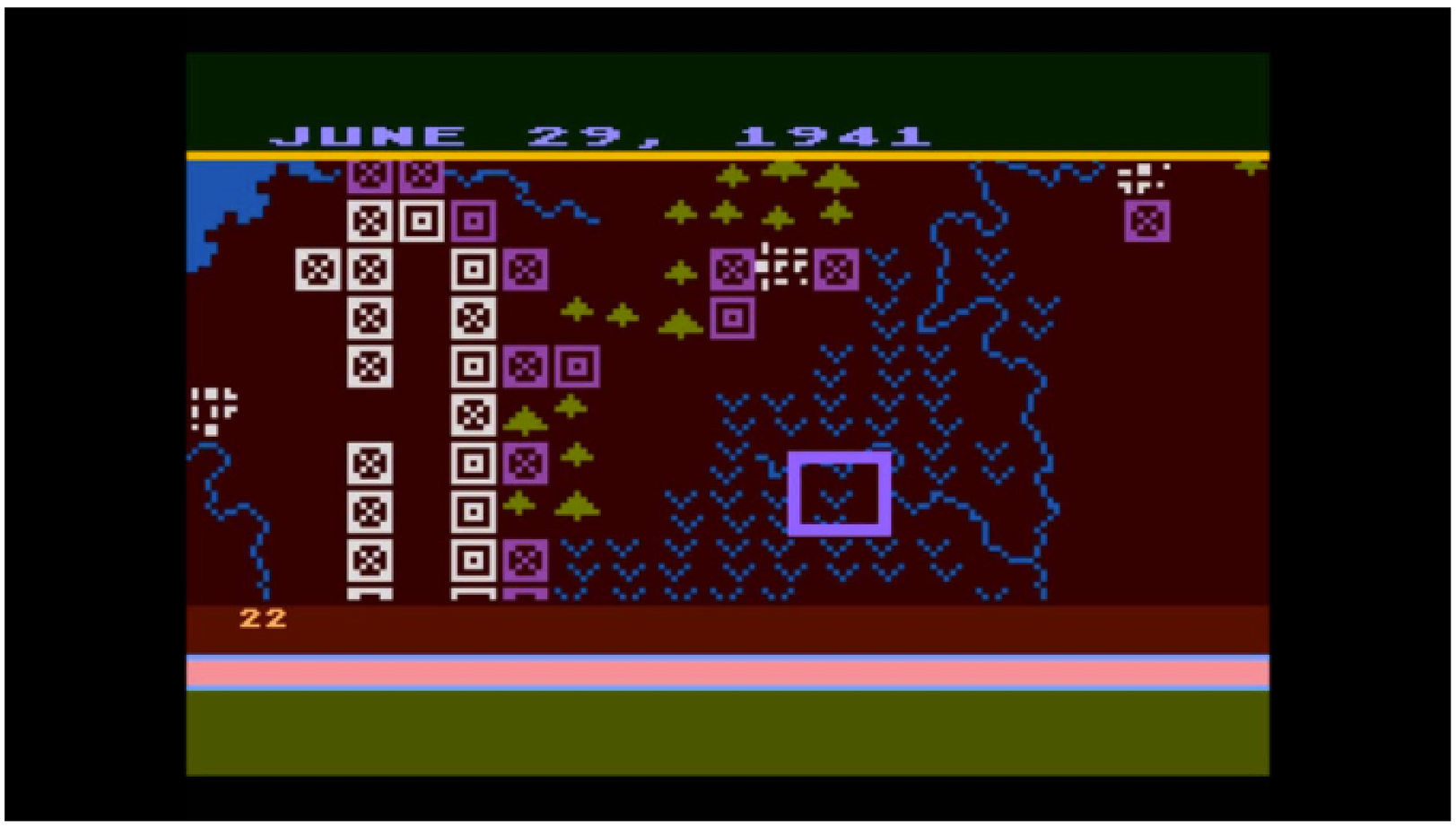
Breaking the AI



In the 1981 Atari 8-bit video game *Eastern Front 1941* which of the following playing strategies would break the opponent AI and essentially assure you of victory?

- ○ (a) Break your units into two blocks, and then advance them on alternate turns.
- ○ (b) Build a continuous front line of units.
- ○ (c) Move only 1 unit per turn, preventing the AI from having enough time generate an effective list of moves since it had no dedicated time to do so in this single-threaded game.
- ○ (d) Do not attack cities, but instead simply advance your units as far as possible each turn.

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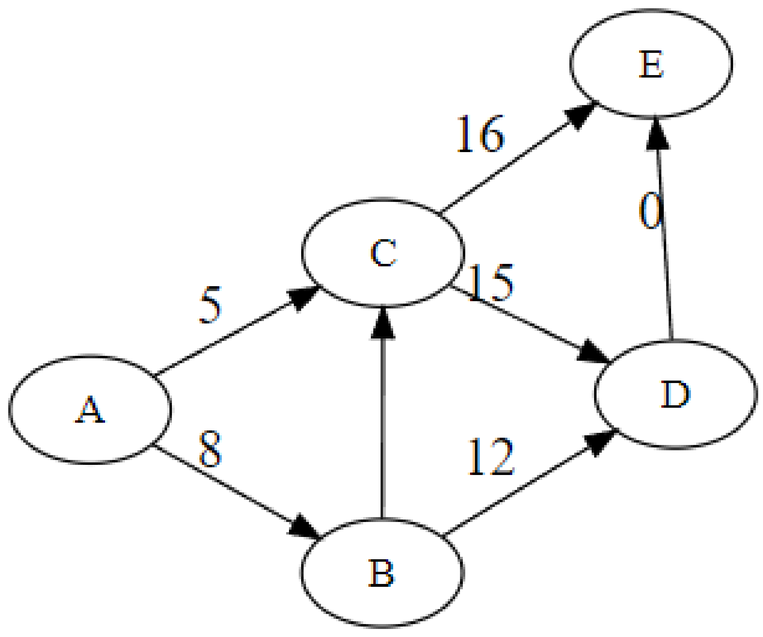
Week 10: Mar 21	Game AI	**No Lecture** **Pre-Recorded Videos:** UE5 Rasterization PDF Game AI History PDF Waypoints PDF

Shortest Path

For the graph below, state the largest integer weight for directed edge $(\mathtt{B},\mathtt{C})$ that makes the given description true. (Note that the edge weight need not be positive!)

The unique shortest path from **A** to **E** is **A B C D E**.



weight(B,C)= integer

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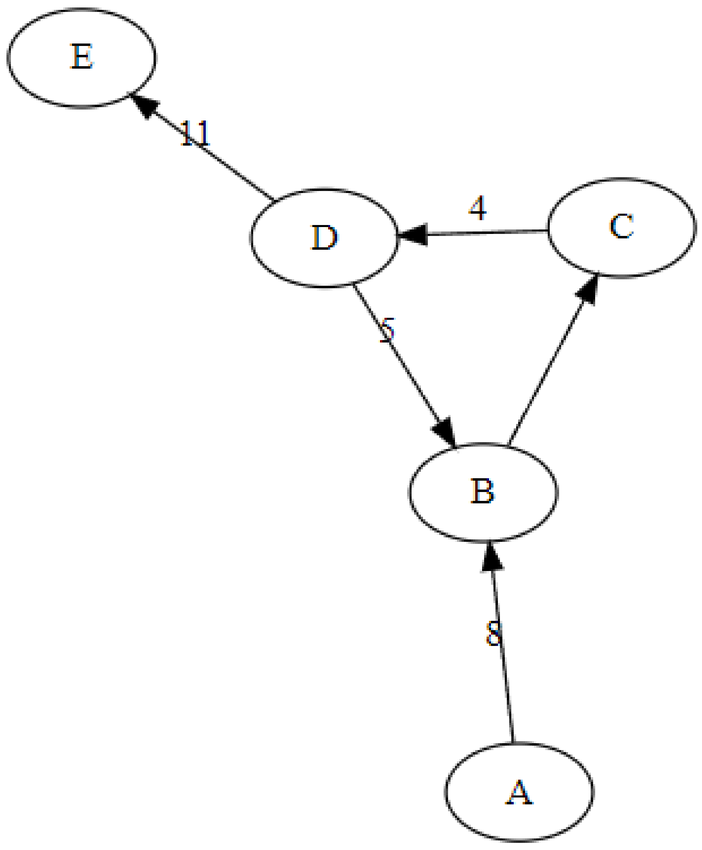
Week 8: Mar 9	Game AI	Live Lecture Link Pathfinding PDF A* in Games PDF

Shortest path

For the graph below, state the largest integer weight for directed edge $(\mathtt{B}, \mathtt{C})$ that makes the given description true. (Note that the edge weight need not be positive!)

A shortest path from $\mathtt{A}$ to $\mathtt{E}$ does not exist.



weight(B,C)= integer

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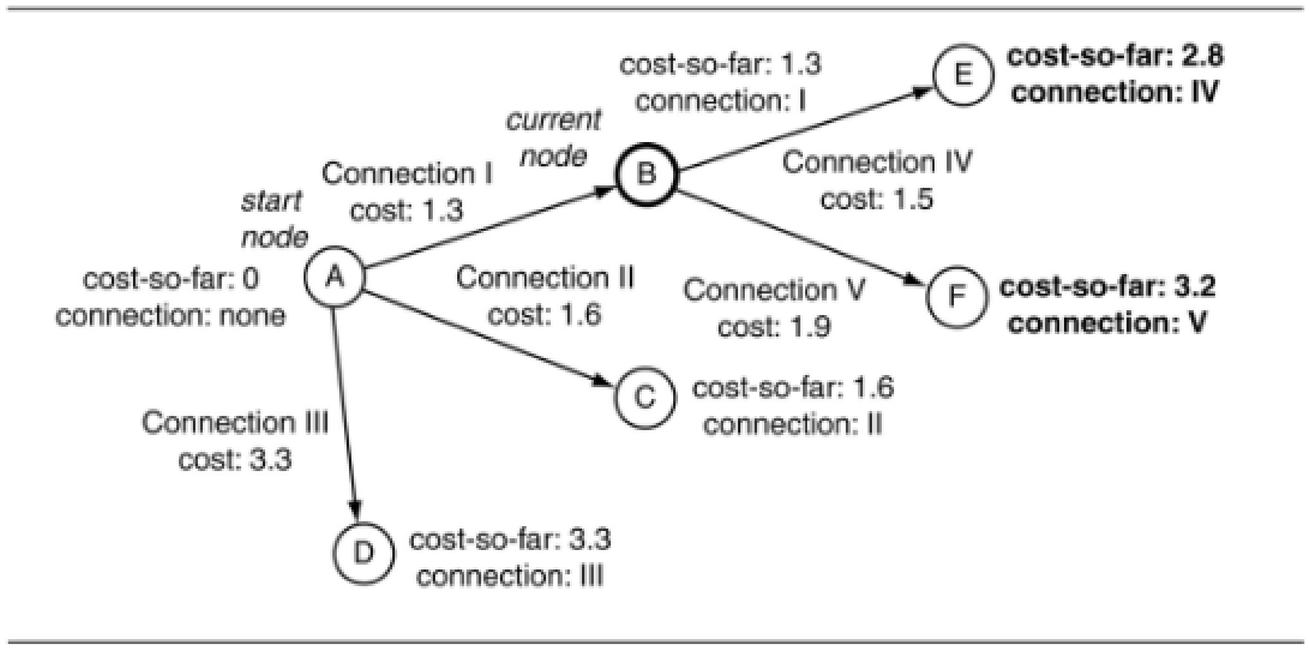
Week 8: Mar 9	Game AI	Live Lecture Link Pathfinding PDF A* in Games PDF

Dijkstra's Algorithm



Imagine we are running Dijkstra's shortest path algorithm on the graph in the picture. If nodes A and B have been explored, which node will get explored next?

- (a) C
- (b) E
- (c) D
- (d) F

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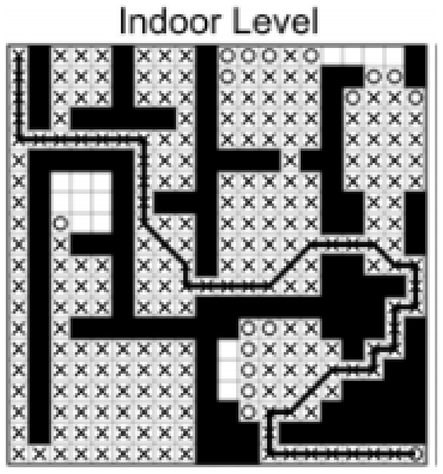
Week 8: Mar 9	Game AI	Live Lecture Link Pathfinding PDF A* in Games PDF

Indoor Pathfinding

Indoor Level



Which method would be the best choice for pathfinding in an indoor game level?

- (a) A* with the cluster heuristic
- (b) A* with the Euclidean heuristic
- (c) A* with the Null heuristic
- (d) Dijkstra's shortest path algorithm

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A*

Which of the following are true for the A* algorithm?

- [ ] (a) Using an underestimating heuristic will generate a minimal path.
- [ ] (b) A node will never be moved from the closed list back to the open list.
- [ ] (c) Using a constant heuristic value (e.g. 10) for all nodes is the same as running Dijkstra's algorithm.
- [ ] (d) Using an overestimating heuristic will yield a path faster than using an underestimating heuristic.

Select all possible options that apply.

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