

# Aspect Graph



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# Aspect Graph

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- 1. An aspect is a set of viewpoints of an object from which the same set of singularities are visible.
- 2. The set of all possible aspects partition space.
- 3. Each region becomes a node and each boundary an edge.
  - Koenderink and van Doorn (1979)
  
- Also known as
  - Visual Potential
  - Characteristic Views

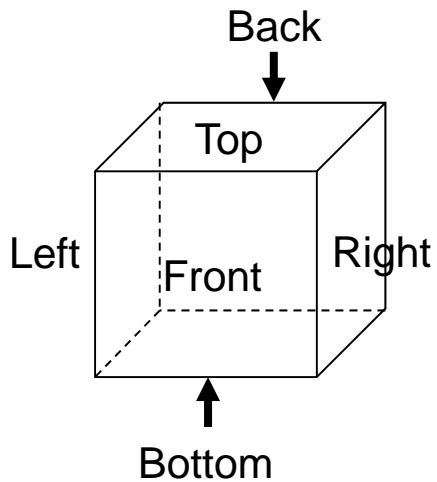
Main reference for this material:

"Visibility, Occlusion, and the Aspect Graph", H. Plantinga, C. Dyer, Int'l Journal of Computer Vision, 1990.

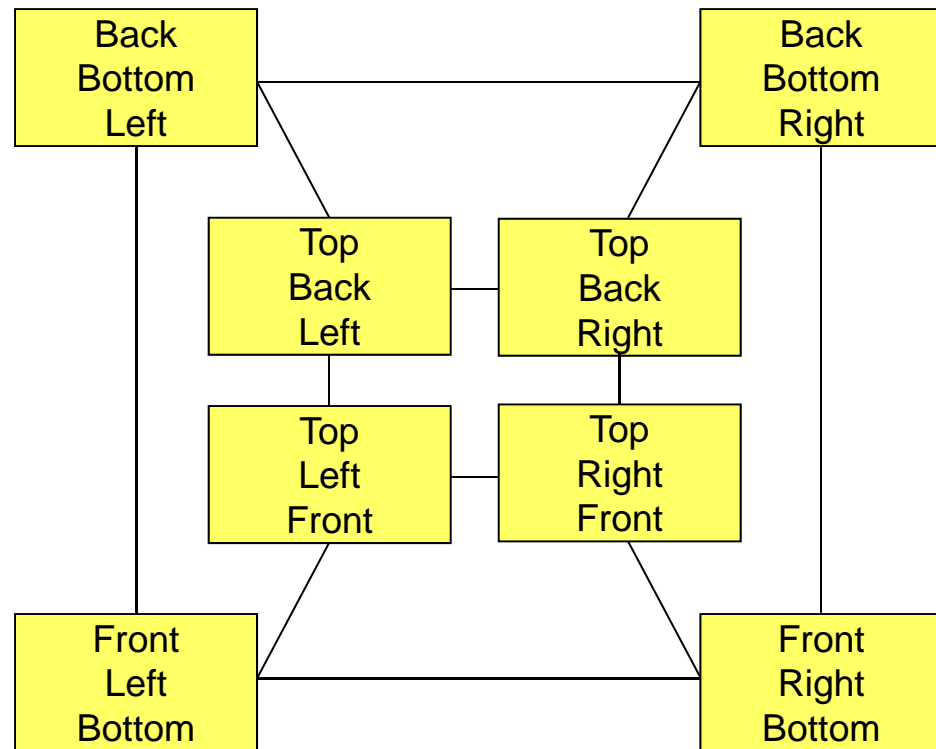
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# Example Aspect Graph

Object



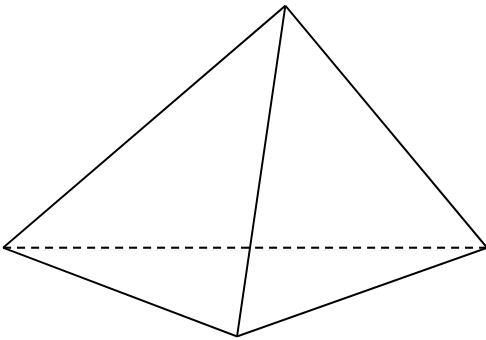
Aspect Graph



# Example Aspect Graph

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Object



# Uses

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- Object recognition
    - Determine the “characteristic views” and compare (e.g., automatic recognition)
  - Visual inspection
    - To see if a particular portion of the object, go to the appropriate aspect (e.g., a camera on a robotic arm)
  - Object sampling and reconstruction
    - Determine where to place cameras to capture objects (e.g., 3D reconstruction)
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# Viewpoint Space Partition

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- One way to obtain the aspect graph is to construct a Viewpoint Space Partition (VSP)
    - A viewing region is a maximal region of constant aspect such for any two viewpoints  $v_1$  and  $v_2$  and any viewpoint in between, the aspect is constant
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# Convex Polyhedra

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- Orthographic Projection
    - Aspect graph is a partition of the sphere
    - Maximum aspect graph size is  $O(n^2)$ 
      - Object consists of two perpendicular bands of quadrilaterals
      - Each quadrilateral defines a plane that intersects the infinite sphere in a great circle
      - $n$  great circles intersect at most  $(n-1)$  great circles
      - Thus  $O(n^2)$  viewpoint regions and  $O(n^2)$  aspect graph
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# Convex Polyhedra

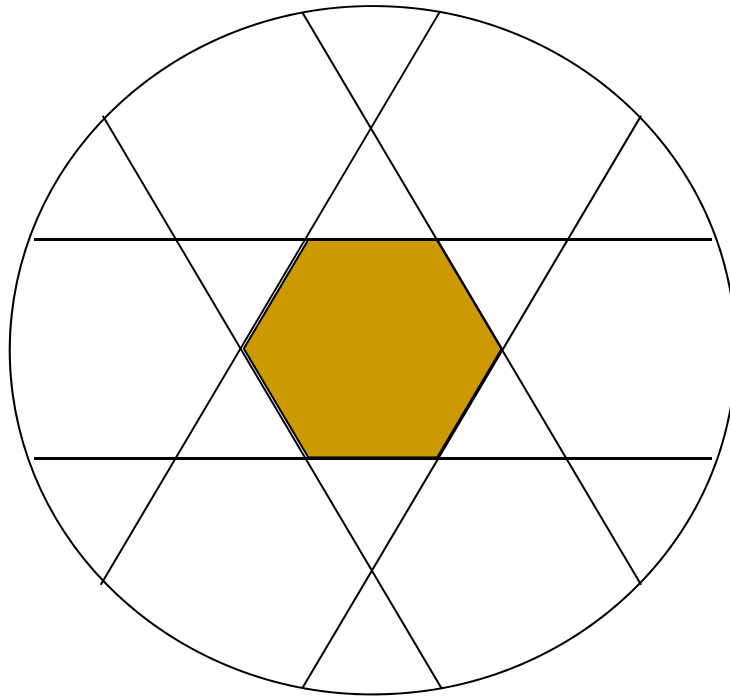
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- Perspective Projection
    - Aspect graph is a partition of space
    - Maximum aspect graph size is  $O(n^3)$
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# Convex Polyhedra

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- 2D example
  - Maximum aspect graph size is  $O(n^2)$



# Convex Polyhedra

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- 3D example
    - 3-space is divided by  $n$ -planes
    - Each plane is intersected by  $(n-1)$  other planes
    - Among all planes there are  $O(n^3)$  intersections
    - Thus the aspect graph is  $O(n^3)$
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# Non-convex Polyhedra

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- In addition to horizon effects, occlusions can occur
    - e.g., faces can occlude faces, etc.
  - Algorithms list all the kinds of events that can occur and compute worst-case
    - horizon boundaries
    - edge-vertex boundaries
    - edge-edge-edge boundaries
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# Aspect Graph Complexity

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	Convex polyhedra	Non-convex polyhedra
Orthographic	$O(n^2)$	$O(n^6)$
Perspective	$O(n^3)$	$O(n^9)$

Maximum size of Aspect Graph

	Convex polyhedra	Non-convex polyhedra
Orthographic	$O(n^2)$	$O(n^6 \log n)$
Perspective	$O(n^3)$	$O(n^9 \log n)$

Construction time of Aspect Graph

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