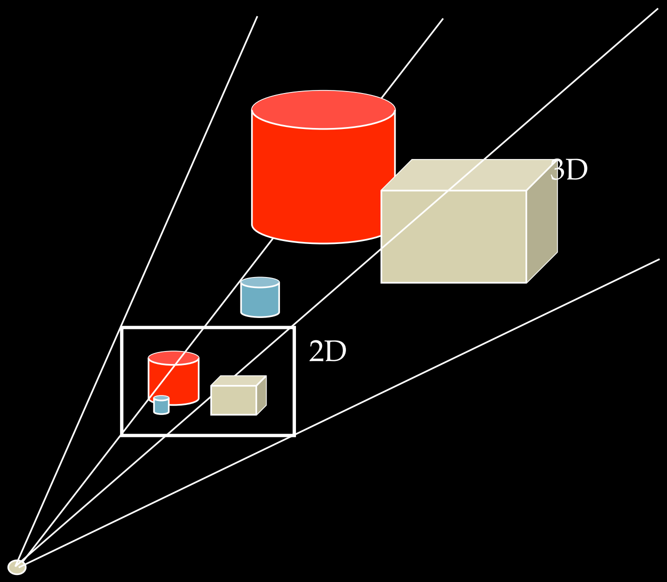
BSP-trees

João Comba

Visibilidade



Principios de Algoritmos de Visibilidade

Coerencia e ordenacao:

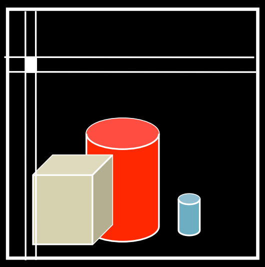
- Caracteristicas da cena sao localmente contante (objetos, imagem, frames,...)

Coerencia Imagem

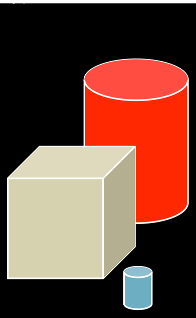
- Objetos visiveis por pixel.
- Hardware Z-buffer.

Coerencia Objetos (Espacial)

- Encontrar partes dos objetos visiveis.
- Estruturas de dados hierarquicas:
  - quadtrees, octrees, BSPs.

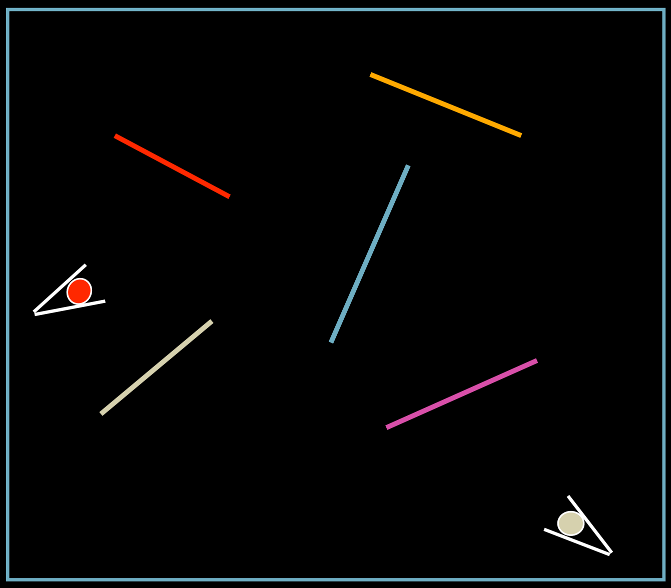


Espaco Imagem



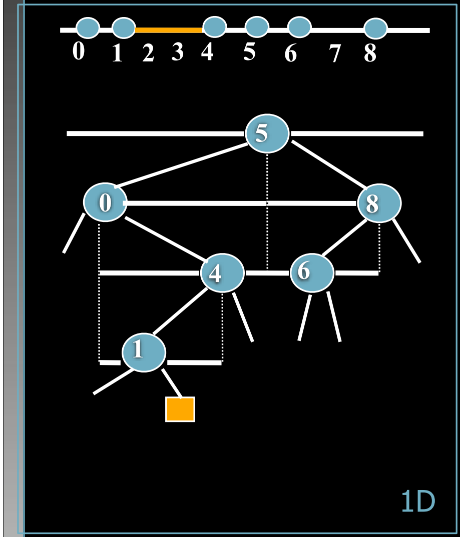
Espaco Objeto

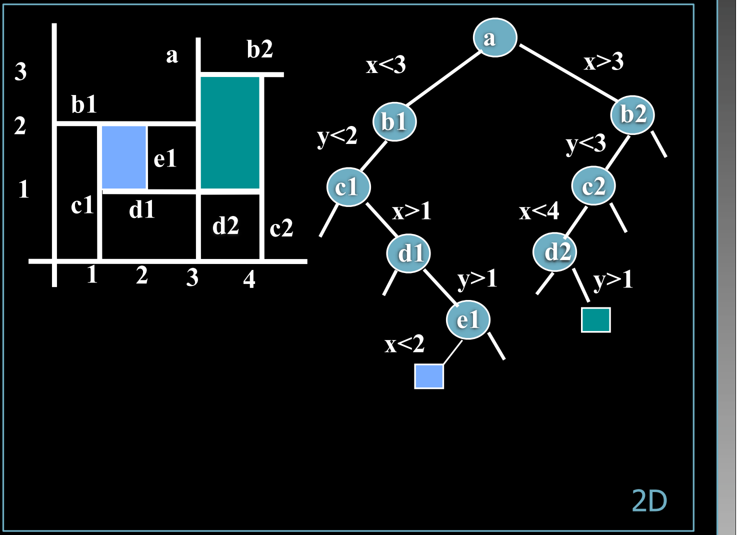
Visibilidade



Binary Space Partitioning Trees

Generalizacao de arvores binarias de buscas para dimensoes maiores dimensions





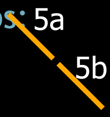
BSP - terminologia

Nodos:

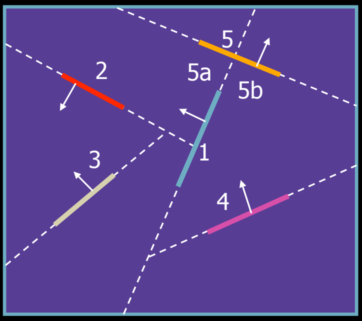
- Hiperplano:

  $h = \{(x_1,\ldots,x_d) \mid a_1x_1+\ldots+a_dx_d+a_{d+1} = 0\}$

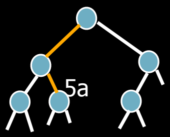
- Fragmentos: 5a

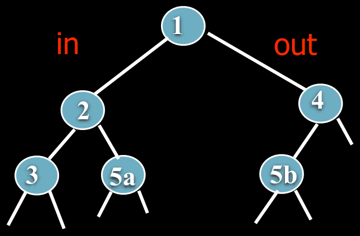


- Semi-espacos (in e out subarvores)

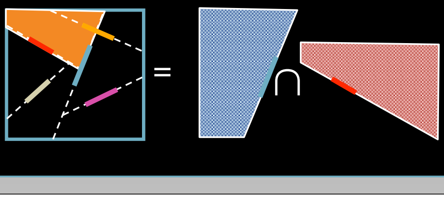


Caminho Região:

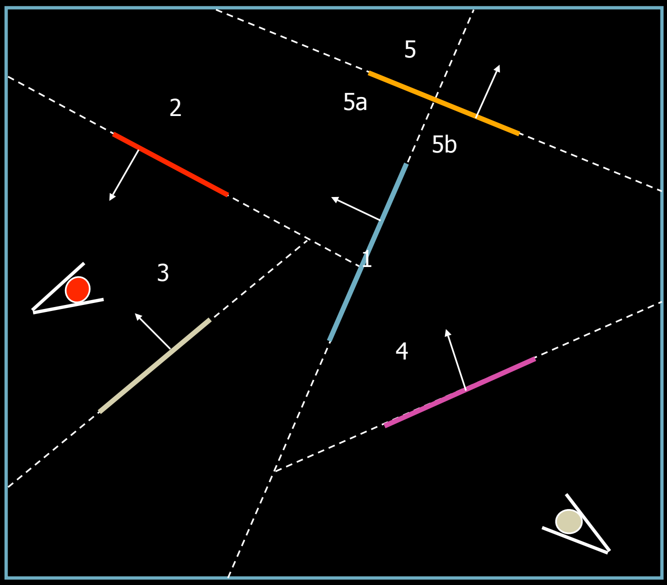


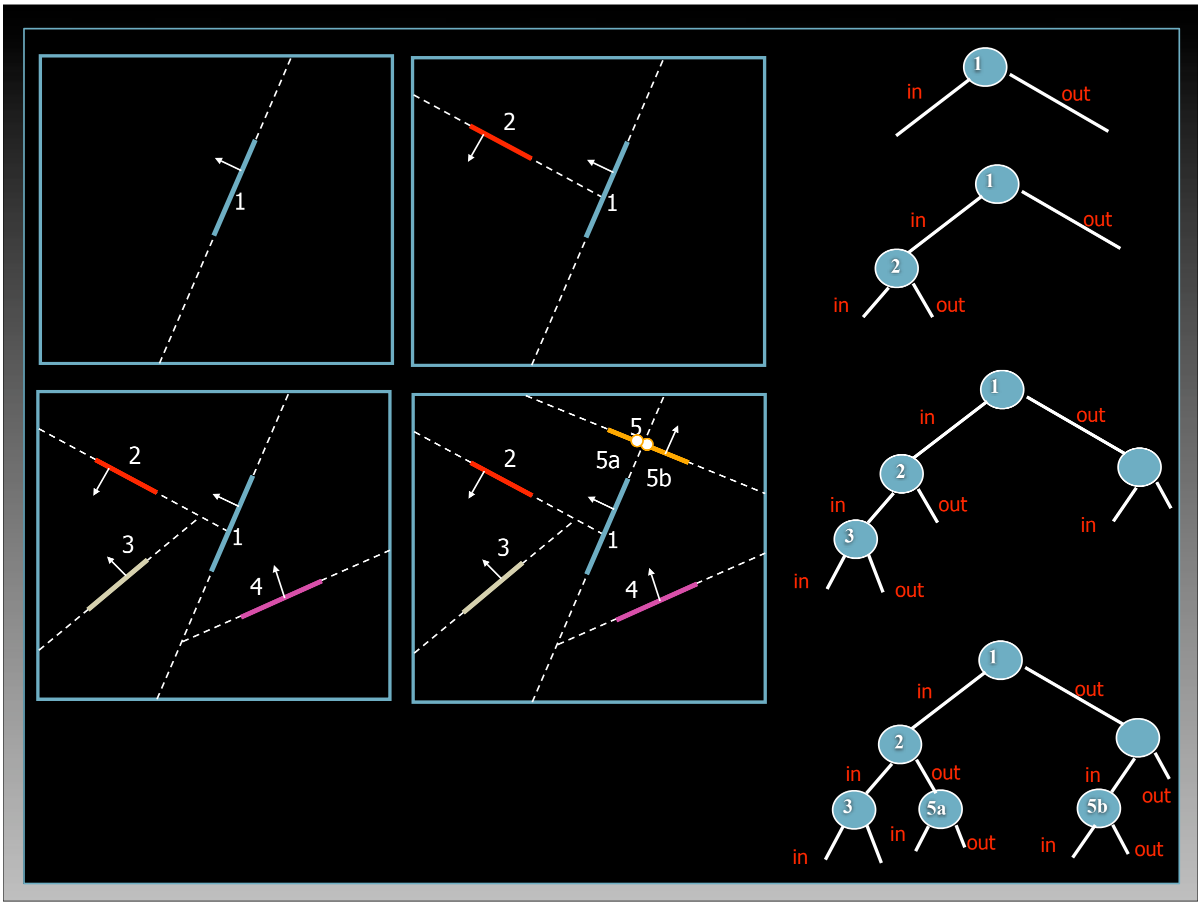


Região:



Visibilidade

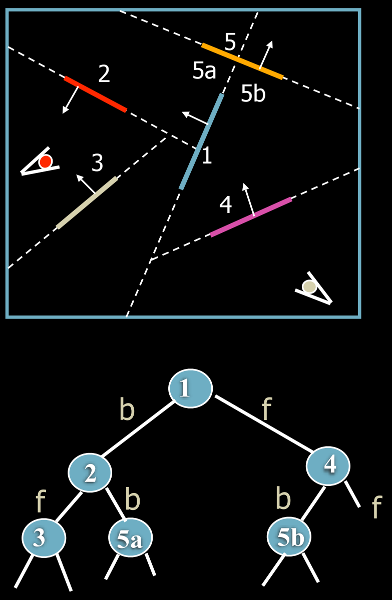




Extraindo visibilidade da BSP

Back-to-front:

```
procedure displayBSP(BSPNode n, Viewer v)
begin
  if (n not empty)
    if (v is in front of n)
      displayBSP(back(n), v)
      displayFrag(subh(n))
      displayBSP(front(n),v)
    else
      displayBSP(front(n), v)
      displayFrag(subh(n))
      displayBSP(back(n),v)
end
```



Exemplos:

-

Extraindo visibilidade da BSP

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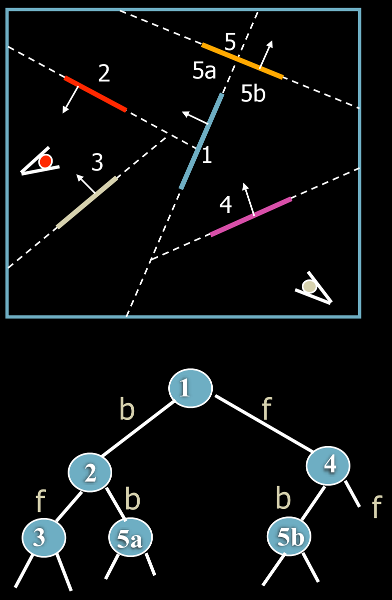
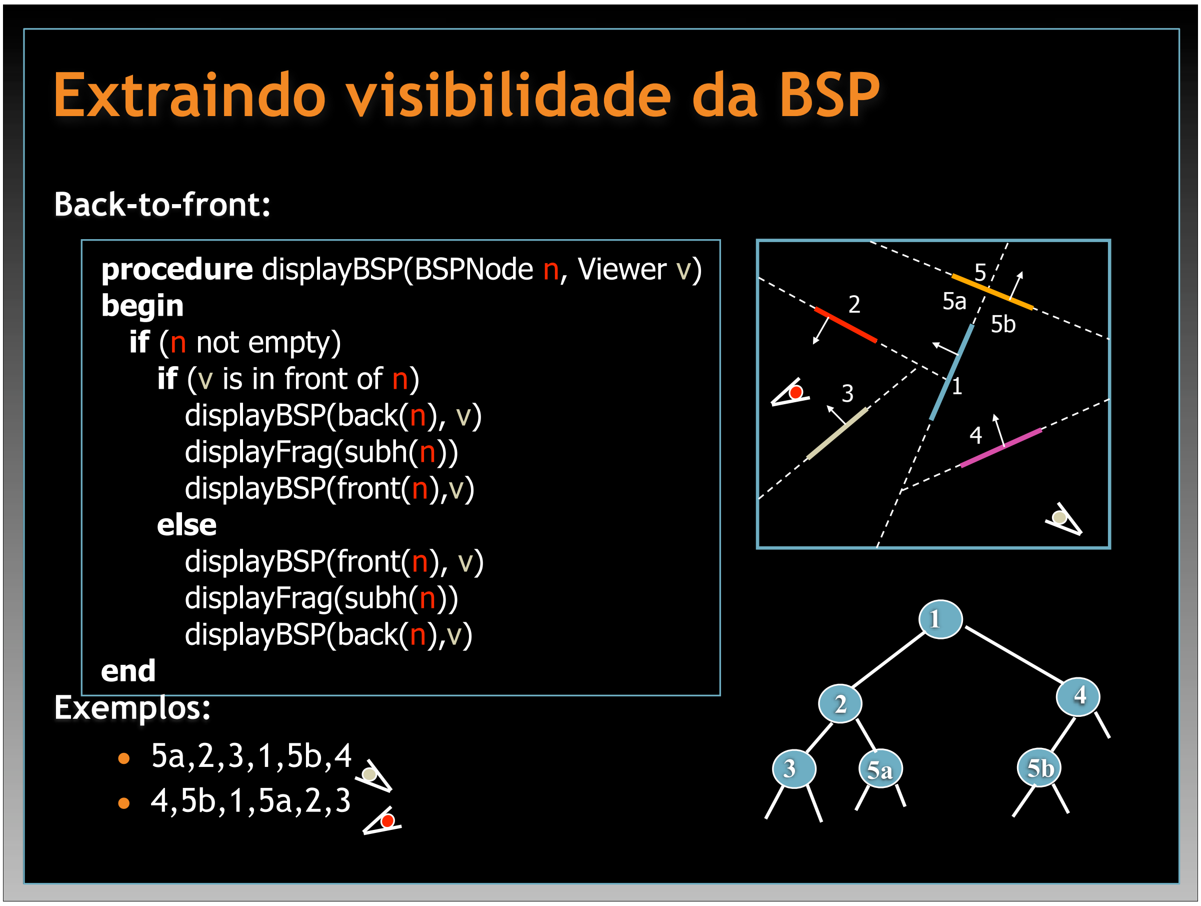


Exemplos:

- 5a,2,3,1,5b,4
-



Extraindo visibilidade da BSP

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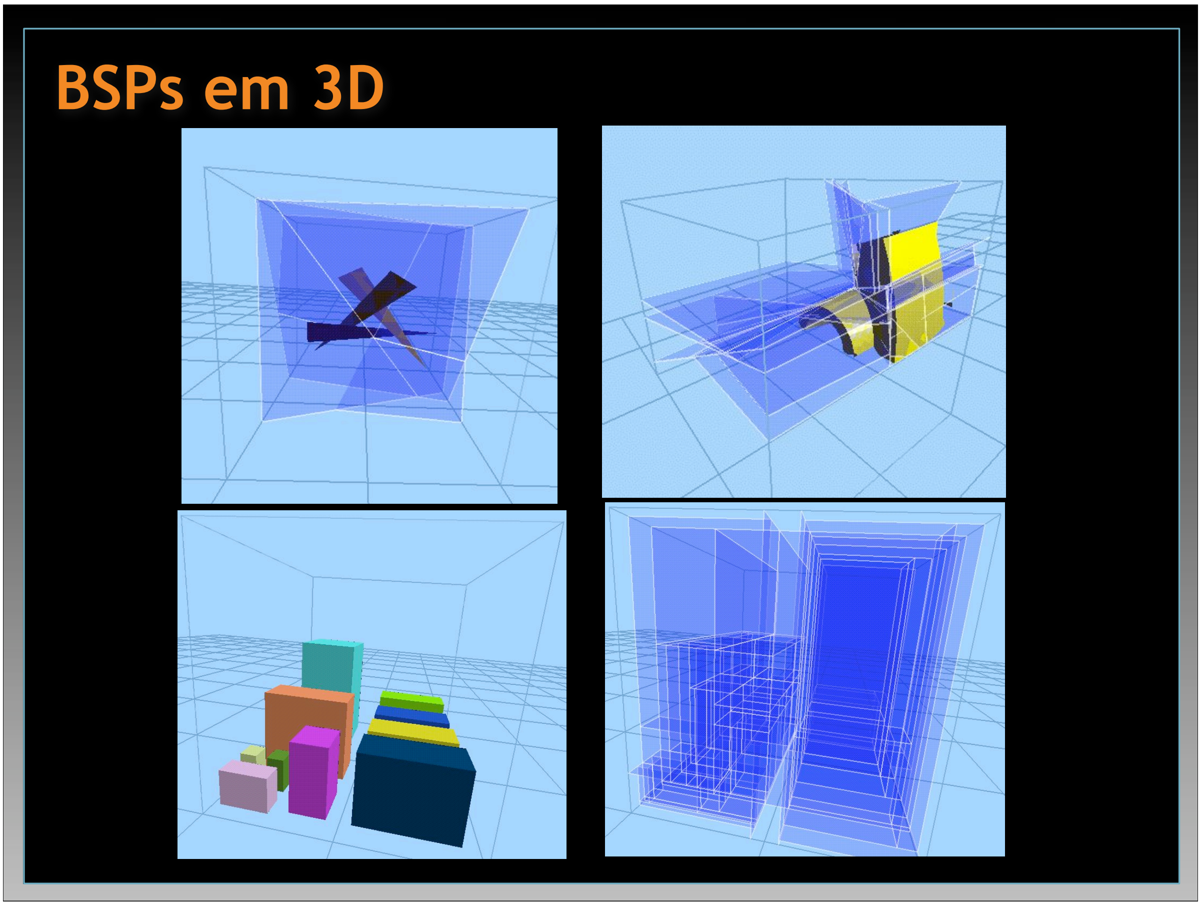
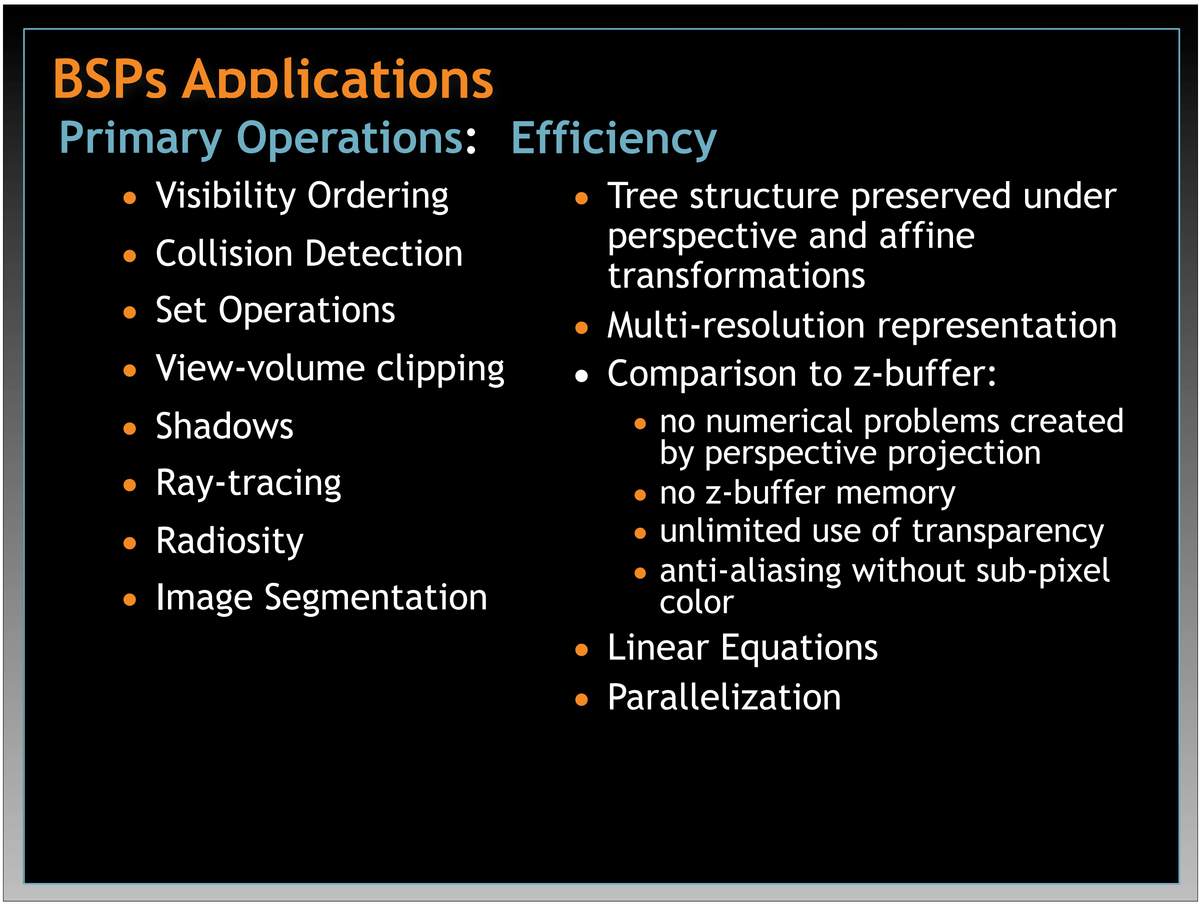
      displayFrag(subh(n))
      displayBSP(back(n),v)
end
```

Exemplos:

- 5a,2,3,1,5b,4
- 4,5b,1,5a,2,3



BSPs em 3D



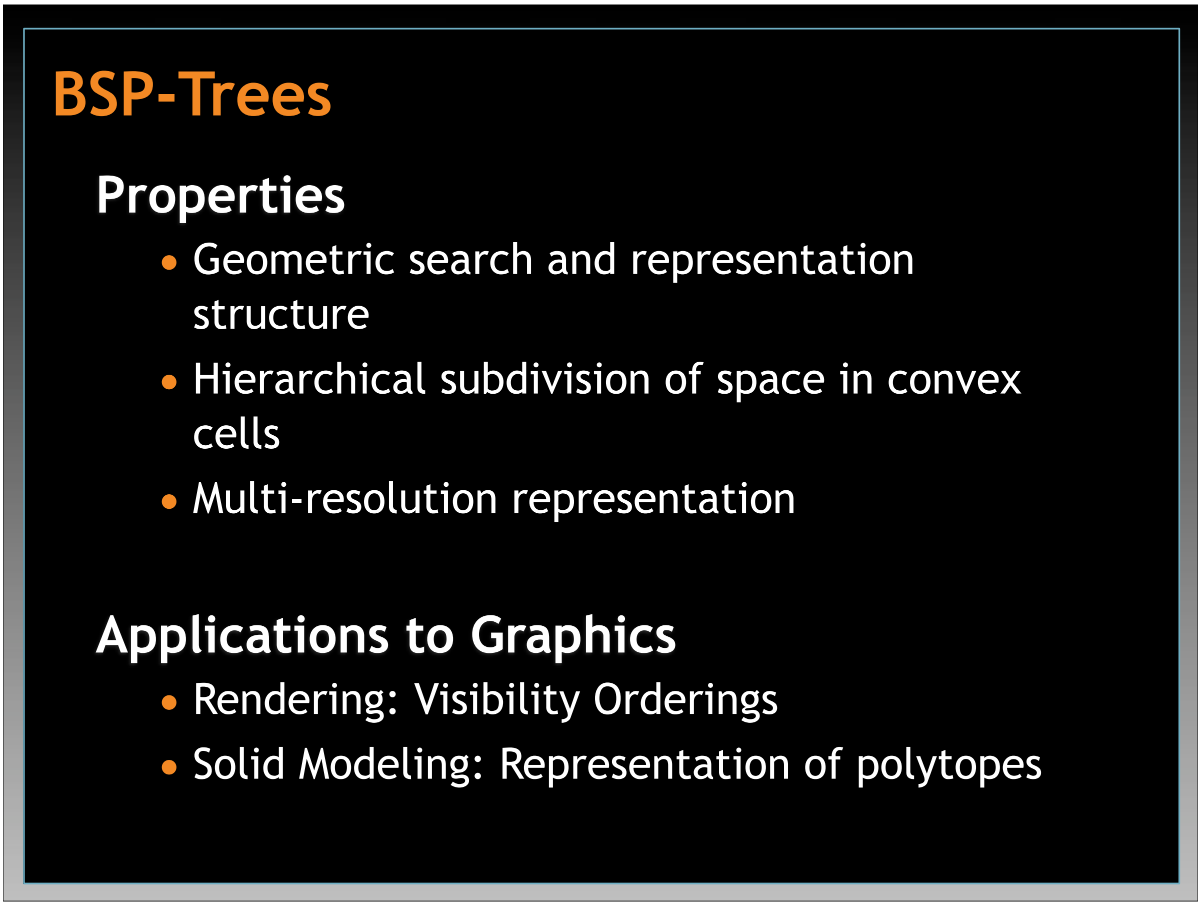
BSPs Applications

Primary Operations:

- Visibility Ordering
- Collision Detection
- Set Operations
- View-volume clipping
- Shadows
- Ray-tracing
- Radiosity
- Image Segmentation

Efficiency

- Tree structure preserved under perspective and affine transformations
- Multi-resolution representation
- Comparison to z-buffer:
  - no numerical problems created by perspective projection
  - no z-buffer memory
  - unlimited use of transparency
  - anti-aliasing without sub-pixel color
- Linear Equations
- Parallelization



BSP-Trees

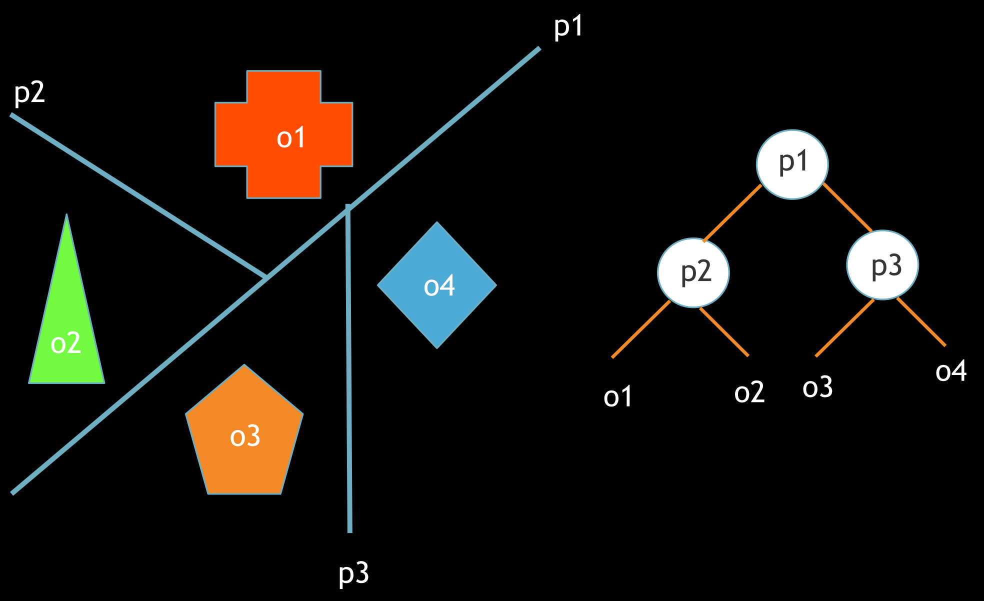
Properties

- Geometric search and representation structure
- Hierarchical subdivision of space in convex cells
- Multi-resolution representation

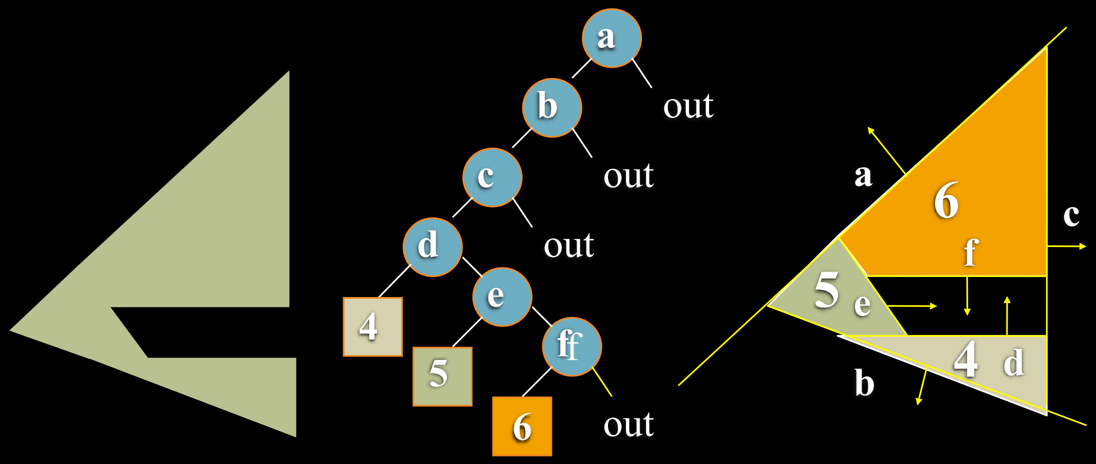
Applications to Graphics

- Rendering: Visibility Orderings
- Solid Modeling: Representation of polytopes

BSPs para indexação objetos



BSP representation of a BRep



Reconstruction of the BRep

Geometry:

- Compute lower dimensional intersections (faces, edges and vertices)

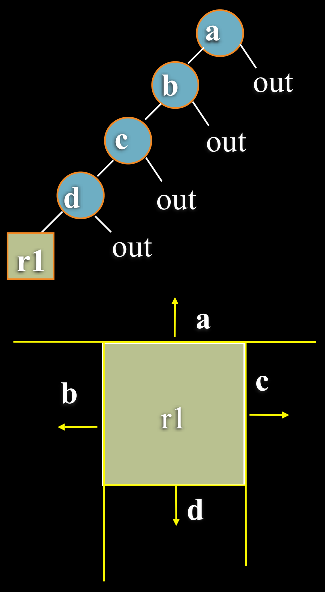
Topology:

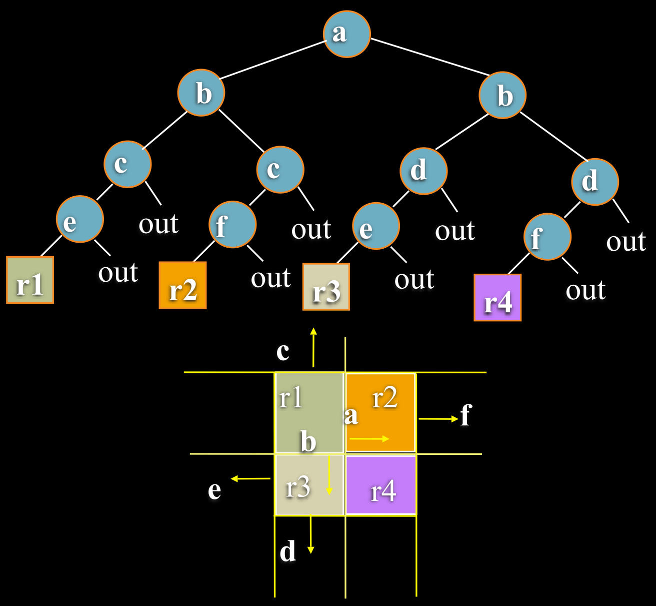
- Establish topological relations among the intersections obtained in previous step

Extract Boundary:

- Remove internal vertices, edges and faces

Geometry and Topology: Computing Regions





Multi-Dimensional BSP-Trees

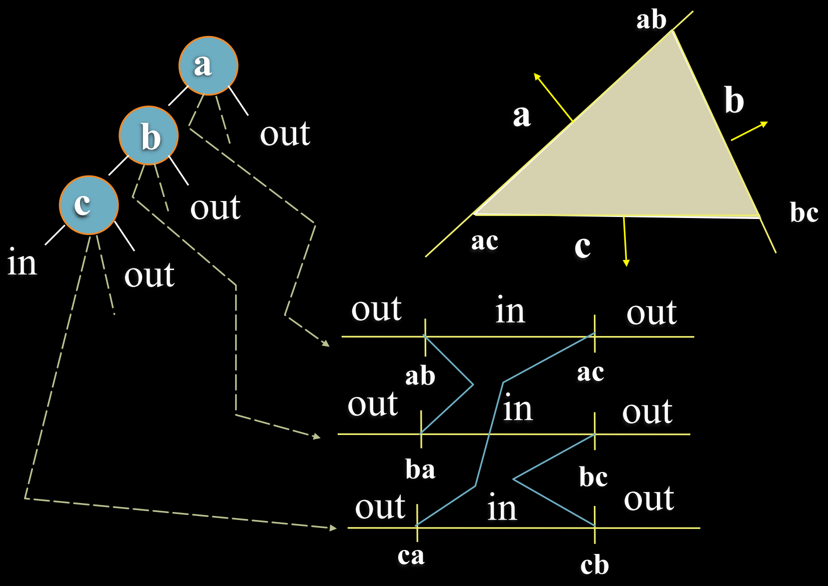
Pure BSP-Tree model (Naylor, 1990)

- Represent lower dimensional information as lower dimensional BSP-Trees

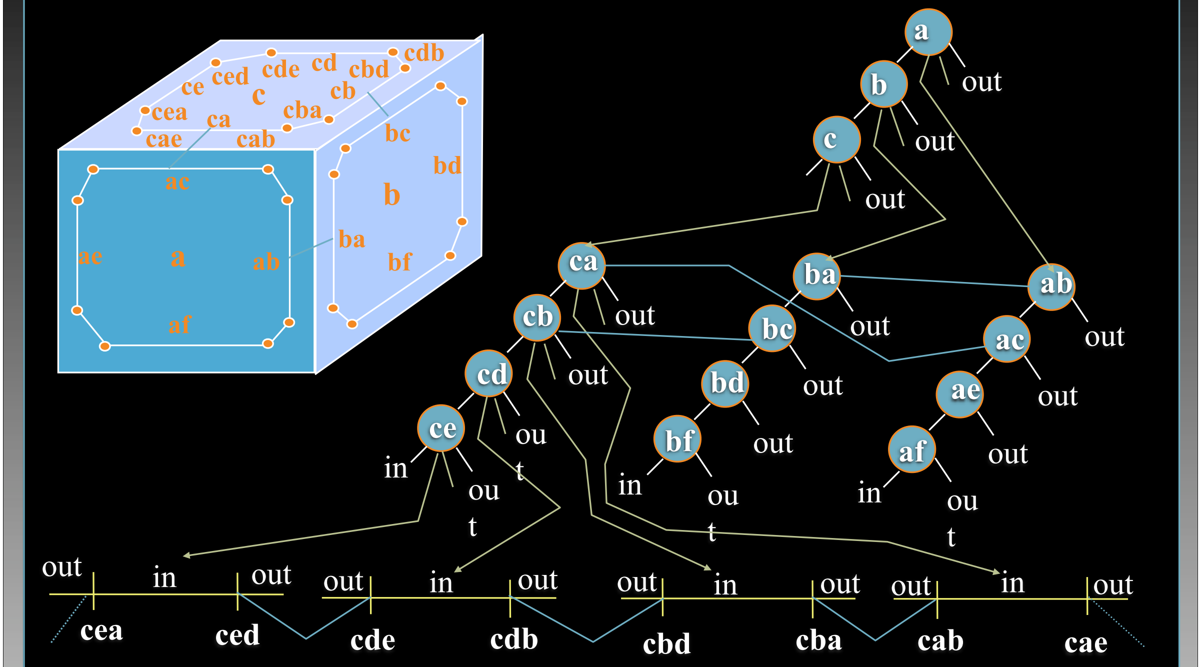
MSP and BRep-Index (Vanecek, 1991)

- Mult-Dimensional BSP-Tree combined with a BRep, with a correspondence between (0,1,2)-d nodes of the MSP with vertices, edges, faces
- One lower dimensional pointer

Topological BSP-Tree in 2D



Topological BSP-Tree in 3D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