Ray Casting (CSG)

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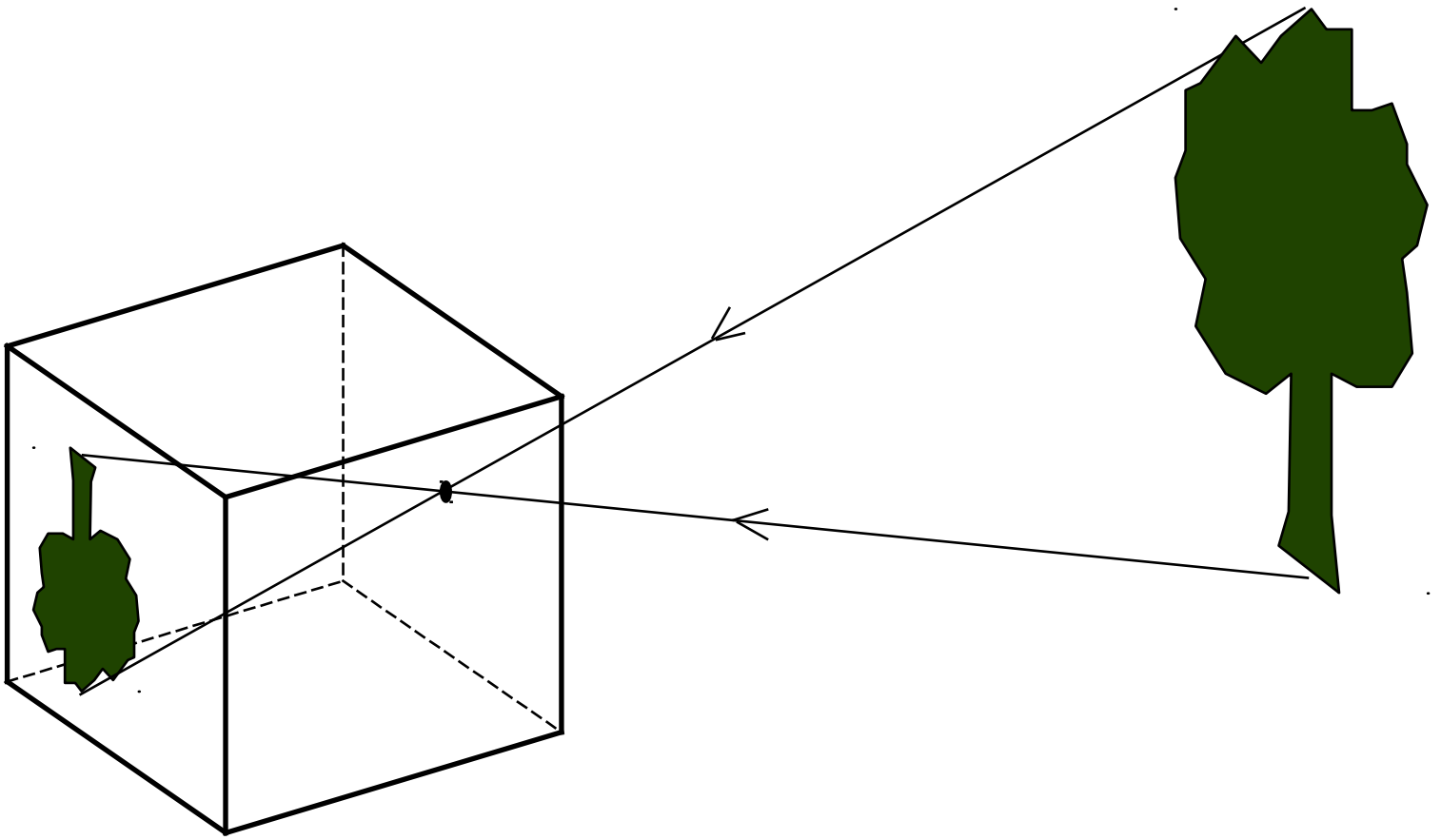
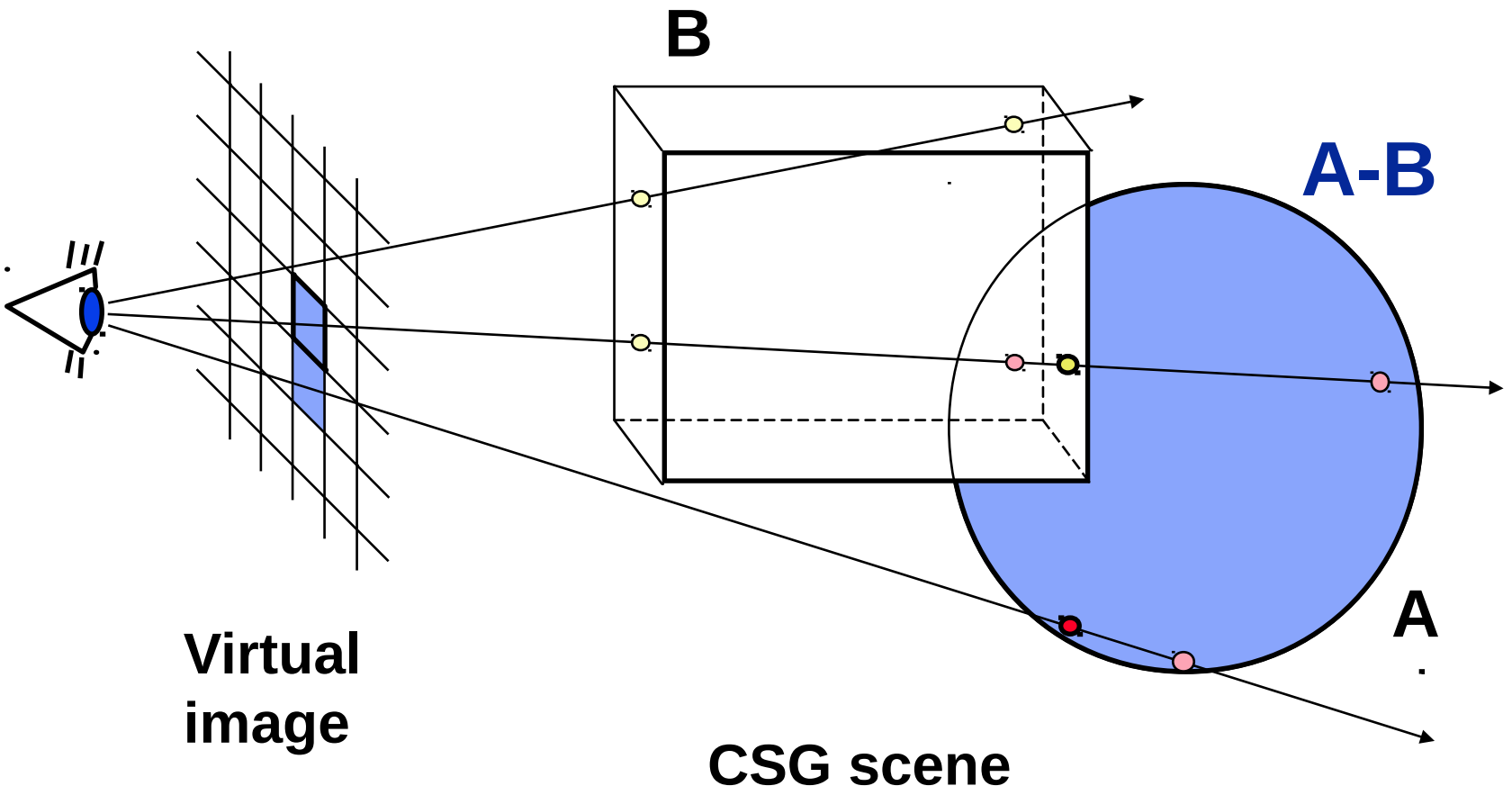
Pinhole Camera



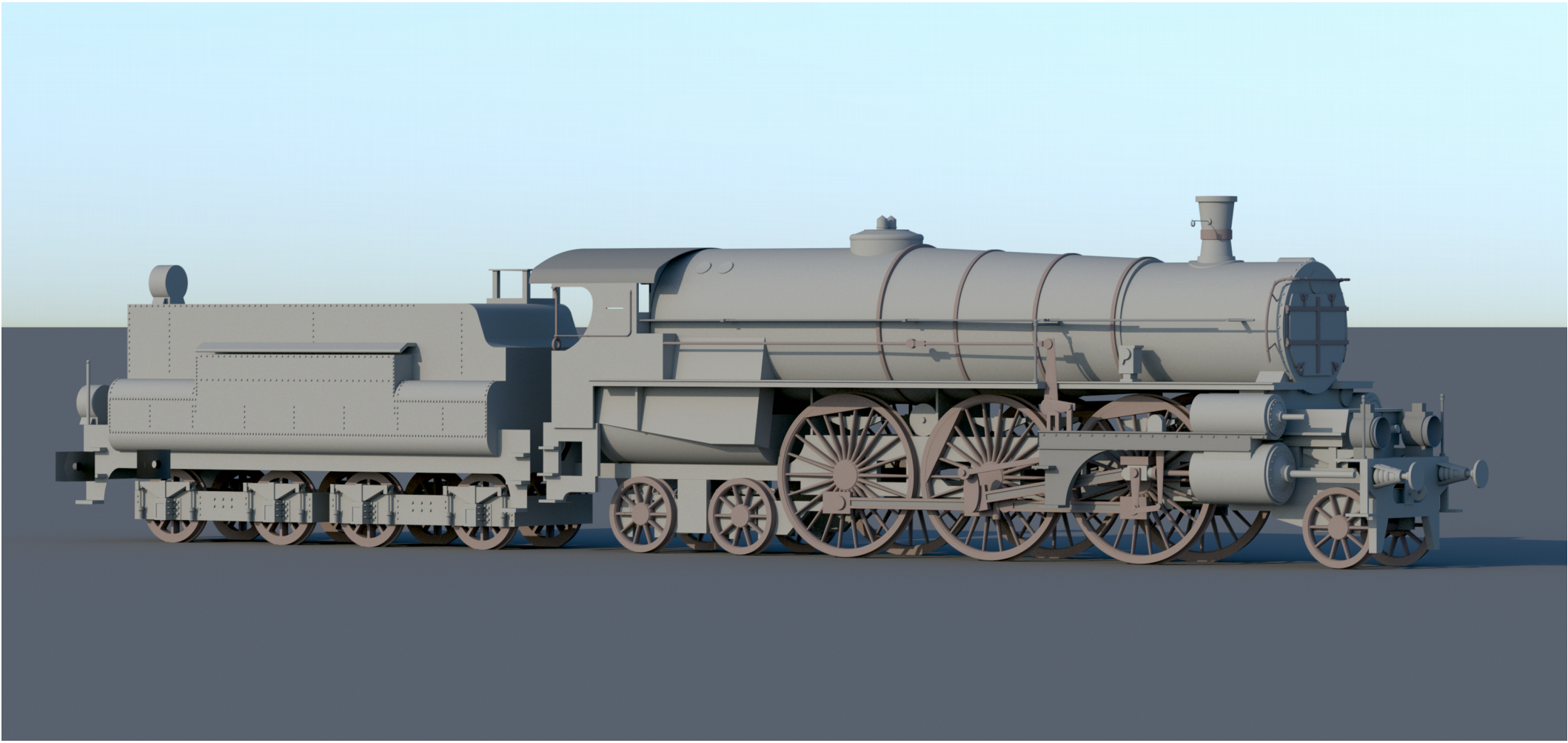
Imaging via Ray Casting



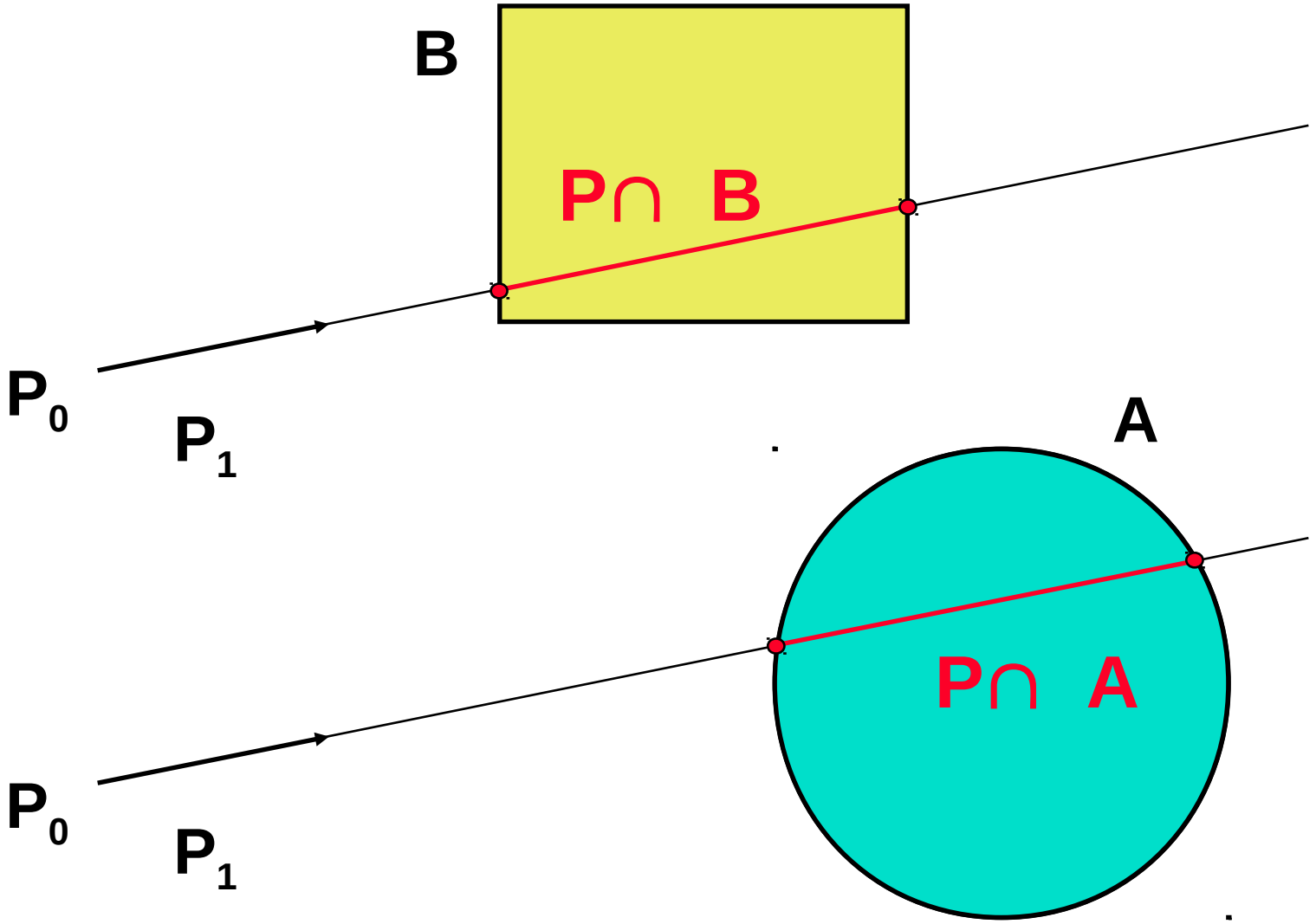
Ray Intersections with CSG

- For **elementary solids**, intersections can be calculated
  - Start and end of ray traversal through a solid body
- **Set theoretic operations** on all intersections along the ray:
  - Distributive: **P ∩ (A-B) = (P∩A) - (P∩B)**
  - The usual ray-object intersection is an interval
- **Geometric transformations**:
  - The inverse transformation is applied to the ray

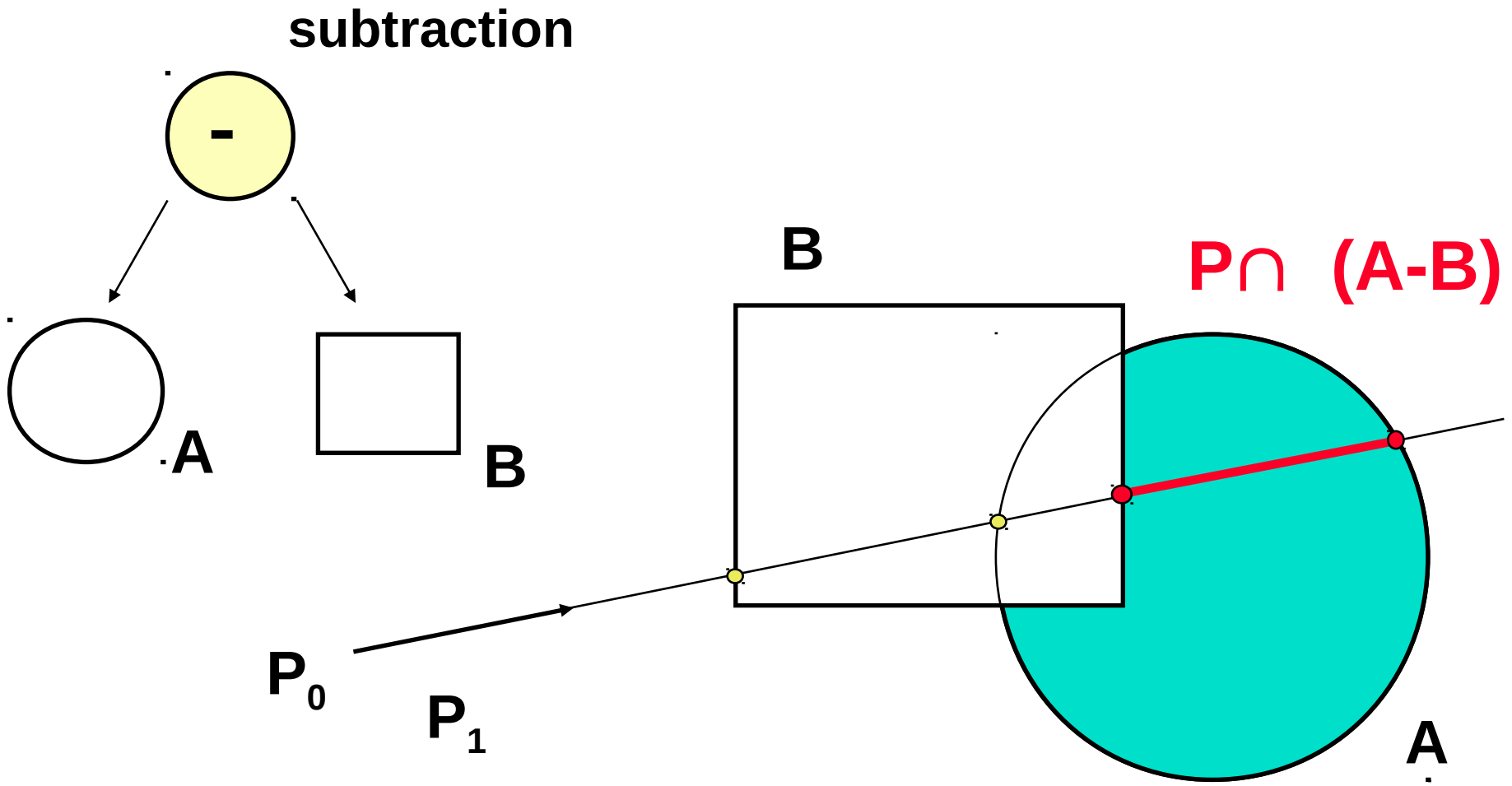
CSG: Motivational Image



Intersections P∩A, P∩B



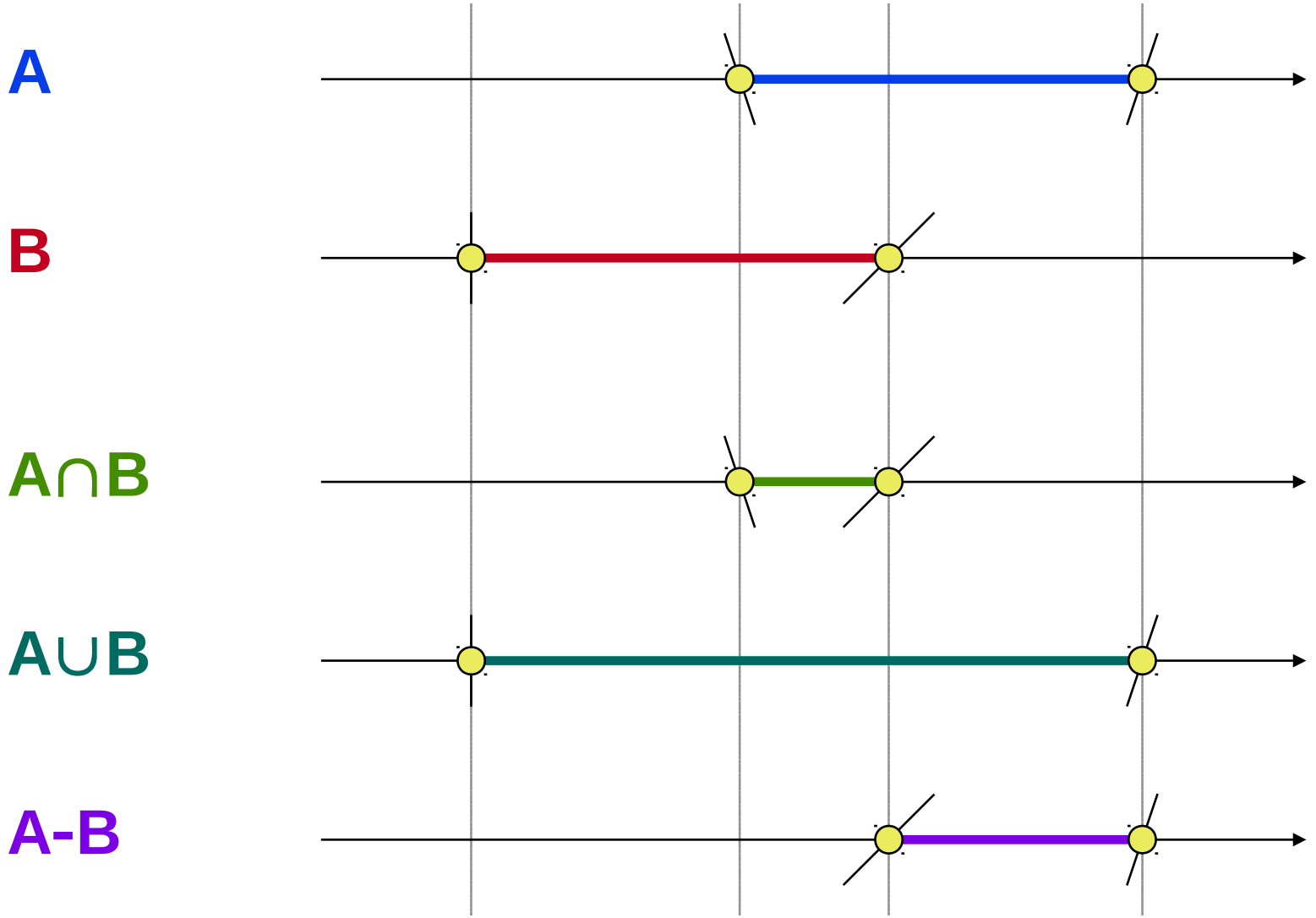
Intersections P∩(A-B)



Implementation

- **Rays**:
  - Starting point $\mathbf{P_0}$ and direction vector $\mathbf{P_1}$
  - Transformed with the inverse matrix $\mathbf{T_i^{-1}}$
- **Intersection list** (part of the scene):
  - An ordered list of values for **t**: [$\mathbf{t_1}$, $\mathbf{t_2}$, $\mathbf{t_3}$, ..]
- **Set-theoretic operations:**
  - Generalised for parameter lists [$\mathbf{t_1}$, $\mathbf{t_2}$, $\mathbf{t_3}$, ..] and [$\mathbf{u_1}$, $\mathbf{u_2}$, $\mathbf{u_3}$, ..]
  - They are seen as state changes („X-transition list”)

Set-theoretic Operations



Determining Pixel Colour

- Intersection list is **empty**:
  - Background colour
- List is **not empty**:
  - Solid colour (according to first intersection – $\mathbf{t_1}$)
  - Shading is possible
- Colouring **depends on operation:**
  - Complex rules for the transferral of colour during set theory operations
  - E.g. special colour for subtracted surfaces

End

Further information:

- **J. Foley, A. van Dam, S. Feiner, J. Hughes**: ***Computer Graphics, Principles and Practice***, 712-714