## *Introduction to Implicit Surfaces*

***BlobTree***

### Implicit Definition

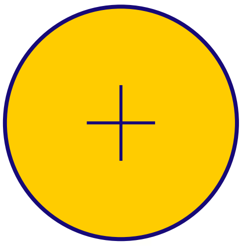
$f(x,y) = x^2 + y^2 - r^2 = 0$
e.g. $r = 1$
$f(0,0) = 0 + 0 - 1 < 0$ inside
$f(0,0) = 1 + 1 - 1 > 0$ outside

implies search space to find x,y to satisfy: $f(x,y) = 0$

iso-surface: $f(x,y) - c = 0$

### Parametric Definition

$x = r \sin(\alpha)$
$y = r \cos(\alpha)$
$0 \leqq \alpha \leqq 2\pi$



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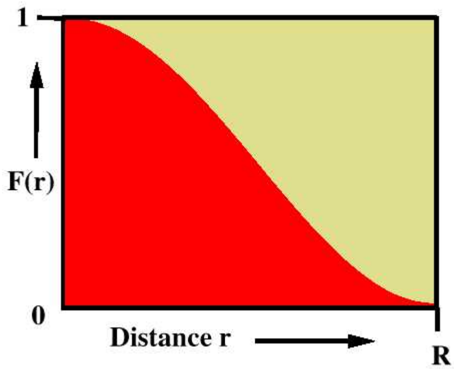
## *The Geoff Function*

***BlobTree***



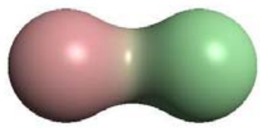

**Blend**

**Proximity Blending:**

**Add contributions from generating skeletal elements in the neighbourhood**

### Field Function

$$F(r) = 1 - (4/9)\frac{r^6}{R^6} + (17/9)\frac{r^4}{R^4} - (22/9)\frac{r^2}{R^2}$$



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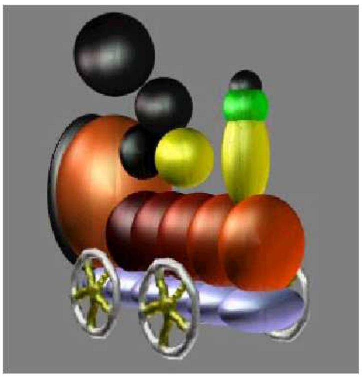
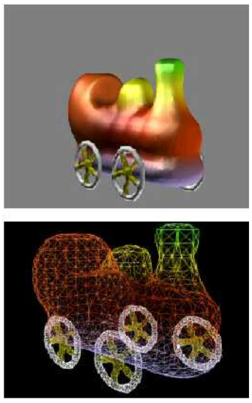
## Blending and The Soft Train

**BlobTree**

- **Polygonizer Info.**
- **Warp Info.**



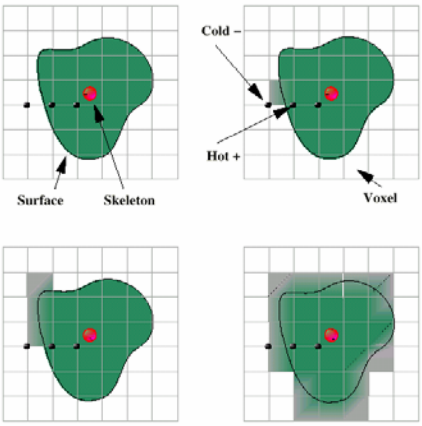


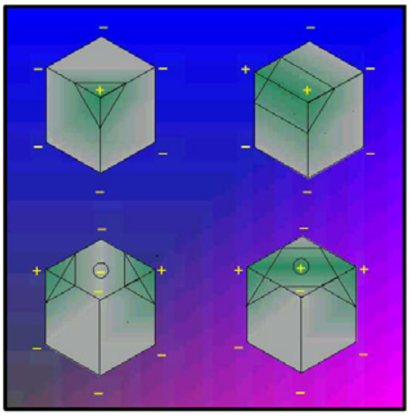
$$F_{total}(P)=\sum_{i=1}^{i=n} c_i F_i(r_i)$$



## Polygonization Algorithm

**BlobTree**

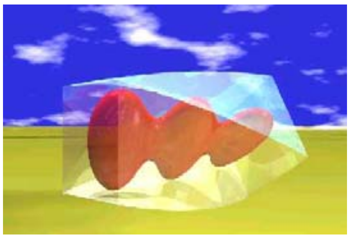


## *Warping*

***BlobTree***

$$F_{total}(P)=\Sigma\ c_i F_i(|P-Q_i|)$$



**Warp function w:**

$$F_{total}(P)=\Sigma\ c_i F_i(|w(P)-Q_i|)$$

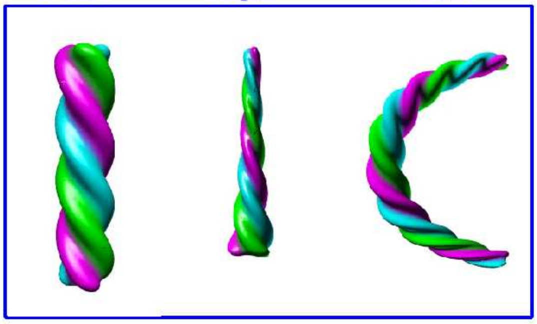


## *Barr Operators*

***BlobTree***

**The Barr operators:**

**Twist** **Taper** **Bend**

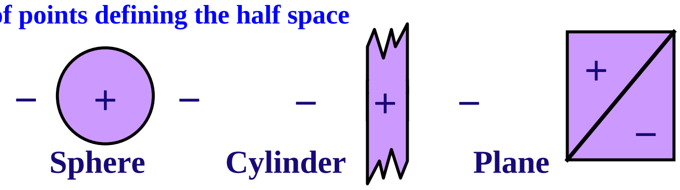


## *Constructive Solid Geometry (CSG)*

***BlobTree***

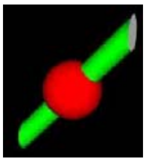
**Primitives are combined using boolean set operations:**
**Union, Intersection, Difference. Each primitive represents a half space, ie the set of points defining the half space**

**E.g.**




**Boolean expression (u= union, d= difference, i= intersection)**

**d( sphere, cylinder)** **u( sphere, i( i( cylinder, plane1), plane2) )**



**The cylinder is infinite in extent it is first intersected with two half space planes.**

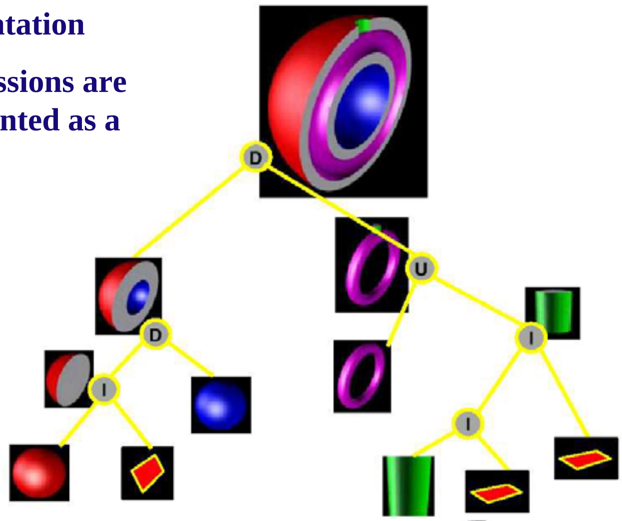


## *CSG Tree*

***BlobTree***

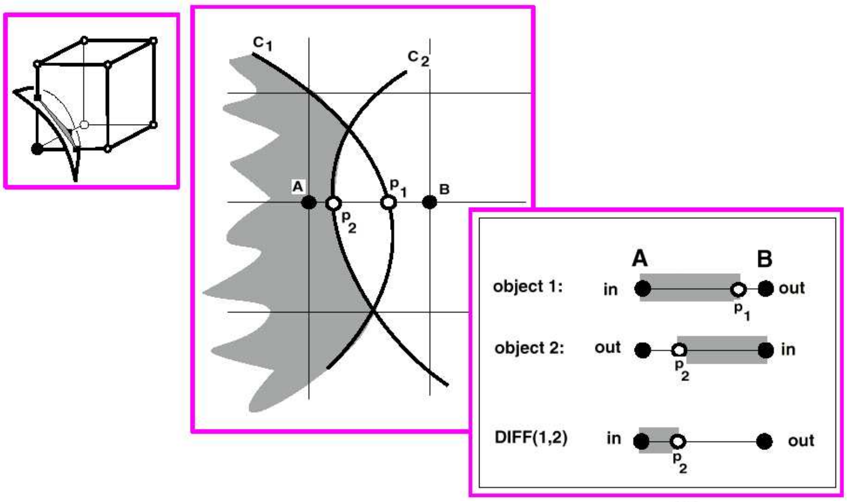
### CSG Implementation

**Boolean Expressions are usually represented as a binary tree.**



## CSG Intersections with Voxels

**BlobTree**






## CSG Intersection Value

**BlobTree**

### Boolean Operations

Union and intersection of primitives, A and B may be respectively defined as a composition of the field values, $F_A$ , $F_B$

$F_A \cup F_B = \max(F_A, F_B)$

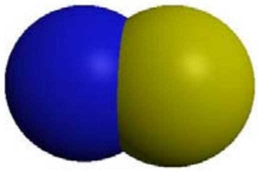
$F_A \cap F_B = \min(F_A, F_B)$

Difference use $-\min(F_A, F_B)$
($-$ in this case inverts inside and outside )

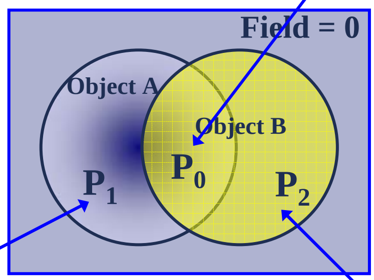
## *CSG - Min and Max*

***BlobTree***

### Union



$f_{A|B}(p_0)=Max(f_A(p_0), f_B(p_0))$
**Depending on position of $p_0$**




$f_A(p_1) =Max(f_A(p_1), f_B(p_1))$

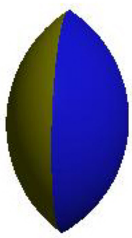
$f_B(p_2)=Max(f_A(p_2), f_B(p_2))$



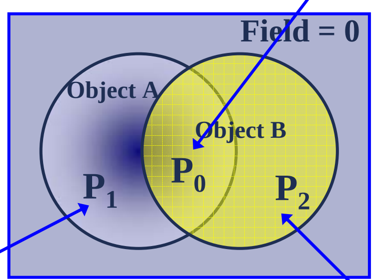
## *CSG - Min*

***BlobTree***

### Intersection

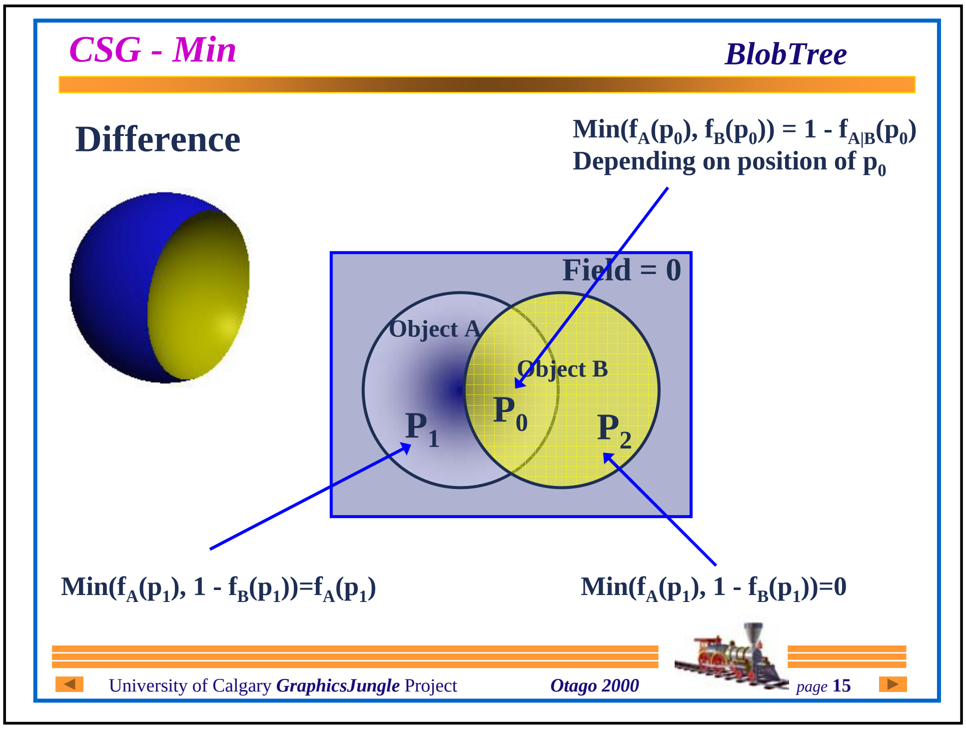


$f_{A|B}(p_0)=Min(f_A(p_0), f_B(p_0))$
**Depending on position of $p_0$**




$f_B(p_1) =Min(f_A(p_1), f_B(p_1))=0$

$f_A(p_2)=Min(f_A(p_2), f_B(p_2))=0$


CSG - Min
BlobTree
Difference
Min(fA(p0), fB(p0)) = 1 - fA|B(p0)
Depending on position of p0
Field = 0
Object A
Object B
P0
P1
P2
Min(fA(p1), 1 - fB(p1))=fA(p1)
Min(fA(p1), 1 - fB(p1))=0
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