

# Fondamenti di Grafica Tridimensionale

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## Subdivision Surfaces

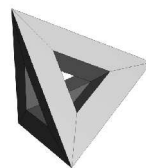
- *Subdivision defines a smooth curve or surface as the limit of a sequence of successive refinements.*
  - Si parte da una mesh poligonale
  - Si suddivide i poligoni che la compongono
  - Smooth della superficie muovendo i vertici
- In effetti quello che si vede sono sempre approx delle vere subdiv surfaces

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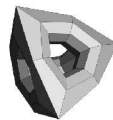
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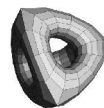
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(a)



(b)



(c)



(d)

## Esempio

- Geri's Game (1997)
  - Primo esempio non accademico di uso di subdivision surfaces

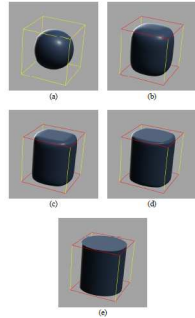


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## Smoothness

- Non solo superfici smooth
- Variable sharpness creases



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## Subdivision Classification

<b>Primal</b>	Faces are split into sub-faces
<b>Dual</b>	Vertices are split into multiple vertices

<b>Approximating</b>	Control points not interpolated
<b>Interpolating</b>	Control points are interpolated

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## Subdivision Classification

Primal	Dual

## Subdivision

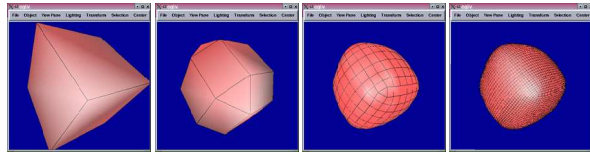
	<i>Primal</i>		<i>Dual</i>
	Triangles	Rectangles	
<b>Approximating</b>	Loop	Catmull-Clark	Doo-Sabin
<b>Interpolating</b>	Butterfly	Kobbelt	Midedge

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## Doo Sabin

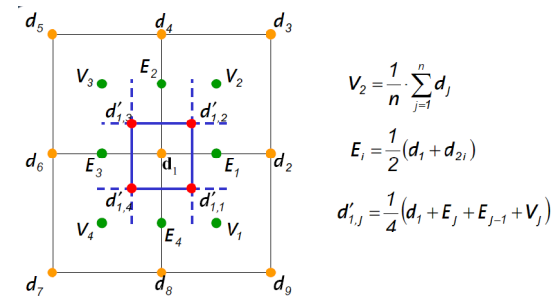
- Per mesh poligonali
- Duale ad ogni vertice corrisponde una nova faccia



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## Doo Sabin

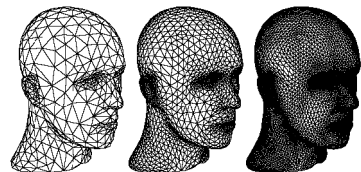


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## Loop Subdivison

- Approssimante (non interpolante)
- Continua
  - C1 su vertici straordinari (valenza !=6)
  - C2 elsewhere

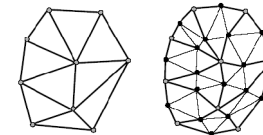


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## Loop Refinement Scheme

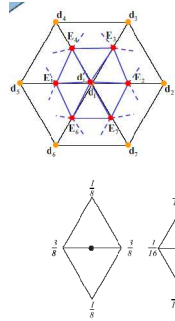
- Funziona per mesh triangolari
- Vertex insertion
  - Ogni edge è diviso in due e i nuovi vertici sono riconnessi per formare nuovi triangoli



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## Loop Subdivision



$$E_i = \frac{3}{8}(d_1 + d_i) + \frac{1}{8}(d_{i-1} + d_{i+1})$$

$$\mathbf{d}'_1 = \alpha_n \mathbf{d}_1 + \frac{(1-\alpha_n)}{n} \sum_{j=2}^{n+1} \mathbf{d}_j$$

$$\alpha_n = \frac{3}{8} + \left( \frac{3}{8} + \frac{1}{4} \cos \frac{2\pi}{n} \right)^2$$

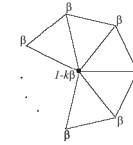
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## Loop Subdivision

- La scelta di B non è unica

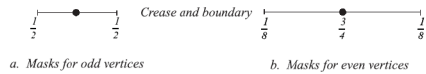
- $\beta = \frac{1}{k} \left( 5/8 - \left( \frac{3}{8} + \frac{1}{4} \cos \frac{2\pi}{k} \right)^2 \right)$



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## Loop Border



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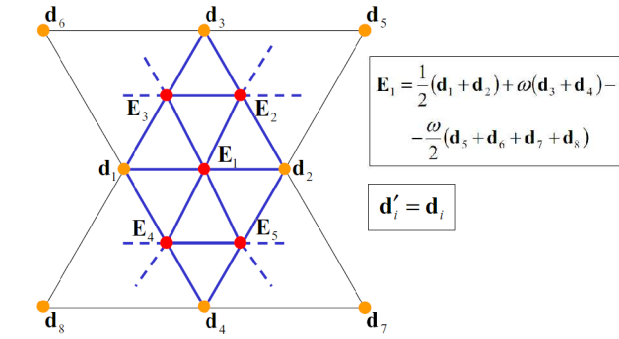
## Butterfly

- Interpolante (non approssimante)
- Continua
  - C0 su vertici straordinari (valenza <4 e >7)
  - C1 elsewhere

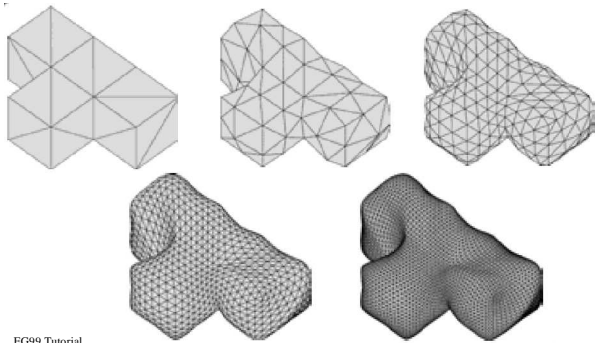
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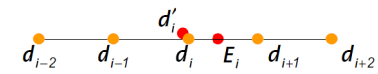
### Butterfly



### Butterfly Subdivision



### Butterfly sul bordo



$$E_i = \frac{9}{16}(d_i + d_{i+1}) - \frac{1}{16}(d_{i-1} + d_{i+2})$$

## Subdivision nella VCG

- `vcg/complex/trimesh/refine.h`
- Templata su
- Mesh (al solito)
- Midpoint Generation
  - Problema Loop?
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