

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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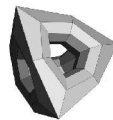
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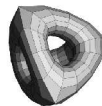
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(a)



(b)



(c)



(d)

Esempio

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

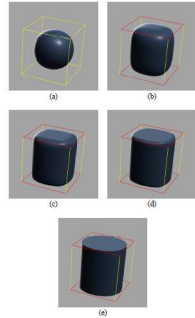


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Smoothness

- Non solo superfici smooth
- Variable sharpness creases



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Subdivision Classification

Primal	Faces are split into sub-faces
Dual	Vertices are split into multiple vertices

Approximating	Control points not interpolated
Interpolating	Control points are interpolated

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Subdivision Classification

Primal	Dual

Subdivision

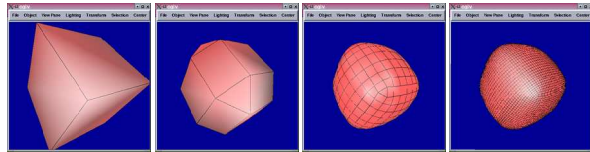
	<i>Primal</i>		<i>Dual</i>
	Triangles	Rectangles	
Approximating	Loop	Catmull-Clark	Doo-Sabin
Interpolating	Butterfly	Kobbelt	Midedge

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Doo Sabin

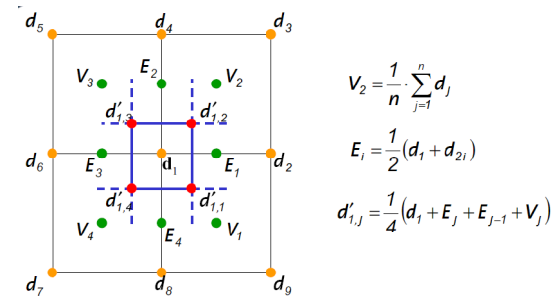
- Per mesh poligonali
- Duale ad ogni vertice corrisponde una nova faccia



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Doo Sabin

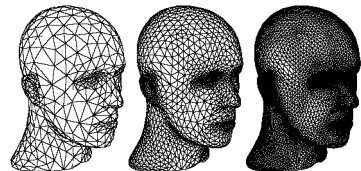


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Loop Subdivison

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

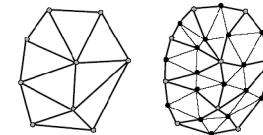


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Loop Refinement Scheme

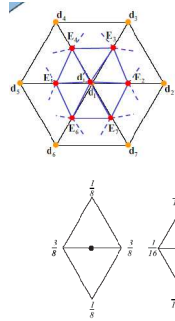
- Funziona per mesh triangolari
- Vertex insertion
 - Ogni edge è diviso in due e i nuovi vertici sono riconnessi per formare nuovi triangoli



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Loop Subdivision



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

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

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

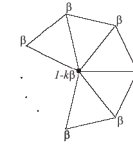
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Loop Subdivision

- La scelta di B non è unica

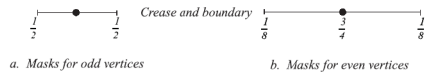
- $\beta = \frac{1}{k} \left(5/8 - \left(\frac{3}{8} + \frac{1}{4} \cos \frac{2\pi}{k} \right)^2 \right)$



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Loop Border



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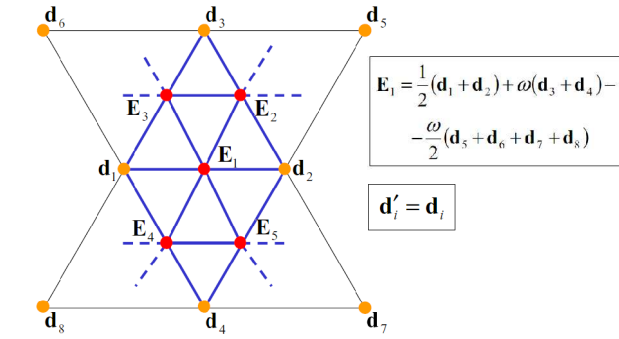
Butterfly

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

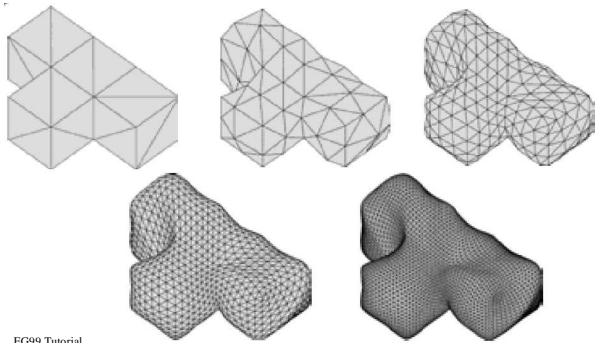
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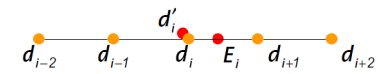
Butterfly



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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