

Projective primitives vs. Topological primitives: What's the benefit?

Dr. Roland Billen

Centre for Geosciences,

Department of Geography and Geomatics,

University of Glasgow

rbillen@geog.gla.ac.uk

Mathematical spaces used to model spatial information

Topological

Projective

Metric

Object's Shape

Spatial relationships

Network
analysis

Dimensional Model

*Ternary relationships
(Eliseo Clementini)*

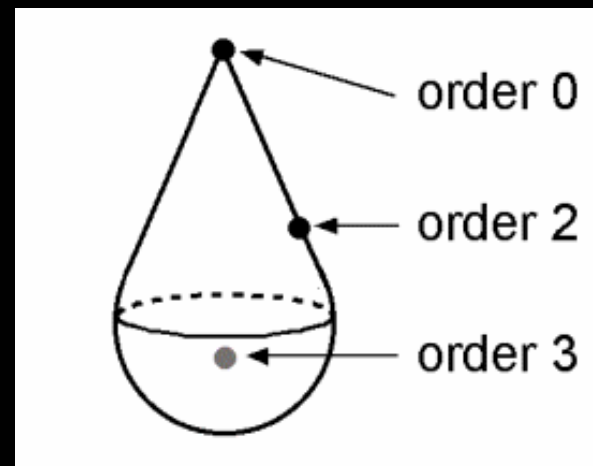
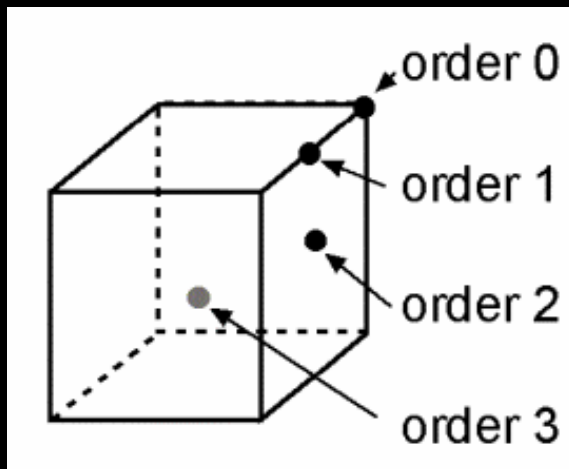
...



Background

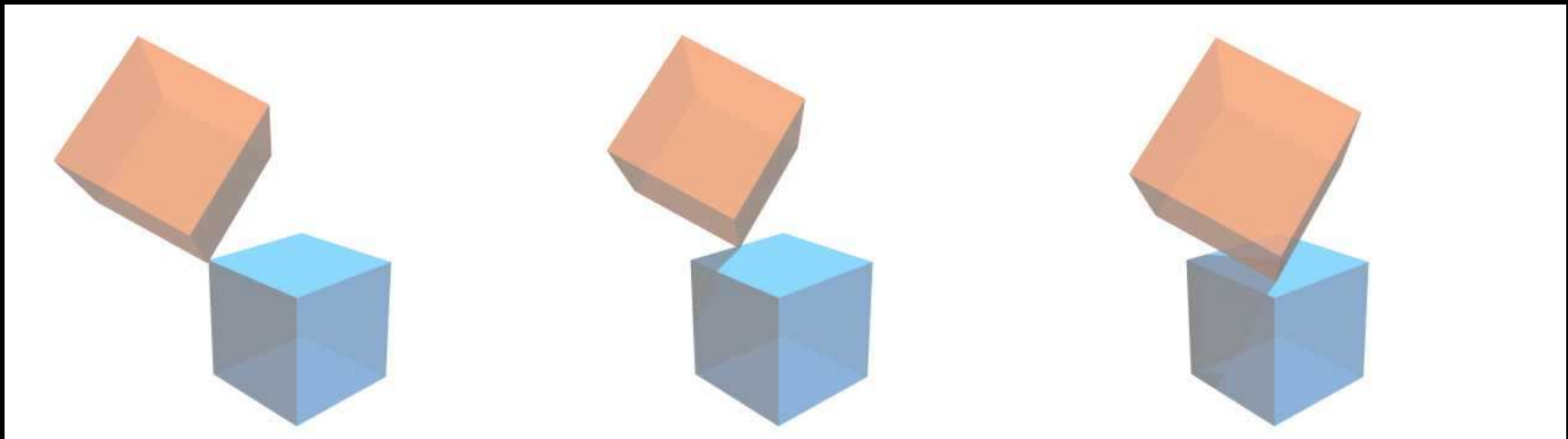
Dimensional Model

- Concept of order of point of a convex set



- →Basis of a new object's partition (*dimensional elements*)

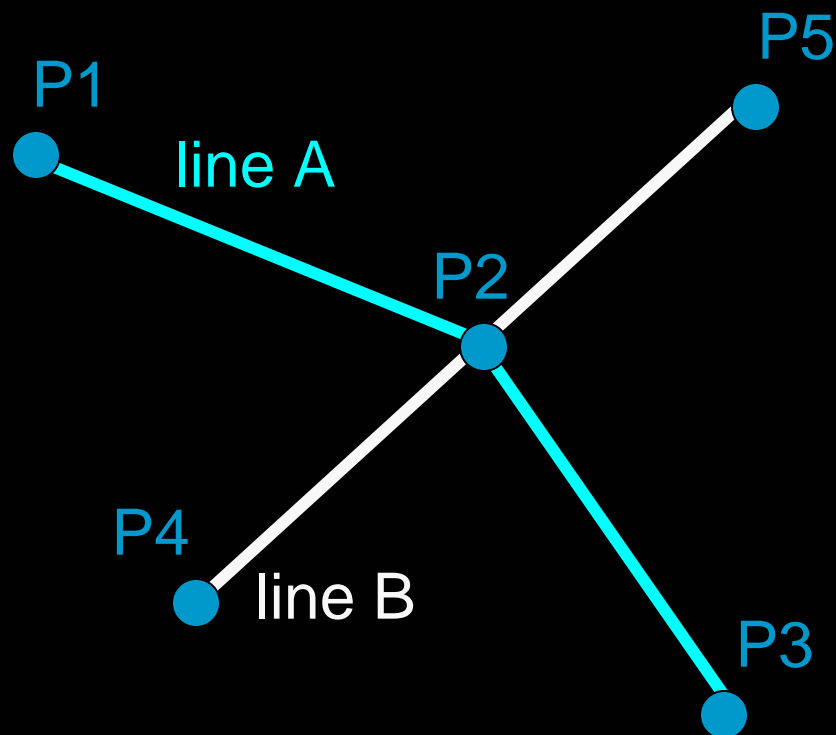
Dimensional relationships



Projective primitives

- *A projective primitive of dimension n (denoted $Proj_nD$) of a spatial object is a set of contiguous object's points of order n , ...*
- *Projective primitives of different objects can share common space. This common space is called singularity...*

Projective primitives

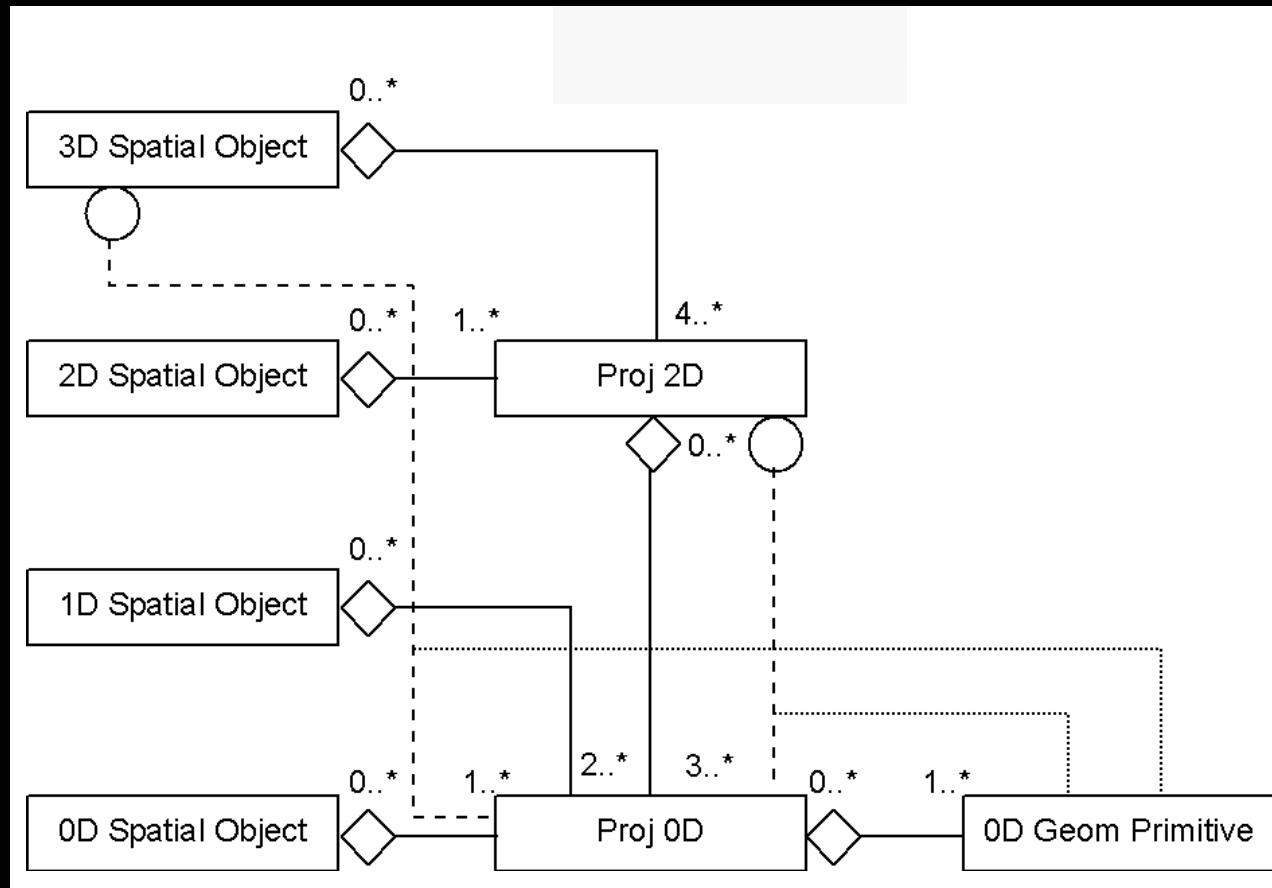


Proj_0D of line A:
P1, P2, P3

Proj_0D of line B:
P4, P5

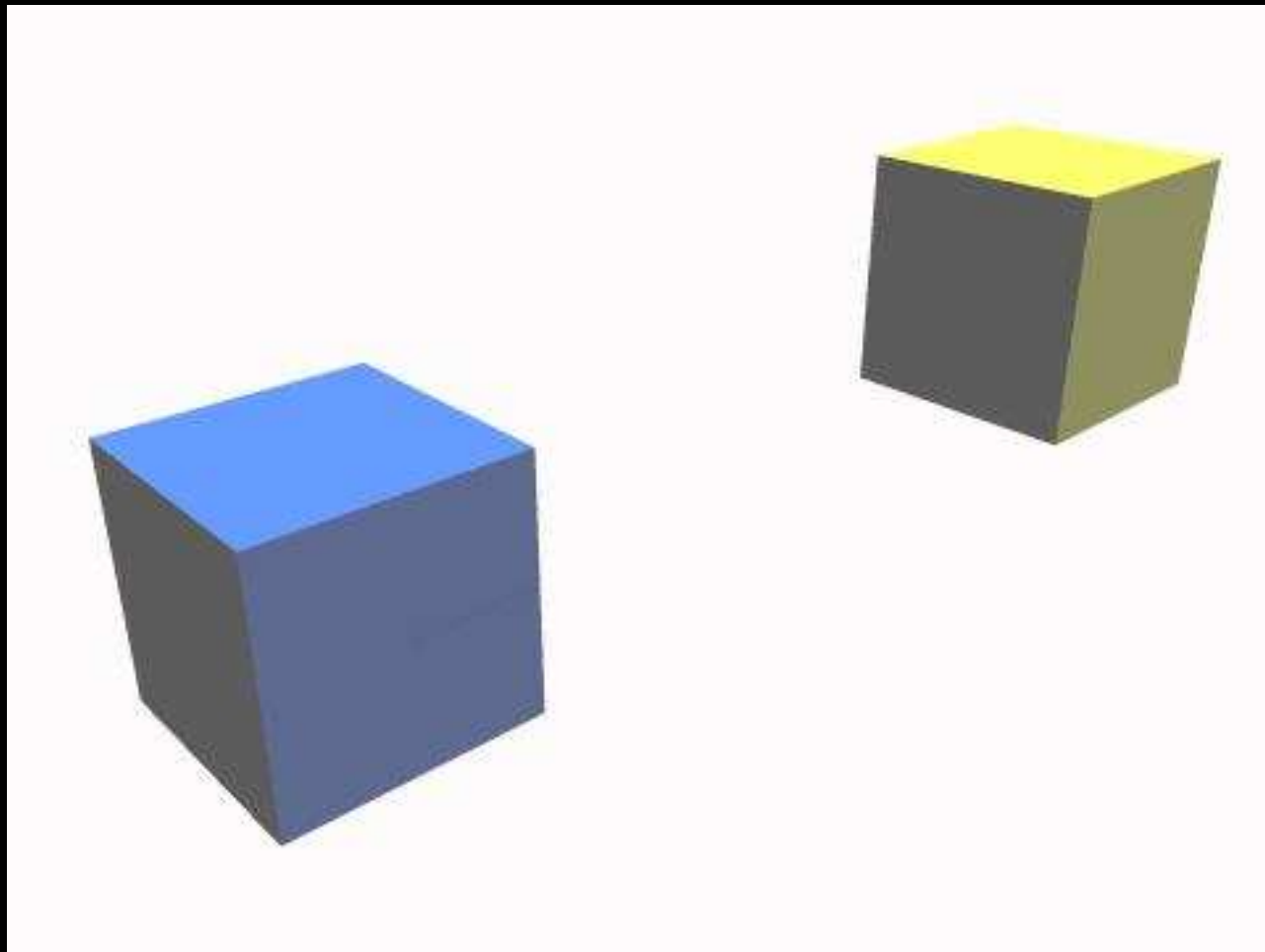
P2 is a singularity
of line B

Spatial Dimensional Data Models



Comparison

Workshop on Topology and spatial databases – Glasgow 05



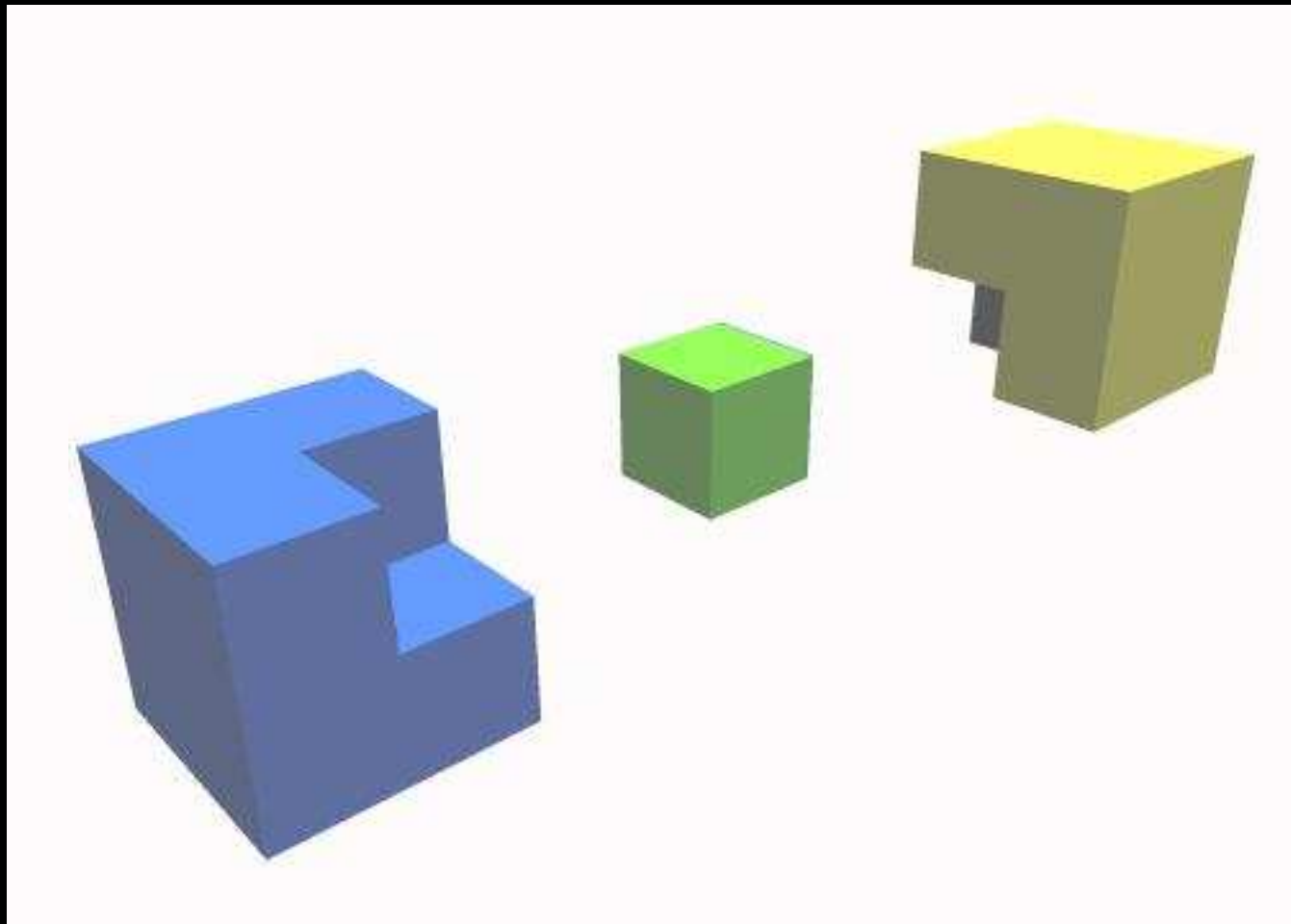
3D FDS

Face	Edge	Arc	
f1: b1, 0	f1: a1, a2, a3, a4	a1: 1, 2	a21: 11, 12
f2: b1, 0	f2: a4, a5, a6, a7	a2: 2, 3	a22: 12, 13
f3: b1, 0	f3: a3, a8, a9, a5	a3: 3, 4	a23: 13, 14
f4: b1, 0	f4: a2, a8, a11, a10	a4: 4, 1	a24: 14, 11
f5: b1, 0	f5: a1, a10, a12, a7	a5: 4, 6	a25: 14, 16
f6: b1, 0	f6: a6, a9, a11, a12	a6: 6, 5	a26: 16, 15
f21: b2, 0	f21: a21, a22, a23, a24	a7: 5, 1	a27: 15, 11
f22: b2, 0	f22: a24, a25, a26, a27	a8: 3, 7	a28: 13, 17
f23: b2, 0	f23: a23, a28, a29, a25	a9: 7, 6	a29: 17, 16
f24: b2, 0	f24: a22, a28, a31, a30	a10: 2, 8	a30: 12, 18
f25: b2, 0	f25: a21, a30, a32, a27	a11: 8, 7	a31: 18, 17
f26: b2, 0	f26: a23, a29, a31, a32	a12: 5, 8	a32: 15, 18

SSDDM-1

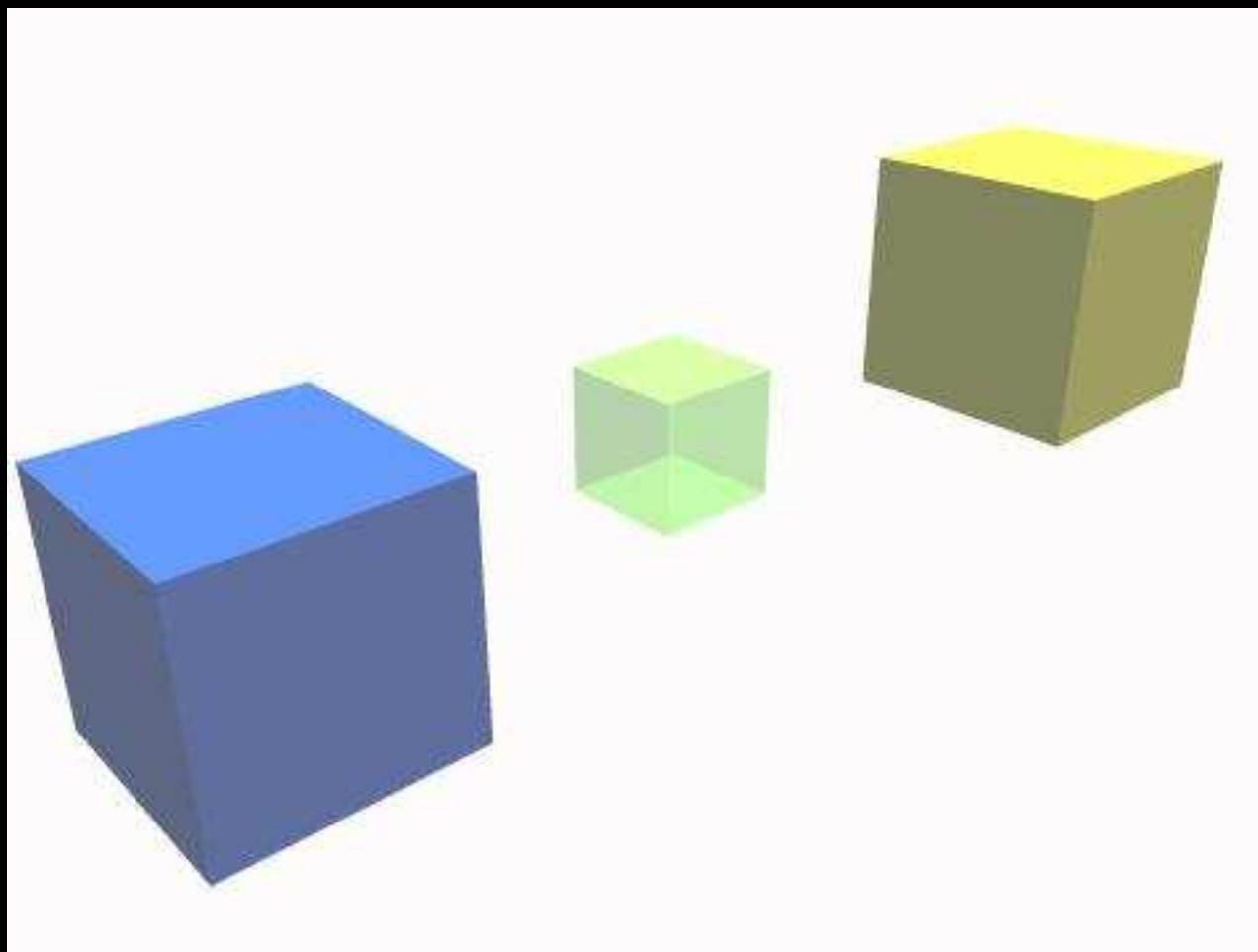
Proj 3D	Proj 2D	Proj 1D	
b1: f1, f2, f3, f4, f5, f6	f1: a1, a2, a3, a4	a1: 1, 2	a21: 11, 12
b2: f21, f22, f23, f24, f25, f26	f2: a4, a5, a6, a7	a2: 2, 3	a22: 12, 13
	f3: a3, a8, a9, a5	a3: 3, 4	a23: 13, 14
	f4: a2, a8, a11, a10	a4: 4, 1	a24: 14, 11
	f5: a1, a10, a12, a7	a5: 4, 6	a25: 14, 16
	f6: a6, a9, a11, a12	a6: 6, 5	a26: 16, 15
	f21: a21, a22, a23, a24	a7: 5, 1	a27: 15, 11
	f22: a24, a25, a26, a27	a8: 3, 7	a28: 13, 17
	f23: a23, a28, a29, a25	a9: 7, 6	a29: 17, 16
	f24: a22, a28, a31, a30	a10: 2, 8	a30: 12, 18
	f25: a21, a30, a32, a27	a11: 8, 7	a31: 18, 17
	f26: a23, a29, a31, a32	a12: 5, 8	a32: 15, 18

Workshop on Topology and spatial databases – Glasgow 05



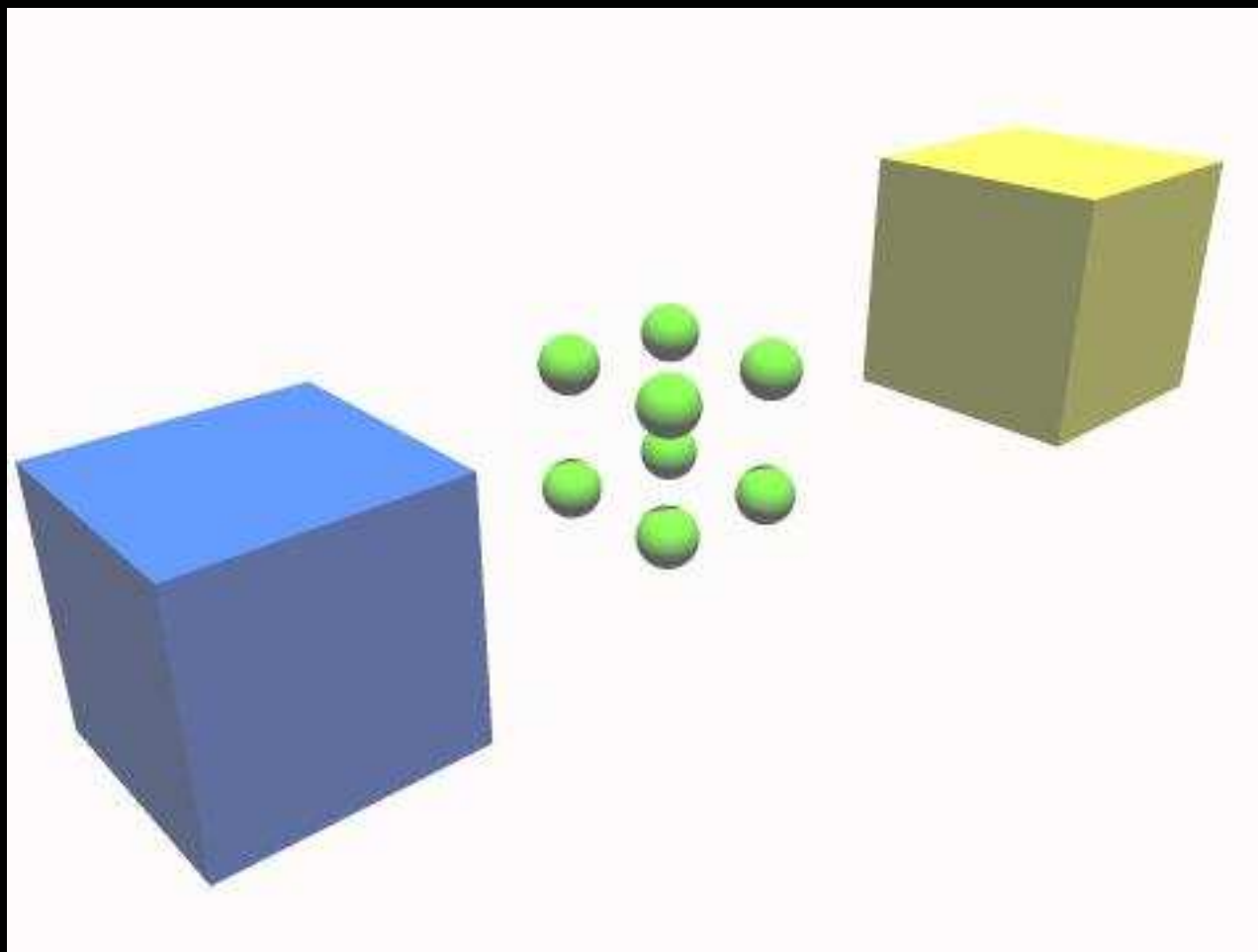
3D FDS

Face	Edge	Arc	
f1a: b1, 0	f1a: a1, a2b, a41, a40, a3b, a4	a1: 1, 2	a24: 14, 11
f2: b1, 0	f2: a4, a5, a6, a7	a2a: 2, 34	a25: 14, 16
f3a: b1, 0	f3a: a3b, a5, a9, a8b, a42, a45	a2b: 34, 3	a26a: 16, 42
f4a: b1, 0	f4a: a2, a44, a43, a8b, a11, a10	a3a: 3, 32	a26b: 42, 15
f5: b1, 0	f5: a1, a10, a12, a7	a3b: 32, 4	a27a: 15, 31
f6: b1, 0	f6: a6, a9, a11, a12	a4: 4, 1	a27b: 31, 11
f1b: b3, b2	f1b: a3a, a40, a41, a2b	a5: 4, 6	a28: 13, 17
f22b: b3, b1	f3b: a3a, a8a, a42, a45	a6: 6, 5	a29: 17, 16
f3b: b3, b2	f4b: a2b, a44, a43, a8a	a7: 5, 1	a30: 12, 18
f4b: b3, b2	f21: a21, a22, a23, a24	a8a: 3, 43	a31: 18, 17
f25b: b3, b1	f22a: a24, a25, a26b, a45, a40, a27b	a8b: 43, 7	a32a: 15, 44
f26b: b3, b1	f23: a23, a28, a29, a25	a9: 7, 6	a32b: 44, 18
f21: b2, 0	f24: a22, a28, a31, a30	a10: 2, 8	a40: 31, 32
f22a: b2, 0	f25a: a21, a30, a32b, a44, a41, a27b	a11: 8, 7	a41: 31, 34
f23: b2, 0	f26a: a26a, a29, a31, a32b, a43, a42	a12: 5, 8	a42: 42, 43
f24: b2, 0	f22b: a40, a45, a26b, a27a	a21: 11, 12	a43: 43, 44
f25a: b2, 0	f25b: a41, a27a, a32a, a44	a22: 12, 13	a44: 44, 34
f26a: b2, 0	f26b: a32a, a26b, a42, a43	a23: 13, 14	a45: 32, 42



SSDDM-1

Proj 3D	Proj 2D	Proj 1D		Sing	
b1: f1, f2, f3, f4, f5, f6 b2: f21, f22, f23, f24, f25, f26	f1: a1, a2, a3, a4 f2: a4, a5, a6, a7 f3: a3, a8, a9, a5 f4: a2, a8, a11, a10 f5: a1, a10, a12, a7 f6: a6, a9, a11, a12 f21: a21, a22, a23, a24 f22: a24, a25, a26, a27 f23: a23, a28, a29, a25 f24: a22, a28, a31, a30 f25: a21, a30, a32, a27 f26: a23, a29, a31, a32	a1: 1, 2 a2: 2, 3 a3: 3, 4 a4: 4, 1 a5: 4, 6 a6: 6, 5 a7: 5, 1 a8: 3, 7 a9: 7, 6 a10: 2, 8 a11: 8, 7 a12: 5, 8	a21: 11, 12 a22: 12, 13 a23: 13, 14 a24: 14, 11 a25: 14, 16 a26: 16, 15 a27: 15, 11 a28: 13, 17 a29: 17, 16 a30: 12, 18 a31: 18, 17 a32: 15, 18	b1: b2 b1: f22 b1: f25 b1: f26 b1: a26 b1: a27 b1: a32 b2: f1 b2: f3 b2: f4 b2: a2 b2: a3 b2: a8 f1: a27 f1: f22 f1: f25 f3: a26 f3: f22 f3: f26 f4: a32 f4: f25 f4: f26 f22: a3 f25: a2 f26: a8	a2: 34 a3: 32 a8: 43 a26: 42 a27: 31 a32: 44 f1: 31 f3: 42 f4: 44 f22: 32 f25: 34 f26: 43 b1: 15 b2: 3



SSDDM-1*

Proj 3D	Proj 2D	Proj 1D		Sing
b1: f1, f2, f3, f4, f5, f6 b2: f21, f22, f23, f24, f25, f26	f1: a1, a2, a3, a4 f2: a4, a5, a6, a7 f3: a3, a8, a9, a5 f4: a2, a8, a11, a10 f5: a1, a10, a12, a7 f6: a6, a9, a11, a12 f21: a21, a22, a23, a24 f22: a24, a25, a26, a27 f23: a23, a28, a29, a25 f24: a22, a28, a31, a30 f25: a21, a30, a32, a27 f26: a23, a29, a31, a32	a1: 1, 2 a2: 2, 3 a3: 3, 4 a4: 4, 1 a5: 4, 6 a6: 6, 5 a7: 5, 1 a8: 3, 7 a9: 7, 6 a10: 2, 8 a11: 8, 7 a12: 5, 8	a21: 11, 12 a22: 12, 13 a23: 13, 14 a24: 14, 11 a25: 14, 16 a26: 16, 15 a27: 15, 11 a28: 13, 17 a29: 17, 16 a30: 12, 18 a31: 18, 17 a32: 15, 18	a2: 34 a3: 32 a8: 43 a26: 42 a27: 31 a32: 44 f1: 31 f3: 42 f4: 44 f22: 32 f25: 34 f26: 43 b1: 15 b2: 3

Workshop on Topology and spatial databases – Glasgow 05

	Topo.	Proj.	Geom.
Object's geometry			

Cube b2 disappears...

3D FDS

Face	Edge	Arc	
f1a: b1, 0	f1a: a1, a2b, a41, a40, a3b, a4	a1: 1, 2	a26a: 16, 42
f2: b1, 0	f2: a4, a5, a6, a7	a2a: 2, 34	a26b: 42, 15
f3a: b1, 0	f3a: a3b, a5, a9, a8b, a42, a45	a2b: 34, 3	a27a: 15, 31
f4a: b1, 0	f4a: a2, a44, a43, a8b, a11, a10	a3a: 3, 32	a27b: 31, 11
f5: b1, 0	f5: a1, a10, a12, a7	a3b: 32, 4	a32a: 15, 44
f6: b1, 0	f6: a6, a9, a11, a12	a4: 4, 1	a32b: 44, 18
f1b: b3, 0	f1b: a3a, a40, a41, a2b	a5: 4, 6	a40: 31, 32
f22b: b3, b1	f3b: a3a, a8a, a42, a45	a6: 6, 5	a41: 31, 34
f3b: b3, 0	f4b: a2b, a44, a43, a8a	a7: 5, 1	a42: 42, 43
f4b: b3, 0	f22b; a40, a45, a26b, a27a	a8a: 3, 43	a43: 43, 44
f25b: b3, b1	f25b: a41, a27a, a32a, a44	a8b: 43, 7	a44: 44, 34
f26b: b3, b1	f26b: a32a, a26b, a42, a43	a9: 7, 6	a45: 32, 42
		a10: 2, 8	
		a11: 8, 7	
		a12: 5, 8	

SSDDM-1

Proj 3D	Proj 2D	Proj 1D
b1: f1, f2, f3, f4, f5, f6	f1: a1, a2, a3, a4 f2: a4, a5, a6, a7 f3: a3, a8, a9, a5 f4: a2, a8, a11, a10 f5: a1, a10, a12, a7 f6: a6, a9, a11, a12	a1: 1, 2 a2: 2, 3 a3: 3, 4 a4: 4, 1 a5: 4, 6 a6: 6, 5 a7: 5, 1 a8: 3, 7 a9: 7, 6 a10: 2, 8 a11: 8, 7 a12: 5, 8

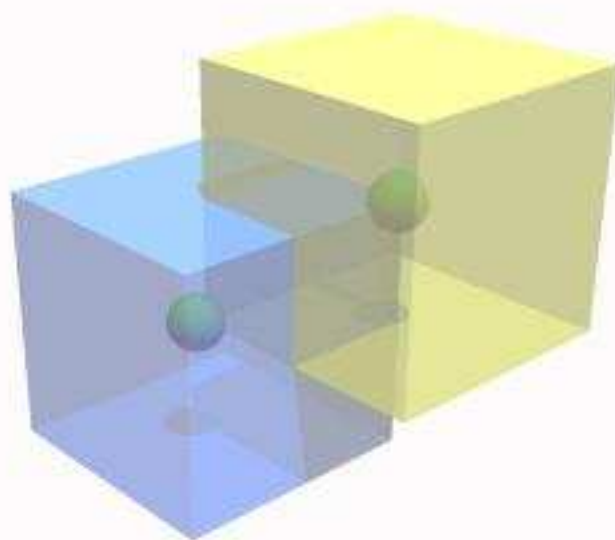
	Topo.	Proj.	Geom.
Object's geometry			
Update (dynamic)			

Workshop on Topology and spatial databases – Glasgow 05

	Topo.	Proj.	Geom.
Object's geometry	Orange	Green	Green
Update (dynamic)	Orange	Green	Green
Dimensional rel.		Green	Orange

	Topo.	Proj.	Geom.
Object's geometry	Orange	Green	Green
Update (dynamic)	Orange	Green	Green
Dimensional rel.		Green	Orange
Topological rel.	Green	Orange	Red

Workshop on Topology and spatial databases – Glasgow 05



	Topo.	Proj.	Geom.
Object's geometry	Orange	Green	Green
Update (dynamic)	Orange	Green	Green
Dimensional rel.		Green	Orange
Topological rel.	Green	Orange	Red
Intersection's geom.	Green	Orange	Red

Temporary table

SSDDM-1

T_o_l	l_id	T_o_oa	a_id	T_o_ob	b_id	Seq_in_a	Seq_in_b	Seq_in_l
P_2D	B	P_2D	A	P_2D	B	0	0	0
P_2D	A	P_2D	B	P_2D	A	0	0	0
P_1D	b1	P_2D	A	P_2D	B	0	1	0
P_1D	b4	P_2D	A	P_2D	B	0	4	0
P_1D	b5	P_2D	A	P_2D	B	0	5	1
P_1D	a1	P_2D	A	P_2D	B	1	0	0
P_1D	a2	P_2D	A	P_2D	B	2	0	5
P_1D	a3	P_2D	A	P_2D	B	3	0	0
P_0D	5	P_2D	A	P_1D	B1	0	1	2
P_0D	5	P_2D	A	P_1D	B5	0	2	0
P_0D	9	P_2D	A	P_1D	B4	0	2	8
P_0D	9	P_2D	A	P_1D	B5	0	1	0
P_0D	2	P_2D	B	P_1D	a1	0	2	4
P_0D	2	P_2D	B	P_1D	A2	0	1	0
P_0D	3	P_2D	B	P_1D	A2	0	2	6
P_0D	3	P_2D	B	P_1D	A3	0	1	0
G_0D	g10	P_1D	A1	P_1D	B1	0	0	3
G_0D	g11	P_1D	A3	P_1D	B4	0	0	7

	Topo.	Proj.	Geom.
Object's geometry	Orange	Green	Green
Update (dynamic)	Orange	Green	Green
Dimensional rel.		Green	Orange
Topological rel.	Green	Orange	Red
Intersection's geom.	Green	Orange	Red
Consistency	Green	Orange	Red

Conclusions

- This comparison is highly ... subjective
→ Need a more formal study...
- It is an intermediate solution between topological and geometric primitives
- In a 3D context, the use of projective primitives is an alternative to topological primitives