Geometrical Modeling of Buildings
The Frame for the Integration of Data Acquisition Techniques

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Data Sources

Distances 1D

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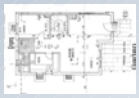


Local 2D Coordinates (cartesian)

Local 3D Coordinates (polar → cartesian)

Local 3D Coordinates (polar → cartesian)

Problem

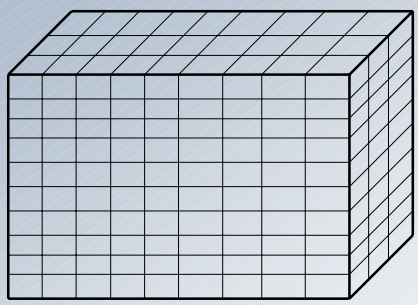
- Task: Transformation of local geometry parameters (observations) into a global reference frame
- Observations are:
  - Redundant
  - Random values
  - Contain blunders
- Option 1: Sequential calculation
  - Result depends of sequence of calculation
  - Unfavorable error propagation
  - Difficult blunder detection
- Option 2: Adjustment
  - Unique result
  - Optimal error propagation
  - Easy blunder detection

Construction versus Reconstruction

- Construction (CAD)
  - All parameters are constants
  - Sequential calculation (no equation systems)
  - Redundant parameterization lead not to inconsistence
- Reconstruction (Adjustment)
  - All parameters are random values
  - Simultaneous calculation → large equation systems
  - Redundant parameterization lead to inconsistence
  - Each redundant parameter requires a constraint equation !

Parameterization

Example: Theoretical Building



10 floors

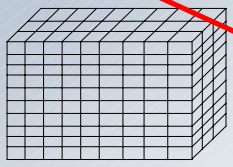
4 walls lengthwise

11 walls transverse

Parameterization

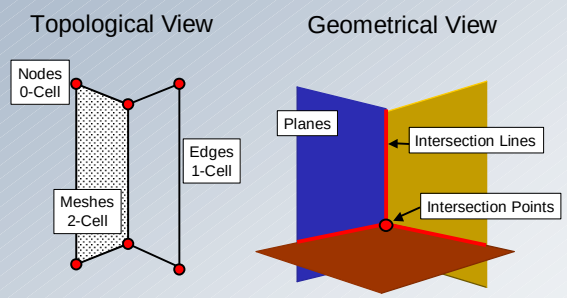
Option 1:
Parameterization with coordinates
x, y, z
10 * 10 * 3 + 1 = 301 rooms
301 * 8 = 2408 points
2408 * 3 = 7224 coordinates

Option 2:
Parameterization with plane parameters
$\boldsymbol{n}\cdot\boldsymbol{x}-d = 0$ → n_x, n_y, n_z, d
10*2 + 4*2 + 11*2 = 50 planes
3 normal vectors * 3 components
+ 50 translations d
= 59 plane parameters

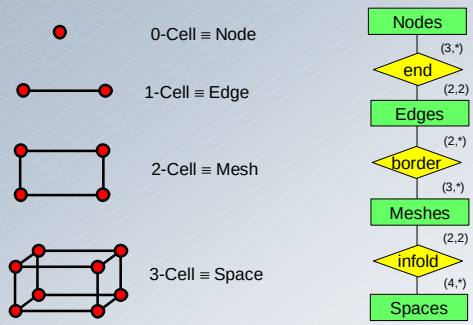


0.8% !

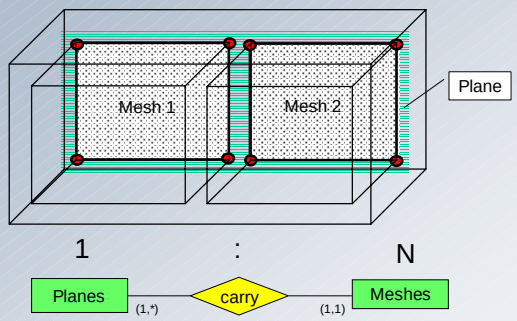
What is a Corner?



Topology



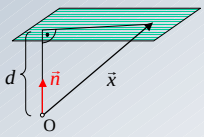
Geometry and Topology



Geometry Parameter

Plane
persistent

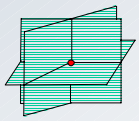
$$\vec{n} \cdot \vec{x} - d = 0$$



Point
View

$$\vec{n}_1 \cdot \vec{x} = d_1$$
$$\vec{n}_2 \cdot \vec{x} = d_2$$
$$\vec{n}_3 \cdot \vec{x} = d_3$$

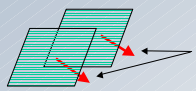
SQL-Statement → $\vec{x}$



Geometrical Constraints

Coplanarity → Implicit

Parallelism

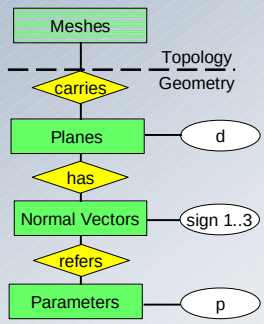


Identical Normal Vectors

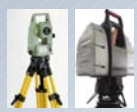
Orthogonality (in X,Y-Plane)

$$\vec{n}_1 = \begin{pmatrix} a \\ b \\ 0 \end{pmatrix} \rightarrow \begin{matrix} a \\ b \end{matrix} \leftarrow \vec{n}_2 = \begin{pmatrix} -b \\ a \\ 0 \end{pmatrix}$$

Data Model

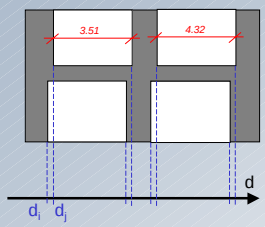


Adjustment Approach

Proceedings	Observables	Unknowns
	Distances d	Global Plane Parameters $\mathbf{n}_i$, d_i
	Local Coordinates x_{ij}, y_{ij}	Global Plane Parameters $\mathbf{n}_i$, d_i Transformation Parameters $\mathbf{t}_j$, $\mathbf{A}_j$
	Local Plane Parameters (preprocessed) $\mathbf{n}_{ij}$, d_{ij}	Global Plane Parameters $\mathbf{n}_i$, d_i Transformation Parameters $\mathbf{t}_j$, q_j

Gauss-Helmert-Model: $f(l+v,x)=0$

Unification of Planes



$$H_0 \quad : \quad \Delta_d = d_j - d_i = 0$$

$$\text{test value} : \quad \frac{\Delta_d}{\sigma_{\Delta_d}} \sim N(0,1)$$

- Grouping of planes by normal vectors
- 1D linear adjustment
- Test of d-differences
- Unification of planes

End

Thank you for your attention!

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