

Structured input to HIJSON

Towards indoor mapping and IoT modeling *

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Abstract

This module aims to prototype the process of entering geometric data representing a complex building, to provide them explicit semantic and a hierarchical model. The generated LAR structures [DPS14, PDFJ15] are finally output to HIJSON format, an experimental data format extending GEOJSON for applications of indoor mapping and the Internet-of-Things. In HIJSON a strongly simplified building model, yet sufficient for useful purposes, accomodates the knowledge concerning the use models of the building and the set of interior devices and their connection.

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1 Introduction

2 Implementation

2.1 Input of geometry from external drawings

File input and computation of cellular complex The modeling process starts with the input of a `.svg` file, the W3C standard for 2D vector graphics on the web. The file must only contain (by now) `<rect>` and `<line>` graphics primitives. The geometric data generate the partition of the plane induced by an arrangement of intersecting lines. The arrangement of (fragmented) lines is finally transformed into a 2D *LAR model*, made by the triple V, FV, EV of vertices, faces and edges. We notice the the LAR input is normalized by the `larFromLines` function: all vertices in V are transformed in the standard plane interval $[0, 1]^2$.

```
<SVG file input and computation of cellular complex 2a>  $\equiv$ 
    """ File input and computation of cellular complex """
    def svg2lar(filename):
        lines = svg2lines(filename)
        larModel = larFromLines(lines)
        V, FV, EV = larModel
        return larModel
     $\diamond$ 
```

Macro referenced in [5a](#).

2.2 Emulation of interactive graphics input

In this section two functions are given to emulate two graphics input primitives, respectively.

Emulation of input from “selection box” The function accepts as input the LAR model V, FV, EV and a `queryBox` given in normalized coordinates. It returns `vertexSubset` $\subseteq V$, `faceSubset` $\subseteq FV$, `edgeSubset` $\subseteq EV$.

```
<Emulation of input from “selection box” 2b>  $\equiv$ 

    """ Emulation of input from “selection box” over a LAR normalized representation """
    from scipy import spatial

    def subComplexInBox(V, FV, EV, queryBox):
        (xmin, ymin), (xmax, ymax) = queryBox
        if xmin > xmax: xmin, xmax = xmax, xmin
        if ymin > ymax: ymin, ymax = ymax, ymin
        vdict = dict([(vcode(vert), k) for k, vert in enumerate(V)])
```

```

vertexSubset = [vdict[vcode((x,y))] for x,y in V if xmin<=x<=xmax and ymin<=y<=ymax]
edgeSubset = [e for e,edge in enumerate(EV) if all([v in vertexSubset for v in edge])]
faceSubset = [f for f,face in enumerate(FV) if all([v in vertexSubset for v in face])]
return vertexSubset,faceSubset,edgeSubset

if __name__=="__main__":
    selectBox = ((0.45, 0.45), (0.65, 0.75))
    vertexSubset,faceSubset,edgeSubset = subComplexInBox(V,FV,EV,selectBox)
    #VIEW(EXPLODE(1.2,1.2,1.2)(MKPOLLS((V,[EV[e] for e in edgeSubset])) + [
        #COLOR(RED)(MK(selectBox[0])), COLOR(RED)(MK(selectBox[1]))]))
    #VIEW(EXPLODE(1.2,1.2,1.2)(MKPOLLS((V,[FV[f] for f in faceSubset])) + [
        #COLOR(RED)(MK(selectBox[0])), COLOR(RED)(MK(selectBox[1]))]))

```

◇

Macro referenced in 5a.

Emulation of “pick” input over a LAR normalized representation The function accepts as input the LAR model V, FV, EV , the incidence relation FE , that provides for each face the list of incident edges, and a `queryPoint` given in normalized coordinates. It returns $vertexSubset \subseteq V$, $faceSubset \subseteq FV$, $edgeSubset \subseteq EV$.

⟨ Emulation of “pick” input 3a ⟩ ≡

```

""" Emulation of ‘pick’ input over a LAR normalized representation """
def subComplexAroundPoint(V,FV,EV,FE,queryPoint):
    tree = spatial.cKDTree(V)
    pts = np.array([queryPoint])
    dist,closestVertex = tree.query(pts)
    VF = invertRelation(FV)
    closestFaces = VF[closestVertex]
    for face in closestFaces:
        faceEdges = [EV[e] for e in FE[face]]
        if pointInPolygonClassification(queryPoint, (V,faceEdges)) == "p_in":
            break
    vertexSubset = FV[face]
    edgeSubset = [EV[e] for e in FE[face]]
    faceSubset = [face]
    return vertexSubset,faceSubset,edgeSubset

if __name__=="__main__":
    FE = crossRelation(FV,EV)
    queryPoint = (0.6,0.58)
    vertexSubset,faceSubset,edgeSubset = subComplexAroundPoint(V,FV,EV,FE,queryPoint)
    ##VIEW(EXPLODE(1.2,1.2,1.2)(MKPOLLS((V,[EV[e] for e in FE[faceSubset[0]]])) + [
        #COLOR(RED)(MK(queryPoint))]) )

```

◇

Macro referenced in 5a.

From LAR chain to colored HPCs The function `cells2hpcs` is used to assign a given `k` color to the cells of a chain (cell subset) of a LAR model `V,FV`. The function returns a list of HPC (colored) objects.

```

⟨From LAR chain to colored HPCs 3b⟩ ≡
    """ From LAR chain to colored HPCs """
    def cells2hpcs(V,FV,cells,k):
        colors = [RED, GREEN, BLUE, CYAN, MAGENTA, YELLOW, WHITE, PURPLE, BROWN]
        return AA(COLOR(colors[k]))(MKPOLs((V,[FV[f] for f in cells])))
    ◇

```

Macro referenced in [5a](#).

2.3 Structural operations

From 2D chains to boundary chains

```

⟨From 2D chains to boundary chains 4a⟩ ≡
    """ From 2D chains to boundary chains """
    def chain2BoundaryChain(FV,EV):
        csrBoundaryMat = boundary(FV,EV)
        nedges,nfaces = csrBoundaryMat.shape
        def chain2BoundaryChain0(chain):
            row = np.array(chain)
            col = np.array([0 for k in range(len(chain))])
            data = np.array([1 for k in range(len(chain))])
            csrFaceVect = scipy.sparse.coo_matrix((data, (row, col)), shape=(nfaces,1)).tocsr()
            csrEdgeVect = csrBoundaryMat*csrFaceVect
            boundaryChain = [h for h,val in
                zip(csrEdgeVect.tocoo().row, csrEdgeVect.tocoo().data) if val%2 != 0]
            return boundaryChain
        return chain2BoundaryChain0
    ◇

```

Macro referenced in [5a](#).

From chains to structures

```

⟨From chains to structures 4b⟩ ≡
    """ From chains to structures """
    def chain2structs(V,FV,EV,FE):
        def chain2structs0(args):
            if args == ([],[],[]): return
            chain,chainName,classtype = args
            struct = []
            for cell in chain:
                vs = [V[v] for v in FV[cell]]

```

```

        vdict = dict([[vcode(vert),k] for k,vert in enumerate(vs)])
        facetEdges = [[V[v] for v in EV[e]] for e in FE[cell]]
        ev = [(vdict[vcode(v1)], vdict[vcode(v2)]) for v1,v2 in facetEdges]
        fv = [range(len(vs))]
        shape = vs,fv,ev
        struct += [ Struct([ shape ], name=None, category="room" ) ]
        out = Struct( struct, name=chainName, category=classtype )
        return out
    return chain2structs0

```

◇

Macro referenced in 5a.

3 Exporting the library

```

"larlib/larlib/hijson.py" 5a ≡
    """ Module for Structured input to HIJSON """
    from larlib import *
    from copy import copy
    DEBUG = False

    ⟨SVG file input and computation of cellular complex 2a⟩
    ⟨Emulation of input from “selection box” 2b⟩
    ⟨Emulation of “pick” input 3a⟩
    ⟨From LAR chain to colored HPCs 3b⟩
    ⟨From 2D chains to boundary chains 4a⟩
    ⟨From chains to structures 4b⟩

```

◇

4 Test examples

4.1 Example of a complex building model: part definition

Visualization of cell numbering in a 2D complex

```

⟨Visualization of cell numbering in a 2D complex 5b⟩ ≡
    """ Visualization of cell numbering in a 2D complex """
    VV = AA(LIST)(range(len(V)))
    submodel = STRUCT(MKPOLS((V,EV)))
    #VIEW(larModelNumbering(1,1,1)(V,[VV,EV,FV[:-1]],submodel,2.5))

```

◇

Macro referenced in 11a.

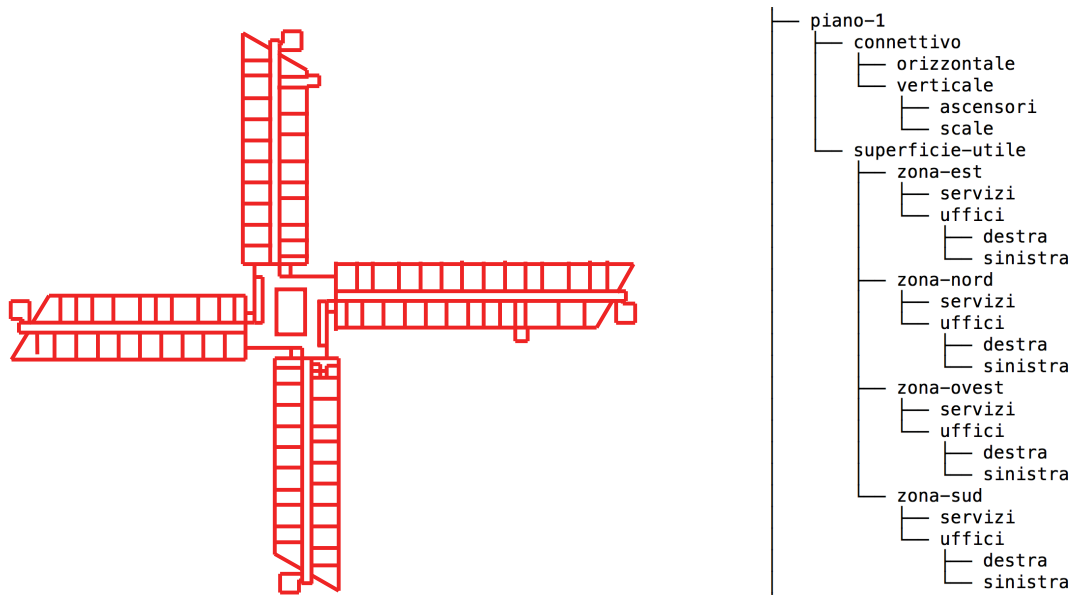


Figure 1: The input SVG drawing of the typical floor layout.

Ala nord (HPCs)

$\langle \text{Ala nord 6a} \rangle \equiv$

```

FE = crossRelation(FV,EV)
chainsToStruct = chain2structs(V,FV,EV,FE)

""" Ala nord """
boxes = [0 for k in range(64)]
point = [0 for k in range(64)]
boxes[0] = array([[0.431, 0.607], [0.474, 0.91]])*scaleFactor #[V[k] for k in [39,208]]
boxes[1] = array([[0.416, 0.657], [0.372, 0.953]])*scaleFactor #[V[k] for k in [162,39]]
boxes[2] = array([[0.416, 0.627], [0.431, 0.986]])*scaleFactor #[V[k] for k in [206,247]]
boxes[3] = array([[0.431, 0.607], [0.448, 0.627]])*scaleFactor #[V[k] for k in [39,7]]
boxes[4] = array([[0.431, 0.91], [0.494, 0.929]])*scaleFactor #[V[k] for k in [213,234]]
boxes[5] = array([[0.431, 0.97], [0.466, 1.0]])*scaleFactor #[V[k] for k in [58,88]]
boxes[27] = array([[0.416, 0.627], [0.372, 0.657]])*scaleFactor #[V[k] for k in [110,82]]

point[0] = array([0.394, 0.9625])*scaleFactor #CCOMB([V[k] for k in [190,197]])
point[1] = array([0.4525, 0.9325])*scaleFactor #CCOMB([V[k] for k in [166,159]])

piano1_superficieUtile_zonaNord_uffici_destra = subComplexInBox(V,FV,EV,boxes[0])[1]
piano1_superficieUtile_zonaNord_uffici_sinistra = subComplexInBox(V,FV,EV,boxes[1])[1]
piano1_connettivo_orizzontale_zonaNord = subComplexInBox(V,FV,EV,boxes[2])[1]
piano1_connettivo_verticale_zonaNord_ascensore = subComplexInBox(V,FV,EV,boxes[3])[1]

```

```

piano1_connettivo_verticale_zonaNord_ascensore += subComplexInBox(V,FV,EV,boxes[4])[1]
piano1_connettivo_verticale_zonaNord_scale = subComplexInBox(V,FV,EV,boxes[5])[1]
piano1_superficieUtile_zonaNord_servizi = subComplexAroundPoint(V,FV,EV,FE,point[0])[1]
piano1_superficieUtile_zonaNord_servizi += subComplexAroundPoint(V,FV,EV,FE,point[1])[1]
piano1_superficieUtile_zonaNord_servizi += subComplexInBox(V,FV,EV,boxes[27])[1]

piano1N = [piano1_superficieUtile_zonaNord_uffici_destra, piano1_superficieUtile_zonaNord_uffi
◇

```

Macro defined by **6ab**.
Macro referenced in **11a**.

⟨Ala nord 6b⟩ ≡

```

""" Ala nord """
piano1N_nomi = ["piano1_superficieUtile_zonaNord_uffici_destra", "piano1_superficieUtile_zonaN
piano1N_categorie = ["uffici","uffici","corridoi","ascensori","scale","servizi"]
p1N = zip(piano1N,piano1N_nomi,piano1N_categorie)
piano1_zonaNord = Struct(AA(chainsToStruct)(p1N),"piano1_zonaNord","ala")
#VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1_zonaNord))))))

nord = CAT([cells2hpcs(V,FV,chain,k) for k,chain in enumerate(piano1N)])
#VIEW(EXPLODE(1.2,1.2,1.2)(nord))
◇

```

Macro defined by **6ab**.
Macro referenced in **11a**.

Ala est (HPCs)

⟨Ala est 7a⟩ ≡

```

""" Ala est """
boxes[6] = array([[0.019, 0.533], [0.376, 0.577]])*scaleFactor #[V[k] for k in [241,29]]
boxes[7] = array([[0.07, 0.474], [0.343, 0.518]])*scaleFactor #[V[k] for k in [264,148]]
boxes[8] = array([[0.013, 0.518], [0.376, 0.533]])*scaleFactor #[V[k] for k in [22,63]]
boxes[9] = array([[0.376, 0.533], [0.39, 0.549]])*scaleFactor #[V[k] for k in [63,92]]
boxes[10] = array([[0.001, 0.474], [0.07, 0.518]])*scaleFactor #[V[k] for k in [263,265]]
boxes[11] = array([[0.343, 0.474], [0.376, 0.518]])*scaleFactor #[V[k] for k in [84,149]]

point[2] = array([0.015, 0.5535])*scaleFactor #CCOMB([V[k] for k in [228,14]])

piano1_superficieUtile_zonaEst_uffici_destra = subComplexInBox(V,FV,EV,boxes[6])[1]
piano1_superficieUtile_zonaEst_uffici_sinistra = subComplexInBox(V,FV,EV,boxes[7])[1]
piano1_connettivo_orizzontale_zonaEst = subComplexInBox(V,FV,EV,boxes[8])[1]
piano1_connettivo_verticale_zonaEst_ascensore = subComplexInBox(V,FV,EV,boxes[9])[1]
piano1_connettivo_verticale_zonaEst_scale = subComplexAroundPoint(V,FV,EV,FE,point[2])[1]
piano1_superficieUtile_zonaEst_servizi = subComplexInBox(V,FV,EV,boxes[10])[1]
piano1_superficieUtile_zonaEst_servizi += subComplexInBox(V,FV,EV,boxes[11])[1]

```

```
piano1E = [piano1_superficieUtile_zonaEst_uffici_destra, piano1_superficieUtile_zonaEst_uffici]
◇
```

Macro defined by 7ab.
Macro referenced in 11a.

⟨Ala est 7b⟩ ≡

```
"" Ala est ""
piano1E_nomi = ["piano1_superficieUtile_zonaEst_uffici_destra", "piano1_superficieUtile_zonaEst_uffici"]
piano1E_categorie = ["uffici","uffici","corridoi","ascensori","scale","servizi"]
p1E = zip(piano1E,piano1E_nomi, piano1E_categorie)
piano1_zonaEst = Struct(AA(chainsToStruct)(p1E), "piano1_zonaEst", "ala")
#VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1_zonaEst))))))

est = CAT([cells2hpcs(V,FV,chain,k) for k,chain in enumerate(piano1E)])
#VIEW(EXPLODE(1.2,1.2,1.2)(est + nord))
◇
```

Macro defined by 7ab.
Macro referenced in 11a.

Ala sud (HPCs)

⟨Ala sud 8a⟩ ≡

```
"" Ala sud ""
boxes[12] = array([[0.467, 0.138], [0.423, 0.476]])*scaleFactor #[V[k] for k in [252,47]]
boxes[13] = array([[0.482, 0.145], [0.525, 0.445]])*scaleFactor #[V[k] for k in [241,126]]
boxes[14] = array([[0.482, 0.476], [0.467, 0.116]])*scaleFactor #[V[k] for k in [254,232]]
boxes[15] = array([[0.449, 0.476], [0.467, 0.493]])*scaleFactor #[V[k] for k in [40,237]]
boxes[16] = array([[0.431, 0.101], [0.467, 0.131]])*scaleFactor #[V[k] for k in [259,2]]
boxes[17] = array([[0.482, 0.445], [0.525, 0.476]])*scaleFactor #[V[k] for k in [155,248]]
boxes[18] = array([[0.525, 0.104], [0.482, 0.145]])*scaleFactor #[V[k] for k in [111,241]]

piano1_superficieUtile_zonaSud_uffici_destra = subComplexInBox(V,FV,EV,boxes[12])[1]
piano1_superficieUtile_zonaSud_uffici_sinistra = subComplexInBox(V,FV,EV,boxes[13])[1]
piano1_connettivo_orizzontale_zonaSud = subComplexInBox(V,FV,EV,boxes[14])[1]
piano1_connettivo_verticale_zonaSud_ascensore = subComplexInBox(V,FV,EV,boxes[15])[1]
piano1_connettivo_verticale_zonaSud_scale = subComplexInBox(V,FV,EV,boxes[16])[1]
piano1_superficieUtile_zonaSud_servizi = subComplexInBox(V,FV,EV,boxes[17])[1]
piano1_superficieUtile_zonaSud_servizi += subComplexInBox(V,FV,EV,boxes[18])[1]

piano1S = [piano1_superficieUtile_zonaSud_uffici_destra, piano1_superficieUtile_zonaSud_uffici]
◇
```

Macro defined by 8ab.
Macro referenced in 11a.

⟨Ala sud 8b⟩ ≡


```

"" Ala sud ""
piano1S_nomi = ["piano1_superficieUtile_zonaSud_uffici_destra", "piano1_superficieUtile_zonaSud_uffici_sinistra"]
piano1S_categorie = ["uffici","uffici","corridoi","ascensori","scale","servizi"]
p1S = zip(piano1S,piano1S_nomi, piano1S_categorie)
piano1_zonaSud = Struct(AA(chainsToStruct)(p1S), "piano1_zonaSud", "ala")
#VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1_zonaSud))))))

sud = CAT([cells2hpcs(V,FV,chain,k) for k,chain in enumerate(piano1S)])
#VIEW(EXPLODE(1.2,1.2,1.2)(est + nord + sud))
◇

```

Macro defined by [8ab](#).
Macro referenced in [11a](#).

Ala ovest (HPCs)

⟨Ala ovest 8c⟩ ≡

```

"" Ala ovest ""
boxes[19] = array([[0.521, 0.526], [0.963, 0.568]])*scaleFactor #[V[k] for k in [169,202]]
boxes[20] = array([[0.555, 0.584], [0.955, 0.627]])*scaleFactor #[V[k] for k in [12,23]]
boxes[21] = array([[0.521, 0.568], [0.985, 0.584]])*scaleFactor #[V[k] for k in [209,204]]
boxes[22] = array([[0.506, 0.551], [0.521, 0.568]])*scaleFactor #[V[k] for k in [89,209]]
boxes[23] = array([[0.808, 0.504], [0.828, 0.526]])*scaleFactor #[V[k] for k in [270,77]]
boxes[24] = array([[0.955, 0.584], [0.997, 0.627]])*scaleFactor #[V[k] for k in [220,24]]
boxes[25] = array([[0.521, 0.584], [0.555, 0.627]])*scaleFactor #[V[k] for k in [11,144]]
boxes[26] = array([[1.0, 0.533], [0.97, 0.568]])*scaleFactor #[V[k] for k in [233,201]]

piano1_superficieUtile_zonaOvest_uffici_destra = subComplexInBox(V,FV,EV,boxes[19])[1]
piano1_superficieUtile_zonaOvest_uffici_sinistra = subComplexInBox(V,FV,EV,boxes[20])[1]
piano1_connettivo_orizzontale_zonaOvest = subComplexInBox(V,FV,EV,boxes[21])[1]
piano1_connettivo_verticale_zonaOvest_ascensore = subComplexInBox(V,FV,EV,boxes[22])[1]
piano1_connettivo_verticale_zonaOvest_ascensore += subComplexInBox(V,FV,EV,boxes[23])[1]
piano1_superficieUtile_zonaOvest_servizi = subComplexInBox(V,FV,EV,boxes[24])[1]
piano1_superficieUtile_zonaOvest_servizi += subComplexInBox(V,FV,EV,boxes[25])[1]
piano1_connettivo_verticale_zonaOvest_scale = subComplexInBox(V,FV,EV,boxes[26])[1]

piano10 = [piano1_superficieUtile_zonaOvest_uffici_destra, piano1_superficieUtile_zonaOvest_uffici_sinistra]
◇

```

Macro defined by [8c](#), [9a](#).
Macro referenced in [11a](#).

⟨Ala ovest 9a⟩ ≡

```

"" Ala ovest ""
piano10_nomi = ["piano1_superficieUtile_zonaOvest_uffici_destra", "piano1_superficieUtile_zonaOvest_uffici_sinistra"]
piano10_categorie = ["uffici","uffici","corridoi","ascensori","scale","servizi"]
p10 = zip(piano10,piano10_nomi, piano10_categorie)
piano1_zonaOvest = Struct(AA(chainsToStruct)(p10), "piano1_zonaOvest", "ala")

```

```

#VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1_zonaOvest))))))

ovest = CAT([cells2hpcs(V,FV,chain,k) for k,chain in enumerate(piano10)])
#VIEW(EXPLODE(1.2,1.2,1.2)(est + nord + sud + ovest))
◇

```

Macro defined by [8c](#), [9a](#).
Macro referenced in [11a](#).

Centro stella (HPCs)

```

⟨ Centro stella 9b ⟩ ≡
  """ Centro stella """
  piano1_connettivo_orizzontale_centroStella = [2]
  piano1_connettivo_verticale_centroStella_scale = [15,26]

  piano1C = [[],[],piano1_connettivo_orizzontale_centroStella,[], piano1_connettivo_verticale_centroStella_scale]
  centro = CAT([cells2hpcs(V,FV,chain,k) for k,chain in enumerate(piano1C)])
  ◇

```

Macro defined by [9b](#), [10a](#).
Macro referenced in [11a](#).

```

⟨ Centro stella 10a ⟩ ≡
  """ Centro stella """
  piano1C_nomi = [[],[],"piano1_connettivo_orizzontale_centroStella", [], "piano1_connettivo_verticale_centroStella_scale"]
  piano1C_categorie = [[],[],"corridoi",[], "ascensori"]
  p1C = zip(piano1C,piano1C_nomi, piano1C_categorie)
  piano1_centroStella = Struct(AA(chainsToStruct)(p1C), "piano1_centroStella", "centro")
  #VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1_centroStella))))))

  #VIEW(EXPLODE(1.2,1.2,1.2)(est + nord + sud + ovest + centro))
  #VIEW(STRUCT(est + nord + sud + ovest + centro))
  ◇

```

Macro defined by [9b](#), [10a](#).
Macro referenced in [11a](#).

4.2 Example of a complex building model: integration

Assembly of parts (HPCs)

```

⟨ Assemblaggio 10b ⟩ ≡
  """ Assemblaggio """
  p1 = p1N + p1S + p1E + p1O + p1C

  piano1_nomi = ["piano1_zonaNord", "piano1_zonaEst", "piano1_zonaSud", "piano1_zonaOvest", "piano1_centro"]
  piano1_categorie = ["ala","ala","ala","ala","centro"]
  piano1 = Struct(AA(chainsToStruct)(p1), "piano1", "level")

```

```

#VIEW(SKEL_1(STRUCT(MKPOLS(struct2lar(piano1))))))

V,boundaryEdges = structBoundaryModel(piano1)
drawing = mkSignedEdges((V,boundaryEdges))
#VIEW(drawing)

polylines = boundaryModel2polylines((V,boundaryEdges))
#VIEW(STRUCT(AA(POLYLINE)(polylines)))

print boundaryPolylines(piano1)
◇

```

Macro referenced in 11a.

Assembling floor layout generation

```

⟨ Assembling floor layout generation 11a ⟩ ≡
    """ Assembling floor layout generation """
    ⟨ Visualization of cell numbering in a 2D complex 5b ⟩
    ⟨ Ala nord 6a, ... ⟩
    ⟨ Ala est 7a, ... ⟩
    ⟨ Ala sud 8a, ... ⟩
    ⟨ Ala ovest 8c, ... ⟩
    ⟨ Centro stella 9b, ... ⟩
    ⟨ Assemblaggio 10b ⟩
◇

```

Macro referenced in 11c, 12.

```

⟨ Tower example initialization 11b ⟩ ≡
    """ make the model of a layout floor """

    scaleFactor = 83.333

    filename = "test/svg/inters/plan.svg"
    larModel = svg2lar(filename)
    larModel = larApply(s(scaleFactor,scaleFactor))(larModel)
    V,FV,EV = larModel
    FV[2] += FV[71]      # for now :o)
◇

```

Macro referenced in 11c, 12.

```

"test/py/hijson/test01.py" 11c ≡
    """ make the model of a layout floor """
    from larlib import *

```

```

⟨ Tower example initialization 11b ⟩
⟨ Assembling floor layout generation 11a ⟩

primoPiano = AA(list)([CAT(AA(S1)(p1N)),CAT(AA(S1)(p1E)),CAT(AA(S1)(p1S)),
                      CAT(AA(S1)(p1O)),CAT(AA(S1)(p1C))])
primoPiano_nomi = ["piano1_zonaNord","piano1_zonaEst","piano1_zonaSud","piano1_zonaOvest","piano1_zonaCentro"]
primoPiano_categorie = ["ala","ala","ala","ala","centro"]
pianoPrimo = zip(primoPiano, primoPiano_nomi, primoPiano_categorie)
piano_1 = Struct( AA(chainsToStruct)(pianoPrimo), "piano1", "level" )

piano_1_3D = embedStruct(1)(piano_1,"3D")
iot3d.printStruct2GeoJson("./",piano_1_3D)

print "piano_1_3D =",piano_1_3D.category
print "piano_1_3D.body[0] =",piano_1_3D.body[0].category
print "piano_1_3D.body[0].body[0] =",piano_1_3D.body[0].body[0].category
◇

"test/py/hijson/test02.py" 12 ≡
""" make the 2.5 model of a building tower """
from larlib import *

⟨ Tower example initialization 11b ⟩
⟨ Assembling floor layout generation 11a ⟩

pianoNord3D = embedStruct(1)(piano1_zonaNord,"3D")
pianoEst3D = embedStruct(1)(piano1_zonaEst,"3D")
pianoSud3D = embedStruct(1)(piano1_zonaSud,"3D")
pianoOvest3D = embedStruct(1)(piano1_zonaOvest,"3D")
pianoCentro3D = embedStruct(1)(piano1_centroStella,"3D")
torreNord = Struct(4*[pianoNord3D,t(0,0,3)], "torreNord", "edificio")
torreEst = Struct(7*[pianoEst3D,t(0,0,3)], "torreEst", "edificio")
torreSud = Struct(7*[pianoSud3D,t(0,0,3)], "torreSud", "edificio")
torreOvest = Struct(7*[pianoOvest3D,t(0,0,3)], "torreOvest", "edificio")
torreCentro = Struct(7*[pianoCentro3D,t(0,0,3)], "torreCentro", "edificio")
torre = Struct([torreNord,torreEst,torreSud,torreOvest,torreCentro],"torre", "edificio")
V,FV,EV = struct2lar(torre)
#VIEW(EXPLODE(1.2,1.2,1.2)(MKPOLs((V,EV))))
#VIEW(STRUCT(MKPOLs((V,FV))))
◇

```

References

- [CL13] CVD-Lab, *Linear algebraic representation*, Tech. Report 13-00, Roma Tre University, October 2013.

- [DPS14] Antonio DiCarlo, Alberto Paoluzzi, and Vadim Shapiro, *Linear algebraic representation for topological structures*, Comput. Aided Des. **46** (2014), 269–274.
- [PDFJ15] Alberto Paoluzzi, Antonio DiCarlo, Francesco Furiani, and Miroslav Jirik, *Cad models from medical images using lar*, Computer-Aided Design and Applications **13** (2015), To appear.