

# Motion analysis and synthesis – Basic tools

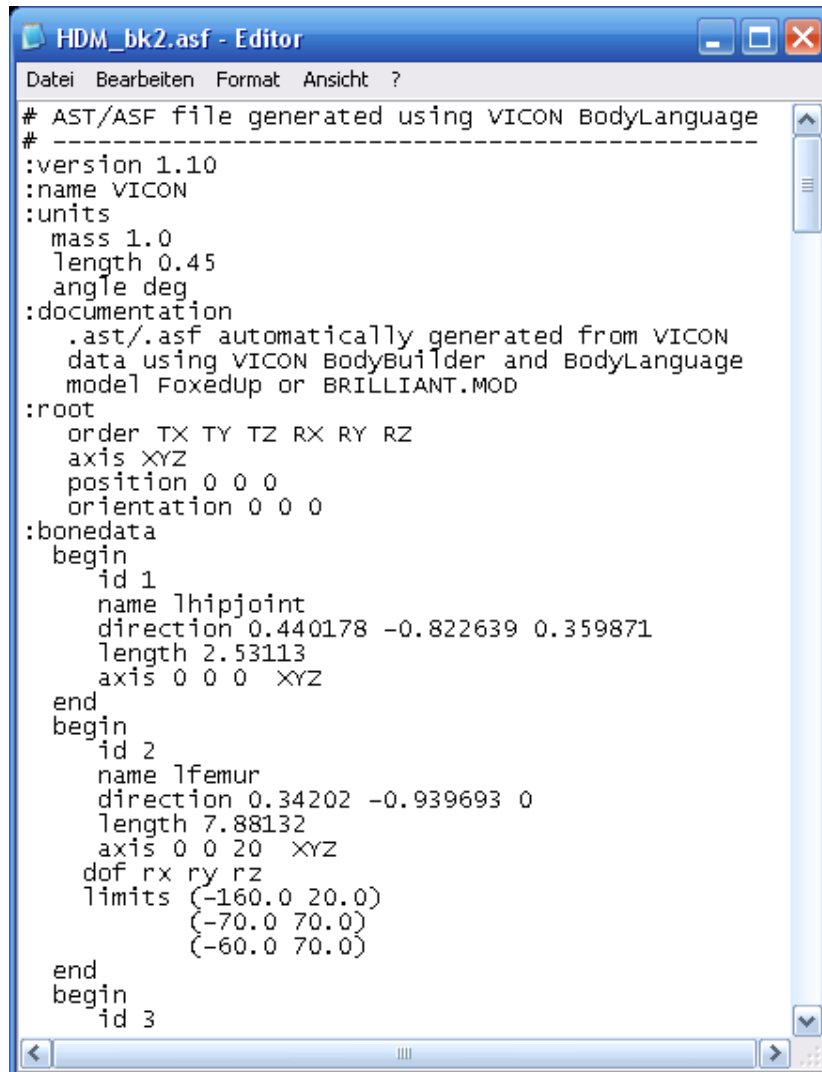
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## Multimedia, Simulation and Virtual Reality Group

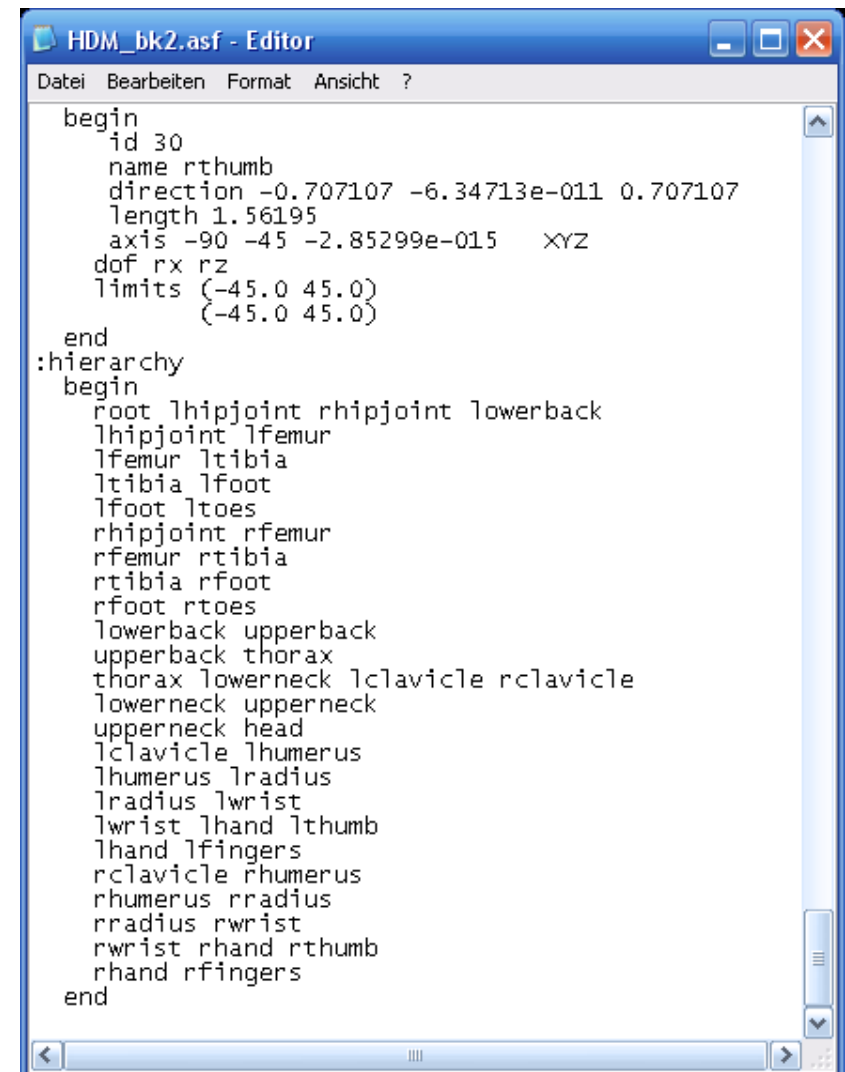
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# asf (acclaim skeleton file)

Anyway we refer to them as "asf-files"...



```
HDM_bk2.asf - Editor
Datei Bearbeiten Format Ansicht ?
# AST/ASF file generated using VICON BodyLanguage
# -----
:version 1.10
:name VICON
:units
  mass 1.0
  length 0.45
  angle deg
:documentation
  .ast/.asf automatically generated from VICON
  data using VICON BodyBuilder and BodyLanguage
  model Foxedup or BRILLIANT.MOD
:root
  order TX TY TZ RX RY RZ
  axis XYZ
  position 0 0 0
  orientation 0 0 0
:bonedata
  begin
    id 1
    name lhipjoint
    direction 0.440178 -0.822639 0.359871
    length 2.53113
    axis 0 0 0 XYZ
  end
  begin
    id 2
    name lfemur
    direction 0.34202 -0.939693 0
    length 7.88132
    axis 0 0 20 XYZ
    dof rx ry rz
    limits (-160.0 20.0)
           (-70.0 70.0)
           (-60.0 70.0)
  end
  begin
    id 3
```



```
HDM_bk2.asf - Editor
Datei Bearbeiten Format Ansicht ?
begin
  id 30
  name rthumb
  direction -0.707107 -6.34713e-011 0.707107
  length 1.56195
  axis -90 -45 -2.85299e-015 XYZ
  dof rx rz
  limits (-45.0 45.0)
         (-45.0 45.0)
end
:hierarchy
begin
  root lhipjoint rhipjoint lowerback
  lhipjoint lfemur
  lfemur ltibia
  ltibia lfoot
  lfoot ltoes
  rhipjoint rfemur
  rfemur rtibia
  rtibia rfoot
  rfoot rtoes
  lowerback upperback
  upperback thorax
  thorax lowerneck lclavicle rclavicle
  lowerneck upperneck
  upperneck head
  lclavicle lhumerus
  lhumerus lradius
  lradius lwrist
  lwrist lhand lthumb
  lhand lfingers
  rclavicle rhumerus
  rhumerus rradius
  rradius rwrist
  rwrist rhand rthumb
  rhand rfingers
end
```

# Handling MoCap data in MATLAB: The skel-structure

- Import of an asf-file to a structure variable in MATLAB

- ◆ `skel = readASF(asf_filename);`

- ⇒ `asf_filename` = MATLAB string (e.g. `'C:\mocap\skeleton.asf'`)

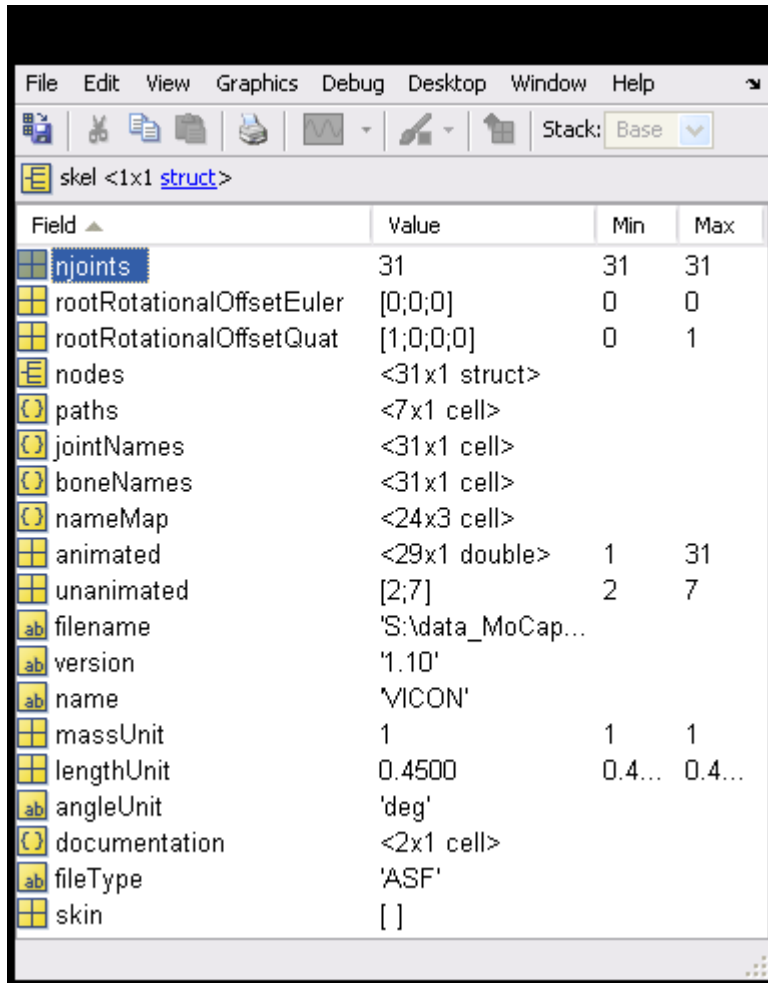
- ⇒ structure variable `skel` is referred to as “**skel-structure**” in our parlance

- ⇒ creation of an empty skel-structure: `skel = emptySkeleton();`

- Analogous: Export of a skel-structure to an asf-file

- ◆ `writeASF(skel, asf_filename);`

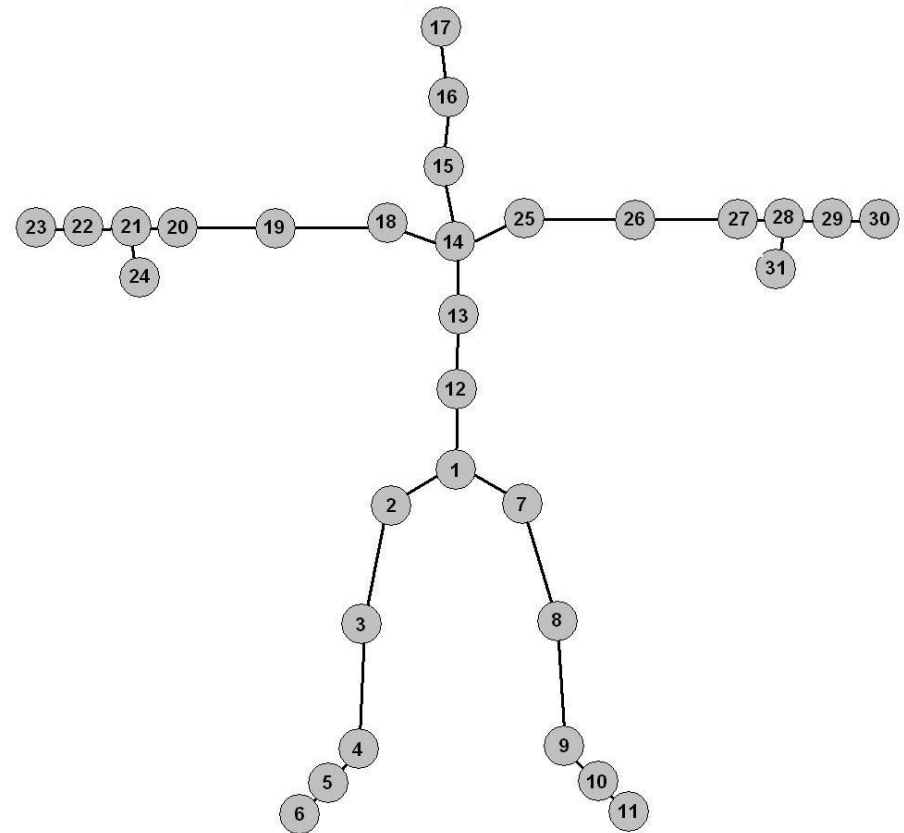
# Handling MoCap data in MATLAB: The skel-structure



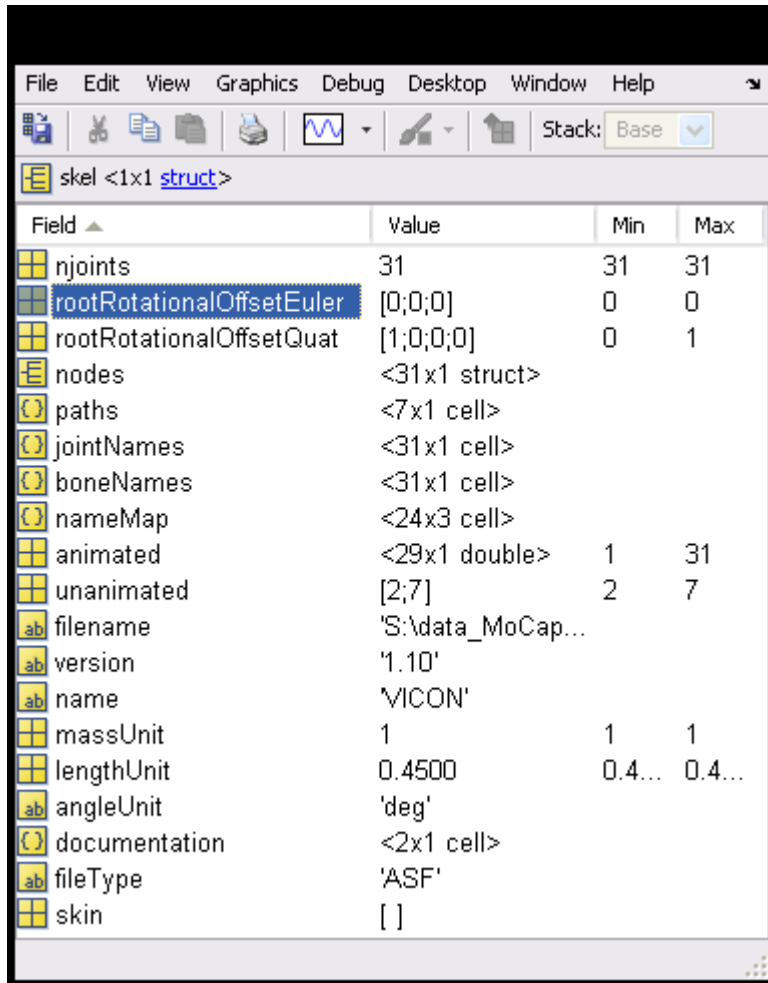
The image shows a MATLAB window displaying the 'skel' structure. The structure contains various fields related to motion capture data, including joint counts, rotational offsets, node information, paths, joint names, bone names, name maps, animation status, units, and file information.

Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

**skel.njoints**



# Handling MoCap data in MATLAB: The skel-structure



The image shows a MATLAB window displaying the 'skel' structure. The structure is a 1x1 struct containing various fields related to motion capture data. The 'rootRotationalOffsetEuler' field is highlighted in blue. The table below represents the data shown in the MATLAB GUI.

Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

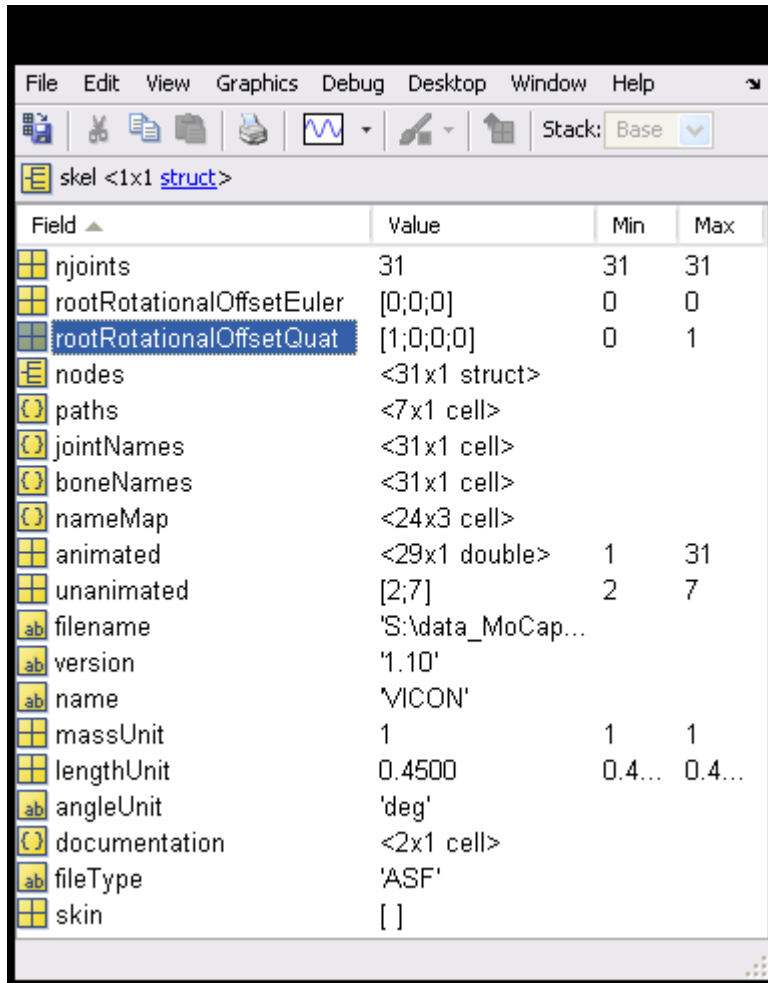
## skel.rootRotationalOffsetEuler

Rotational offset of the root in Euler angles

**“These are typically, but not always zero.”**

[<http://www.cs.wisc.edu/graphics/Courses/cs-838-1999/Jeff/ASF-AMC.html>]

# Handling MoCap data in MATLAB: The skel-structure



The screenshot shows the MATLAB Variable Editor for a structure named 'skel'. The 'rootRotationalOffsetQuat' field is selected and highlighted in blue. The table below represents the data shown in the editor.

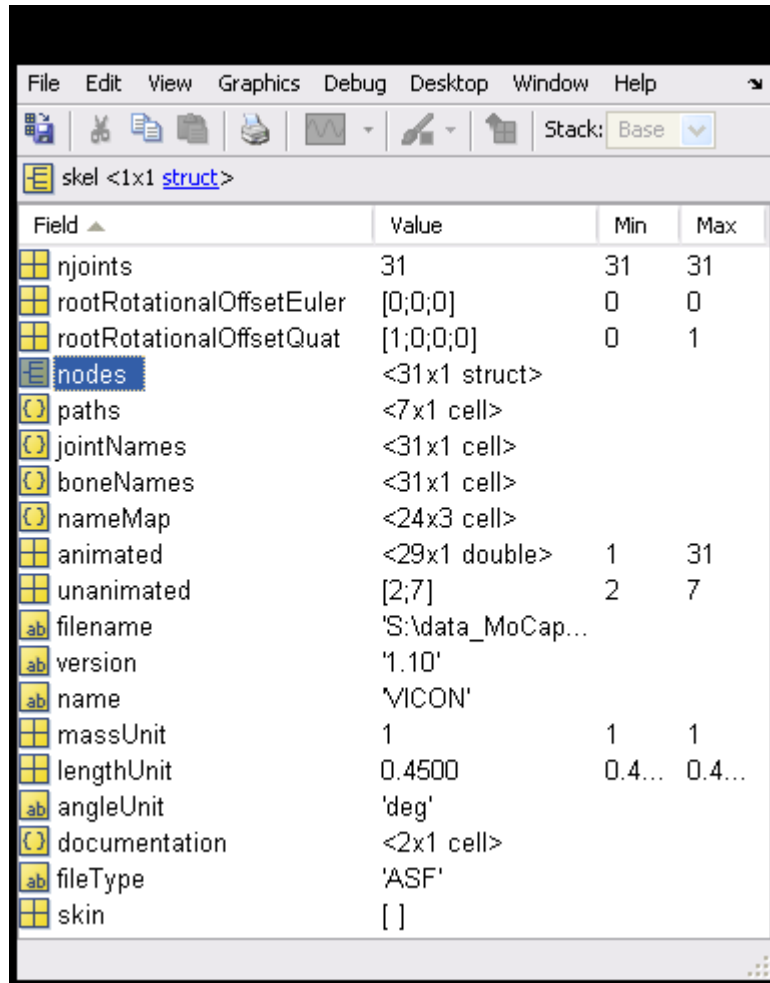
Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
<b>rootRotationalOffsetQuat</b>	<b>[1;0;0;0]</b>	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

**skel.rootRotationalOffsetQuat**

**Rotational offset of the root in quaternions**

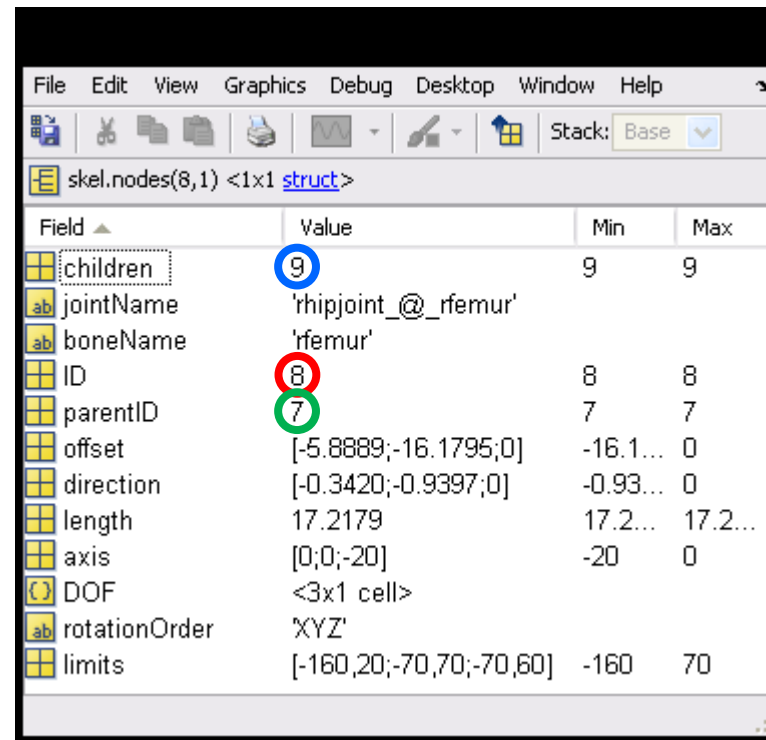
**(redundant)**

# Handling MoCap data in MATLAB: The skel-structure

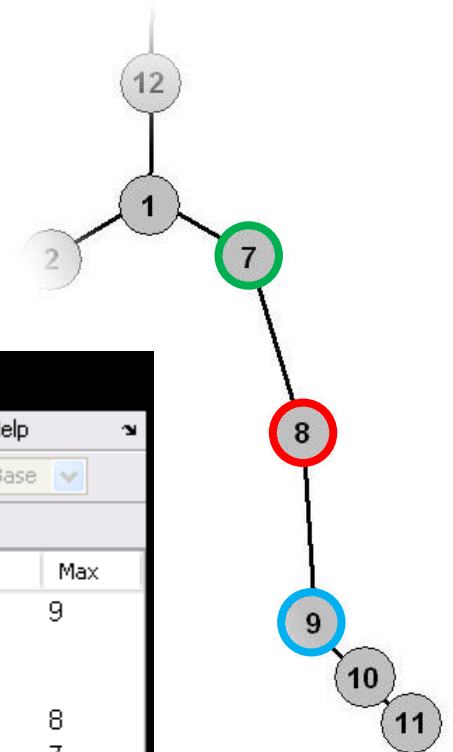


Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

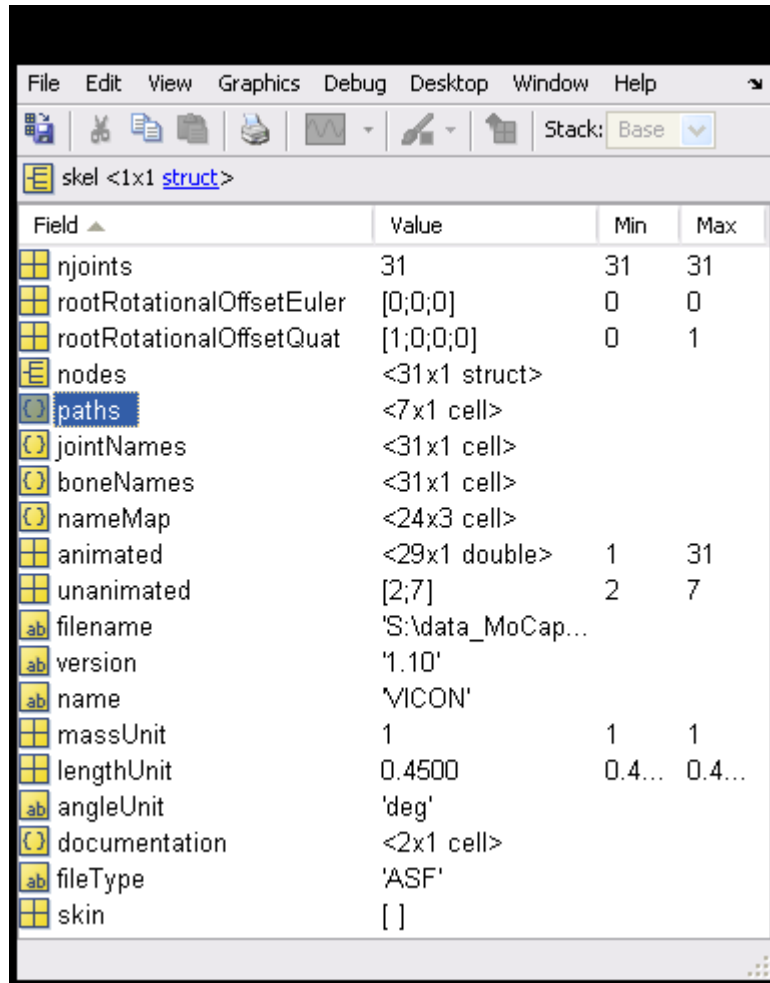
## skel.nodes



Field	Value	Min	Max
children	9	9	9
jointName	'rhipjoint @_rfemur'		
boneName	'rfemur'		
ID	8	8	8
parentID	7	7	7
offset	[-5.8889;-16.1795;0]	-16.1...	0
direction	[-0.3420;-0.9397;0]	-0.93...	0
length	17.2179	17.2...	17.2...
axis	[0;0;-20]	-20	0
DOF	<3x1 cell>		
rotationOrder	'XYZ'		
limits	[-160,20;-70,70;-70,60]	-160	70



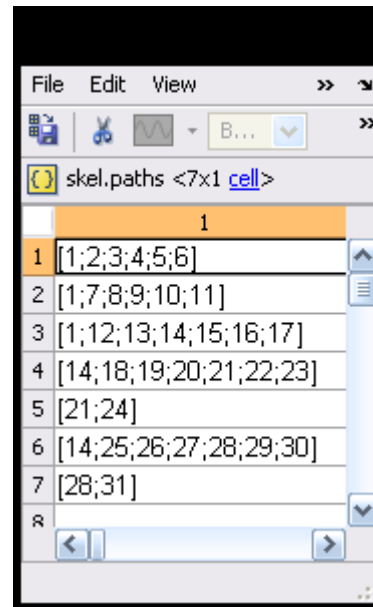
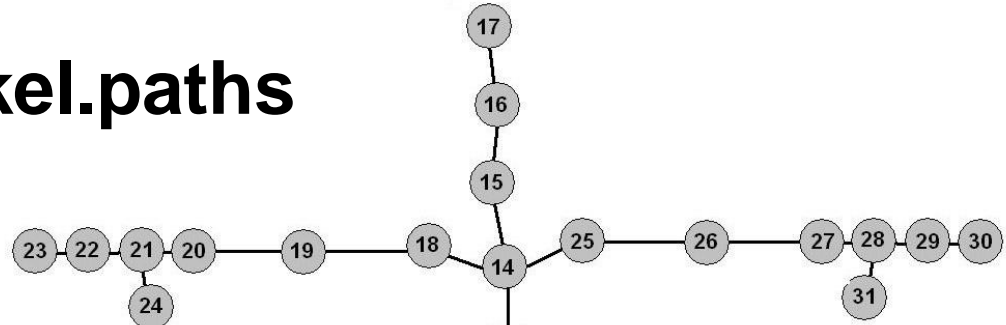
# Handling MoCap data in MATLAB: The skel-structure



The image shows a MATLAB window with the 'skel' structure selected. The 'paths' field is highlighted, showing a 7x1 cell array. The structure contains various fields for joint and bone information, as well as animation settings.

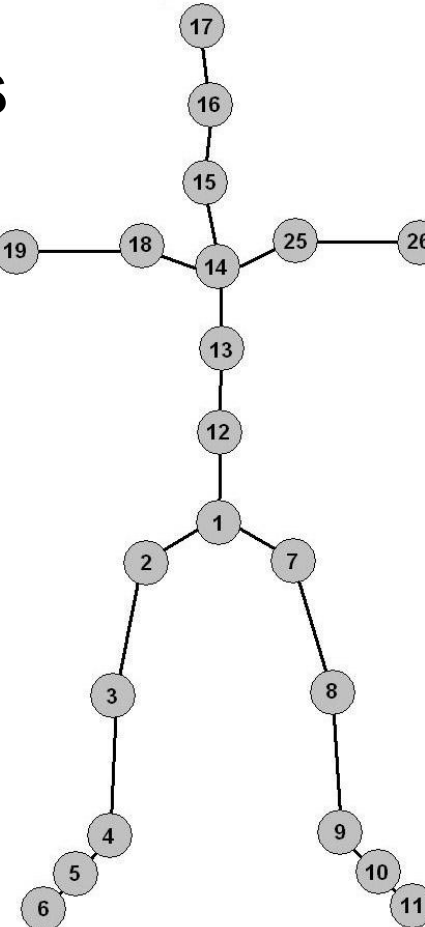
Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

**skel.paths**



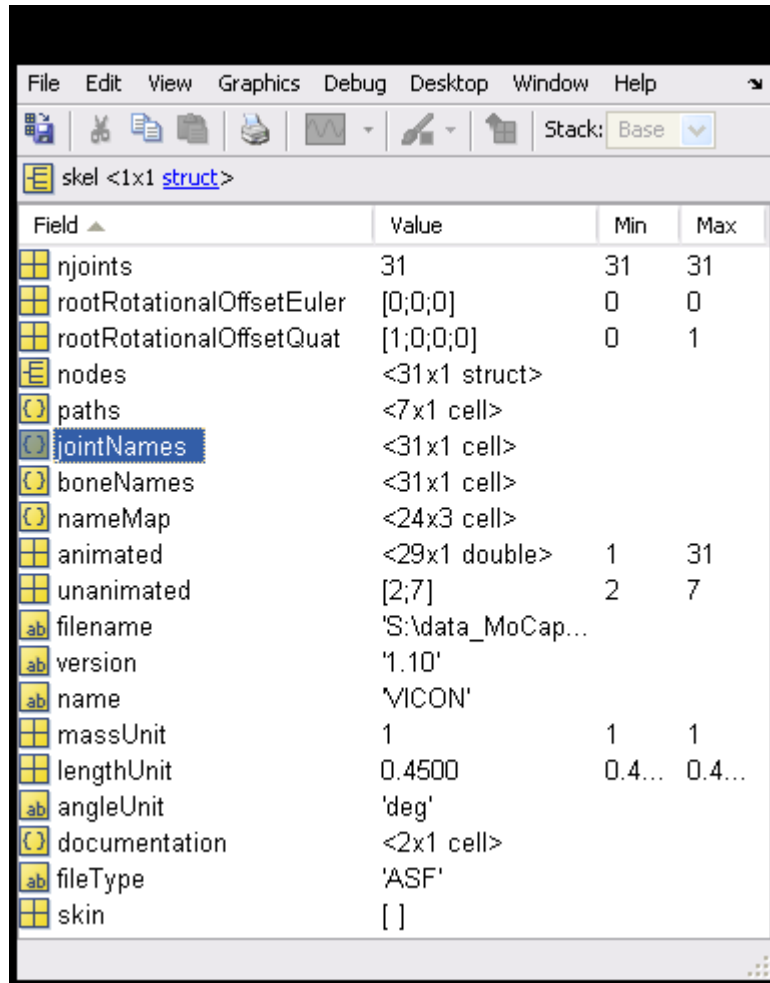
The image shows a MATLAB window displaying the 'skel.paths' cell array. The array contains 7 rows, each representing a path of joints. The paths are numbered 1 through 7.

Path	Joints
1	[1;2;3;4;5;6]
2	[1;7;8;9;10;11]
3	[1;12;13;14;15;16;17]
4	[14;18;19;20;21;22;23]
5	[21;24]
6	[14;25;26;27;28;29;30]
7	[28;31]



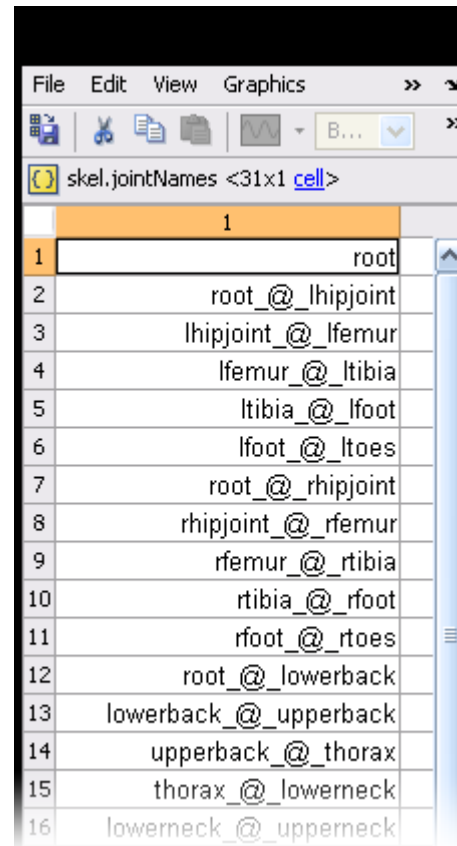


# Handling MoCap data in MATLAB: The skel-structure



Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

## skel.jointNames

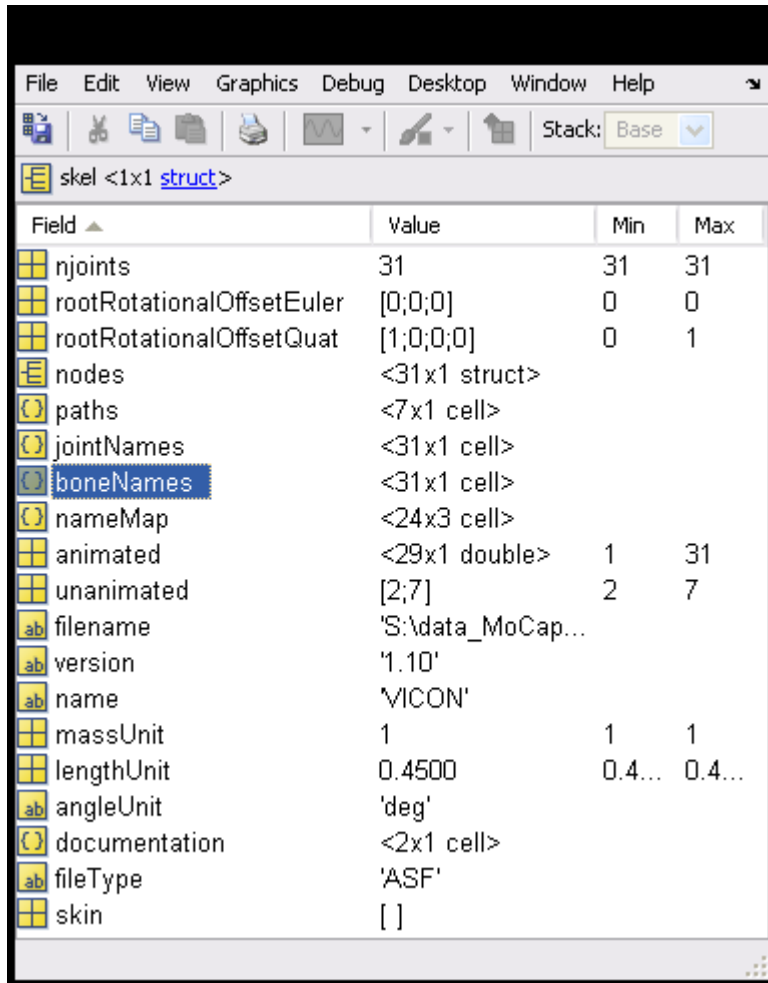


skel.jointNames <31x1 cell>	
1	root
2	root_@_lhipjoint
3	lhipjoint_@_lfemur
4	lfemur_@_ltibia
5	ltibia_@_lfoot
6	lfoot_@_ltoes
7	root_@_rhipjoint
8	rhipjoint_@_rfemur
9	rfemur_@_rtibia
10	rtibia_@_rfoot
11	rfoot_@_rtoes
12	root_@_lowerback
13	lowerback_@_upperback
14	upperback_@_thorax
15	thorax_@_lowerneck
16	lowerneck_@_upperneck

**redundancy:**

`skel.jointNames{i} ==`  
`skel.nodes{i}.jointName`

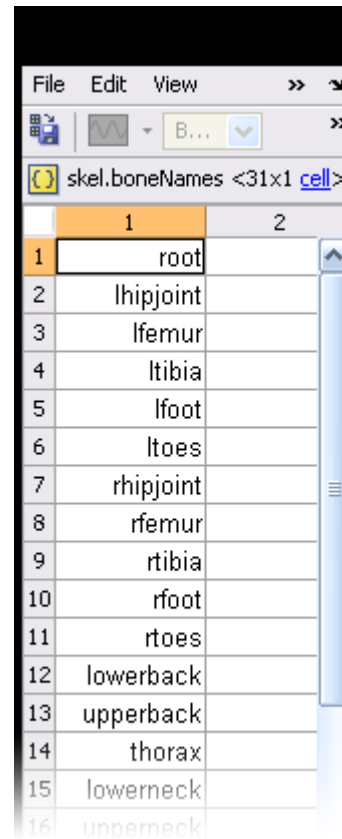
# Handling MoCap data in MATLAB: The skel-structure



The image shows the MATLAB Variable Editor for a structure named 'skel'. The structure contains various fields related to motion capture data, including joints, nodes, paths, and animation settings. The 'boneNames' field is highlighted.

Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

## skel.boneNames



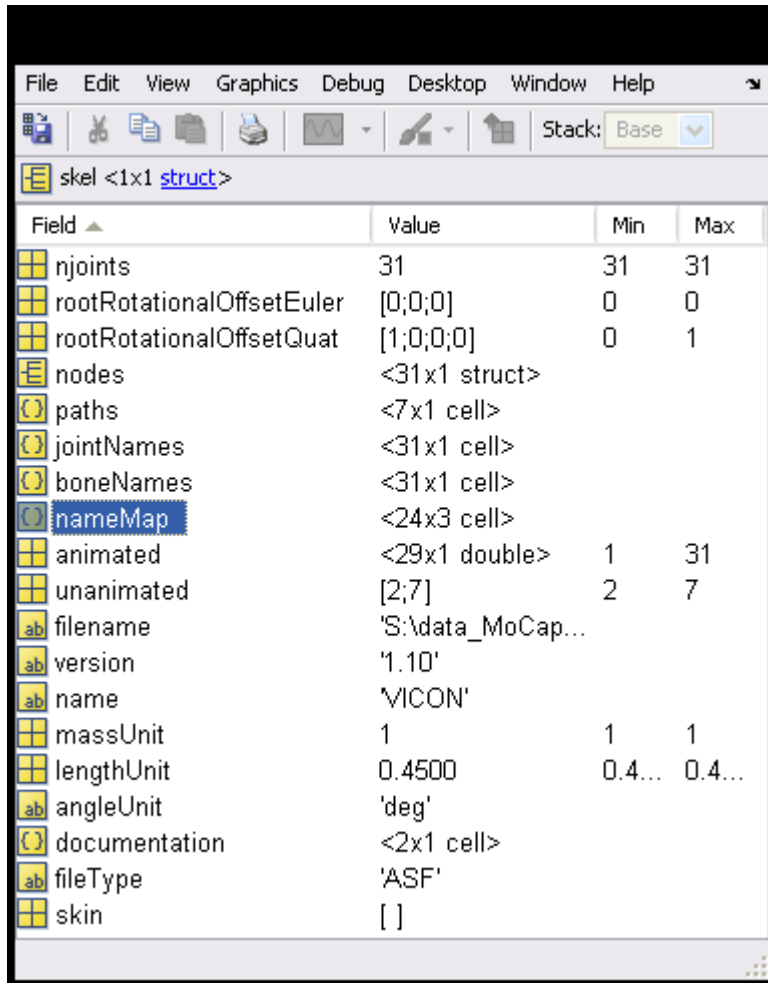
The image shows the MATLAB Variable Editor for the 'skel.boneNames' cell array, which contains 31 elements. The first 16 elements are visible in the screenshot.

	1	2
1	root	
2	lhipjoint	
3	lfemur	
4	ltibia	
5	lfoot	
6	ltoes	
7	rhipjoint	
8	rfemur	
9	rtibia	
10	rfoot	
11	rtoes	
12	lowerback	
13	upperback	
14	thorax	
15	lowerneck	
16	upperneck	

**redundancy:**

`skel.boneNames{i} ==`  
`skel.nodes{i}.boneName`

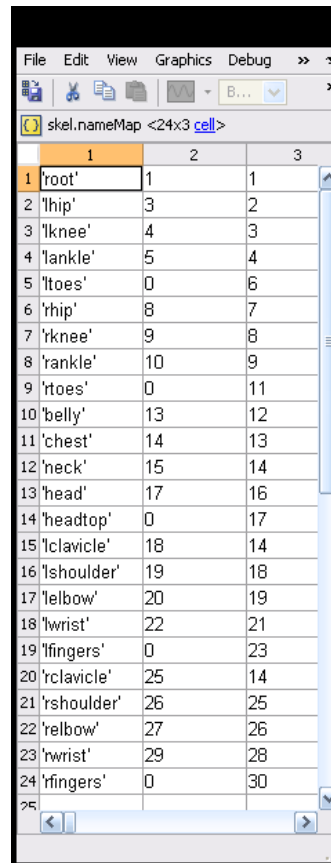
# Handling MoCap data in MATLAB: The skel-structure



skel <1x1 struct>

Field ▲	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
<b>nameMap</b>	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...'		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

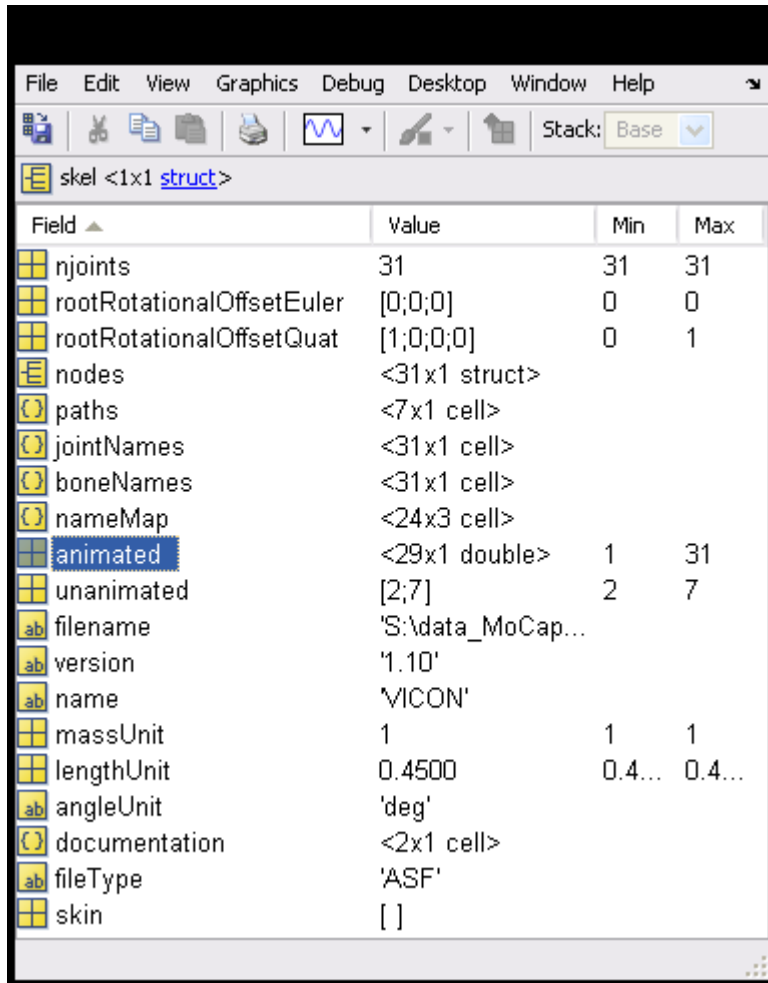
## skel.nameMap



skel.nameMap <24x3 cell>

	1	2	3
1 'root'	1		1
2 'hip'	3		2
3 'knee'	4		3
4 'ankle'	5		4
5 'toes'	0		6
6 'rhip'	8		7
7 'rknee'	9		8
8 'rankle'	10		9
9 'rtoes'	0		11
10 'belly'	13		12
11 'chest'	14		13
12 'neck'	15		14
13 'head'	17		16
14 'headtop'	0		17
15 'lclavicle'	18		14
16 'lshoulder'	19		18
17 'l elbow'	20		19
18 'lwrist'	22		21
19 'lfingers'	0		23
20 'rclavicle'	25		14
21 'rshoulder'	26		25
22 'relbow'	27		26
23 'rwrist'	29		28
24 'rfingers'	0		30

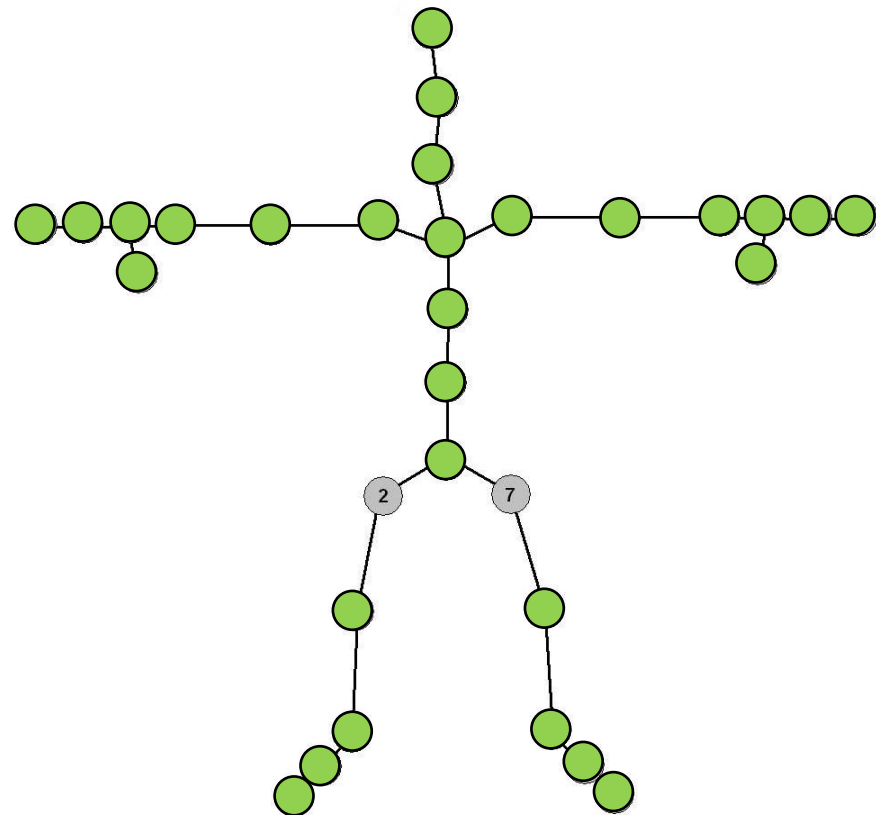
# Handling MoCap data in MATLAB: The skel-structure



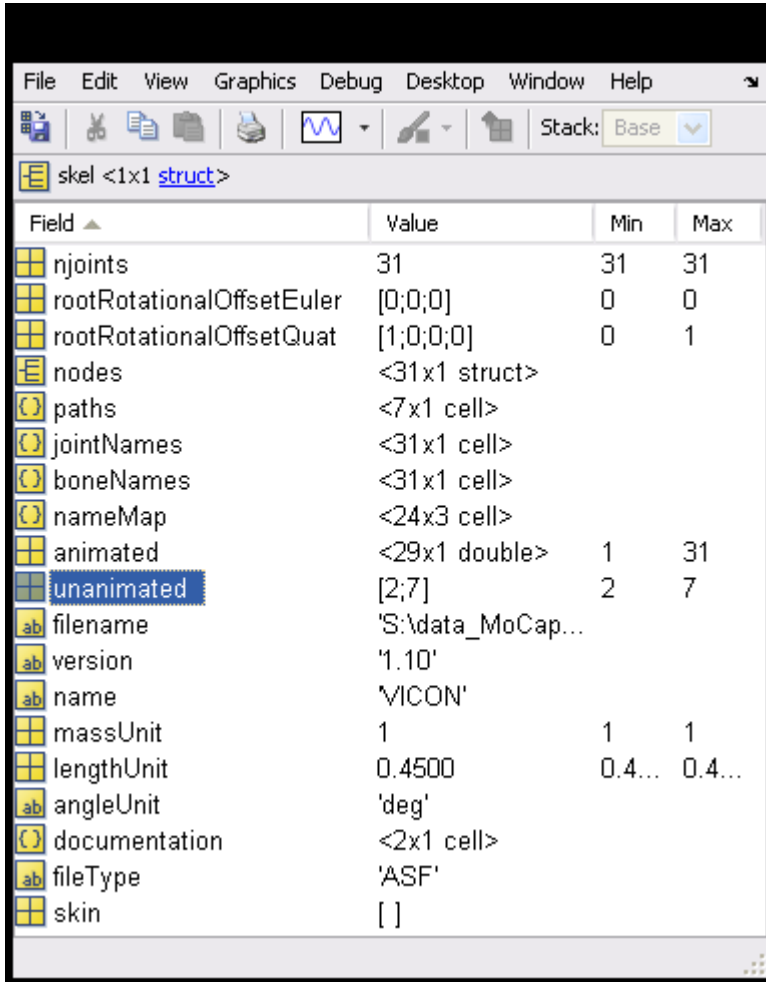
skel <1x1 struct>

Field ▲	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
<b>animated</b>	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

**skel.animated**



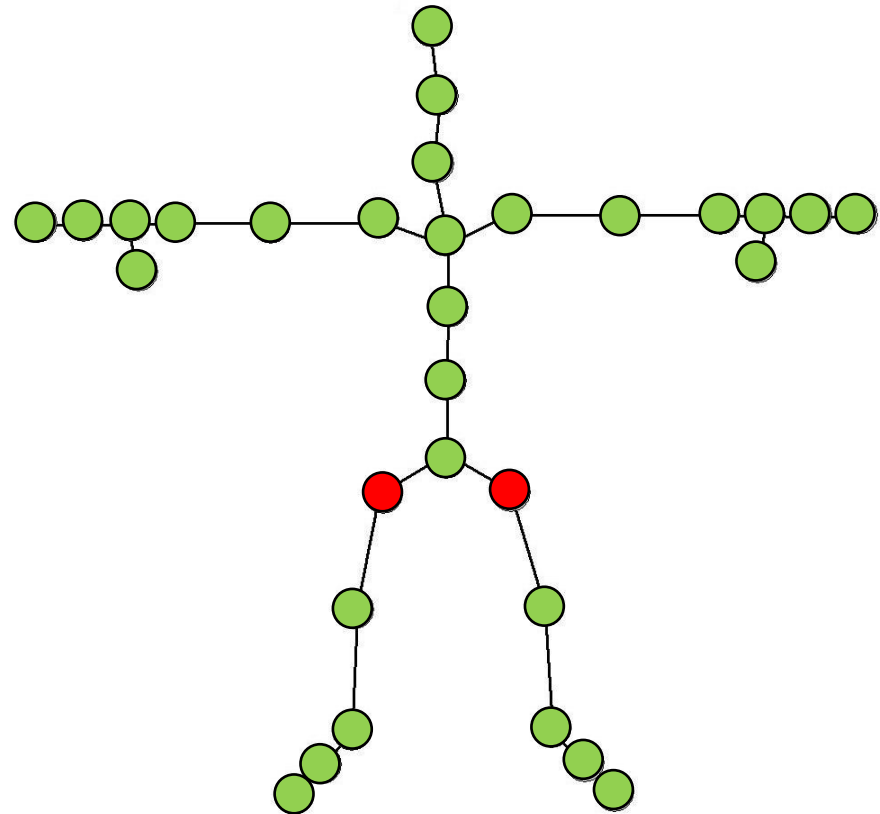
# Handling MoCap data in MATLAB: The skel-structure



skel <1x1 struct>

Field ▲	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
<b>unanimated</b>	[2;7]	2	7
filename	'S:\data_MoCap...		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

**skel.unanimated**



# Handling MoCap data in MATLAB: The skel-structure

animated (#DOFs>0)

unanimated (#DOFs=0)

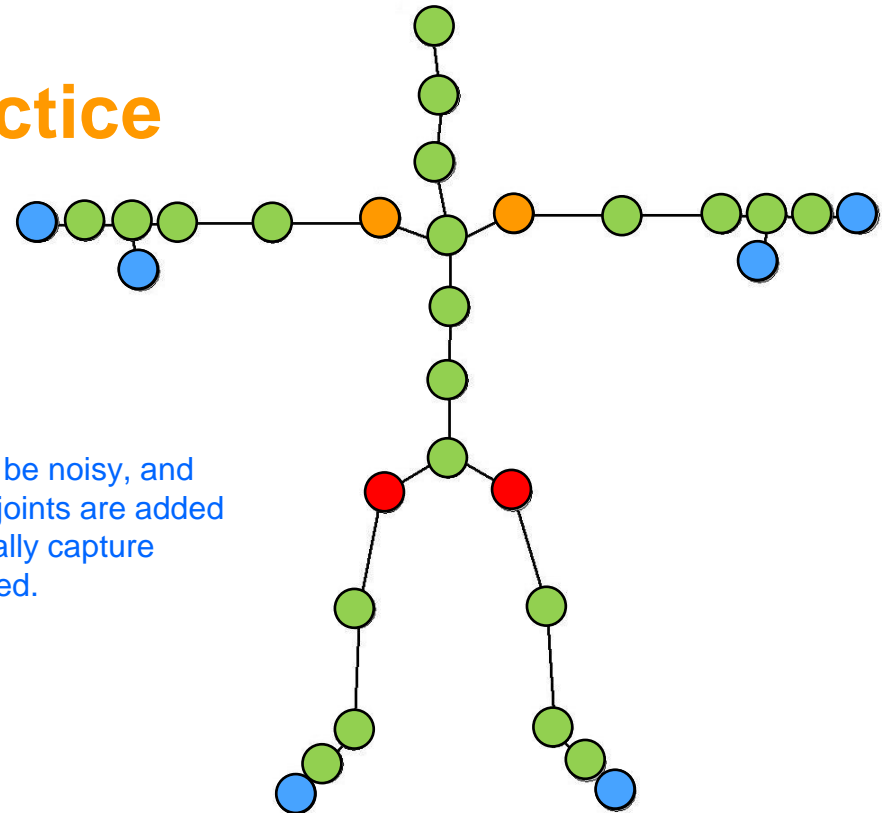
rather unanimated in practice

error-prone

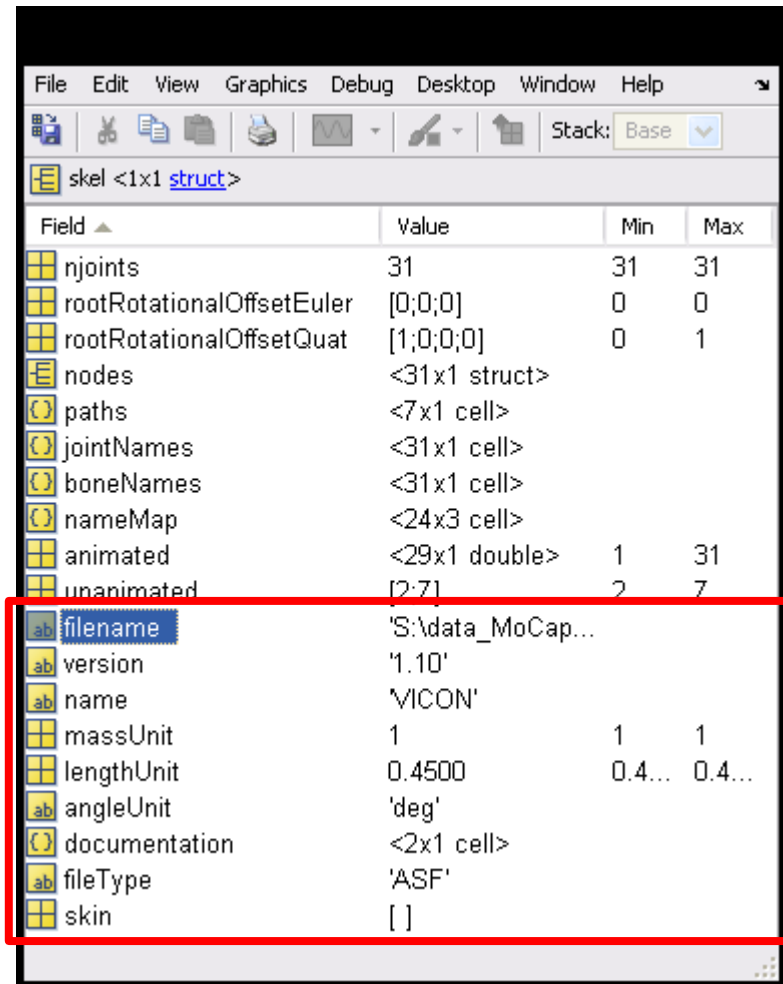
## Citation:

**Note:** The "toe" and "hand" joints in our motions tend to be noisy, and may require some smoothing. The "finger" and "thumb" joints are added to the skeleton for editing convenience - we do not actually capture these joints' motions and any such data should be ignored.

[<http://mocap.cs.cmu.edu/>]



# Handling MoCap data in MATLAB: The skel-structure



Field	Value	Min	Max
njoints	31	31	31
rootRotationalOffsetEuler	[0;0;0]	0	0
rootRotationalOffsetQuat	[1;0;0;0]	0	1
nodes	<31x1 struct>		
paths	<7x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 double>	1	31
unanimated	[2;7]	2	7
filename	'S:\data_MoCap...		
version	'1.10'		
name	'VICON'		
massUnit	1	1	1
lengthUnit	0.4500	0.4...	0.4...
angleUnit	'deg'		
documentation	<2x1 cell>		
fileType	'ASF'		
skin	[]		

## General information:

skel.filename

skel.version

skel.name

skel.massUnit

skel.lengthUnit

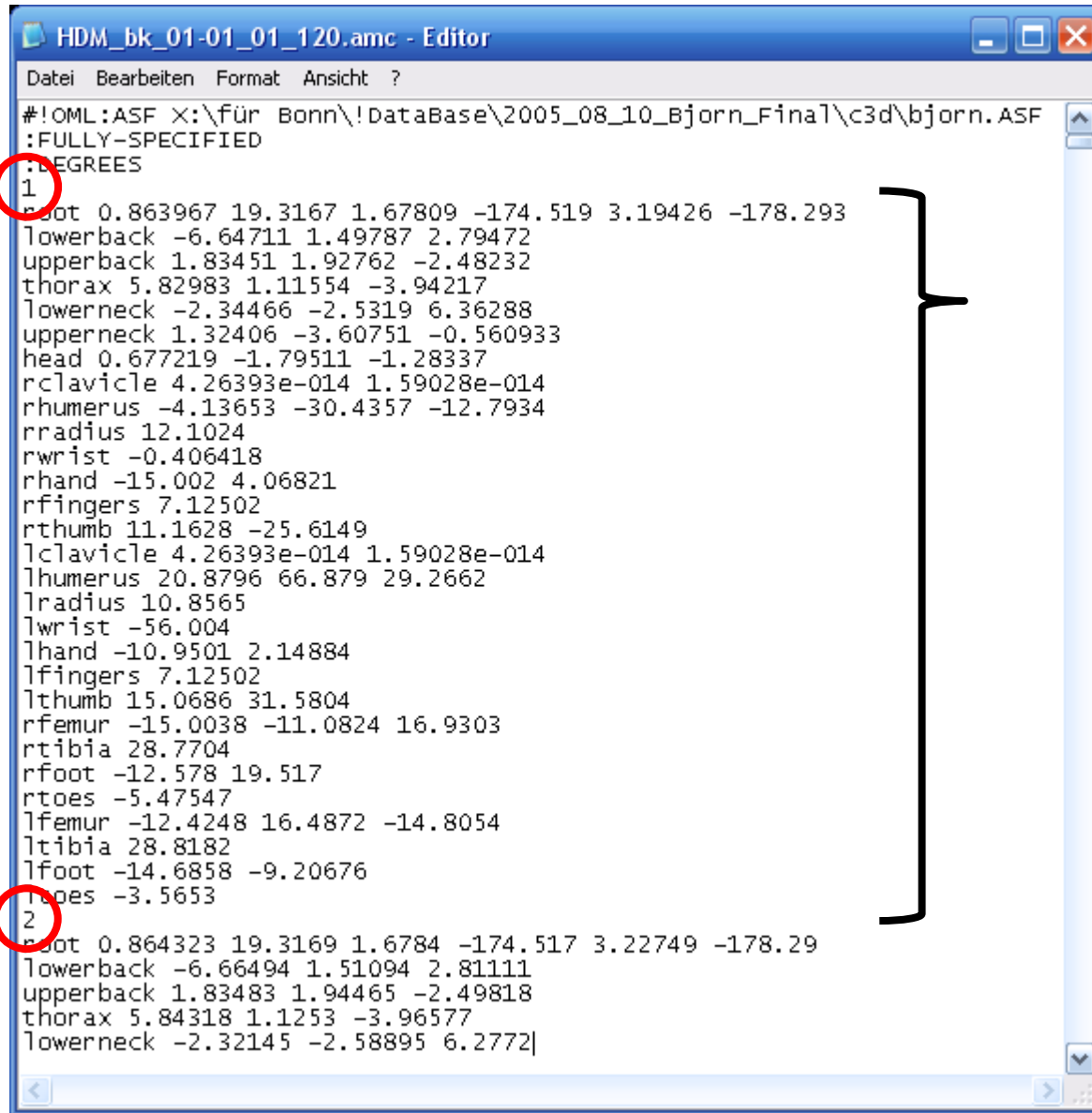
skel.angleUnit

skel.documentation

skel.fileType

skel.skin

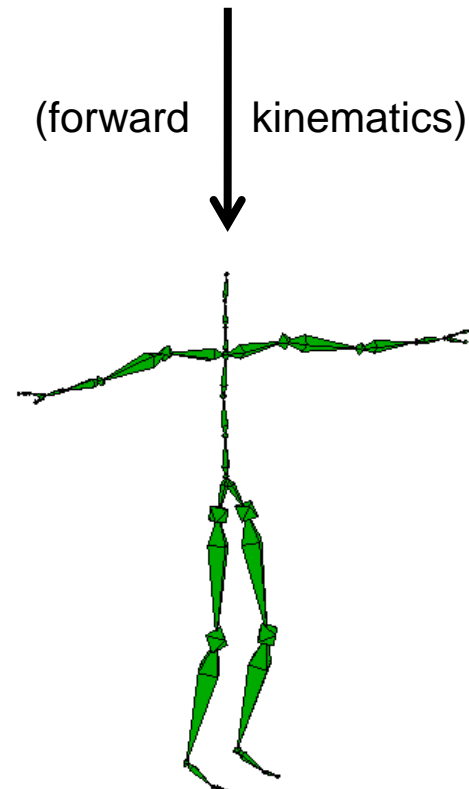
# amc (acclaim motion capture)



```
HDM_bk_01-01_01_120.amc - Editor
Datei Bearbeiten Format Ansicht ?
#!OML:ASF X:\für Bonn\!DataBase\2005_08_10_Bjorn_Final\c3d\bjorn.ASF
:FULLY-SPECIFIED
:DEGREES
1
root 0.863967 19.3167 1.67809 -174.519 3.19426 -178.293
lowerback -6.64711 1.49787 2.79472
upperback 1.83451 1.92762 -2.48232
thorax 5.82983 1.11554 -3.94217
lowerneck -2.34466 -2.5319 6.36288
upperneck 1.32406 -3.60751 -0.560933
head 0.677219 -1.79511 -1.28337
rclavicle 4.26393e-014 1.59028e-014
rhumerus -4.13653 -30.4357 -12.7934
rradius 12.1024
rwrist -0.406418
rhand -15.002 4.06821
rfingers 7.12502
rthumb 11.1628 -25.6149
lclavicle 4.26393e-014 1.59028e-014
lhumerus 20.8796 66.879 29.2662
lradius 10.8565
lwrist -56.004
lhand -10.9501 2.14884
lfingers 7.12502
lthumb 15.0686 31.5804
rfemur -15.0038 -11.0824 16.9303
rtibia 28.7704
rfoot -12.578 19.517
rtoes -5.47547
lfemur -12.4248 16.4872 -14.8054
ltibia 28.8182
lfoot -14.6858 -9.20676
ltoes -3.5653
2
root 0.864323 19.3169 1.6784 -174.517 3.22749 -178.29
lowerback -6.66494 1.51094 2.81111
upperback 1.83483 1.94465 -2.49818
thorax 5.84318 1.1253 -3.96577
lowerneck -2.32145 -2.58895 6.2772]
```

frame numbers

+ skeleton information



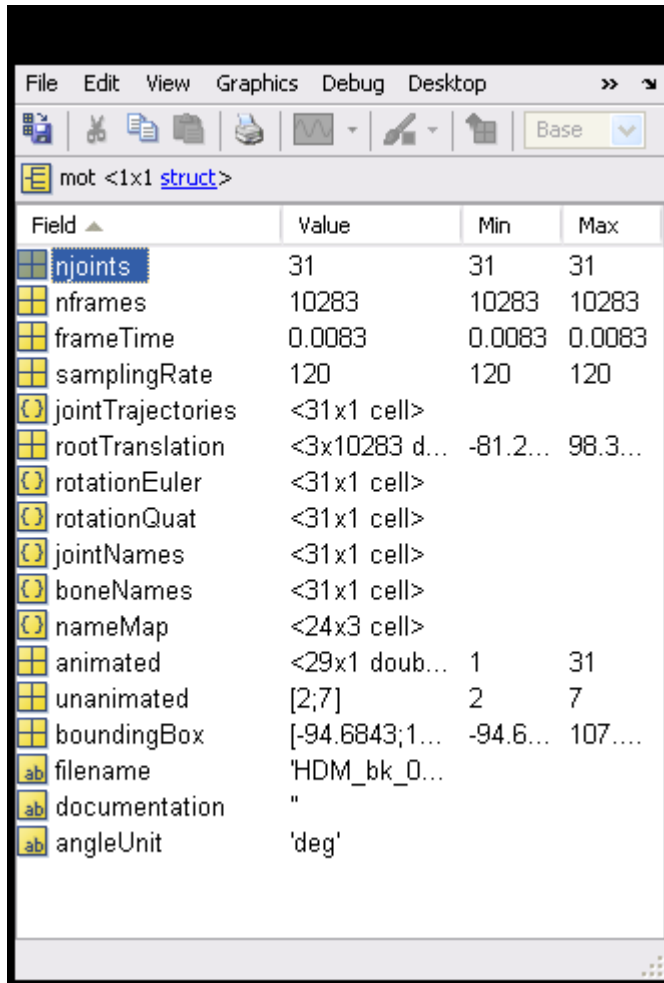


# Handling MoCap data in MATLAB: The mot-structure

- Import of an amc-file to a structure variable in MATLAB
  - ◆ `mot = readAMC(amc_filename, skel);`
    - ⇒ structure variable `mot` is referred to as “**mot-structure**” in our parlance
    - ⇒ creation of an empty mot-structure: `mot = emptyMotion();`
- Analogous: Export of a mot-structure to an amc-file
  - ◆ `writeAMC(skel, mot, amc_filename);`

# Handling MoCap data in MATLAB: The mot-structure

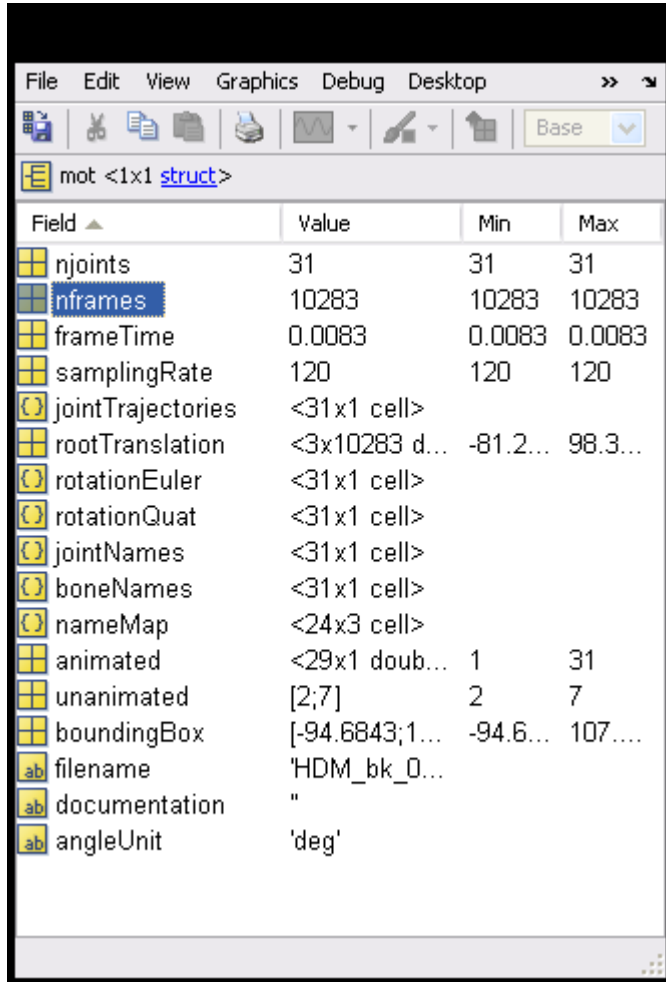
**mot.njoints**



The image shows a MATLAB workspace window with the 'mot' structure. The 'njoints' field is highlighted in blue. The table below represents the data shown in the workspace window.

Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

# Handling MoCap data in MATLAB: The mot-structure



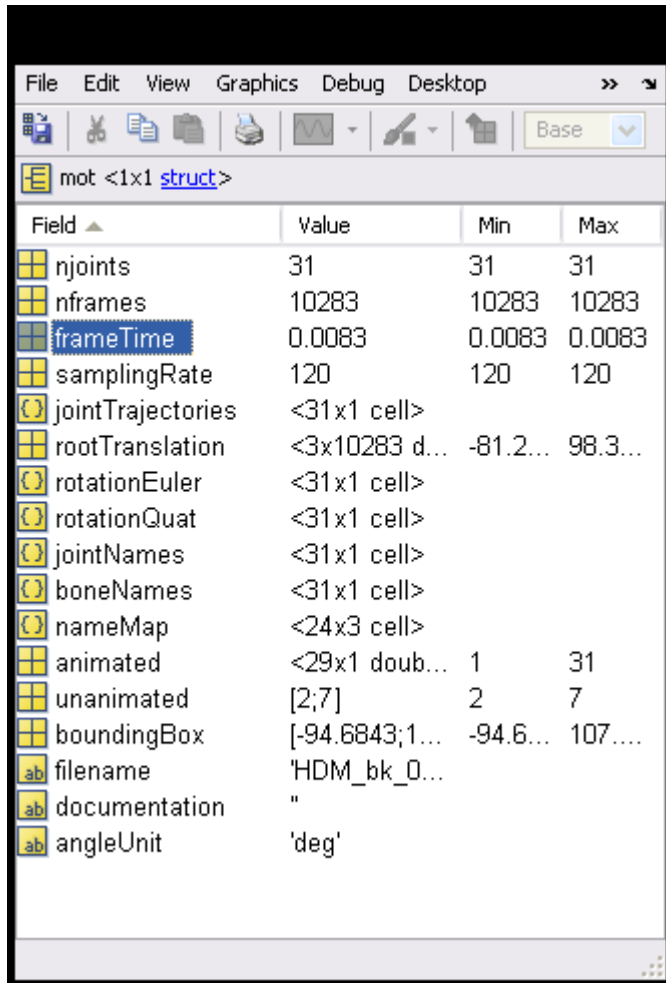
The image shows a MATLAB GUI window titled 'mot <1x1 struct>'. It displays a table of fields and their values. The 'nframes' field is highlighted in blue. The table has columns for Field, Value, Min, and Max.

Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

## mot.nframes

```
mot = cutMotion(mot,startFrame,endFrame);
```

# Handling MoCap data in MATLAB: The mot-structure



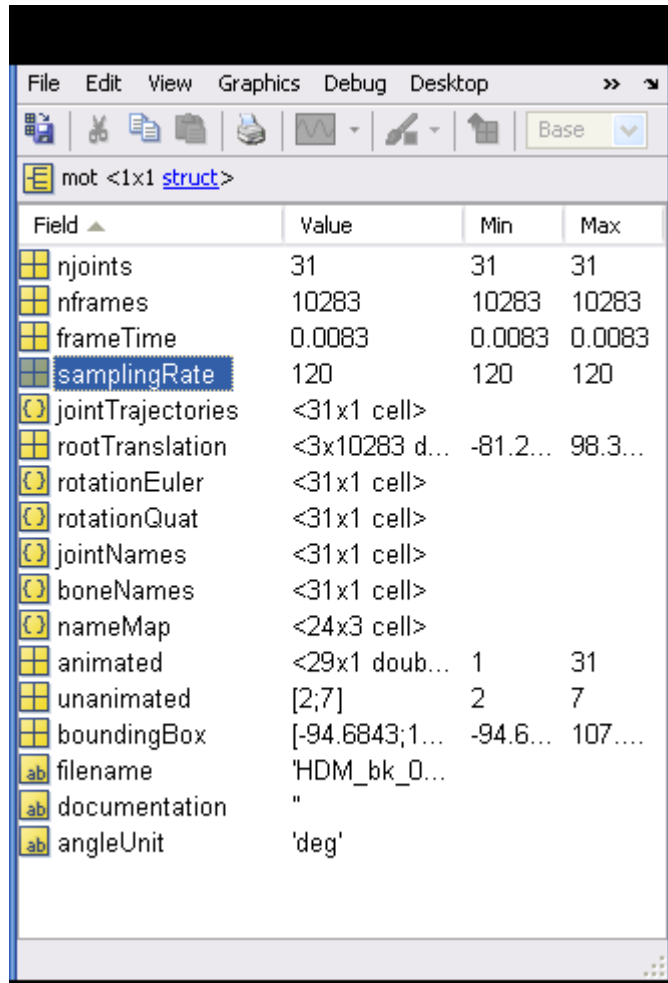
The image shows a MATLAB Variable Editor window for a structure named 'mot'. The structure contains the following fields and values:

Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

**mot.frameTime**

**= 1/mot.samplingRate**

# Handling MoCap data in MATLAB: The mot-structure



The image shows a MATLAB window with the 'Base' workspace selected. A structure named 'mot' is displayed, containing various fields related to motion capture data. The 'samplingRate' field is highlighted in blue. The table below represents the data shown in the MATLAB GUI.

Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

## mot.samplingRate

**Samples per second usually not defined in amc-file!**

“The AMC file format is as simple as it is impractical to parse.

Neither does it contain a field for the sampling rate, nor does its header specify the total number of frames, nor does it give the name of the associated ASF file.”

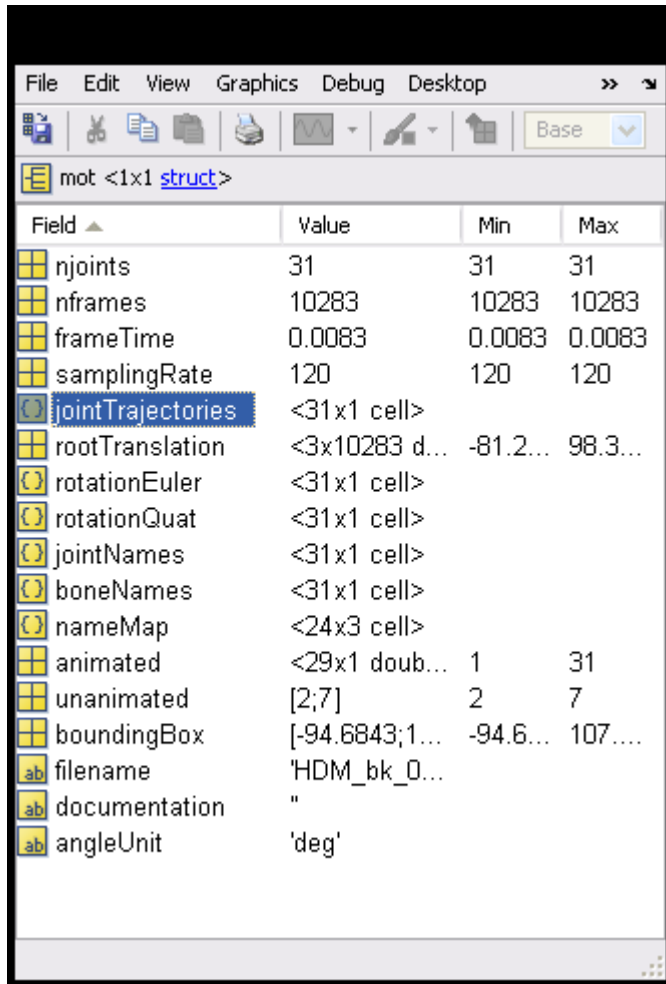
**[Documentation Mocap Database HDM05]**

**Change of frame rate:**

```
mot = changeFrameRate(skel,mot,newFrameRate)
```

**(using spline interpolation)**

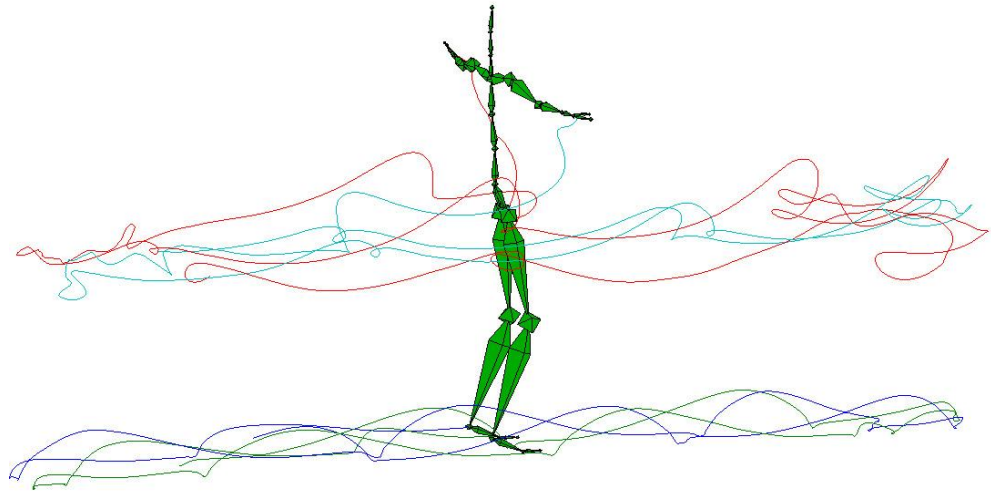
# Handling MoCap data in MATLAB: The mot-structure



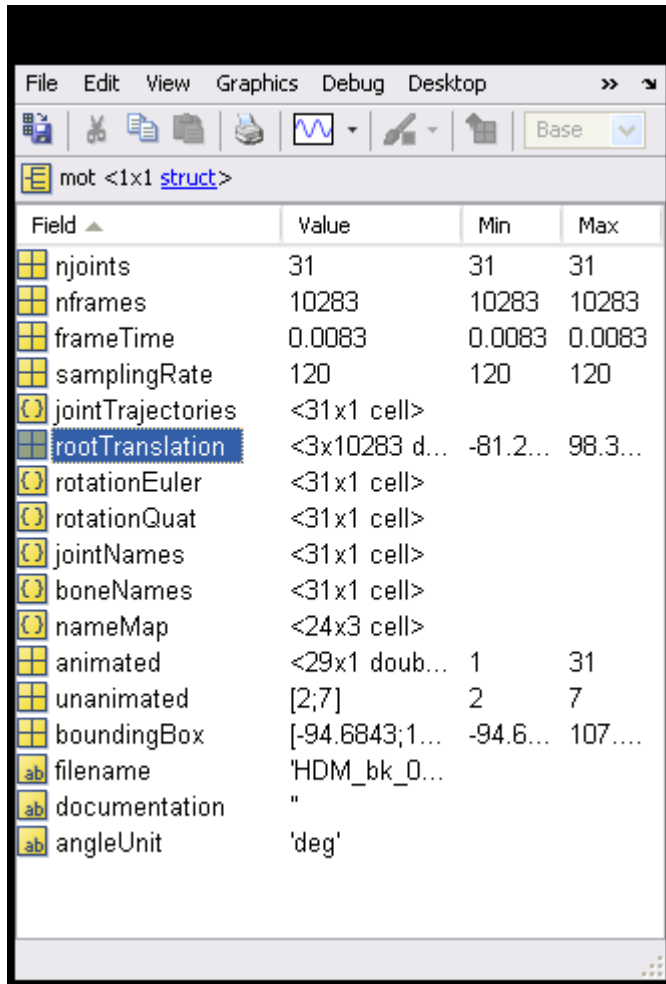
Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...	-94.6...	107....
filename	'HDM_bk_0...		
documentation	"		
angleUnit	'deg'		

## mot.jointTrajectories

```
mot.jointTrajectories = ...  
    forwardKinematicsQuat(skel,mot);  
  
mot.jointTrajectories = ...  
    C_forwardKinematicsQuat(skel,mot);
```



# Handling MoCap data in MATLAB: The mot-structure

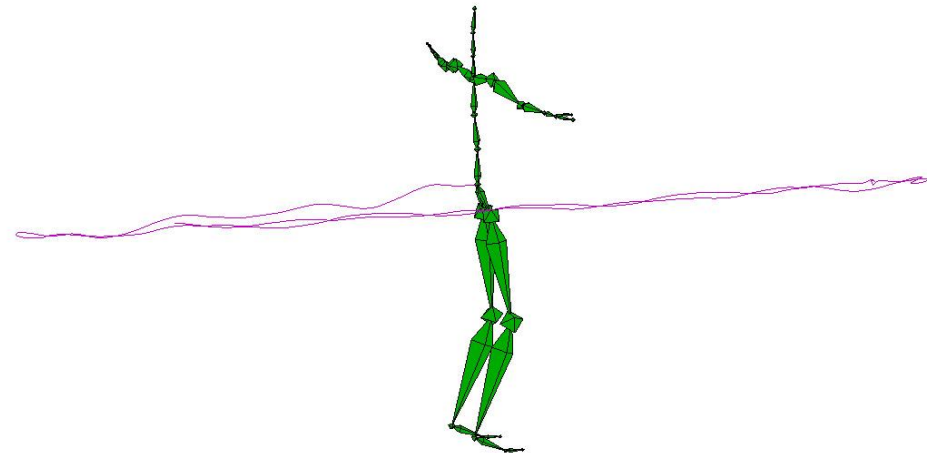


Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
<b>rootTranslation</b>	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

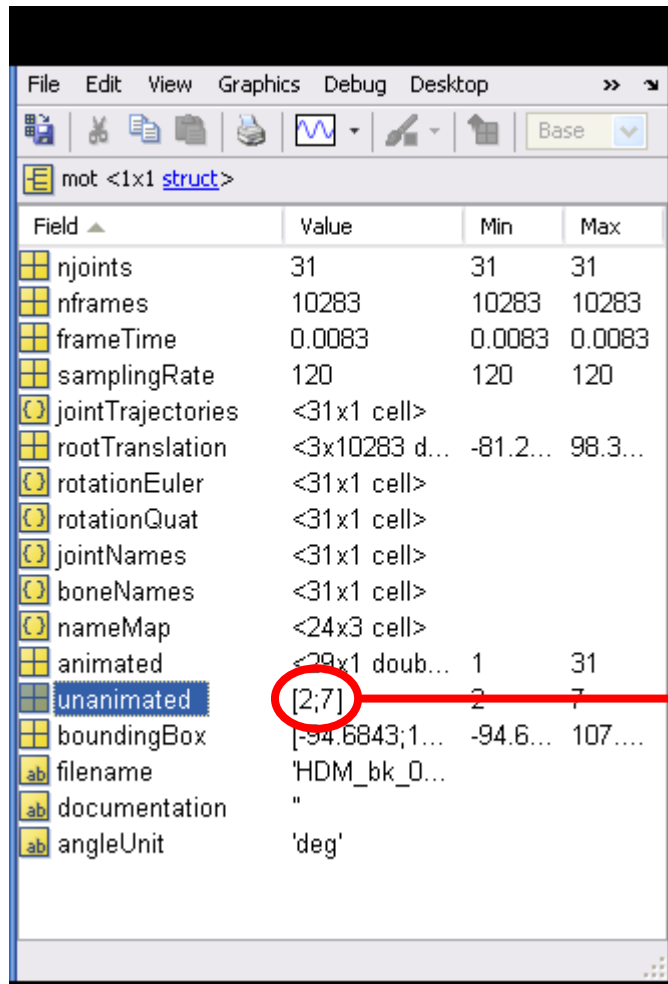
## mot.rootTranslation

**Note: 3D positions (mot.rootTranslation,  
mot.jointTrajectories) are given in inches!**

**(going metric is still being planned...)**



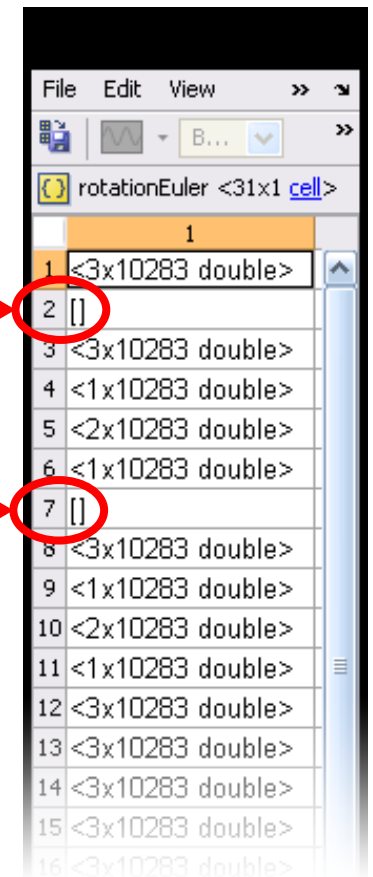
# Handling MoCap data in MATLAB: The mot-structure



Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...]	-94.6...	107....
filename	'HDM_bk_0...'		
documentation	' '		
angleUnit	'deg'		

**mot.rotationEuler**

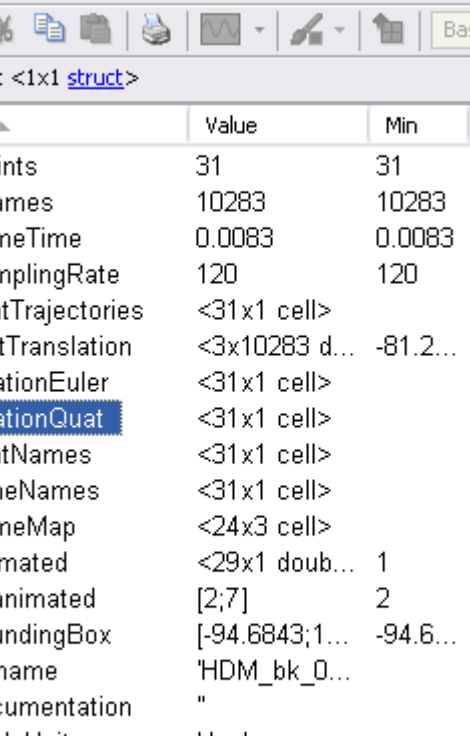
**# rotational DOFs = 59**



	1
1	<3x10283 double>
2	[]
3	<3x10283 double>
4	<1x10283 double>
5	<2x10283 double>
6	<1x10283 double>
7	[]
8	<3x10283 double>
9	<1x10283 double>
10	<2x10283 double>
11	<1x10283 double>
12	<3x10283 double>
13	<3x10283 double>
14	<3x10283 double>
15	<3x10283 double>
16	<3x10283 double>



# Handling MoCap data in MATLAB: The mot-structure



Field ▲	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...	-94.6...	107....
filename	'HDM_bk_0...		
documentation	"		
angleUnit	'deg'		

## mot.rotationQuat

**mot.rotationEuler**

mot = ...

```
convert2euler...
(skel,mot);
```

```
convert2quat...
(skel,mot);
```

	1
1	<4x10283 double>
2	<4x10283 double>
3	<4x10283 double>
4	<4x10283 double>
5	<4x10283 double>
6	<4x10283 double>
7	<4x10283 double>
8	<4x10283 double>
9	<4x10283 double>
10	<4x10283 double>
11	<4x10283 double>
12	<4x10283 double>
13	<4x10283 double>
14	<4x10283 double>
15	<4x10283 double>

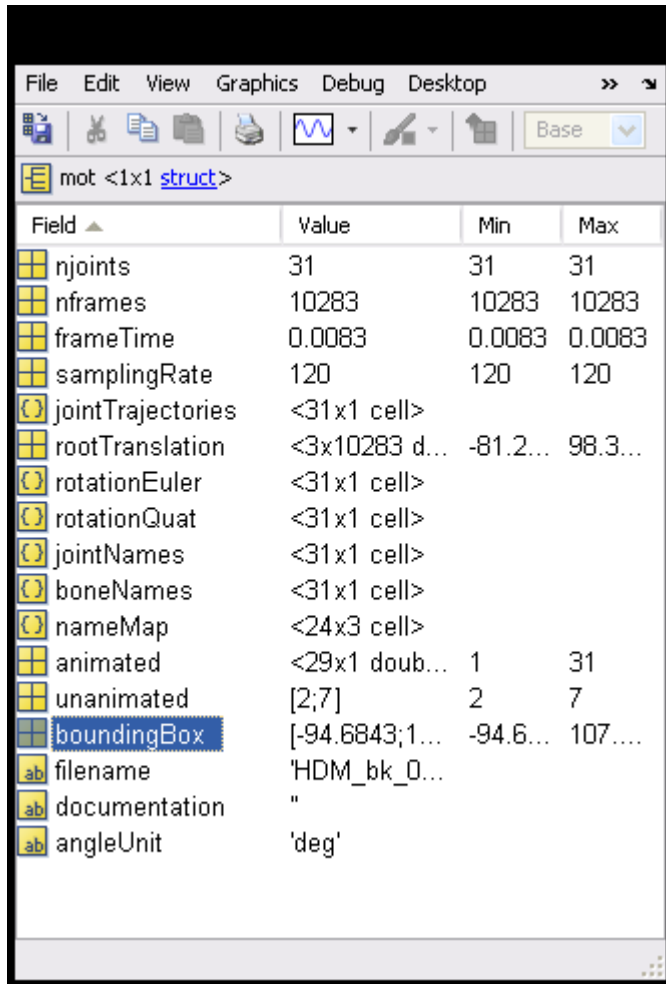
File Edit View »

B... »

(C) rotationEuler <31x1 cell>

	1
1	<3x10283 double>
2	[]
3	<3x10283 double>
4	<1x10283 double>
5	<2x10283 double>
6	<1x10283 double>
7	[]
8	<3x10283 double>
9	<1x10283 double>
10	<2x10283 double>
11	<1x10283 double>
12	<3x10283 double>
13	<3x10283 double>
14	<3x10283 double>
15	<3x10283 double>

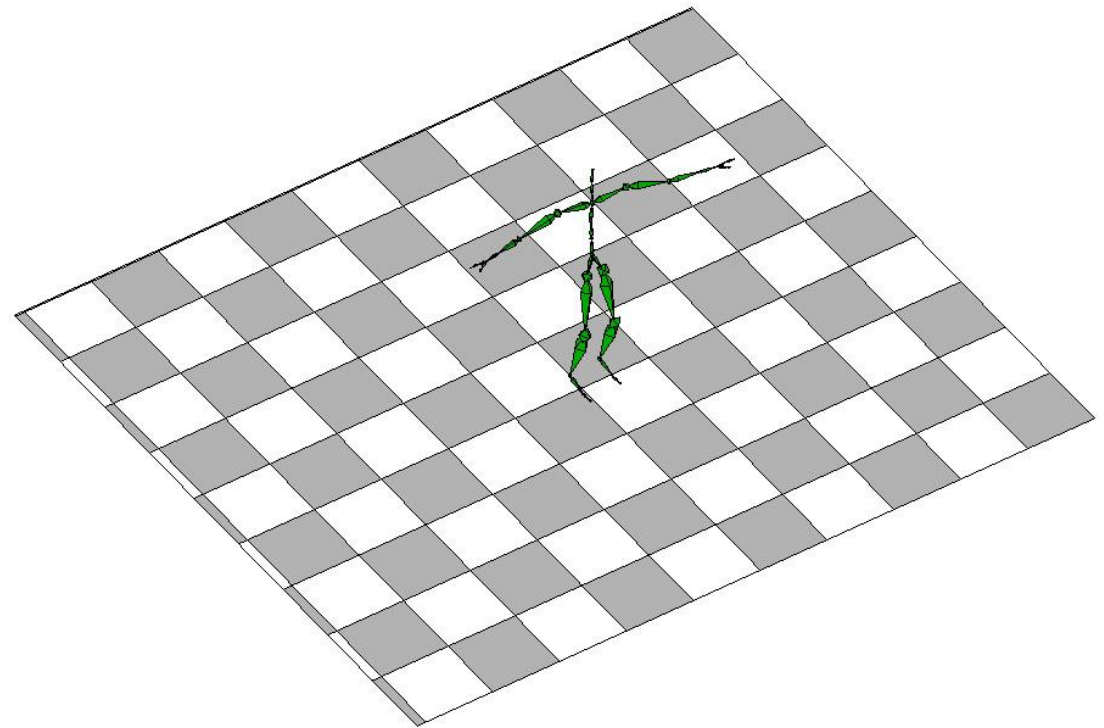
# Handling MoCap data in MATLAB: The mot-structure



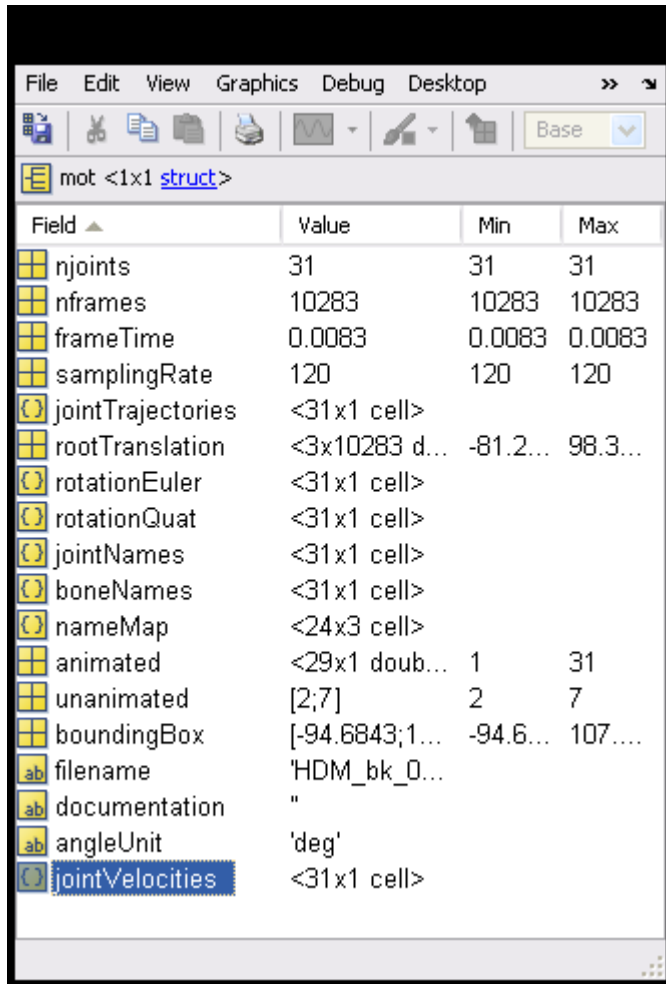
Field ▲	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...>	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...>	1	31
unanimated	[2;7]	2	7
<b>boundingBox</b>	[-94.6843;1...	-94.6...	107....
filename	'HDM_bk_0...		
documentation	"		
angleUnit	'deg'		

## mot.boundingBox

```
mot.boundingBox = computeBoundingBox(mot);
```



# Handling MoCap data in MATLAB: The mot-structure



The image shows a MATLAB window with the 'mot' structure selected. The structure contains the following fields:

Field	Value	Min	Max
njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...	-94.6...	107....
filename	'HDM_bk_0...		
documentation	"		
angleUnit	'deg'		
jointVelocities	<31x1 cell>		

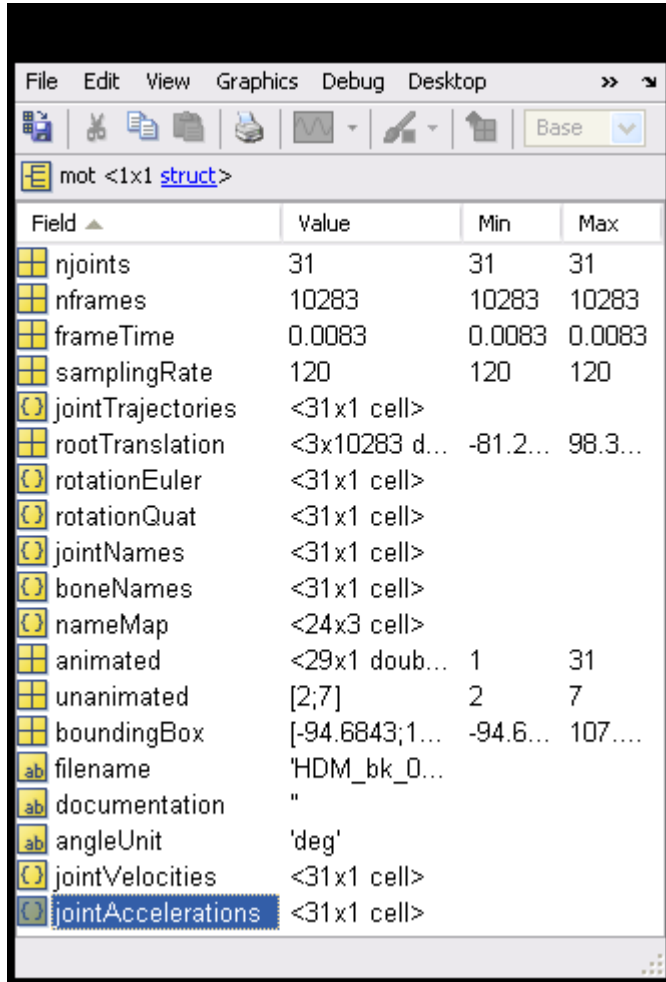
## mot.jointVelocities

```
mot = addVelToMot(mot);
```

Using 5-point-derivation:

$$\dot{p}_t = v_t = \frac{1 \cdot p_{t-2} - 8 \cdot p_{t-1} + 8 \cdot p_{t+1} - 1 \cdot p_{t+2}}{12 \cdot \Delta t}$$

# Handling MoCap data in MATLAB: The mot-structure



Field Value Min Max

njoints	31	31	31
nframes	10283	10283	10283
frameTime	0.0083	0.0083	0.0083
samplingRate	120	120	120
jointTrajectories	<31x1 cell>		
rootTranslation	<3x10283 d...	-81.2...	98.3...
rotationEuler	<31x1 cell>		
rotationQuat	<31x1 cell>		
jointNames	<31x1 cell>		
boneNames	<31x1 cell>		
nameMap	<24x3 cell>		
animated	<29x1 doub...	1	31
unanimated	[2;7]	2	7
boundingBox	[-94.6843;1...	-94.6...	107....
filename	'HDM_bk_0...		
documentation	"		
angleUnit	'deg'		
jointVelocities	<31x1 cell>		
jointAccelerations	<31x1 cell>		

## mot.jointAccelerations

```
mot = addAccToMot(mot);
```

Using 5-point-derivation:

$$\ddot{p}_t = a_t = \frac{-1 \cdot p_{t-2} + 16 \cdot p_{t-1} - 30 \cdot p_t + 16 \cdot p_{t+1} - 1 \cdot p_{t+2}}{12 \cdot \Delta t^2}$$

# More parsing...

- `[skel,mot] = readMocap('asf_filename','amc_filename');`
- `[skel,mot] = readMocapGUI();`