AIM@SHAPE

In Search for your own Virtual Individual

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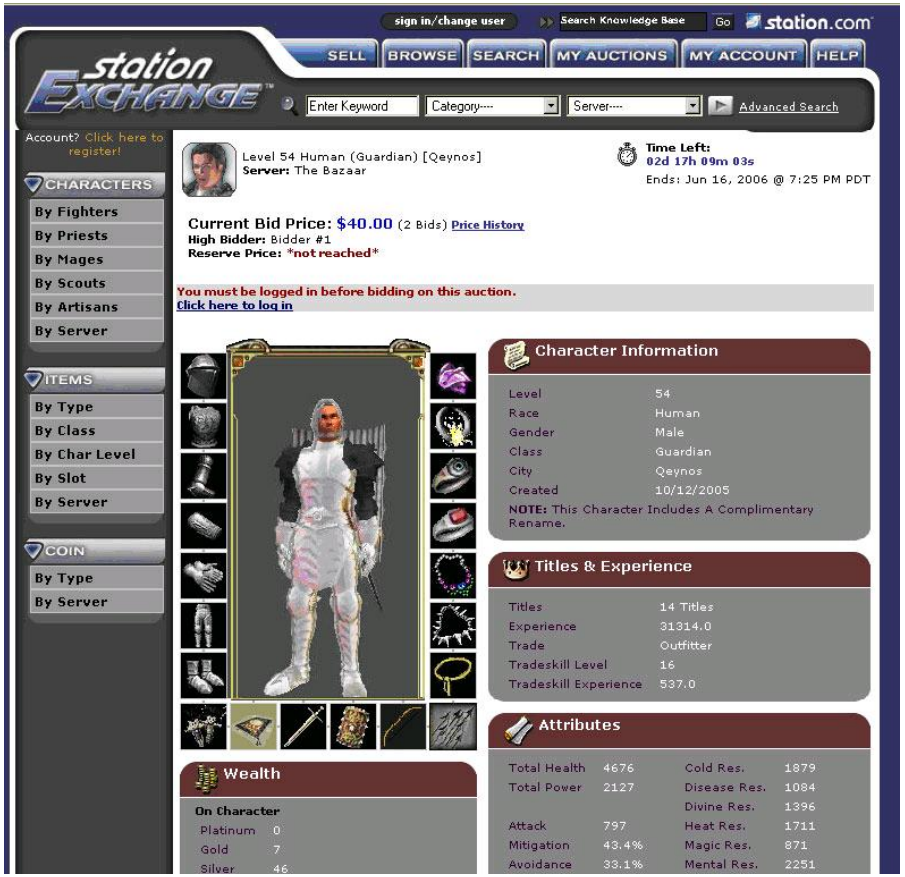
- Our contribution is a semantics-based method for organizing the various types of data that constitute a Virtual Human, in order to foster a common understanding and sharing of such complex 3D entities.
- The knowledge related to the synthesis, animation and functionalities of VHs is formally specified in the form of an ontology.
- The current ontology provides a good starting point towards the creation of a more versatile and reusable representation of Virtual Humans.

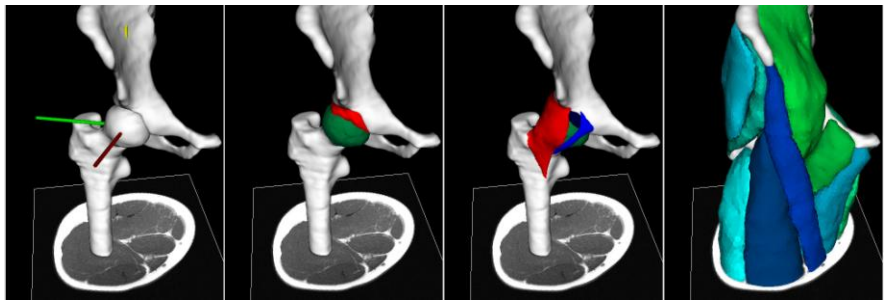
- The Virtual Humans (VH) ontology aims at organizing the knowledge and data of three main research topics and applications involving the virtual representations of humans:
  - Game Industry
  - Simulation
  - Computer-aided Design (CAD)

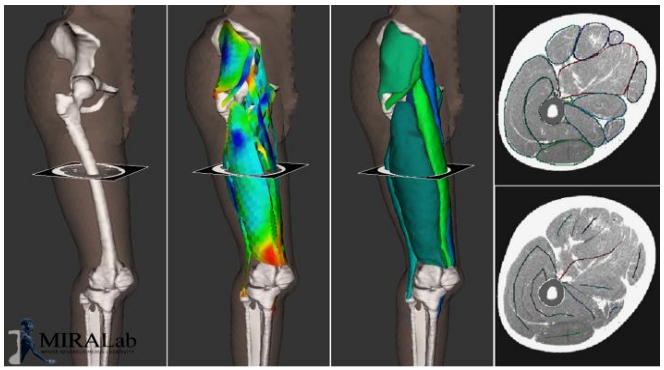
- **Game industry**
  - The use of inhabited Virtual Environments is continuously growing.
  - People can embody a human-like avatar to participate inside these Virtual Environments or they can have a personalized character acting as mediator; sometimes they can even customize it to some extent.
  - Those Virtual Characters belong to the software owner, but they could be potentially shared, exchanged and individualized between participants, such as already proposed by Sony with Station Exchange.



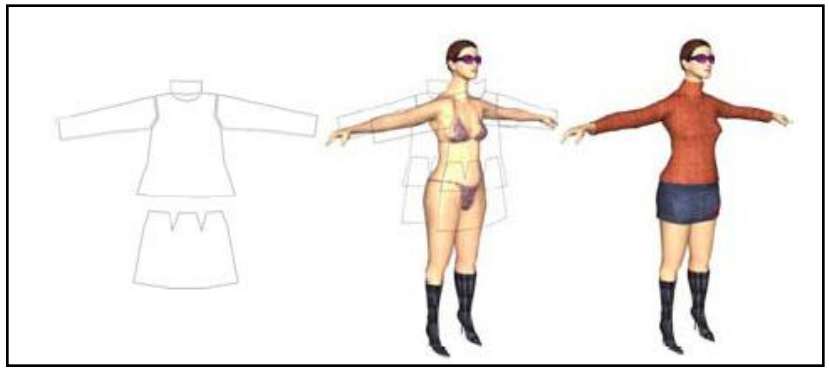
- **Simulation**
  - VH are used to simulate work in process for analysis, maintenance operations for training purpose.

- **CAD** (Computer Aid Design)
  - In medical research virtual humans are used for visualization and prothesis design





  - Clothes and accessories design



- H-ANIM
  - Abstract, **standardized** representation for modeling three dimensional human figures.
- Human Markup Language
  - The Human Markup Language:
    - an XML based representation proposed by the OASIS Human Markup Technical Committee.
  - Enabling real-time animated behaviors for 3D representations of humans.
  - All these characteristics can be applied to represent artificial humans as well as real humans.

Virtual Human Representations

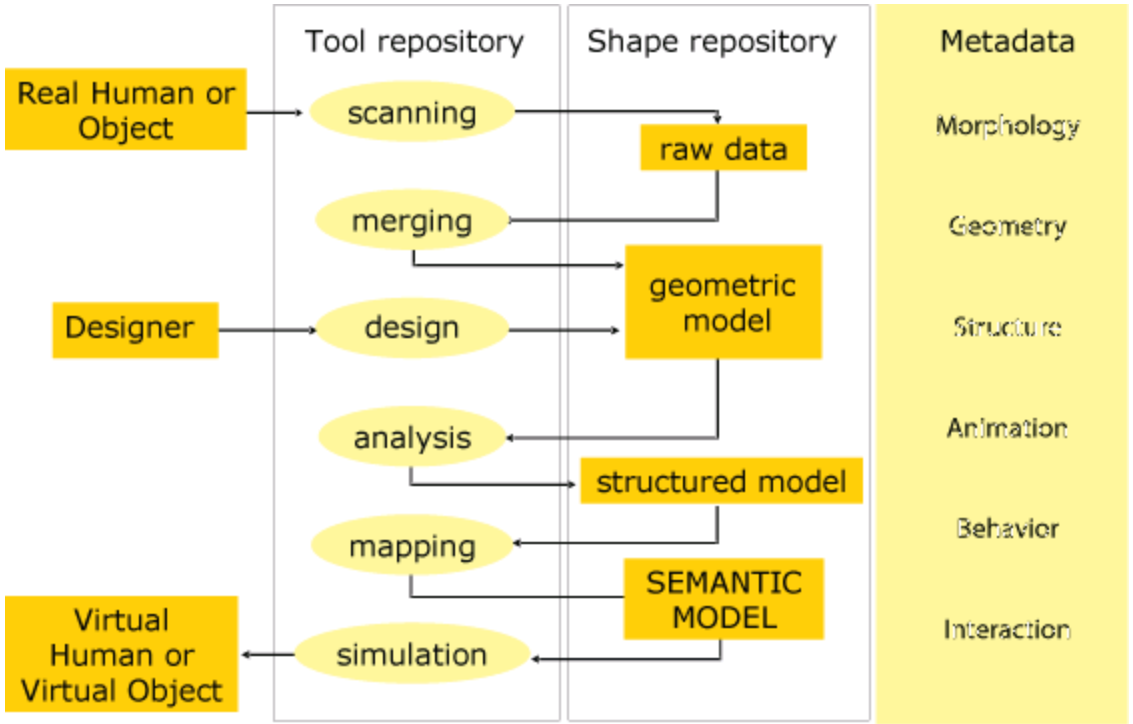
- For CAD-CAM simulations involving human activities representations such as the one proposed in [1], the target is.
- The proposal for representing Virtual Humans is focused towards the anthropometric attributes for CAD applications.
- It considers
  - 1) human information: gender, stature, age, mass, joints, clothing, nationality...;
  - 2) human's state: orientation, location, direction of motion, posture, joint angle...
  - It also takes into account clothing, objects and environment.

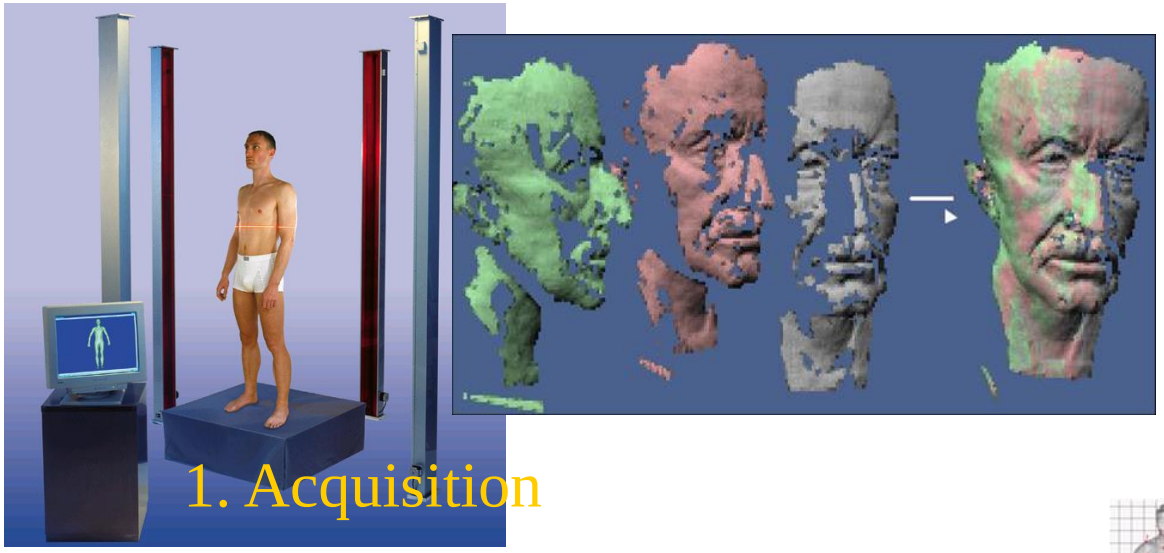
[1] J.D. Ianni. *Standardizing Human Model Queries*. in *Digital Human Modeling For Design And Engineering Conference And Exhibition*. 2001. Arlington, VA, USA.

- Other representations have been proposed with specific scopes of application:
  - Scripting languages (XML-based) for scripting animation:
    - The Character Mark-up Language (CML) links engines for generating and controlling behaviors with the corresponding animated representations.
    - The Avatar Markup Language (AML), aims at encapsulating the Text to Speech, Facial Animation and Body Animation.
    - The Emotion Annotation and Representation Language (EARL) provides an annotation of emotions like intensity, variation, confidence, etc.; with the goal of interpretation and generation of behaviors.
  - The Foundational Model of Anatomy ontology **(FMA**)
    - Computer-based knowledge source for bioinformatics
    - Symbolic modeling of the structure of the human body in a form that is understandable to humans and is also navigable, parseable and interpretable by machine-based systems.

Virtual Human Creation Pipeline

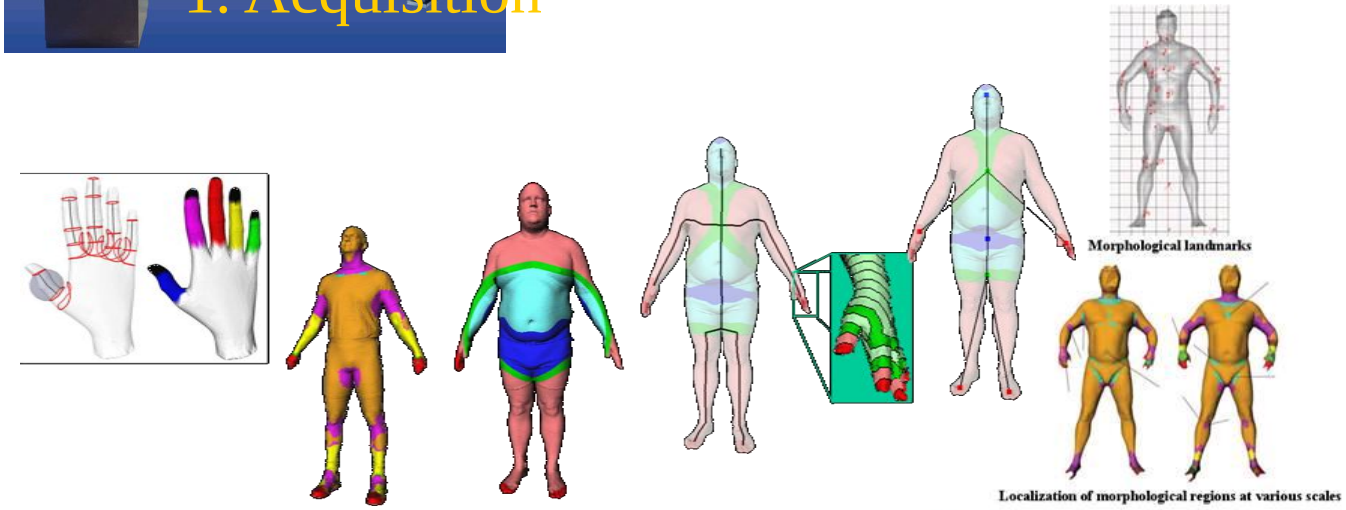
- One approach of the virtual human creation is bottom-up. It starts with shape acquisition technologies and several processes for its reconstruction, analysis and structuring.
- In this process, there exist several tools (tools repository) that produces shapes with different attributes (shape repository).
- During each phase in the process some metadata can be attached to the shape.





1. Acquisition

3. Animation



2. Analysis and structuring

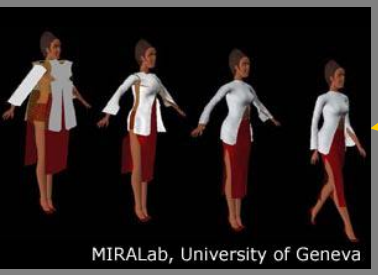
3. Animation

4. Behaviour

5. Interactions

- The ontology for VHs has been developed in the framework of the AIM@SHAPE NoE.
- We have followed a methodology based on the definition of Competency Questions (CQ).
- CQs are a list of questions that a knowledge-base supported by the ontology should be able to answer.

VH Ontology illustrated



Virtual Human

has Garment

has Structure

has geometry

has animation

has animation

has object

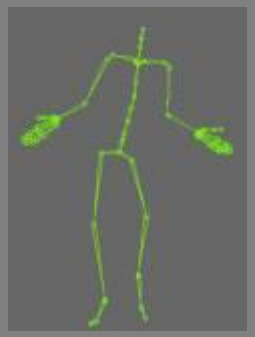
has descriptor

has descriptor

Individuality
Personality, emotion

Morphology
Sex: female
Age: 25-30
Constitution: Slender
Etc…

Structure



Landmarks

Geometry

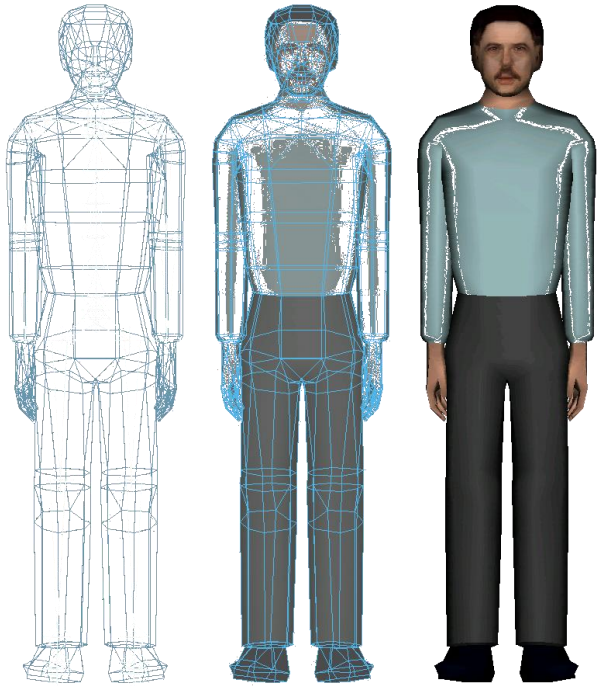
Texture

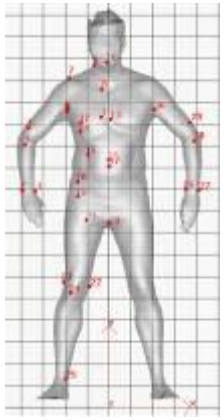
Animation Sequence

Behavior controller

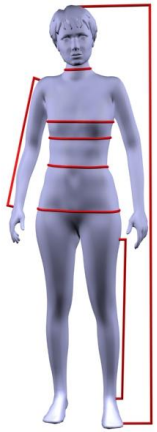
Smart Object

- The proposed ontology should be able to answer the following categories of CQ:
  - Model history
  - Features listing
  - Questions whose answer is a function of low/high level features
  - Animation sequences
  - Animation algorithms
  - Interaction with objects





- **Features listing:**
  - What is the height of the model?
  - Is the model male or female?
  - Is the model european?
  - Does this model represent a real person?
  - Which model has landmarks description?
  - Which are the available structural descriptors for a particular model?
  - Which are the standing(seating, walking, ….) models?
  - How is the model represented? (a mesh/ a point set/...)
  - Is the model complete? (does it have a skeleton/ a hierarchy of body parts/ a set of landmarks attached to it?)



Competency Questions

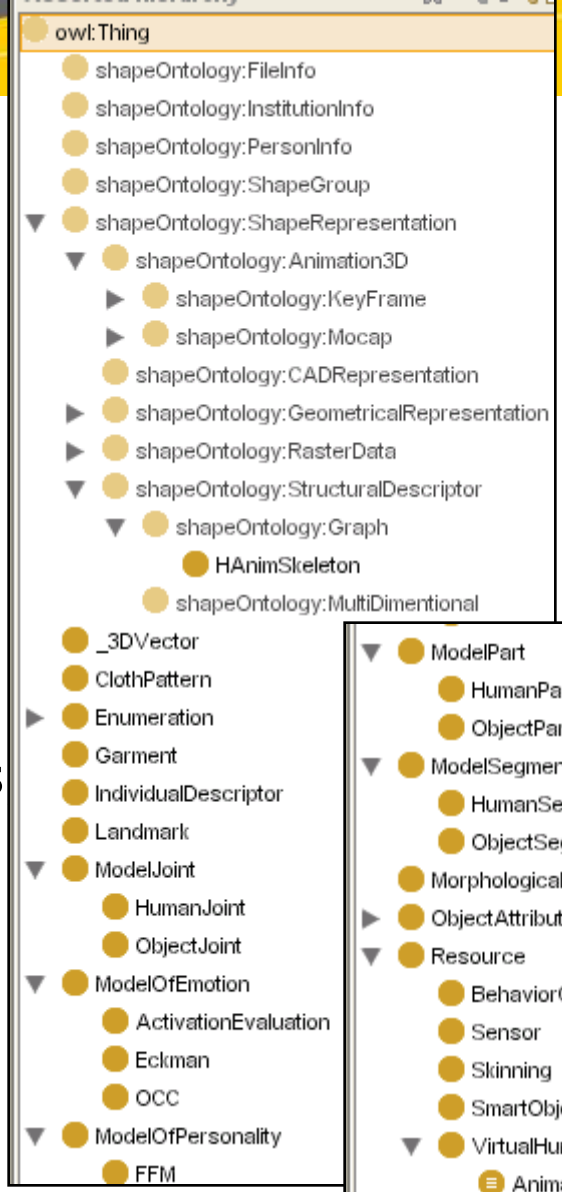
- **Questions whose answer is a function of low/high level features**
  - Most of the answers to these questions cannot be directly answered by the ontology.
  - Answers will be provided by external algorithms which will take as input the data retrieved through the ontology:
    - Which are the VH that are fat/slim/short?
    - Is this VH a child or an adult?
    - Does it have a long nose?
    - Does it miss any body part?
    - Does this VH match another VH (or how much do they match)? And in particular: Are they in the same posture?
    - Do they have the same structure?
    - Do they have similar parts? (same arm length/same fatness/similar nose?)
    - Do they have similar anthropometric measurements (in terms of landmarks?)
    - Is the model suitable for animation?

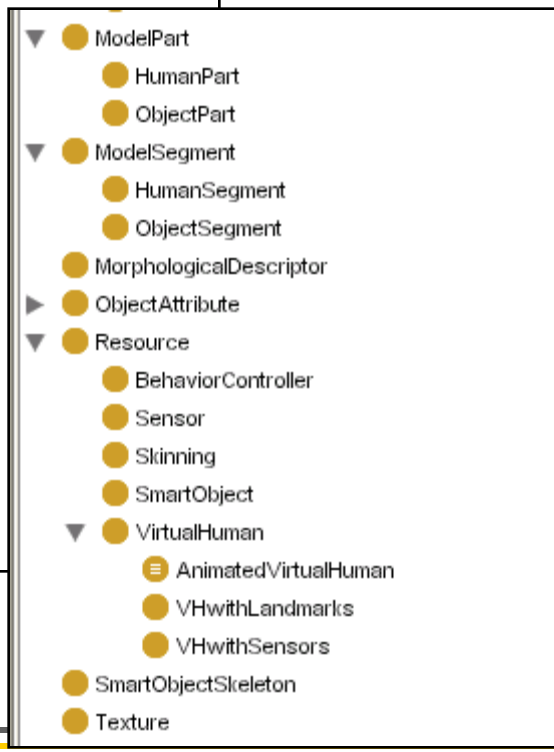
- **Animation sequences**
  - What model does this animation use?
  - What are the joints affected by this animation sequence?
  - Are there any animation sequences lasting more than 1 minute suitable for this VH?
  - Are there any “running”/”football playing” animation sequences for this kind of VH?
  - Can the animation sequence X be applied to the VH Y? (in the case of key-frames for skeleton-based animation this would basically depend on the possibility to match the key-frame data to the skeleton of the VH)

- **Animation algorithms**
  - What are the models suitable to be animated with this algorithm?
  - Does this VH have a vision sensor attached?
  - Can this VH react to sound events in its virtual environment?

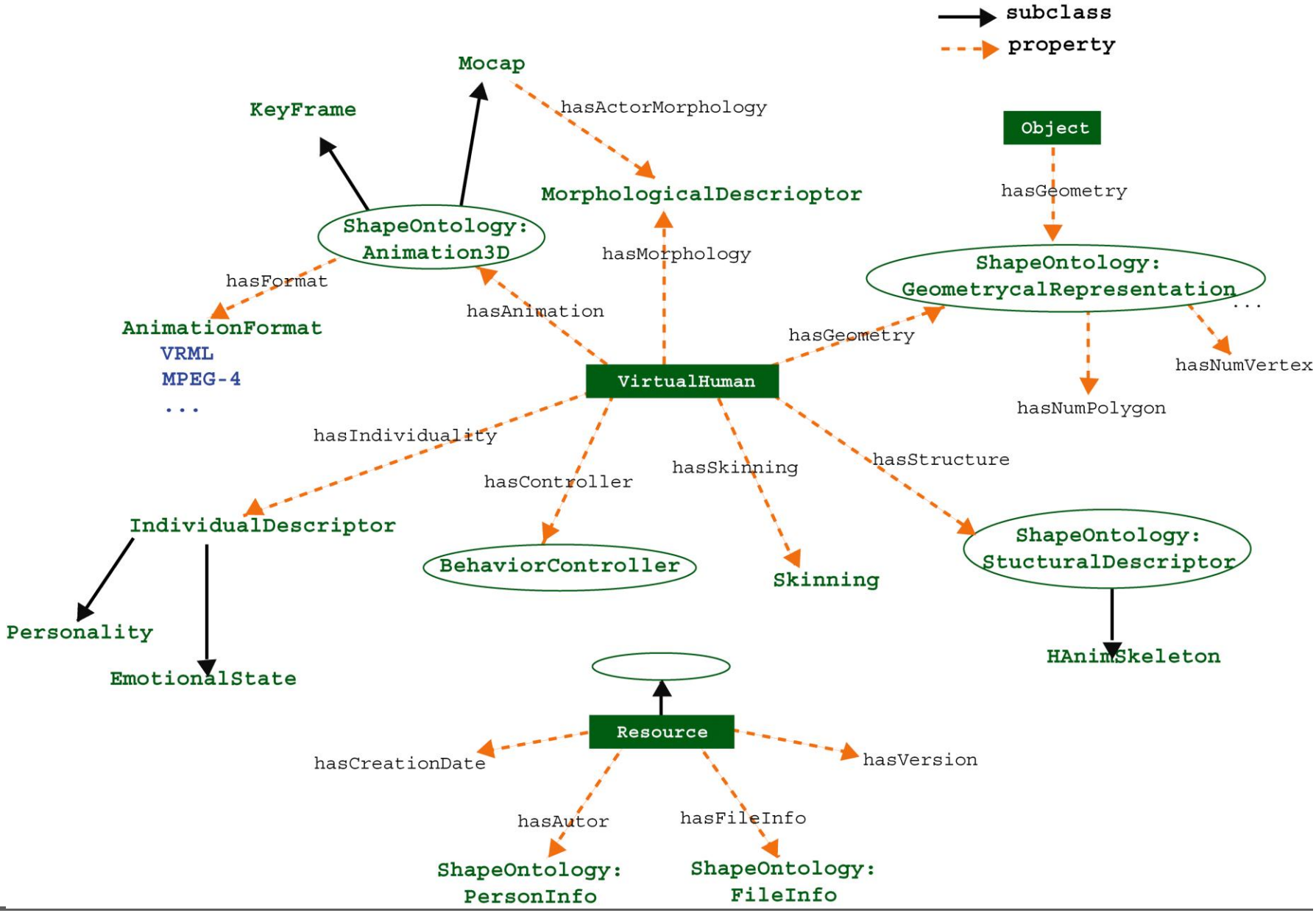
- **Interaction with objects**
  - What are the actions the human can execute on the object?
  - What are the characteristics of an object? (structure, physical properties, etc.)
  - How can an object be grasped?

- The main classes that characterize a VH are :
  - the *geometry* of the VH: polygonal mesh, NURBS, etc.
  - the *descriptors*: geometric skeletons, animation skeletons
  - associated info : modeling history, landmarks, sensors, animation sequences, accessories, emotions ..





Ontology illustrated



Main Concepts of the Ontology

- Virtual Human
  - General info
  - Morphology
  - Individuality
- Geometry → Geometrical Representation
- Structure → Structural Descriptor
  - H-Anim Skeleton
  - Topological Graphs
- Animation → Animation 3D
  - Mocap
  - KeyFrame
- Garments
- Behavior controller
- Models of Personality and Emotions
- Smart Objects
  - Geometry
  - Structure
  - Attributes

- **Virtual characters model and animation repositoriy**
  - An animation need scenario can be where a user wants to create a game with a male virtual character. This character should be an animatable character, which means it should have a skeleton. The user could perform the following search:

SEARCH 1

Find VirtualHuman x?, FileInfo y?
hasMorphology
hasGender: Male
hasSkeleton >1

RESULT:

x? VirtualHuman_Tomy
y? FileInfo_Tomy

x? VirtualHuman_Peter
y? FileInfo_Peter

x? VirtualHuman_Keith
y? FileInfo_Keith

- From the search for male characters with an skeletal structure, the user could chose Keith.
- To make the animation of Keith, one may want to use Inverse Kinematics. We need to know the end effectors of Keith. The end-effectors are Human Joints that are localized at the end of the skeletal structure, and as a consequence do not have children.
- The user could perform in the ontology following query:

SEARCH 2

From VirtualHuman
hasName = Keith
hasStructure = HAnimSkeleton
hasRootJoint = ModelJoint
hasChild = HumanJoint
NOT (hasChild = HumanJoint)

RESULT:

HumanJoint_Keith_l_midtarsal
HumanJoint_Keith_r_midtarsal
HumanJoint_Keith_l_wrist
HumanJoint_Keith_r_wrist
HumanJoint_Keith_skulbase

The animation using the l_wrist as end-efector for raching objects.

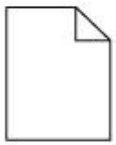
Case Scenario 2

- An other scenario, let's say that a designer wants an animation of a woman dancing;
- she looks in the ontology for animations of women that have the keyword dancing. She found one in C3D format which can be open it in Motion Builder; there she makes a retargeting of the mocap animation to the h-anim skeleton, and she exports the animation to 3DMax.
- There, she can export the animation in a proprietary format WRK, using a home made plug-in, this format uses H-Anim standard.
- She found that the mocap animation is made for a woman of 1.70 m.

SEARCH 1

Find: Animation 3d
has Keyword: dance
has Actror Morphology:
    has Gender: female

RESULT:



dance.c3d

complementary information extracted with the file:

has Actror Morphology:
    has Heigth: 1.70

SEARCH 2

Find: Virtuial Human
has Geometry > 0
    hasNumPolygon > 50 000 and < 80 000
has Morphology:
    Gender: female
    has Heigth: 1.70
has Structure
    HAnim > 0

RESULT:

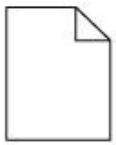
Case Scenario 2

- She needs to search for a woman with a height of 1.70 m, with a structure of H-Anim, and also with a number of polygons between 50k and 80k (for real-time display constraints).
- She found a model in Collada format that can be opened in 3DMax, and exported in the format we use in the lab. Finally we can load both model in a 3D sequence viewer and play the animation.

SEARCH 1

Find: Animation 3d
has Keyword: dance
has Actror Morphology:
has Gender: female

RESULT:



dance.c3d

complementary information extracted with the file:

has Actror Morphology:
has Heigth: 1.70

SEARCH 2

Find: Virtuial Human
has Geometry > 0
hasNumPolygon > 50 000 and < 80 000
has Morphology:
Gender: female
has Heigth: 1.70
has Structure
HAnim > 0

RESULT:

- Achievements
  - The knowledge related to the synthesis, animation and functionalities of VHs can be formally specified in the form of an ontology.
  - The proposed ontology defines a promising initial step towards the creation of a more versatile and reusable representation of Virtual Humans.
- Such representations will greatly improve the availability, management and reusability of Virtual Humans.
- Remaining issues:
  - Integration of KM in the Virtual Humans modeling process.
  - Semantic annotation methodologies for Virtual Humans.