SIFEM

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Semantic Infostructure interlinking an open source Finite Element tool and libraries with a model repository for the multi-scale Modelling and 3d visualization of the inner-ear

Deliverable D5.4.1

Clinical Knowledge Documentation

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Abstract:	In this deliverable, clinical, biological and physiological datasets as well as inner ear models devised by finite element methods (FEMs) will be automatically or semi-automatically described using terms from commonly used ontologies and vocabularies. This will ensure data and models harmonization. In cases where vocabulary reuse is not possible (e.g. datasets or models with differences in the granularity of data elements) semantic rules will be devised for describing the entailment relationship between datasets or models. Semantic rules will also be used for the identification of inconsistencies and dependencies between overlapping FEM models, the input datasets and the evaluation and validation of the simulation output against a set of physiological measurements.
Keyword List:	Clinical knowledge, vocabulary, terms, inner ear modelling, finite elements, relations

Document revision history

Version	*Date*	*Modifications Introduced*	
		Modified by	***Modification Reason***
1	15/07/2014	ICCS	Table of Contents
2	31/08/2014	ICCS, UoA, DERI, UCL, LiU, BioIRC, ISVR, TUM	Terms provided by partners according to their expertise
3	30/10/2014	ICCS, UoA, DERI, UCL, LiU, BioIRC, ISVR, TUM	Updated terms and description provided by partners according to their expertise
4	11/11/2014	ICCS	Final modifications

1 GUIDELINES

Overview

The following report denotes the deliverable D5.4.1 Clinical Knowledge Documentation.

Prerequisites

D2.1 State of the Art: The research conducted during this deliverable is necessary to identify state of the art inner ear modelling techniques and identify the innovation of SIFEM.

D2.2 User Requirements and Data Availability Analysis: This deliverable recorded the requirements of the SIFEM users and guides activities that are undertaken during Task 2.4 System Architecture and Functional Specifications and reported in this D2.3 SIFEM System Architecture.

D2.3 SIFEM System Architecture: A detailed report providing a thorough description of the hardware and software components of the SIFEM system, together with their functionalities.

Moreover, this deliverable takes into account the outcome of the meetings held up to now.

No Other Prerequisites are needed.

Responsibilities

Each technical partner that has responsibilities in the design and the development of a specific part of the SIFEM should clearly define the major hazards and risk that would be introduced by its software or hardware part. The Technical Manager would be responsible for the circulation of the ToC and final version of the consolidated deliverable.

This deliverable will expand in parallel to the development and research activities of the project and more risks will be identified and recorded in the second version of the deliverable.

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2 EXECUTIVE SUMMARY

The aim of this deliverable is to gather and describe terms from different domains (clinical, modelling, image processing, finite elements, etc.) that could serve as a common vocabulary among different disciplines. In addition, the vocabulary presented here will feed the SIFEM conceptual model, where the links among terms will be described (adding the object and data properties) and the respective ontology will be implemented.

This deliverable will be constantly updated until M27, where the D5.4.2 “Clinical Knowledge Documentation Report“ will be submitted, reporting the updates of the vocabulary according the work progress.

The terms have been divided into nine (9) main categories and extend the title of the deliverable that limits the vocabulary only to clinical terms:

i. Anatomy: Models the macro anatomy of the ear (especially the inner ear) for the SIFEM project
ii. Argumentation
iii. Clinical Data
iv. Data Analysis
v. Material Properties
vi. Physiology
vii. Simulation
viii. Reconstruction
ix. Finite Element Modelling

3 SIFEM KNOWLEDGE DOCUMENTATION

This chapter presents terms that were defined and their description, divided in nine categories, as mentioned in the executive chapter. The terms are described with no gaps among the words, as needed by the ontology implementation.

3.1 ANATOMY

Term	Description
acoustic_hair_cell	Amplifies sound waves and transduce auditory information to the Brain Stem
Acoustic_nerve	The acoustic nerve (n. acusticus; auditory nerve or nerve of hearing) divides near the bottom of the internal acoustic meatus into an anterior or cochlear and a posterior or vestibular branch.
AcousticNerveFibre	Is a threadlike extension of a nerve cell and consists of an axon and myelin sheath (if present)
Actin filament	Actin filament (also known as microfilaments) are two-stranded helical polymers of the protein actin with a diamenter of 5-9nm. Although actin filaments are dispersed throughout the cell, they are most highly concentrated in the cortex, just beneath the plasma membrane. Gene Ontology - A two-stranded helical polymer of the protein actin. Actin filaments are a major component of the contractile apparatus of skeletal muscle and the microfilaments of the cytoskeleton of eukaryotic cells. The filaments, comprising polymerized globular actin molecules, appear as flexible structures with a diameter of 5-9 nm. They are organized into a variety of linear bundles, two-dimensional networks, and three dimensional gels. In the cytoskeleton they are most highly concentrated in the cortex of the cell just beneath the plasma membrane
Afferent neuron	A neuron conducting impulses inwards to the brain or spinal cord.
AfferentAcousticNerveFibre	The sensory nerves, called also centripetal or afferent nerves, transmit to the nervous centers

	impressions made upon the peripheral extremities of the nerves, and in this way the mind, through the medium of the brain, becomes conscious of external objects
Apex of cochlea	The top part (helicotrema)
Apical_turn_of_the_cochlea	The top turn of the cochlea
Auditory ossicle	The ossicles (also called auditory ossicles) are three bones in either middle ear that are among the smallest bones in the human body. They serve to transmit sounds from the air to the fluid-filled labyrinth (cochlea). The absence of the auditory ossicles would constitute a moderate-to-severe hearing loss. The term "ossicle" literally means "tiny bone" and, though the term may refer to any small bone throughout the body, it typically refers to the malleus, the incus and the stapes of the middle ear.
Auditory_nerve	The cochlear nerve (also auditory or acoustic nerve) is one of two parts of the vestibulocochlear nerve, a cranial nerve present in higher vertebrates
Auditory_sensory_cell	Hair cells are the sensory receptors of both the auditory system and the vestibular system in all vertebrates. In mammals, the auditory hair cells are located within the organ of Corti on a thin basilar membrane in the cochlea of the inner ear
Basal_turn_of_cochlea	The bottom turn of the cochlea
Base_of_cochlea	near the middle ear and the oval window)
Basilar membrane of cochlea	Stretches from the tympanic lip of the osseous spiral lamina to the crista basilaris; consists of two zones, a thin zona arcuata stretching from the limbus spiralis to the bases of the outer rods and supporting the organ of Corti and an outer thicker zona pectinata, commencing beneath the bases of the outer rods and attached laterally to the crista basilaris.

Boettcher's_cell	Boettcher cells are a special cell type located in the inner ear. Boettcher cells are polyhedral cells on the basilar membrane of the cochlea, and are located beneath Claudius cells. Boettcher cells are considered supporting cells for the organ of Corti, and are present only in the lower turn of the cochlea. These cells interweave with each other, and project microvilli into the intercellular space.
Bony labyrinth	It has three regions: vestibule, semicircular canals and cochlea. These are all cavities within bone, lined by periosteum and containing a clear fluid, the perilymph, within which is the membranous labyrinth.
Cavity	A cavity is a hollow in an object
Cell	In the FMA, cell implies eukaryotic cell. Prokaryotic cells included in a metazoon are not parts of the metazoan organism. Old definition: anatomical structure that has as its parts a maximally connected cell compartment surronded by a maximally connected plasma membrane.
Cerebrospinal fluid	Is the cochlea a subdivision of the compartment "bony labyrinth" or is it an anatomical cluster consisting of cochlear part of membranous labyrinth and cochlear part of wall of bony labyrinth (temporal bone)? Oxford defines a labyrinth as a "complex cavity".
Cochear_canal	A minute canal in the temporal bone that passes from the cochlea inferiorly to open in front of the medial side of the jugular fossa.
Cochlear aqueduct	Medial to the opening for the carotid canal and close to its posterior border, in front of the jugular fossa, is a triangular depression; at the apex of this is a small opening, the aquaeductus cochleae (or cochlear aqueduct, or aqueduct of cochlea), which lodges a tubular prolongation of the dura mater

	establishing a communication between the perilymphatic space and the subarachnoid space, and transmits a vein from the cochlea to join the internal jugular.
Cochlear duct of membranous labyrinth	The cochlear duct (or scala media) is an endolymph filled cavity inside the cochlea, located in between the tympanic duct and the vestibular duct, separated by the basilar membrane and Reissner's membrane (the vestibular membrane) respectively.
Cochlear ganglion	The spiral (cochlear) ganglion is the group of nerve cells that serve the sense of hearing by sending a representation of sound from the cochlea to the brain.
Cochlear hair cell	Vertically elongate cell with a group of regular microvilli, stereocilia; sensory transducer of the cochlea which collectively detects the amplitude and frequency of the sound waves entering. Two types: inner hair cell and outer hair cell, depending upon their position in relation to the cochlear modiolus; inner, towards the axis, outer, away from the axis.
Cochlear inner hair cell	Pear-shaped, slightly curved, the narrower end directed towards the spiral organ's surface, the wider basal end positioned some distance above the inner end of the basilar membrane; apex bears stereocilia; number about 3500; nucleus is rounded and euchromatic, cytoplasm contains abundant organelles.
Cochlear labyrinth	The cochlear labyrinth is the portion of the inner ear that contains the cochlear duct and the perilymphatic space. The cochlear labyrinth is a fluid filled membrane that helps in the detection of sound. The cochlear labyrinth is primarily used to sense lower frequencies.
Cochlear nerve	The cochlear nerve (also auditory or acoustic nerve) is one of two parts of the vestibulocochlear

	nerve, a cranial nerve present in higher vertebrates. The cochlear nerve carries sound information from the cochlea of the inner ear directly to the brain. The other portion of the vestibulocochlear nerve is the vestibular nerve, which carries spatial orientation information to the brain from the semicircular canals.
Cochlear outer hair cell	Long, cylindrical nearly twice as tall as the inner hari cell; arranged in three to five rows, interspersed with supproting cells, number about 12,000; nucleus is rounded and euchromatic, cytoplasm has a scarcity of organelles compared to inner cell.
Cochlear_hair_cell_base	The hair cells located at the base of the cochlea
Cochlear_hair_cell_top	The hair cells located at the apex of the cochlea
Cochlear_outer_hair_cell_base	The outer hair cells number about 12,000, and are nearly twice as long as the inner. In the basal coil of the cochlea they are arranged in three regular rows; in the apical coil, in four, somewhat irregular, rows.
Connective tissue cell	We accept only proper connective tissue cells (including cells of specialized connective tissue) as bonafide connective tissue cells. Traditional sources called these fixed connective tissue cells and include another class of cells called free cells. The latter include macrophages, lymphocytes, etc. We consider these to be incidental cells of connective tissues that are of bone marrow/lymphoid tissue derivation. We will show these as components of connective tissue once that have been entered in these tissues.
Connective_tissue	Connective tissue (CT) is a kind of animal tissue that supports, connects, or separates different types of tissues and organs of the body. It is one of the four general classes of animal tissues—as well as epithelial, muscle, and nervous tissues. Connective tissue is found everywhere including in

	the central nervous system. It is located in between other tissues.
Cranial nerve	In TA it is represented in plural form, "Nervi craniales". Neural tree organ which is continuous with the brain. Examples: Trochlear nerve, facial nerve.
Cranial_nerve	Cranial nerves (sometimes termed cerebral nerves), are nerves that emerge directly from the brain and the brainstem, in contrast to spinal nerves (which emerge from various segments of the spinal cord). Information is exchanged between the brain and various regions, primarily of the head and neck, via the cranial nerves.
Deiter's_cell	Each outer hair cell is supported by a phalangeal cell of Deiters, or supporting cell, which holds the base of the hair cell in a cup-shaped depression. From each Deiters' cell a projection extends upward to the stiff membrane, the reticular lamina, that covers the organ of Corti
Ductus_cochlearis	The cochlear duct (or scala media or Ductus cochlearis) is an endolymph filled cavity inside the cochlea, located in between the tympanic duct and the vestibular duct, separated by the basilar membrane and Reissner's membrane (the vestibular membrane) respectively
Ear	The ear is the organ that detects sound. It not only receives sound, but also aids in balance and body position. The ear is part of the auditory system.
EfferentAcousticNerveFibre	The efferent of the threadlike extension of a nerve cell, as described earlier
Endolymph	Transudate contained within the membranous labyrinth.
External ear	The outer ear is the external portion of the ear, which consists of the pinna and external auditory meatus.

External pillar cell of cochlea	A rod-shaped cell found in 3 or 4 rows that lie adjacent to and support the outer hair cells.
External_pillar_cell_apex	The organ of Corti consists of a series of epithelial structures that lie on the zona arcuata of the basilar membrane. The more central of these structures are two rows of cells, the internal and external pillar cells. This represents the apex of these cells.
External_pillar_cell_base	The organ of Corti consists of a series of epithelial structures that lie on the zona arcuata of the basilar membrane. The more central of these structures are two rows of cells, the internal and external pillar cells. This represents the base of these cells.
Facial nerve	The facial nerve is the seventh cranial nerve, or simply cranial nerve VII. It emerges from the brainstem between the pons and the medulla, and controls the muscles of facial expression, and functions in the conveyance of taste sensations from the anterior two-thirds of the tongue and oral cavity. It also supplies preganglionic parasympathetic fibers to several head and neck ganglia.
Hair_bundle	A group of cellular processes resembling hair, characteristic of hair cells
Hair_cell	Referring to the tufts of stereocilia that protrude from the apical surface of the cell, a structure known as the hair bundle, into the scala media, a fluid-filled tube within the cochlea
Hair_cell_body	In mammalian outer hair cells, the receptor potential triggers active vibrations of the cell body
Hair_cell_row	The cochlear hair cells in humans consist of one row of inner hair cells and three rows of outer hair cells
Hardesty's_membrane	Hardesty's membrane divides the subtectorial space into two compartments: one facing the

	surfaces of inner hair cells and one facing the surfaces of outer hair cells.
Helicotrema	The helicotrema (from Greek ἕλιξ meaning coil and τρῆμα meaning hole) is the part of the cochlear labyrinth where the scala tympani and the scala vestibuli meet. It is the main component of the cochlear apex. The hair cells near this area best detect low frequency sounds.
Hensen's_cell	One of the supporting cells in the spiral organ
Huschke's_teeth	Tooth-shaped formations or ridges occurring on the vestibular lip of the limbus laminae spiralis of the cochlear duct
IAC	The internal auditory meatus (also meatus acusticus internus, internal acoustic meatus, internal auditory canal, internal acoustic canal, or IAC) is a canal in the petrous part of the temporal bone of the skull, on each side, and serves as the passageway for the cranial nerves, namely cranial nerve VII and cranial nerve VIII, and for the labyrinthine artery, between the middle and inner ear.
Incus	The incus /ˈɪŋkəs/ is a bone in the middle ear. The anvil-shaped small bone is one of three ossicles in the middle ear. The incus receives vibrations from the malleus, to which it is connected laterally, and transmits these to the stapes, medially. The incus is so-called because of its resemblance to an anvil (Latin: Incus).
Inner phalangeal cell of cochlea	These cells are found in the organ of Corti in the inner ear (the spiral organ), a complex structure containing a single row of inner hair cells and three rows of outer hair cells. One row of inner phalangeal cells and three rows of outer phalangeal cells (called also Deiters' cells, after the German pathologist Otto Deiters [1834-1863]) are the supporting cells of the hair cell area in the

	cochlea.
Inner spiral sulcus	A concavity in the floor of the cochlear duct formed by the overhanging vestibular lip.
Inner_hair_cell	The inner hair cells are arranged in a single row on the medial side of the inner rods, and their diameters being greater than those of the rods it follows that each hair cell is supported by more than one rod. The free ends of the inner hair cells are encircled by a cuticular membrane, which is fixed to the heads of the inner rods.
Inner_hair_cell_row	The pillar cells furnish the major support of this structure. They separate a single row of larger, pear-shaped, inner hair cells from three or more rows of smaller, cylindrical, outer hair cells.
Inner_pillar_cell_of_cochlea	There are outer pillar cells and inner pillar cells, both cell types being characterized by the presence of thousands of cross-linked microtubules and actin filaments in parallel orientation
Interdental cell of cochlea	Interdental cells found in the spiral limbus between the dens acustici, which secrete the tectorial membrane of the cochlear duct.
Internal acoustic meatus	The internal auditory meatus (also meatus acusticus internus, internal acoustic meatus, internal auditory canal, internal acoustic canal, or IAC) is a canal in the petrous part of the temporal bone of the skull, on each side, and serves as the passageway for the cranial nerves, namely cranial nerve VII and cranial nerve VIII, and for the labyrinthine artery, between the middle and inner ear.
Internal ear	The inner ear (internal ear, auris interna) is the innermost part of the vertebrate ear. In vertebrates, the inner ear is mainly responsible for sound detection and balance.
Internal pillar cell of cochlea	These cells are found in the organ of Corti in the inner ear (the spiral organ), a complex structure

	containing a single row of inner hair cells and three rows of outer hair cells. Pillar cells, together with phalangeal cells, are supporting cells for hair cells in the cochlea. There are outer pillar cells and inner pillar cells, both cell types being characterized by the presence of thousands of cross-linked microtubules and actin filaments in parallel orientation. These cells provide mechanical coupling between the basement membrane and the mechanosensory hair cells.
Internal_acoustic_canal	A mnemonic to remember the relative position of nerves inside the internal auditory canal (IAC). Four are the nerves and four are the quadrants of the IAC: antero-superior, antero-inferior, postero-superior, postero-inferior. In each quadrant there is the passage of one nerve.
Internal_auditory_canal	The internal auditory meatus (also meatus acusticus internus, internal acoustic meatus, internal auditory canal, internal acoustic canal, or IAC) is a canal in the petrous part of the temporal bone of the skull, on each side, and serves as the passageway for the cranial nerves, namely cranial nerve VII and cranial nerve VIII, and for the labyrinthine artery, between the middle and inner ear.
Internal_auditory_meatus	The internal auditory meatus (also meatus acusticus internus, internal acoustic meatus, internal auditory canal, internal acoustic canal, or IAC) is a canal in the petrous part of the temporal bone of the skull, on each side, and serves as the passageway for the cranial nerves, namely cranial nerve VII and cranial nerve VIII, and for the labyrinthine artery, between the middle and inner ear.
Internal_spiral_sulcus	A concavity in the floor of the cochlear duct formed by the overhanging vestibular lip.
IonOfElectrolyte	An electrolyte is a substance that ionizes when dissolved in suitable ionizing solvents such as

	water. In physiology, the primary ions of electrolytes are sodium (Na+), potassium (K+), calcium (Ca2+), magnesium (Mg2+), chloride (Cl−), hydrogen phosphate (HPO42−), and hydrogen carbonate (HCO3−).
Kimura's_membrane	A thickening of the lower surface into which the hair bundles of the outer hair cells are imbedded
Lamina_spiralis_membranacea	The osseous spiral lamina is a bony shelf or ledge which projects from the modiolus into the interior of the canal, and, like the canal, takes two-and-three-quarter turns around the modiolus.
Lateral wall of cochlear duct	The lateral wall of the cochlear duct is formed by the spiral ligament and the stria vascularis, which produces the endolymph. The hair cells develop from the lateral and medial ridges of the cochlear duct, which together with the tectorial membrane make up the organ of Corti.
Lower_turn_of_the_cochlea	Boettcher cells are considered supporting cells for the organ of Corti, and are present only in the lower turn of the cochlea
Malleus	The malleus /ˈmæliəs/ or hammer is a hammer-shaped small bone or ossicle of the middle ear which connects with the incus and is attached to the inner surface of the eardrum. The word is Latin for hammer. It transmits the sound vibrations from the eardrum to the incus.
Meatus_acusticus_internus	A canal beginning at the opening of the internal acoustic meatus in the posterior cranial fossa, passing laterally through the petrous portion of the temporal bone to end at the fundus, where a thin plate of bone separates it from the vestibule; it gives passage to the facial and vestibulocochlear nerves together with the labyrinthine artery and veins.
Membrana_tectoria	Covering the sulcus spiralis internus and the spiral

	organ of Corti is the tectorial membrane, which is attached to the limbus laminæ spiralis close to the inner edge of the vestibular membrane. Its inner part is thin and overlies the auditory teeth of Huschke; its outer part is thick, and along its lower surface, opposite the inner hair cells, is a clear band, named Hensen's stripe, due to the intercrossing of its fibers. The lateral margin of the membrane is much thinner. Hardesty considers the tectorial membrane as the vibrating mechanism in the cochlea
Membranous labyrinth	Continuous system of ducts contained within the osseous labyrinth of the petrous temporal bone; filled with endolymph and separated from the periosteum by a space which contains perilymph and a web-like network of fine blood vessels; divided into two major regions, the vestibular apparatus and the cochlear duct.
Microtubule	Microtubules are polymeric fibers with hollow cylinders present in most cell types, abundant in neurons, leucocytes, blood platelets and in the mitotic spindles of dividing cells; form part of the structure of cilia, flagella and centrioles. Alberts 94:789 fig.16-2 - Microtubules are long, hollow cylinders made of the protein tubulin.
Microvillus	Finger-like cell extensions; covered by plasma membrane; supported internally by closely packed bundles of actin microfilaments, linked by villin and fimbrin.
Middle ear	The middle ear is the portion of the ear internal to the eardrum, and external to the oval window of the inner ear. The mammalian middle ear contains three ossicles, which transfers the vibrations of the eardrum into waves in the fluid and membranes of the inner ear.
Middle_turn_of_the_cochlea	The middle turn of the 2.5 turns of the cochlea

Modiolus of cochlea	Central conical axis with a spiral canal; has broad base near the lateral end of the internal acoustic meatus.
Nerve fiber	Consists of an axon enveloped in a sheath of Schwann cells from near its origin to near its termination. Many peripheral axons have a myelin sheath interposed between the Schwann cells and the axon. The myelin sheath is derived from the Schwann cell. Other axons lack a myelin sheath.
Neuroglial cell	Glial cells, sometimes called neuroglia or simply glia (Greek γλία, γλοία "glue"; pronounced in English as either /ˈgliːə/ or /ˈglaɪə/), are non-neuronal cells that maintain homeostasis, form myelin, and provide support and protection for neurons in the brain and peripheral nervous system.
Nuel's_space	An interval in the spiral organ (of Corti) between the outer pillar cells on one side and the phalangeal cells and hair cells on the other
Olivocochlear bundle	The olivocochlear system is a component of the auditory system involved with the descending control of the cochlea. Its nerve fibres, the olivocochlear bundle (OCB), form part of the vestibulocochlear nerve (VIIIth cranial nerve, also known as the auditory-vestibular nerve), and project from the superior olivary complex in the brainstem (pons) to the cochlea.
Organ_of_Corti	The organ of Corti (or "spiral organ"), found only in mammals, is in the cochlear duct, of the cochlea of the inner ear and is provided with hair cells or auditory sensory cells. It evolved from the basilar papilla found in all tetrapods, except for a few derived species that have lost it. The spiral organ of Corti (organon spirale [Corti]; organ of Corti) is composed of a series of epithelial structures placed upon the inner part of the basilar

	membrane.
Osseous spiral lamina of cochlea	The osseous spiral lamina is a bony shelf or ledge which projects from the modiolus into the interior of the canal, and, like the canal, takes two-and-three-quarter turns around the modiolus. It reaches about half-way toward the outer wall of the tube, and partially divides its cavity into two passages or scalae, of which the upper is named the scala vestibuli, while the lower is termed the scala tympani.
Osseus_labyrinth	The osseous labyrinth consists of three parts: the vestibule, semicircular canals, and cochlea. These are cavities hollowed out of the substance of the bone, and lined by periosteum; they contain a clear fluid, the perilymph, in which the membranous labyrinth is situated.
Osseus_lamina	The osseous spiral lamina is a bony shelf or ledge which projects from the modiolus into the interior of the canal, and, like the canal, takes two-and-three-quarter turns around the modiolus.
Outer phalangeal cell of cochlea	Supporting cell; connects with outer hair cell to form reticular lamina or reticular membrane. Gray's 99:1392 - Lie between the rows of outer hair cells, their expanded bases lying on the basilar membrane and their apical ends partially enveloping the bases of hair cells with a finger-like phalangeal process extending up diagonally between the hair cells to the reticular membrane.
Outer spiral sulcus	A concavity in the outer wall of the cochlear duct between the spiral prominence and the spiral organ.
Outer_hair_cell	The outer hair cells number about 12,000, and are nearly twice as long as the inner. In the basal coil of the cochlea they are arranged in three regular rows; in the apical coil, in four, somewhat irregular, rows.

Outer_hair_cell_row	Outer hair cells (OHCs) are disposed in three rows on the external side of the tunnel of Corti. OHCs are quite atypical sensory cells.
Outer_pillar_cell_of_cochlea	There are outer pillar cells and inner pillar cells, both cell types being characterized by the presence of thousands of cross-linked microtubules and actin filaments in parallel orientation. These cells provide mechanical coupling between the basement membrane and the mechanosensory hair cells.
Outer_tunnel_of_organ_of_Corti	An interval in the spiral organ (of Corti) between the outer pillar cells on one side and the phalangeal cells and hair cells on the other.
Oval window	The oval window (or vestibular window) is a membrane-covered opening, which leads from the middle ear to the vestibule of the inner ear. Vibrations that come into contact with the tympanic membrane travel through the three ossicles and into the inner ear. The oval window is the intersection of the middle ear with the inner ear, and is directly contacted by the stapes; by the time vibrations reach the oval window, they have been amplified over twenty times from what they were when they contacted the tympanic membrane, a testament to the amplifying power of the middle ear.
Perilymph	Transudate contained in the osseous labyrinth outside the membranous labyrinth.
Periosteum	The outer surface of bone is always lined by a fibrocellular layer, the periosteum and on the inner surface is a similar, though thinner, endosteum.
Petrous part of temporal bone	The petrous portion of the temporal bone or pyramid is pyramidal and is wedged in at the base of the skull between the sphenoid and occipital bones. Directed medially, forward, and a little upward, it presents for examination a base, an

	apex, three surfaces, and three angles, and contains, in its interior, the essential parts of the organ of hearing. The petrous portion is among the most basal elements of the skull and forms part of the endocranium. Petrous comes from the Latin word petrosus, meaning "stone-like, hard". It is one of the most dense bones in the body.
Phalangeal cell of cochlea	These cells are found in the organ of Corti in the inner ear (the spiral organ), a complex structure containing a single row of inner hair cells and three rows of outer hair cells. One row of inner phalangeal cells and three rows of outer phalangeal cells (called also Deiters' cells, after the German pathologist Otto Deiters [1834-1863]) are the supporting cells of the hair cell area in the cochlea. Phalangeal cells are epithelial cells in nature.
Pillar cell of cochlea	Gray's 99:1387 - Has a base, an elongated rod ('scapus') and a head.
Reissner's_membrane	Reissner's membrane (vestibular membrane, vestibular wall) is a membrane inside the cochlea of the inner ear. It separates scala media from scala vestibuli. Together with the basilar membrane it creates a compartment in the cochlea filled with endolymph, which is important for the function of the organ of Corti. It primarily functions as a diffusion barrier, allowing nutrients to travel from the perilymph to the endolymph of the membranous labyrinth.
Reticular laminac	Consists of dense matrix containing collagen filaments which bind the lamina densa to the adjacent connective tissue. Alberts 94:990 - Contains collagen fibrils, connects the basal lamina to the underlying connective tissue.
Rosenthal's_canal	The myelin-ensheathed fibres of the vestibulocochlear nerve fan out in spiral fashion from the modiolus to pass into the channel near

	the root of the osseous spiral lamina, called the canal of Rosenthal.
Round window	The round window is one of the two openings into the inner ear. It is closed off from the middle ear by the round window membrane, which vibrates with opposite phase to vibrations entering the inner ear through the oval window. It allows fluid in the cochlea to move, which in turn ensures that hair cells of the basilar membrane will be stimulated and that audition will occur.
Scala media	The cochlear duct (or scala media) is an endolymph filled cavity inside the cochlea, located in between the tympanic duct and the vestibular duct, separated by the basilar membrane and Reissner's membrane (the vestibular membrane) respectively. The cochlear duct houses the organ of Corti.
Scala tympani	The tympanic duct or scala tympani is one of the perilymph-filled cavities in the inner ear of the human. It is separated from the cochlear duct by the basilar membrane, and it extends from the round window to the helicotrema, where it continues as vestibular duct.
Scala vestibuli	The vestibular duct or scala vestibuli is a perilymph-filled cavity inside the cochlea of the inner ear that conducts sound vibrations to the cochlear duct. It is separated from the cochlear duct by Reissner's membrane and extends from the vestibule of the ear to the helicotrema where it joins the tympanic duct.
Semicircular canal	A semicircular canal or a semicircular duct is one of three semicircular, interconnected tubes located inside each ear. The three canals are: • the horizontal semicircular canal (also known as the lateral semicircular canal),

	• superior semicircular canal (also known as the anterior semicircular canal), • and the posterior semicircular canal.

Space_of_Nuel	A fluid filled space within the organ of Corti called also space of Nuel
Spiral canal of cochlea	Rosenthal's canal or the spiral canal of the cochlea is a section of the bony labyrinth of the inner ear that is approximately 30 mm long and makes 2¾ turns about the modiolus.
Spiral ligament of cochlear duct	The periosteum, forming the outer wall of the ductus cochlearis, is greatly thickened and altered in character, and is called the spiral ligament.
Spiral limbus	The osseous spiral lamina consists of two plates of bone, and between these are the canals for the transmission of the filaments of the acoustic nerve. On the upper plate of that part of the lamina which is outside the vestibular membrane, the periosteum is thickened to form the limbus spiralis (or limbus laminæ spiralis), this ends externally in a concavity, the sulcus spiralis internus, which represents, on section, the form of the letter C.
Spiral organ of cochlea	The organ of Corti (or "spiral organ"), found only in mammals, is in the cochlear duct, of the cochlea of the inner ear and is provided with hair cells or auditory sensory cells. It evolved from the basilar papilla found in all tetrapods, except for a few derived species that have lost it.
Spiral sulcus	A concavity in the floor of the cochlear duct formed by the overhanging vestibular lip.
Spiral_canal_of_the_cochlea	Rosenthal's canal or the spiral canal of the cochlea is a section of the bony labyrinth of the inner ear that is approximately 30 mm long and makes 2¾ turns about the modiolus.
Spiral_ganglion	The spiral (cochlear) ganglion is the group of nerve cells that serve the sense of hearing by sending a representation of sound from the cochlea to the brain. The cell bodies of the spiral ganglion neurons are found in the modiolus, the conical shaped central axis in the cochlea.

Spiral_lamina_of_cochlea	A spiral bony shelf extending from the modiolus across the spiral canal of the cochlea, forming the division between the scala vestibuli and scala tympani in the inner ear.
Spongy_bone	Bone in which the spicules form a latticework, with interstices filled with embryonic connective tissue or bone marrow
Stapes	The stapes /ˈsteɪpiːz/ is a bone in the middle ear of humans and other mammals which is involved in the conduction of sound vibrations to the inner ear. The stirrup-shaped small bone is one of three ossicles in the middle ear. The stapes receives vibrations from the incus, to which it is connected laterally, and transmits these to the oval window, medially. The stapes is the smallest and lightest named bone in the human body, and is so-called because of its resemblance to a stirrup (Latin: Stapes).
Stapes_footplate	The footplate of the stapes helps with hearing. The stapes bone notifies the oval window when movement occurs. The stapes footplate proceeds into the oval window, sending the round window membrane out, allowing for the fluid in the cochlea to move, which leads to the cochlear inner hair cells' movement, and finally, hearing.
Stereocilia	Stereocilia (or stereovilli) are apical modifications of the cell, which are distinct from cilia and microvilli, but closely related to the latter. Though their name is similar to cilia, they are actually more closely related to microvilli, and some sources consider them to be a variant of the latter,[1] rather than their own distinct type of structure. In structure, they are longer than typical microvilli, and have more of the characteristics of the cellular membrane proper
Stereocilium	In the inner ear, stereocilia are the mechanosensing organelles of hair cells, which

	respond to fluid motion in numerous types of animals for various functions, including hearing and balance. They are about 10–50 micrometers in length and share some similar features of microvilli. The hair cells turn the fluid pressure and other mechanical stimuli into electric stimuli via the many microvilli that make up stereocilia rods. Stereocilia exist in the auditory and vestibular systems.
Stereocilium of cochlear hair cell	As acoustic sensors in mammals, stereocilia are lined up in the Organ of Corti within the cochlea of the inner ear. In hearing, stereocilia transform the mechanical energy of sound waves into electrical signals for the hair cells, which ultimately leads to an excitation of the auditory nerve.
Stereovilli	Stereocilia (or stereovilli) are apical modifications of the cell, which are distinct from cilia and microvilli, but closely related to the latter.
Stria vascularis of cochlear duct	The upper portion of the spiral ligament contains numerous capillary loops and small blood vessels, and is termed the stria vascularis. It produces endolymph for the scala media, one of the three fluid-filled compartments of the cochlea. The stria is a somewhat stratified epithelium containing primarily three cell types (marginal, intermediate, and basal cells) and intraepithelial capillaries. The marginal cells are involved primarily in K+ transport and line the endolymphatic space of the scala media. The intermediate pigment-containing cells are scattered among capillaries. The basal cells separate stria vascularis from the underlying spiral ligament.
Superior_olivary_complex_of_the_brain_stem	The fibers synapse, and second-order neurons pass mainly to the opposite side of the brain stem to terminate in the superior olivary nucleus. A few second-order fibers also pass to the superior olivary nucleus on the same side.

	From the superior olivary nucleus, the auditory pathway passes upward through the lateral lemniscus.
Supporting cell	General term - maybe of carotid body, of organ of Corti.
Tectorial membrane of cochlea	The tectorial membrane (TM) is one of two acellular gels in the cochlea of the inner ear, the other being the basilar membrane (BM). The TM is located above the sulcus spiralis internus and the spiral organ of Corti and extends along the longitudinal length of the cochlea parallel to the BM. Radially the TM is divided into three zones, the limbal, middle and marginal zones.
Temporal bone	The temporal bones are situated at the sides and base of the skull, and lateral to the temporal lobes of the cerebrum. The temporal bone supports that part of the face known as the temple and houses the structures of the organ of hearing. The lower seven cranial nerves and the major vessels to and from the brain traverse the temporal bone.
Transudate	Body substance in liquid state, which is derived from plasma by passage through the (intact) wall of capillaries without further processing by secretory cells or glands.
Tunnel_of_Corti	Viewed in cross section the most striking feature of the organ of Corti is the arch, or tunnel, of Corti, formed by two rows of pillar cells, or rods. The pillar cells furnish the major support of this structure.
Tympanic membrane	In human anatomy, the eardrum, or tympanic membrane, is a thin, cone-shaped membrane that separates the external ear from the middle ear in humans and other tetrapods. Its function is to transmit sound from the air to the ossicles inside the middle ear, and then to the oval window in the

	fluid-filled cochlea. Hence, it ultimately converts and amplifies vibration in air to vibration in fluid. The malleus bone bridges the gap between the eardrum and the other ossicles.
Tympanic_canal	A minute canal that passes from the petrous portion of the temporal bone between the jugular fossa and carotid canal to the floor of the tympanic cavity and transmits the tympanic branch of the glossopharyngeal nerve.
Tympanic_duct	The tympanic duct or scala tympani is one of the perilymph-filled cavities in the inner ear of the human. It is separated from the cochlear duct by the basilar membrane, and it extends from the round window to the helicotrema, where it continues as vestibular duct. The purpose of the perilymph-filled tympanic duct and vestibular duct is to transduce the movement of air that causes the tympanic membrane and the ossicles to vibrate, to movement of liquid and the basilar membrane.
Vestibular membrane of cochlear duct	Has two layers of squamous epithelial cells separated by a basal lamina; the aspect facing the scala vestibuli bears perilymphatic cells; the endolymphatic aspect has typical squamous epithelial cells, also joined by zonulae occludentes and containing mitochondria and many vesicles.
Vestibular nerve	The vestibular nerve is one of the two branches of the Vestibulocochlear nerve (the cochlear nerve being the other). In humans the vestibular nerve transmits sensory information transmitted by vestibular hair cells located in the two otolith organs (the utricle and the saccule) and the three semicircular canals via the vestibular ganglion. Information from the otolith organs reflects gravity and linear accelerations of the head. Information from the semicircular canals reflects rotational movement of the head. Both are necessary for the

	sensation of body position and gaze stability in relation to a moving environment.
Vestibular system	The vestibular system, which contributes to balance in most mammals and to the sense of spatial orientation, is the sensory system that provides the leading contribution about movement and sense of balance.
Vestibular_canal	The division of the spiral canal of the cochlea lying above the spiral lamina and the vestibular membrane
Vestibular_duct	The vestibular duct or scala vestibuli is a perilymph-filled cavity inside the cochlea of the inner ear that conducts sound vibrations to the cochlear duct. It is separated from the cochlear duct by Reissner's membrane and extends from the vestibule of the ear to the helicotrema where it joins the tympanic duct.
Vestibular_wall	The membrane separating the cochlear duct from the vestibular canal; it consists of squamous epithelial cells with microvilli toward the ductus, a basement membrane, and a thin layer of connective tissue toward the scala.
Vestibule of bony labyrinth	Central part of the bony labyrinth; lies medial to the tympanic cavity, posterior to the cochlea and anterior to the semicircular canals
Vestibulocochlear nerve	The vestibulocochlear nerve (auditory vestibular nerve), known as the eighth cranial nerve, transmits sound and equilibrium (balance) information from the inner ear to the brain.

3.2 ARGUMENTATION

The Argumentation terms feed the Argument Model Ontology, which is an OWL 2 DL ontology that allows to describe argumentation according to the 'Toulmin Model of Argument'. Throughout many of his works, Toulmin pointed out that absolutism (represented by theoretical or analytic arguments) has limited practical value. Absolutism is derived from Plato's idealized formal logic, which advocates universal truth; accordingly, absolutists believe that moral issues can be resolved by adhering to a standard set of moral principles, regardless of context. By contrast, Toulmin asserts that many of these so-called standard principles are irrelevant to real situations encountered by human beings in daily life.

Term	Description
argument	An argument, or practical argument according to the 'Toulmin model of argument', focuses on the justificatory function of argumentation: practical arguments first find a claim of interest, and then provide justification for it. Each argument must be analyzed according to six interrelated components: claim, evidence, warrant, backing, rebuttal and qualifier. The first three elements, 'claim', 'data' and 'warrant', are considered as the essential components of practical arguments, while the second triad, 'qualifier', 'backing', and 'rebuttal', may not be needed in some arguments.
argumentation entity	An entity that takes part in an argument according to the 'Toulmin model of argument'.
backing	Sort of credentials that certifies the warrant - e.g., the OWL 2 document specifications.
claim	A fact that must be established - e.g., 'This is a consistent OWL ontology'.
evidence	A fact that represents a foundation for the claim - e.g., 'This ontology was developed in OWL'.
qualifier	Words or phrases that express the degree of certainty of the claim such as "certainly", "possible", "probably", "presumably", etc.
rebuttal	Restrictions that may be applied to the claim - 'Unless a reasoner for OWL 2 proves that it is not consistent'.
warrant	A statement bridging from the evidence to the claim -

	e.g., 'An ontology developed in OWL is a consistent OWL ontology'.

3.3 CLINICAL DATA

Term	Description
ActionPotentials	Component potentials of the human electrocochleogram are: cochlear microphonics (CM), summating potentials (SP), and action potentials (AP). APs are the neural potentials generated by the cochlear nerve.
AirConduction	In air conduction, the sound energy moves the tympanic membrane (ear drum). The membrane is connected to the malleus bone, which connects to the incus bone, which connects to the stapes bone. Thus the movement of the air results in the movement of the stapes. When the stapes moves, it vibrates the fluid in cochlea and moves the basilar membrane, which stimulates the hair cells. The hair cells stimulate the acoustic nerve (cranial nerve VIII), and this nerve conveys the sound information into the brain via the cochlear nuclei and complicated pathways within the brain. This is air conduction.
Audiometry	Audiometry is the science of measuring hearing acuity for variations in sound intensity and pitch and for tonal purity, involving thresholds and differing frequencies. Results of audiometric tests are used to diagnose hearing loss or diseases of the ear, and often make use of an audiogram.
AuditoryBrainstemResponse	is an auditory evoked potential extracted from ongoing electrical activity in the brain and recorded via electrodes placed on the scalp. It carries a little relation to cochlea; it is mainly directed and used for retro-cochlear lesions.
AuditorySteadyStateResponse	Auditory Steady State Response is an auditory evoked potential, elicited with modulated tones that can be used to predict hearing sensitivity in patients of all ages.
BoneConduction	Bone conduction is the conduction of sound to the

	inner ear through the bones of the skull.
BoneVibrator	is a vibrator placed on the mastoid process of the skull used to stimulate the cochlea by bone conduction of sound.
Click	Auditory nerve and brainstem evoked potentials (ABEP) are optimally recorded from the scalp by disc or cup electrodes in response to high intensity clicks presented at a rate of approximately ten per second. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008
CochlearMicrophonic	Component potentials of the human electrocochleogram are: cochlear microphonics (CM), summating potentials (SP), and action potentials (AP). These potentials can either be recorded independently or in various combinations. CM and SP are generated in the organ of Corti and are a type of receptor potential.
Conduction	Conduction of sound to the inner ear
DistortionProductOAE	Distortion product OAEs (DPOAEs) are evoked using a pair of primary tones f_1 and f_2 with particular intensity (usually either 65 - 55 dBSPL or 65 for both) and ratio ($f_1 : f_2$). The evoked responses from these stimuli occur at frequencies (f_{dp}) mathematically related to the primary frequencies, with the two most prominent being $f_{dp} = 2f_1 - f_2$ (the "cubic" distortion tone, most commonly used for hearing screening) and $f_{dp} = f_2 - f_1$ (the "quadratic" distortion tone, or simple difference tone).
ElectricalNoise	Electrical Noise: When equipment is plugged in to wall outlets i.e. not battery operated, line noise can interfere with the test and lead to inaccurate results. http://www.azdhs.gov/lab/aznewborn/documents/pr

	oviders/A13-Glossary.pdf
Electrocochleography	is a technique of recording stimulus-related responses or electrical potentials of the inner ear and auditory nerve. Component potentials of the human electrocochleogram are: cochlear microphonics (CM), summating potentials (SP), and action potentials (AP). These potentials can either be recorded independently or in various combinations. CM and SP are generated in the organ of Corti and are a type of receptor potential. APs are the neural potentials generated by the cochlear nerve.
Exam	Clinical examination for evaluation of patient hearing
ExtraTympanicElectrode	Some of the commercially available ear canal electrodes are foam earplug, eartrode and tiptrode. http://en.wikipedia.org/wiki/Electrocochleography
FoamEarplug	An earplug is a device that is meant to be inserted in the ear canal to protect the user's ears from loud noises or the intrusion of water, foreign bodies, dust or excessive wind. Foam earplugs, mainly made of memory foam, which are compressed and put into the ear canal, where they expand to plug it.
Headphone	Used for air conduction of sound
HearingInNoiseTest	The Hearing in Noise Test (HINT) measures a person's ability to hear speech in quiet and in noise. During the test, the patient uses both ears together (binaural hearing) to repeat sentences. Binaural hearing ability is essential for communication in noisy settings and for other aspects of functional hearing, such as sound localization and recognition of environmental sounds. In this test, the patient is required to repeat sentences both in a quiet environment and with competing noise being presented from different directions. http://www.californiaearinstitute.com/audiology-

	services-hint-bay-area-ca.php
HearingThreshold	The threshold of hearing is defined as the 'level of a sound at which, under specified conditions, a person gives 50 percent of correct detection responses on repeated trials'. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008
HistologySection	Histology sections: These refer to the segmented images, coming from temporal bones of already dead patients. Temporal bones are prepared in the standard manner for light microscopic study including fixation in 10% formalin, decalcification with ethylene diamine tetra-acetate, embedment in celloidin, serial sectioning at a thickness of 20 mm, and staining of every tenth section with hematoxylin and eosin. This means that the representative slices are taken for studying the pathology of cochlea elements.
Insert	Refers to insert earphones
Loudspeaker	A loudspeaker (or loud-speaker or speaker) is an electroacoustic transducer; a device which converts an electrical audio signal into a corresponding sound.
MicroCTImage	Micro CT images: Microtomography (commonly known as Industrial CT Scanning), is similar to tomography; uses X-rays to create cross-sections of a 3D-object that later can be used to recreate a virtual model without destroying the original model. The termmicro is used to indicate that the pixel sizes of the cross-sections are in the micrometer range. These pixel sizes have also resulted in the terminology micro-computed tomography, micro-ct, micro-computer tomography, high-resolution X-ray tomography, and similar terminologies. All of these names generally represent the same class of instruments.
MinimumAudibilityCurve	This is a graph of hearing threshold against frequency.

	It is used as a reference level when using an audiogram to measure hearing loss.
MyogenicNoise	Myogenic noise: Noise that comes from muscles when they contract such as when a baby moves or sucks that can interfere with getting accurate screening results. http://www.azdhs.gov/lab/aznewborn/documents/providers/A13-Glossary.pdf
NeuralPotential	Are potentials generated by the cochlear nerve
Noise	In electrocochleography analysis time of 5-10 ms allows signal averaging and preamplifier amplification factor may be as high as 50,000 -100,000 times for ET and 5,000-25,000 times for TT is used depending on the level of background, electrical, myogenic, and encephalographic noise. http://en.wikipedia.org/wiki/Electrocochleography
NoiseLevel	The level of noise of a signal.
NonInvasive	Recorded from the ear canal or from using an electrode resting on the tympanic membrane.
NormalHearingLevel	Defined as -10dB to 25 dB
OtoaccousticEmission	Otoacoustic Emissions (OAEs): OAEs are considered to be related to the amplification function of the cochlea. In the absence of external stimulation, the activity of the cochlear amplifier increases, leading to the production of sound. Evaluating this does not require patient compliance, thus it is suitable for infants. It examines cochlea (specifically Outer Hair Cell) functionality only. It is highly sensitive.
Potential	These are electrical voltages (potentials) that are stimulus-related responses of the inner ear and auditory nerve that are recorded in electrocochleagraphy (ECochG or Ecog).
PsychoacousticTuningCurve	PTCs show the level of a masker (dB SPL) tone at threshold, as a function of deviation from center frequency (Hz).

	They are measured by presenting a fixed low intensity pure tone while also presenting a narrow-band masker, with a varying center frequency. The masker level is varied, so that the level of masker needed to just mask the test signal is found for the masker at each center frequency. The tip of the PTC is where the masker level needed to just mask the test signal is the lowest. For normal hearing people this is when the masker center frequency is closest to the frequency of the test signal.
PureToneAudiometry	Is where a patient responds to different sounds and threshold is determined as the lowest level of sound, which the patient can detect. It examines middle and inner ear output. Purpose of PTA is to 'determine hearing threshold levels for pure tones'. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008.
PureToneTestFrequency	A pure tone is completely characterised by one frequency value and one sound pressure level. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008.
Rarefaction	Rarefaction is the reduction of an item's density, the opposite of compression.[1] Like compression, which can travel in waves (sound waves, for instance), rarefaction waves also exist in nature. A common rarefaction wave is the area of low relative pressure following a shock wave (see picture).
ReceptorPotential	Receptor potential is the Trans membrane potential of a sensory receptor. http://www.ask.com/question/what-is-a-receptor-potential, also called 'generator potential’
RestingPotential	Same as steady state potential

RinneTest	The Rinne test (/ˈrɪnə/ rin-ə) is a hearing test, primarily for evaluating loss of hearing in one ear (unilateral hearing loss). It compares perception of sounds transmitted by air conduction to those transmitted by bone conduction through the mastoid. Thus, one can quickly screen for the presence of conductive hearing loss. A Rinne test should always be accompanied by a Weber test to also detect sensorineural hearing loss and thus confirm the nature of hearing loss.
SignalToNoiseRatio	Difference in dB between level of signal and level of background noise (SNR or S/N). http://quizlet.com/24196451/introduction-to-audiology-speech-audiometry-flash-cards/
SoundField	When sounds are presented through speakers inside a sound booth it is called sound-field screening. This is used when use of earphones for the test is not possible such as when a child refuses to wear them. Since sound-field screening does not give ear-specific information, a unilateral hearing loss (hearing loss in only one ear) may be missed. http://www.asha.org/public/hearing/Pure-Tone-Testing
SoundLevel	Sound pressure level (SPL) or sound level is a logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level. The standard reference sound pressure in air or other gases is 20 µPa, which is usually considered the threshold of human hearing (at 1 kHz).
SoundPressureLevel	Sound pressure level (SPL) or sound level is a logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level. The standard reference sound pressure in air or other gases is 20 µPa, which is usually considered the

	threshold of human hearing (at 1 kHz).
SpontaneousOAE	Spontaneous OAEs (SOAEs) appear without any sound stimulation at a few frequencies in a healthy cochlea and seem to be a direct consequence of the cellular force generation of outer hair cells.
Stacked	Stacked ABR is defined as "…an attempt to record the sum of the neural activity across the entire frequency region of the cochlea in response to a click stimuli."
Stimulus	Used to evoke an electricl potential response of the inner ear and auditory nerve.
StimulusFrequencyOAE	Stimulus Frequency OAEs (SFOAEs) are measured during the application of a pure-tone stimulus, and are detected by the vectorial difference between the stimulus waveform and the recorded waveform (which consists of the sum of the stimulus and the OAE).
StimulusPolarity	The polarity of the stimuli used in electrocochleography can be rarefaction, condensation or alternating.
SummatingPotential	Component potentials of the human electrocochleogram are: cochlear microphonics (CM), summating potentials (SP), and action potentials (AP). These potentials can either be recorded independently or in various combinations. CM and SP are generated in the organ of Corti and are a type of receptor potential.
SurfaceElectrode	A surface electrode may be used to monitor the general picture of muscle activation.
ThresholdEqualisingNoise	The Threshold Equalising Noise test (TEN) involves doing pure-tone audiometry in the presence of a special background noise called "threshold-equalising noise" (Moore et al, 2000). Moore, B.C.J., Huss, M., Vickers, D.A., Galsberg, B.R., and Alcantara, J.I. 2000. A test for the diagnosis of dead regions in the cochlea. British Journal of

	Audiology 34: 205-224.
Transducer	Converts from one form of energy to another form - for Sifem the energy being transduced is sound energy e.g. of transducer is earphone or speaker.
TransducerPosition	Attached to the scalp, on the mastoid, the ear lobe or resting on tympanic membrane etc.
TransientOAE	Transient-evoked OAEs (TEOAEs or TrOAEs) are evoked using a click (broad frequency range) or toneburst (brief duration pure tone) stimulus. The evoked response from a click covers the frequency range up to around 4 kHz, while a toneburst will elicit a response from the region that has the same frequency as the pure tone.
TranstympanicNeedle	Is a needle electrode that is inserted through the tympanic membrane to measue the cochlear microphonic potential (which is one of the component potentials of the electrocochleogram).
TuningForkTest	Tuning forks are used to distinguish between a conductiveand a sensorineural hearing loss. There are three commonly used tuning forks: 256, 512 and 1024 Hz. The most commonly used forks are the 256- and 512-Hzforks, as these give more reliable responses than the 1024-Hz fork. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008
VisualInspection	Visual inspection, and preferably tympanometric measurement prior to AOEs recordings, will help determine if middle ear and external ear abnormalities might reduce or block acoustic transmission of OAEs from the cochlea. Gleeson, Michael J., et al., eds. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press, 2008.
Wave I, II, III, IV, V	The auditory structures that generate the auditory

	brainstem response are believed to be as follows: Wave I – generated by cranial nerve VIII Wave II – generated by the cochlear nucleus Wave III – generated by the superior olivary complex Wave IV – generated by the lateral lemniscus Wave V – generated by the inferior colliculus http://en.wikipedia.org/wiki/Auditory_brainstem_response
WeberTest	The Weber test is a quick screening test for hearing. It can detect unilateral (one-sided) conductive hearing loss (middle ear hearing loss) and unilateral sensorineural hearing loss (inner ear hearing loss).

3.4 DATA ANALYSIS

Term	Description
BehaviourRegion	This is a region of interest in one DataViewDimension which can be delineated by the hasRegionStart and hasRegionEnd data properties which hold values of the Index of the DataViewDimension
ConcaveShape	A shape that curves or bends inward
ConvexShape	A shape that curves or bulges outward
CurveShape	A continuously bending line that has no straight parts
DataSet	A dataSet represents the results of a single experiment
DataView	A data view is a subset of a dataset that has one or more data view dimensions
DataViewDimension	A data view dimension is one dimension of a data view. Each dimension is composed of a set of data value and index pairs (like an array holds values at a given position in the array).
DataViewDimensionPair	A DataViewDimensionPair is like one item from an array consisting of the array index and the information value stored at this index
ExponentialGrowth	Exponential growth occurs when the growth rate of the value of a mathematical function is proportional to the function's current value
Growth	The process of increasing in size.
InflexionPoint	An inflection point is a point on a curve at which the sign of the curvature (i.e., the concavity) changes. Inflection points may be stationary points, but are not local maxima or local minima.
LinearGrowth	A quantity increasing in line with another variable, in a relationship which approximates to a straight line on a graph
Maximum	The greatest amount, extent, or intensity possible, permitted, or recorded.
Minimum	The least or smallest amount or quantity possible,

	attainable, or required
NegativeSlope	A line with a negative slope is a line that is trending downward from left to right. In other words, the line's rise to run ratio is a negative value.
NeutralSlope	The neutral slope is an slope in the cross section of a beam (a member resisting bending) or shaft along which there are no longitudinal stresses or strain
Optimum	Most conducive to a favourable outcome; best
PolynomialGrowth	If $\#(n) \leq C(n^k + 1)$ for some $C, k < \infty$ we say that G has a polynomial growth rate.
PositiveSlope	If a line has a positive slope, the changes in x and y will always have the same sign.
SigmoidShape	A sigmoid function is a mathematical function having an "S" shape (sigmoid curve). Often, sigmoid function refers to the special case of the logistic function shown in the first figure and defined by the formula $S(t) = \frac{1}{1 + e^{-t}}.$
Slope	In mathematics, the slope or gradient of a line is a number that describes both the direction and the steepness of the line. Slope is often denoted by the letter m. The direction of a line is either increasing, decreasing, horizontal or vertical.

3.5 MATERIAL PROPERTIES

Term	Description
EngineeringMaterial	Materials science, also commonly known as materials science and engineering, is an interdisciplinary field, which deals with the discovery and design of new materials.
InformationSource	An information source is a source of information for somebody, i.e. anything that might inform a person about something or provide knowledge about it. Different types of questions require different sources of information.
MaterialProperty	A materials property is an intensive, often quantitative, property of some material. Quantitative properties may be used as a metric by which the benefits of one material versus another can be assessed, thereby aiding in materials selection. A property may be a constant or may be a function of one or more independent variables, such as temperature. Materials properties often vary to some degree according to the direction in the material in which they are measured, a condition referred to as anisotropy. Materials properties that relate two different physical phenomena often behave linearly (or approximately so) in a given operating range, and may then be modeled as a constant for that range. This linearization can significantly simplify the differential constitutive equations that the property describes.
ChemicalComposition	The chemical composition (or simple composition) is a concept that has different (but similar) meanings if referred to a single pure substance or a mixture.
Equation	A statement that the values of two mathematical expressions are equal
ManufacturingCondition	A process in which a stimulus that was previously neutral comes to evoke a particular response, as

	salivation, by being repeatedly paired with another stimulus that normally evokes the response
MeasurementMethod	The technique or process used to obtain data describing the factors of a process or the quality of the output of the process.
Specimen	A part or an individual taken as exemplifying a whole mass or number
Orientation	The action of orienting someone or something relative to the points of a compass or other specified positions.

3.6 PHYSIOLOGY

Term	Description
ActionPotential	In physiology, an action potential is a short-lasting event in which the electrical membrane potential of a cell rapidly rises and falls, following a consistent trajectory. Action potentials occur in several types of animal cells, called excitable cells, which include neurons, muscle cells, and endocrine cells, as well as in some plant cells. In neurons, they play a central role in cell-to-cell communication. In other types of cells, their main function is to activate intracellular processes. In muscle cells, for example, an action potential is the first step in the chain of events leading to contraction. In beta cells of the pancreas, they provoke release of insulin.[a] Action potentials in neurons are also known as "nerve impulses" or "spikes", and the temporal sequence of action potentials generated by a neuron is called its "spike train". A neuron that emits an action potential is often said to "fire".
Amplitude	The extent of a movement measured from the starting point or position of equilibrium; applied especially to vibratory movements.
ApexToBasis	From the top to the bottom of cochlea
BasilarMembranePosition	The basilar membrane position towards scala tympani
BasilarMembraneTuningGraph	These graphs have Frequency (measured in kHz) on the (logarithmic) x-axis and Sound pressure level (measured in deciBels) on th e(linear) y-axs. e.g. Figure 229.23 page 3199 Scott-Brown's Otorhinilaryngology Head and Neck Surgery Vol. Used to see if the tuning graph has a high or low threshold and whether it is sharply or broadly tuned.
BasisToApex	From the bottom to the top of cochlea
BMTuningGraphPointPair	Frequency selectivity precedes the transduction to neural signals, as shown by the sharp tuning of mechanical responses of the basilar membrane (BM).
BMTuningGraphXAxis	The horizontal axis plots the frequency of the input stimulus

BMTuningGraphYAxis	The vertical axis plots the threshold stimulus intensity, the minimum sound pressure level (in dB) needed to evoke a response.
CharacteristicFrequency	The frequency at which the neuron responds at the minimum threshold.
CochlearCondition	Poor, good or post mortem
FrequencyUnit	In Hz
GraphScale	Linear or logarithmic
Frequency	Frequency is usually measured in cycles per second, or hertz. The human ear is most sensitive to and most easily detects frequencies of 1,000 to 4,000 hertz, but at least for normal young ears the entire audible range of sounds extends from about 20 to 20,000 hertz. Sound waves of still higher frequency are referred to as ultrasonic, although they can be heard by other mammals
HearingThreshold	The hearing threshold is the sound level below which a person's ear is unable to detect any sound. For adults, 0 dB is the reference level. A threshold shift is an increase in the hearing threshold for a particular sound frequency.

HighFrequency	Modelling 'Place coding' and 'Characteristic frequency' concept by making three classes (HighFrequency, MidFrequency and LowFrequency) which are subclasses of Frequency and appling a onstraint that HighFrequency is responded to by some Basal turn etc. Definitions of low. mid and high depend on species e.g.
	• Human:
	  ○ Base 20kHz
	  ○ Apical <10 Hz
	• Bat:
	  ○ Base 160 kHz
	• Cat:
	  ○ Basal 40 kHz
	• Guinea pig:
	  ○ Basal turn 16-21 kHz
	  ○ 2nd turn 5 kHz
	  ○ Start of 3rd turn 2-5 kHz
	  ○ End of third turn 15 Hz

	• Mole rat: Apical 15 Hz

InputFrequency	The frequency in Hz entered by the researcher
Location	Left cochlea or right cochlea
Loudness	Loudness is the characteristic of a sound that is primarily a psychological correlate of physical strength (amplitude). In acoustics, attribute of sound that determines the intensity of auditory sensation produced. The loudness of sound as perceived by human ears is roughly proportional to the logarithm of sound intensity: when the intensity is very small, the sound is not audible; when it is too great, it becomes painful and dangerous to the ear. The sound intensity that the ear can tolerate is approximately 1012 times greater than the amount that is just perceptible. This range varies from person to person and with the frequency of the sound.
LowFrequency	Low frequency or low freq or LF is the ITU designation[1] for radio frequencies (RF) in the range of 30 kHz–300 kHz.
MaximumDisplacement	Maximun displacement or Amplitude is the maximum variation in: height, depth, pressure, field strength, current density, etc. that the wave produces
NerveImpulse	A nerve impulse is a wave of electrical activity that passes from one end of a neuron to the other.
PeakAmplitude	This is the maximum absolute value of the signal.
PhysicalUnit	In Hz for frequency
Pitch	Pitch is the perception of the frequency of sound waves—i.e., the number of wavelengths that pass a fixed point in a unit of time
SoundIntensity	Sound intensity or acoustic intensity is defined as the sound power per unit area. The usual context is the noise measurement of sound intensity in the air at a listener's location as a sound energy quantity. Sound intensity is not the same physical quantity as sound pressure. Hearing is directly sensitive to sound pressure, which is related to sound intensity. In consumer audio electronics, the level differences are called "intensity" differences, but sound intensity is a specifically defined quantity and cannot be sensed by a simple microphone.
SoundPressure	Sound pressure or acoustic pressure is the local pressure

	deviation from the ambient (average, or equilibrium) atmospheric pressure, caused by a sound wave. In air, sound pressure can be measured using a microphone, and in water with a hydrophone.
SoundPressureUnit	It is measured in pascals (Pa).
Species	Guinea pig or human or embryonic mouse
TravellingWave	Refers to the mechanical travelling wave in the cochlea
TuningType	Applies to basilar membrane tuning graph which can be broadly or sharply tuned
Vibration	Vibration is a mechanical phenomenon whereby oscillations occur about an equilibrium point

3.7 SIMULATION

Term	Description
DataFile	Data files can be read by the read data command to begin a simulation, which also describes their format
DataMapping	Data Mapping is a straightforward one to one type Data Transformation that involves no calculations.
DataTransformation	There are two classes of data transformation Data mapping and derivation: Data Mapping is a straightforward one to one type of data transformation that involves no calculations while Derivations are a type of data mapping that are not a straighforward one to one mapping but instead involve some work e.g. such as the calcuklation of the distance from the cavity base in the OpenFOAm moving lid example. They may involve the use of a SPARQL query or of a script in which case you will need to use the data properties 'hasAssociatedQuery' or 'hasAssociatedScript' respectively.
Derivation	Derivations are a type of data mapping that are not a straighforward one to on emapping but involve some work e.g. such as the calculation of the distance from the cavity base in the OpenFOAm moving lid example. They may involve the use of a SPARQL query or of a script in which case you will need to use the data properties 'hasAssociatedQuery' or 'hasAssociatedScript' respectively.
FeatureExtraction	This involves the extraction of features such as slopes and maxima and minima.
GraphFile	Consider moving this class to Graph Ontology and Data Analysis Ontology
InputDataFile	Mainly in .igs format or .dat format or .stl.
Method	The finite element modelling method

OutputDataFile	The output data file of the PAK software
Simulation	Simulation is the imitation of the operation of a real-world process or system over time.[1] The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviors/functions of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.
Solver	End user can set geometrical parameters of the cochlea model, set material properties, create mesh, set boundary conditions and loads of the model, either box model or coiled model of the cochlea. Model can be solved with modal analysis or with time domain analysis.
VectorEntity	The entity that will be used in the simulation
VectorFieldGraphFile	It can visualize the vector field, calculate divergence and also plot the curl of the field
VectorValue	The value of the vector that will be used in the simulation
Visualisation	Visualisation -- of data gathered from experiment as well as simulation -- is key to extract insight and understanding.
Activity	A case study scenario of the simulation
ActivityInfluence	ActivityInfluence provides additional descriptions of an Activity's binary influence upon any other kind of resource. Instances of ActivityInfluence use the prov:activity property to cite the influencing Activity
AgentInfluence	It is not recommended that the type AgentInfluence be asserted without also asserting one of its more specific subclasses
Association	An instance of prov:Association provides additional descriptions about the binary prov:wasAssociatedWith relation from an prov:Activity to some prov:Agent that had some

	responsiblity for it. For example, :baking prov:wasAssociatedWith :baker; prov:qualifiedAssociation [a prov:Association; prov:agent :baker; :foo :bar].
Attribution	An instance of prov:Attribution provides additional descriptions about the binary prov:wasAttributedTo relation from an prov:Entity to some prov:Agent that had some responsible for it. For example, :cake prov:wasAttributedTo :baker; prov:qualifiedAttribution [a prov:Attribution; prov:entity :baker; :foo :bar].
Bundle	Note that there are kinds of bundles (e.g. handwritten letters, audio recordings, etc.) that are not expressed in PROV-O, but can be still be described by PROV-O.
Collection	A collection of entities
Communication	An instance of prov:Communication provides additional descriptions about the binary prov:wasInformedBy relation from an informed prov:Activity to the prov:Activity that informed it. For example, :you_jumping_off_bridge prov:wasInformedBy :everyone_else_jumping_off_bridge; prov:qualifiedCommunication [a prov:Communication; prov:activity :everyone_else_jumping_off_bridge; :foo :bar].
Delegation	An instance of prov:Delegation provides additional descriptions about the binary prov:actedOnBehalfOf relation from a performing prov:Agent to some prov:Agent for whom it was performed. For example, :mixing prov:wasAssociatedWith :toddler . :toddler prov:actedOnBehalfOf :mother; prov:qualifiedDelegation [a prov:Delegation; prov:entity :mother; :foo :bar].
Derivation	An instance of prov:Derivation provides additional descriptions about the binary prov:wasDerivedFrom relation from some derived prov:Entity to another

	prov:Entity from which it was derived. For example, :chewed_bubble_gum prov:wasDerivedFrom :unwrapped_bubble_gum; prov:qualifiedDerivation [a prov:Derivation; prov:entity :unwrapped_bubble_gum; :foo :bar].
EmptyCollection	An empty collection of entities
End	An instance of prov:End provides additional descriptions about the binary prov:wasEndedBy relation from some ended prov:Activity to an prov:Entity that ended it. For example, :ball_game prov:wasEndedBy :buzzer; prov:qualifiedEnd [a prov:End; prov:entity :buzzer; :foo :bar; prov:atTime '2012-03-09T08:05:08-05:00'^^xsd:dateTime].
Entity	A parameter used in the simulation
EntityInfluence	EntityInfluence provides additional descriptions of an Entity's binary influence upon any other kind of resource. Instances of EntityInfluence use the prov:entity property to cite the influencing Entity.
Generation	An instance of prov:Generation provides additional descriptions about the binary prov:wasGeneratedBy relation from a generated prov:Entity to the prov:Activity that generated it. For example, :cake prov:wasGeneratedBy :baking; prov:qualifiedGeneration [a prov:Generation; prov:activity :baking; :foo :bar].
Influence	An instance of prov:Influence provides additional descriptions about the binary prov:wasInfluencedBy relation from some influenced Activity, Entity, or Agent to the influencing Activity, Entity, or Agent. For example, :stomach_ache prov:wasInfluencedBy :spoon; prov:qualifiedInfluence [a prov:Influence; prov:entity :spoon; :foo :bar] . Because prov:Influence is a broad relation, the more specific relations (Communication, Delegation, End, etc.) should be used when applicable.
InstantaneousEvent	An instantaneous event, or event for short, happens

	in the world and marks a change in the world, in its activities and in its entities. The term 'event' is commonly used in process algebra with a similar meaning. Events represent communications or interactions; they are assumed to be atomic and instantaneous.
Invalidation	An instance of prov:Invalidation provides additional descriptions about the binary prov:wasInvalidatedBy relation from an invalidated prov:Entity to the prov:Activity that invalidated it. For example, :uncracked_egg prov:wasInvalidatedBy :baking; prov:qualifiedInvalidation [a prov:Invalidation; prov:activity :baking; :foo :bar].
Plan	There exist no prescriptive requirement on the nature of plans, their representation, the actions or steps they consist of, or their intended goals. Since plans may evolve over time, it may become necessary to track their provenance, so plans themselves are entities. Representing the plan explicitly in the provenance can be useful for various tasks: for example, to validate the execution as represented in the provenance record, to manage expectation failures, or to provide explanations.
PrimarySource	An instance of prov:PrimarySource provides additional descriptions about the binary prov:hadPrimarySource relation from some secondary prov:Entity to an earlier, primary prov:Entity. For example, :blog prov:hadPrimarySource :newsArticle; prov:qualifiedPrimarySource [a prov:PrimarySource; prov:entity :newsArticle; :foo :bar] .
Quotation	An instance of prov:Quotation provides additional descriptions about the binary prov:wasQuotedFrom relation from some taken prov:Entity from an earlier, larger prov:Entity. For example, :here_is_looking_at_you_kid prov:wasQuotedFrom :casablanca_script; prov:qualifiedQuotation [a

	prov:Quotation; prov:entity :casablanca_script; :foo :bar].
Revision	An instance of prov:Revision provides additional descriptions about the binary prov:wasRevisionOf relation from some newer prov:Entity to an earlier prov:Entity. For example, :draft_2 prov:wasRevisionOf :draft_1; prov:qualifiedRevision [a prov:Revision; prov:entity :draft_1; :foo :bar].
Start	An instance of prov:Start provides additional descriptions about the binary prov:wasStartedBy relation from some started prov:Activity to an prov:Entity that started it. For example, :foot_race prov:wasStartedBy :bang; prov:qualifiedStart [a prov:Start; prov:entity :bang; :foo :bar; prov:atTime '2012-03-09T08:05:08-05:00'^^xsd:dateTime] .
Usage	An instance of prov:Usage provides additional descriptions about the binary prov:used relation from some prov:Activity to an prov:Entity that it used. For example, :keynote prov:used :podium; prov:qualifiedUsage [a prov:Usage; prov:entity :podium; :foo :bar].

3.8 RECONSTRUCTION

Term	Description
Accuracy of centerline extraction	The accuracy of centerline extraction is defined as the average distance from correctly automatically extracted parts of the centerline to the reference standard.
Atlas formation	A mathematical instance of an object can be registered with an image to localize the instance of that object in the image. Using SpatialObjects, mutual information, cross-correlation, and boundary-to-image metrics can be applied without modification to perform spatial object-to-image registration.
Boundary condition	A neighborhood-based calculation in a neighborhood close to an image boundary may require data that falls outside the boundary. When the extent of a neighborhood falls outside the image, pixel values for missing neighbors are supplied according to a rule, usually chosen to satisfy the numerical requirements of the algorithm. A rule for supplying out-of-bounds values are called a boundary condition.
CellPixelType	The type associated with every cell.
CoordRepType	The type used to represent space coordinates.
CovariantVectors	Are actually PixelType used to instantiate the PointSet type and subsequently create a PointSet object.
Cropping	Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio.
Data Processing Pipeline	The data processing pipeline is a directed graph of process and data objects. The pipeline inputs, operators on, and outputs data.
Data Representation	Describing the basic classes responsible for representing data, i.e. image, mesh and pointset
Delaunay region	Each region of the Delaunay triangulation corresponds to a facet of the lower half of the convex

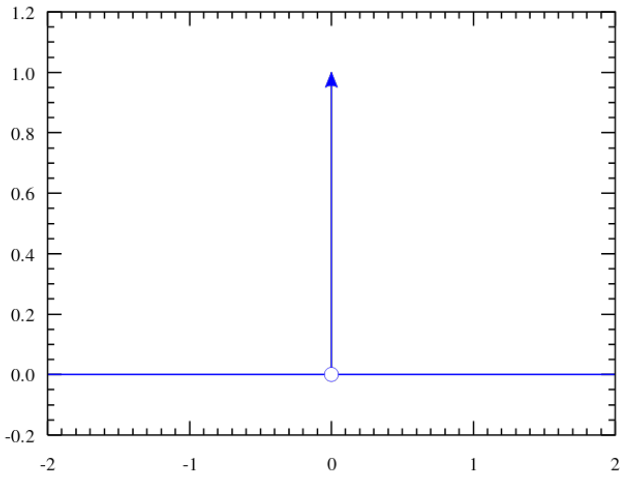
	hull. Facets of the upper half of the convex hull correspond to the furthest-site Delaunay triangulation. A Delaunay triangulation for a set P of points in a plane is a triangulation DT (P) such that no point in P is inside the circumcircle of any triangle in DT(P). Delaunay triangulations maximize the minimum angle of all the angles of the triangles in the triangulation; they tend to avoid skinny triangles.
Dirac Delta Function	The Dirac delta function, or δ function, is a generalized function, or distribution, on the real number line that is zero everywhere except at zero, with an integral of one over the entire real line. 
Error Handling	Techniques to minimize the error in the reconstruction process.
Filtering	Applying a filter to the image
Histological images	Histology (compound of the Greek words: ἱστός histos "tissue", and -λογία -logia "science") is the study of the microscopic anatomy of cells and tissues of plants and animals. It is commonly performed by examining cells and tissues by sectioning and staining, followed by examination under a light microscope or electron microscope.
Image adapting	The purpose of an image adaptor is to make one image appear like another image, possibly of a different pixel type. A typical example is to take an

	image of pixel type unsigned char and present it as an image of pixel type float. The motivation for using image adaptors in this case is to avoid the extra memory resources required by using a casting filter. The purpose of an image adaptor is to make one image appear like another image, possibly of a different pixel type. A typical example is to take an image of pixel type unsigned char and present it as an image of pixel type float. The motivation for using image adaptors in this case is to avoid the extra memory resources required by using a casting filter.
Image Casting	It is an alternative process to image adapting. ImageAdaptors convert pixel values when iterators access them. Thus, they do not produce an intermediate image. Instead, by image casting, the image is simulated on the fly each time an iterator from the filter downstream attempts to access the image data.
Image Origin	The image origin is associated with the coordinates of the first pixel in the image. The image origin is managed in a similar way to the spacing. A Point of the appropriate dimension must first be allocated. The coordinates of the origin can then be assigned to every component. These coordinates correspond to the position of the first pixel of the image with respect to an arbitrary reference system in physicals pace. It is the user's responsibility to make sure that multiple images used in the same application are using a consistent reference system.
InterpolationWeightType	The type used to represent interpolation weights.
K-Complex	A K-Complex is a topological structure in which for every cell of dimension N, its boundary faces which are cells of dimension N −1 also belong to the structure.
Linear interpolation	Linear interpolation of image values is performed inside the Delaunay region whose corners are pixel centers. It assumes that intensity varies linearly

	between grid positions. Unlike nearest neighbour interpolation, the interpolated intensity is spatially continuous. However, the intensity gradient will be discontinuous at grid positions.
Material property	A materials property is an intensive, often quantitative, property of some material. Quantitative properties may be used as a metric by which the benefits of one material versus another can be assessed, thereby aiding in materials selection. A property may be a constant or may be a function of one or more independent variables, such as temperature. Materials properties often vary to some degree according to the direction in the material in which they are measured, a condition referred to as anisotropy. Materials properties that relate two different physical phenomena often behave linearly (or approximately so) in a given operating range, and may then be modeled as a constant for that range. This linearization can significantly simplify the differential constitutive equations that the property describes.
Mesh	A mesh is a collection of vertices, edges and faces that defines the shape of a polyhedral object in 3D computer graphics and solid modelling.
microCT images	Micro-CT has applications both in medical imaging and in industrial computed tomography. They use x-rays to create cross-sections of a physical object that can be used to recreate a virtual model (3D model) without destroying the original object.
Model-to-image registration	A mathematical instance of an object can be registered with an image to localize the instance of that object in the image. Using SpatialObjects, mutual information, cross-correlation, and boundary-to-image metrics can be applied without modification to perform spatial object-to-image registration.
Model-to-model registration	A mathematical instance of an object can be registered with an image to localize the instance of

	that object in the image. Using SpatialObjects, mutual information, cross-correlation, and boundary-to-image metrics can be applied without modification to perform spatial object-to-image registration.
Object Detection	Object detection is the process of finding instances of real-world objects such as images. Object detection algorithms typically use extracted features and learning algorithms to recognize instances of an object category.
Physical extent	The extent of an image is defined by the pixel spacing and a set of regions
Pixel	A pixel is considered to be the rectangular region surrounding the pixel center holding the data value
Pixel center	The center of the pixels. Pixel spacing is measured between the pixel centers and can be different along each dimension.
Pixel coordinates	Depending on the dimension of the image: • In case of 1D: X position • In case of 2D: X position and a Y position • In case of 3D: X, Y and a Z position
Pixel Data	Pixel data are the actual images inputted in the 3D reconstruction tool. Image iterators are the appropriate mechanism to efficiently access image pixel data.
Pixel Neighborhood	A pixel neighborhood is loosely defined as a small set of pixels that are locally adjacent to one another in an image. The size and shape of a neighborhood, as well the connectivity among pixels in a neighborhood, may vary with the application. Many image processing algorithms are neighborhood-based, that is, the result at a pixel i is computed from the values of pixels in the ND neighborhood of i. Consider finite difference operations in 2D. A derivative at pixel index i = (j,k), for example, is taken as a weighted difference of the values at (j + 1,k) and

	(j − 1,k). Other common examples of neighbourhood operations include convolution filtering and image morphology.
Pixel spacing	Pixel spacing is measured between the pixel centers and can be different along each dimension.
PixelType	The type associated with every point. The PixelType is the first template parameter of the PointSet.
PointDimension	The dimension of the space in which the mesh is embedded.
PointSet	It represents geometry in the form of a set of points in n-dimensional space
PolyLine	A continuous line composed of one or more line segments. A PolyLine only involves zero and one dimensional cells.
Reconstruction	Image reconstruction techniques are used to create 2-D and 3-D images from sets of 1-D projections. These reconstruction techniques form the basis for common imaging modalities such as CT, MRI, and PET. The mathematical foundation for these reconstruction methods is the Radon transform, the inverse Radon transform, and the projection slice theorem. Computational techniques include filtered backprojection and a variety of iterative methods. Several projection geometries are commonly used, including parallel beam, fan beam, and cone beam. The Shepp-Logan phantom image is often used to evaluate different reconstruction algorithms. An effective approach to performing image reconstruction includes using methods in a technical computing environment for data analysis, visualization, and algorithm development
Registration	The basic input data to the registration process are two images: one is defined as the fixed image f(X) and the other as the moving image m(X). Where X represents a position in N-dimensional space. Registration is treated as an optimization problem with the goal of finding the spatial mapping that will

	bring the moving image into alignment with the fixed image
RGB (Red, Green, Blue)	The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue. The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems.
Scapturing functional and logical relationships between objects	SpatialObjects can have parent and children objects. Queries made of an object (such as to determine if a point is inside of the object) can be made to integrate the responses from the children object. Transformations applied to a parent can also be propagated to the children. Thus, for example, when a liver model is moved, its vessels move with it.
Segmentation	Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.
Spacing	The "Spacing" is the size of a pixel in physical space along each dimension. Spacing is represented in a FixedArray whose size matches the dimension of the image. In order to manually set the spacing of the image, an array of the corresponding type must be created. The elements of the array should then be

	initialized with the spacing between the centers of adjacent pixels.
Spatial Objects	The spatial object framework supports the philosophy that the task of image segmentation and registration is actually the task of object processing. The image is but one medium for representing objects of interest, and much processing and data analysis can and should occur at the object level and not based on the medium used to represent the object.
Spatial Objects	Currently implemented types of spatial objects include: Blob, Ellipse, Group, Image, Line, Surface, and Tube. New types can be added, only by defining one or two member functions in a derived class.
Storing segmentation results	Results of segmentations are best stored in physical/world coordinates so that they can be combined and compared with other segmentations from other images taken at other resolutions. Segmentation results from hand drawn contours, pixel labelings, or model-to-image registrations are treated consistently.
Three dimensional	Image reconstruction from sets of 1-D projections or 2D images to 3D
Thresholding	The thresholding operation is used to change or identify pixel values based on specifying one or more values (called the threshold value).
Two dimensional	Image reconstruction from sets of 1-D projections to 2D space
Vector Images	The use of geometrical primitives such as points, lines, curves, and shapes or polygons to represent images in computer graphics.

3.9 FINITE ELEMENT MODELLING

Term	Description
Block	Block is an OpenFOAM term It is defined in blockMeshDict is the equivalent of Domain in General Finite Element Modelling and (size wise) is equivalent of ElementGroup in PAK Block contains information about: • the shape of the block, • the number of cells in each of x,y and z directions and • the relative size of the cells in each direction - given by simpleGrading The coordinates of the block's corners are given by Vertices. The coordinates of the cells within the block are calculated by the solver and are not explicitly given. The boundaris of the block are given by patch boundaries
BoundaryConditionType	BoundaryConditionType term is an OpenFOAM term even though boundary conditions are a general finite element modelling condept OpenFOAM PatchBoundaries are given names in the blockMeshDict which are later referred to in the boundaryField section of the parameter files where the boundary conditions are defined. For OpenFOAm a patchBoundary (on which boundary conditions are defined) is for a Block (which is made up of many cells) In PAK a boundary surface is a surface (or line for a 2D element) of one finite element (not an ElementGroup). In PAK boundaries are not given names but a given boundary is defined (in card 13 of the input .dat file) for a specific element number by listing the nodes that make up the boundary for that element. In PAK (at least in Example F-1) the boundary

	conditions which were for pressure were given in card 10-1 and were given to individual nodes (that were at the outer edge of the elements that made up the element group). Then in card 13 which is titled 'Data about Boundary Conditions - Surface Tractions) the boundaries, for element which made up the outer edges of the element group, were defined and indicators values given to tell whether or not surface tractions are to be included.
BulkModulusForFluid	Bulk Modulus is a measure of the resistance of a fluid to compression. It is defined as the ratio of pressure stress to volumetric strain. The value of bulk modulus equals the pressure change x 100 required to cause a one percent change in volume. For a fluid, only the bulk modulus is meaningful.
BulkModulusForSolid	Bulk Modulus is a measure of the resistance of a fluid to compression. It is defined as the ratio of pressure stress to volumetric strain. The value of bulk modulus equals the pressure change x 100 required to cause a one percent change in volume. For an anisotropic solid such as wood or paper, these three moduli do not contain enough information to describe its behaviour, and one must use the full generalized Hooke's law.
Calculated	The result of the simulation
Cell	Cell is an OpenFOAM term. It is defined in blockMeshDict • is the equivalent of subdomain in General Finite Element Modelling and • is almost the equivalent of Element in PAK and • is almost the equivalent of Node in PAK The number of cells in each of x,y and z directions of a Block are given in the block definition of blockMeshDict as is the relative size of the cells in

	each direction (given by simpleGrading information). The coordinates of the cells within the block are calculated by the solver and are not explicitly given. Cells hold parameter information e.g. for pressure, temperature and Velocity in x,y and z directions. In PAK nodes hold parameter values for temperature and velocity and corner nodes hold pressure when it is not an element variable. Pressure is an element variable for 4 Node 2D Elements and 8 node 3D Elements.
CFD	Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing, e.g. flight tests.
Conduction	The process by which sound waves travel through a medium
ConductionCoefficient	When a sound wave in a room strikes a surface, a certain fraction of it is absorbed, and a certain amount is transmitted into the surface. Both of these amounts are lost from the room, and the fractional loss is characterized by an absorption coefficient a which can take values between 0 and

	1, 1 being a perfect absorber.
DensityForFluid	The density, or more precisely, the volumetric mass density, of a substance is its mass per unit volume.
DensityForSolid	The density, or more precisely, the volumetric mass density, of a substance is its mass per unit volume.
DerivedPatchFieldType	A complex patch condition, derived from the primitive type, assigned to a field variable on the patch.
Dimension	Dimension is an OpenFOAM term that defines thedimension of a parameter. t is defined in the parameter files. The format for a dimensionSet is 7 scalars delimited by square brackets, e.g. [0 2 -1 0 0 0 0] No. Property SI unit USCS unit 1 Mass kilogram (kg) pound-mass (lbm) 2 Length metre (m) foot (ft) 3 Time — — — — second (s) — — — — 4 Temperature Kelvin (K) degree Rankine 5 Quantity kilogram-mole (kgmol) pound-mole (lbmol) 6 Current — — — — ampere (A) — — — — 7 Luminous intensity— — — — candela (cd) — — — — So e.g for presssure the dimension would be given by [0 2 -2 0 0 0 0] i.e. metres squared per second squared.
DirectionMixed	A mixed condition with tensorial valueFraction, e.g. for different levels of mixing in normal and tangential directions
Displacement	The occupation by a submerged body or part of a body of a volume which would otherwise be occupied by a fluid
DisplacementParameter	Velocity or thickness

Distance	Will be linked to DistanceFromCavityBase class in the DataAnalysis ontology.
Electromagnetic	Based on computational electromagnetic techniques, which is the process of modeling the interaction of electromagnetic fields with physical objects and the environment.
Element	Element is a PAK term It is defined in an input .dat file is the equivalent of subdomain in General Finite Element Modelling and (size wise) is equivalent of cell in OpenFOAM 2D Elements can have 4 or 9 nodes 3D Elements can have 8 or 21 nodes In both cases the smaller number refers to corner nodes while the larger number refers to corner and mid nodes. For a 4 node and 8 node elements - fluid pressure is an element variable otherwise it is a variable of the corner nodes of the element. Velocity and temperature parameter values are held by all nodes. The coordinates of the nodes give the coordinates of the element.
ElementBoundary	Element boundary is a PAK term. It is defined in an input .dat file. Is the equivalent of PatchBoundary in OpenFOAM except that PatchBoundaries are given names in the blockMeshDict which are later referred to in the boundaryField section of the parameter files where the boundary conditions are defined. In PAK boundaries are not given names but a given boundary is defined, as needed, (in card 13 of the input .dat file) for a specific element number by listing the nodes that make up the boundary for that element. Also boundary surface is a surface (or line for a 2D element) of one finite element (not an ElementGroup) in PAK whereas for OpenFOAm a patchBoundary (on which boundary conditions are

	defined) is for a Block (which is made up of many cells) For a 2D PAK element a boundary is defined by 2 nodes. For a 3D PAK element a boundary is defined by 4 node.
FEMDomain	This is called FEMDomain becasue Domain is a reserved word in Protege
FEMModel	This class is common to both OpenFOAM and PAK. A FEMModel is modelled by a Mesh class and has boundary conditions and internal conditions
Field	This class is to cover such cases as the OpenFOAM class volScalarField files of data in the time directories that contain information at all cell positions for a given parameter e.g. the pressure volScalarField file.
FixedGradient	Normal gradient of 0 is specified
FixedValue	Value of 0 is specified
GravityAcceleration	The acceleration for any object moving under the sole influence of gravity
GravityAccelerationInXDirection	The acceleration for any object moving under the sole influence of gravity in the X axis
GravityAccelerationInYDirection	The acceleration for any object moving under the sole influence of gravity in the Y axis
GravityAccelerationInZDirection	The acceleration for any object moving under the sole influence of gravity in the Z axis
InternalConditionType	This is a general concept - applying to both OpenFOAM and PAK referring to the whether the parameter values in the cells (in OpenFOAM) or in the nodes or elements (in PAK) are uniform or not - i.e. if the parameter value is the same in all cells/nodes/elements then it is a uniform internal condition and conversely if they don't all hold the same value then the InternalConditionTpe is NonUniform. Initial internal condition values are given in Card 11 for PAK with variable bnames:

	• UINIT for initial fluid velocity U0 • VINIT for initial fluid velocity V0 • WINIT for initial fluid velocity W0 • PINIT for initial fluid velocity P0 • TINIT for initial fluid velocity T0 Initial internal condition values are given in the parameter files in OpenFOAM after the dimension has been specified and before the boundaryField is specified. In OpenFOAM where the initial internal field is uniform then the value for that variable in all position is given as a single number for a scalar parameter (e.g. pressure) and a set of numbers for a vector parameter (e.g. velocity)

MaterialPropertyDynamicViscosity	This is prefixed by Materialproperty to differentiate it from the Dynamic viscosity class, which is from the Unit class.
MaterialPropertyPermeability	This is prefixed by MaterialProperty to differentiate it from the Permeability in the Unit Class
MergePatchPair	OpenFOAM class - not used in LidWall example
Node	All nodes must be different from zero
NumericalMethod	Note that even though these are referred to as 'Solvers' in the fvSolution file of the OpenFOAM system folder they actually refer to the method of number-crunching to solve a set of linear equations (rather than the application solver which describes the set of equations used to solve the problem) and so the class is called NumericalMethod. For more details see Section 4.5.1 of the OpenFOAM User Guide
PAKMesh	PAK class is a type of finite element mesh. PAKMesh is made up of groups of elements
Parameter	These are the physical variables whose values we want to determine in our finite lement analysis. They can be Scalar values e.g. Pressure and Temperature or Vector valued e.g. Velocity PAK: For a 4 node and 8 node Elements - fluid pressure is an element variable otherwise it is a variable of the corner nodes PAK:Velocity and temperature parameter values are held by all nodes. OpenFOAM: all parameter values are held by Cells
PatchBoundary	PatchBoundary is an OpenFOAM term. OpenFOAM PatchBoundaries are given names in the blockMeshDict which are later referred to in the boundaryField section of the parameter files

	where the boundary conditions are defined. For OpenFOAm a patchBoundary (on which boundary conditions are defined) is for a Block (which is made up of many cells) In PAK a boundary surface is a surface (or line for a 2D element) of one finite element (not an ElementGroup). In PAK boundaries are not given names but a given boundary is defined (in card 13 of the input .dat file) for a specific element number by listing the nodes that make up the boundary for that element.
PatchFieldType	This is an OpenFOAM concept specified in the parameter files for the patch boundaries. Can be primitive or derived
PrimitivePatchFieldType	The base numerical patch condition assigned to a field variable on the patch. The primitive types are listed in the following Table.

Type	Description of condition for patch field ϕ	Data to specify
fixedValue	Value of ϕ is specified	`value`
fixedGradient	Normal gradient of ϕ is specified	`gradient`
zeroGradient	Normal gradient of ϕ is zero	—
calculated	Boundary field ϕ derived from other fields	—
mixed	Mixed *fixedValuel fixedGradient* condition depending on the value in `valueFraction`	`refValue`, `refGradient`, `valueFraction`, `value`
directionMixed	A *mixed* condition with tensorial `valueFraction`, *e.g.* for different levels of mixing in normal and tangential directions	`refValue`, `refGradient`, `valueFraction`, `value`

ProblemDimension	Two or Three dimensions
ProblemIs2D	2 dimensions of the studied problem
Problemis3D	3 dimensions of the studied problem
ScalarParameter	The string contents depend on the parameter and can be numeric (scalar, vector, or matrix), a variable name, a filename, or a particular value
SifemMaterialProperty	These classes were added to the ontology since they were not defined in our OML materials ontology. They have not been subdivided into

	Structural, Thermal etc. Class names that begin with 'MaterialProperty' have been so named to differentiate them from the class names which are subclasses of UnitDimension e.g Dynamic Viscosity and Permeability are both subclasses of UnitDimension but we need these to be more than just units. Other OML classes were extended e.g. Density was extended to include subclasses for DensityForFluid and DensityForSolid
StructuralMechanics	Conduct structural simulation of product designs and assemblies
UniformCondition	Uniform condition means that every internal cell (in OpenFOAM) or node/element (in PAK) holds the same value for that parameter. For PAK see note 3 card 11 of PAK-F manual
UNVBlock	Each UNV file is made up of several blocks, which are given a two part id. The ids are as follows: • Nodes = 15 • Elements = 71 • Loads = 407 • onstraints = 757 • Nodal results = 55 • Element results = 57. For Nodal results, for the id to uniquely identify the block, a second part of the id is required - hence the need for two data properties: hasUNVBlockIdPartOne and hasUNVBlockIdPartTwo. For non-nodal results blocks the second data property will be blank. The start and end delimiters for a UNVBlock are the sentinel value -1.

UNVConstraintBlock	Constraint block of .unv files format
UNVElementBlock	Element block of .unv files format
UNVElementResultsBlock	It is assumed that for the element results block (which has id number 57) the groups of 8 rows in 'cochlea.unv' (where the elements have 8 nodes) are in the order given in the element block (which has id number 71) i.e. the first row in the group of 8 rows is for the first node number mentioned for the element, the second row in the group of 8 rows is for the second node number mentioned for the element etc.
UNVOutputFile	This class represents the output file generated by the PAK program that is subsequently imported into the CAD program (which later should be made a subclass of the OutputDataFile class from the Simulation ontology.) Each UNV file is made up of several blocks, which are given a two part id. The ids are as follows: • Nodes = 15 • Elements = 71 • Loads = 407 • onstraints = 757 • Nodal results = 55 • Element results = 57. For Nodal results, for the id to uniquely identify the block, a second part of the id is required - hence the need for two data properties: • hasUNVBlockIdPartOne and • hasUNVBlockIdPartTwo. For non-nodal results blocks the second data property will be blank
Velocity	Parameter of the simulation
Vertex	Vertex is an OpenFOAM class These give the coordinates of the corners of the

	Block (from which internal cell coordinates are calculated). Unlike Nodes of PAK - Vertices do not hold parameter values. PAK has midnodes but OpenFOAM does not have midVertices. In blockMeshDict the x,y and z coordinates of each Vertex is given in a list with the first set of values referring to Vertex 0, the next to Vertex 1 etc. The Block and Patchboundaries are then later defined in blockMeshDict using these Vertex numbers

4 CONCLUSIONS

In this document are presented various terms and their descriptions from different domains (clinical, modelling, image processing, finite elements, etc.) that could serve as a common vocabulary among different disciplines. This deliverable is crucial to interconnect different disciplines or even experts from the same domain that may use different reference terms to describe the same concept.

So, this can serve as a reference point that will, also, lead at the establishment of the SIFEM conceptual model. To this end, the links among terms will be defined (adding the object and data properties) and the respective ontology will be implemented.

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