FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)

Una manera de hacer Europa

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ONTOLOGY DOCUMENTATION

Contents

1. Ontological design

This section is going to break down from minor to major detail the design of the ROH ontology network. Starting in section 1 with a high-level diagram, the most important entities will be shown. Then, the main entities modelled are broken down (sections 1.2 to 1.7). Before, the following table shows a summary of the reused ontologies together with their respective user licenses. All reused ontologies have been evaluated for compatibility with their import and extension.

prefix	Ontology names	License	Ontology website
bibo	Bibliographic Ontology	Creative Commons Attribution 1.0 Generic (CC BY 1.0)	http://purl.org/ontology/bibo
foaf	FOAF (Friend of a Friend) Vocabulary Specification	Creative Commons Attribution License 1.0	http://xmlns.com/foaf/0.1
geonames	Geonames ontology	Creative Commons Attribution License 3.0	http://www.geonames.org/ontology#
obo	Open Biological and Biomedical Ontology (OBO)	Creative Commons Attribution License 4.0	http://purl.obolibrary.org/obo/
obo-bfo	OBO Foundry, Basic Formal Ontology	Creative Commons Attribution License 4.0	http://www.obofoundry.org/ontology/bfo.html
obo-ero	OBO Foundry, eagle-i Research Resource	Creative Commons Attribution License 4.0	https://open.catalyst.harvard.edu/wiki/display/eaglei/Ontology

	Ontology (ERO)		
obo-iao	OBO Foundry, Informatio n Artifact Ontology	Creative Commons Attribution License 4.0	https://github.com/information-artifact-ontology/IAO/
obo-ro	OBO Foundry, Relations Ontology	Creative Commons Attribution License 4.0	http://www.obofoundry.org/ontology/ro.html
rdfs	RDF Schema	Creative Commons Attribution License 4.0	http://www.w3.org/2000/01/rdf-schema#
roh	Red de Ontologías Hercules	Creative Commons Attribution License 4.0	http://purl.org/roh
skos	SKOS Simple Knowledge Organizatio n System RDF Schema	Creative Commons Attribution License 4.0	http://www.w3.org/2004/02/skos/core#
terms	DCMI Metadata Terms	Creative Commons Attribution License 4.0	https://www.dublincore.org/specifications/dublin-core/dcmi-terms/
vcard	vCard Ontology - for describing People and Organizatio ns	Creative Commons Attribution License 4.0	https://www.w3.org/2006/vcard/ns#
vivo	VIVO Ontology for Researcher Discovery	Creative Commons Attribution License 4.0	http://vivoweb.org/ontology/core#

1.1. Conceptual diagram of ontology ROH

Figura 1 shows the main entities modelled in the Hercules Ontology Network (HON in English, ROH-Red de Ontologías Hércules in Spanish). Note that in the diagram, the arrows with a filled tip denote kinship (inheritance) relationships while the arrows that end in a non-filled tip indicate that there is an Object Property relationship between these entities. Finally, the dashed arrows reflect the fact that several entities in ROH have geographic (class `Geonames:Feature`) and temporal (class `vivo:DateTimeInterval`) constraints.

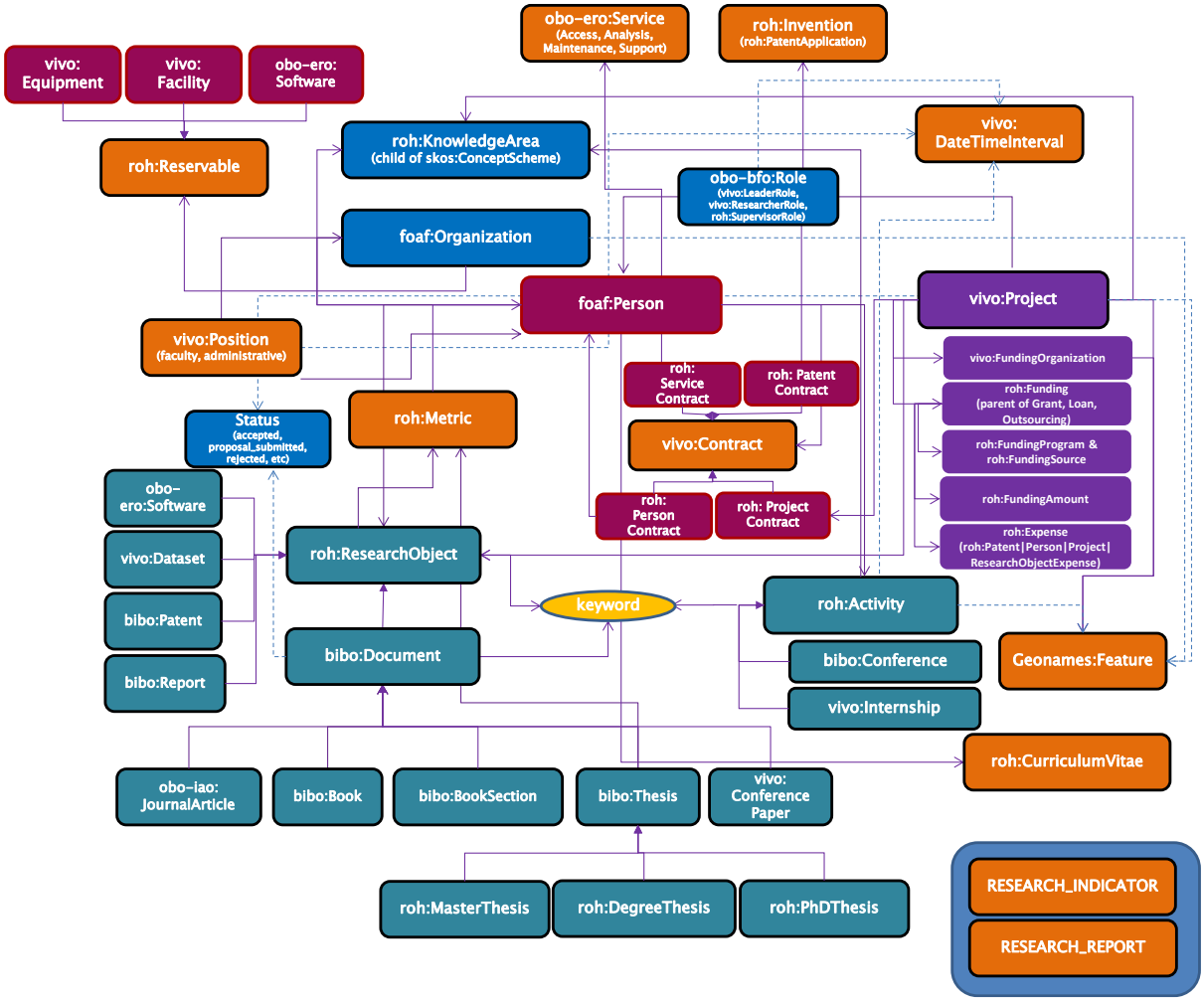

Figura 1. High level diagram of ROH –Red de Ontologías Hércules.

1.2. Entity Project

The main ROH entity is `vivo:Project` (see Figura 2), a new entity defined within ROH. In ROH, a Project models a collaborative activity in business and science that often involves research or design and is carefully planned to achieve a particular goal. Its configuration is inspired by the `swrc:Project` and takes into account the data properties of the `cerif:Project` and `vivo:Project`. It comprises all those properties and adds some new ones, for example, `roh:projectStatus`, `roh:modality` or `roh:title`.

It includes the Data Properties `vivo:identifier`, `vivo:abbreviation`, `vivo:description`, `roh:title`, `vivo:ProjectStatus`, `vivo:freeTextKeyword`, `roh:modality`, `roh:foreseenJustificationDate` and `roh:needsEthicalValidation`.

An `vivo:Project` includes a property `roh:hasKnowledgeArea` with allows to associate a project with different instances of knowledge areas, e.g. instances of `roh:UNESCOKnowledgeArea` or `rohes:FECYTKnowledgeArea` concept hierarchies, but importantly allows a project also to be classified according the hierarchy defined under `roh:ProjectClassification` concept hierarchy, e.g. `roh:Horizon2020`.

Besides, an instance of a `vivo:Project` is associated to the following entities through object properties:

- `foaf:Organización`, where different organizations may play different `obo-bfo:Roles` in a project, e.g. `vivo:MemberRole` or `vivo:AdministratorRole`.
- `foaf:Person`, where an person may play different `obo-bfo:Roles`, e.g. `vivo:PrincipalInvestigatorRole` or `vivo:ResearcherRole`,
- `roh:ResearchObject`, where a project `roh:produces` several `roh:ResearchObject`, where some results of a project might be for example of types `bibo:Journal`, `obo-iao:JournalArticle`, or `roh:PhDThesis`.
- `roh:Funding` `roh:supports` a `vivo:Project`, where funding `roh:hasPart` `roh:FundingAmount`. A `roh:FundingAmount` `roh:grants` `foaf:Organization` and describes the details about the funding associated to a project, in what period and what organization it funds. A `roh:FundingSource` is `roh:promotedBy` a `vivo:FundingOrganization` and `roh:funds` a `roh:FundingProgram`.

- `roh:Expense` is `roh:spentBy` a project, details allows to associate a project with its expenses.
- `roh:Activity` is `roh:participatedBy` a project, describes what activities a project participates in.
- `skos:Concept` is linked through `roh:knowledgeAreaOf` to a project, indicating the topics/concepts a project deals with and allowing it to be classified under different taxonomies, e.g. `roh:ProjectClassification`.
- `vivo:ProjectContract` subtype of `vivo:Contract`, a project may be associated to a contract through relationship `roh:hasContract`.
- `roh:Justification` through relationship `vivo:relates` binds justifications with a `vivo:Project`.
- `roh:Dossier` through relationship `vivo:relates` binds a set of documents, including the proposal, evaluation document, reports and so on with a `vivo:Project`. A dossier is an administrative file collection in which all assets related to a Project are stored, including the Research Proposal, approval documents, viability plans and so on associated to a project are stored.

Notice that a `vivo:Project` may also be part (`vivo:hasPart`) of another project, e.g. child of a parent project. Besides, every instance of a `vivo:Project` is time bound by being associated with an instance of `vivo:DateTimeInterval` and geographically bound to an instance of `gn:Feature` (through relationship (`gn:locatedIn`).

The following table shows the object and data properties associated to `vivo:Project`:

Prefix	Class	Prefix	**Object property** (bold indicates explicit Domain, otherwise a Restriction)	Range Class	Prefix	**Datatype Property** (bold indicates explicit domain; otherwise a restriction)	**Range Datatype** (if typed)	**Range values**
vivo	**Project**	roh	hasKnowledgeArea	skos:Concept and (skos:inScheme some roh:Knowledge Area)	roh	identifier	xsd:string	
		vivo	relates	roh:Audit or obo-bfo:Role	vivo	abbreviation	rdfs:Literal	
		roh	hasContract	vivo:ProjectContract	vivo	description	rdfs:Literal	
		terms	hasPart	vivo:Project	roh	title	xsd:string	
		vivo	participates	roh:Activity	vivo	freeTextKeyword	xsd:string	
		roh	spends	roh:ProjectExpense	roh	**modality**	xsd:string	
		roh	produces	roh:ResearchObject	roh	**needsEthicalValidation**	xsd:boolean	
		vivo	relatedBy	roh:Dossier or roh:Justification or obo-bfo:Role	roh	**isCompetitive**	xsd:boolean	
		roh	**isSupportedBy**	roh:Funding	roh:	**projectObjective**	xsd:string	
		gn	locatedIn	gn:Feature				
		vivo	dateTimeInterval	vivo:DateTimeInterval				
		roh	**hasProjectCategorization**	(skos:Concept and (skos:inScheme some roh:ProjectClassification)				
		roh	**hasHRClassification**	(skos:Concept and (skos:inScheme some roh:HRClassification))				
		roh	**projectStatus**	roh:Status (roh:Closed or roh:Open or roh:ProposalSubmitted or roh:Rejected)				
		roh	**coordinatedBy**	foaf:Agent				
		roh	**foreseenJustificationDate**	vivo:DateTimeValue				

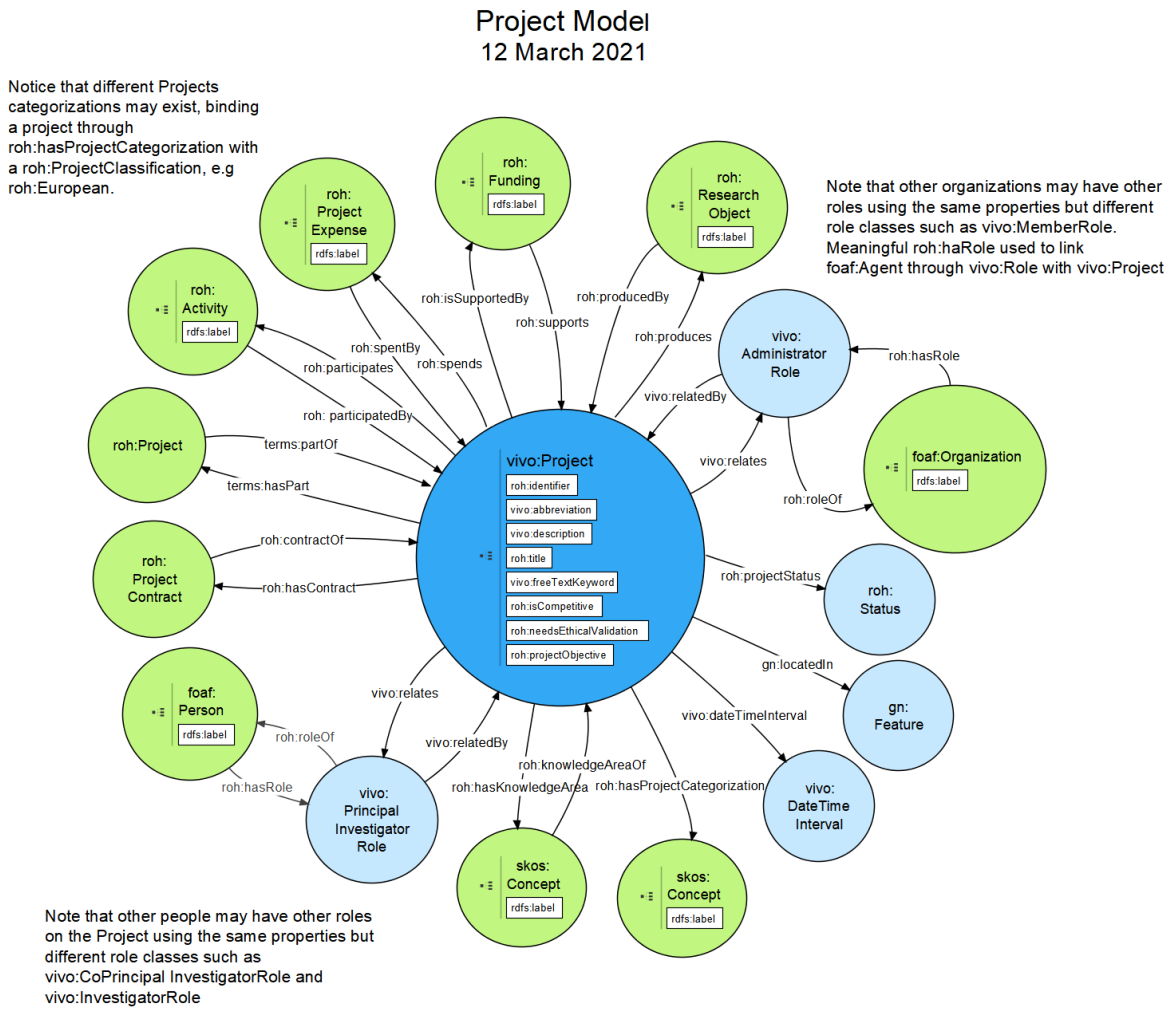

Figura 2. Ontological diagram for entity `Project`.

1.3. Entity Person

In ROH, there is a `foaf:Person` entity (see Figura 3) that inherits from `foaf:Agent`. The specialization of this entity imported from the VIVO ontology already adds some DataType properties of the research domain, but in ROH we also incorporate `roh:taxID`, `roh:ORCID`, `vivo:researcherId` or `vivo:scopusId` (all of them are subtypes of `vivo:identifier`, a given person may use or several alternatives of those identifiers) and also several object specific properties of the research domain as "has a Role" (`roh:hasRole`) in an Organization, "has a CurriculumVitae" (`roh:hasCV`), "has some Accreditations" (`roh:hasAccreditation`), "has an Employment Contract" (`roh:hasContract`), "has some Knowledge Areas" (`roh:hasKnowledgeArea`) or "has some Roles" (`roh:hasRole`) in

Projects or participates through "bibo:authorList" with Research Objects of subclass bibo:Document. A person can "have different roles" in the Project over time.

As mentioned above, foaf:Person in ROH is based on FOAF (Friend of a Friend [2], following patterns used in VIVO. That explains why it includes some of the basic FOAF properties such as foaf:name, foaf:nickname, foaf:title, foaf:mbox (note that this in fact an object property), foaf:img (note that this in fact an object property), vivo:description, foaf:firstName, foaf:surname, and rohes:secondFamilyName (for countries using two surnames). However, it considers all attributes and links defined in CERIF through the cfPers entity. foaf:Person incorporates the following data properties declared as attributes in cfPers, especially: identifier (vivo:identifier but preferrably roh:ORCID), roh:birthdate, foaf:gender, foaf:homepage (note that this in fact an object property), roh:researchLine, vivo:freeTextKeyword. Some important CERIF relationships that have also been adopted: Curriculum Vitae (roh:hasCV) which links foaf:Person with roh:CurriculumVitae, Event (roh:Activity) and Indicator (roh:Accreditation).

Besides, an instance of a foaf:Person is associated to the following entities through object properties:

- vivo:AwardedDegree, where a researcher vivo:relates with an roh:AcademicDegree
- roh:Accreditation, where a researcher roh:hasAccreditation of different types, e.g. roh:ResearchAccreditation or roh:AcademicAccreditation.
- roh:Activity, where a researcher roh:participates in diverse activities, e.g. vivo:InvitedTalk or bibo:Conference.
- roh:CorrespondingAuthor, where a researcher is the roh:correspondingAuthor of different subtypes of roh:ResearchObject, e.g. obo-iao:JournalArticle, vivo:ConferencePaper or bibo:Proceedings.
- roh:CurriculumVitae, where a researcher roh:hasCV which includes data type properties like roh:cites, roh:factorH or roh:summary
- bibo:Document, where a researcher through bibo:authorList is participating in a bibo:Document as one of its authors.
- vcard:Individual, where a researcher obo:hasContactInfo described through ontology vcard.

- `vivo:Position`, where a researcher `roh:hasPosition` usually in an organization linking it to any of the `vivo:Position` subclasess like `vivo:FacultyAdministrativePosition` or `vivo:FacultyPosition`.
- `roh:Role`, where a `foaf:Agent` may `roh:hasRole` like `vivo:ResearcherRole` or `vivo:TeacherRole` either in a `vivo:Project` or a `foaf:Organization`.
- `roh:PersonContract`, where a researcher `roh:hasContract` described according to the attributes corresponding to parent class `vivo:Contract`.
- `bibo:Thesis`, where a researcher is `roh:supervisorOf` of a `bibo:Thesis`, concretely, any of its subtypes subclasess like `roh:MasterThesis` or `roh:PhDThesis`.

The following table fully describes the object and data properties defined within the foaf:Person entity in ROH.

Prefix	Class		Prefix	Object property (bold indicates explicit Domain, otherwise a Restriction)	Range Class	Prefix	Datatype Property (bold indicates explicit domain; otherwise a restriction)	Range Datatype (if typed)	Range values
foaf	**Agent**		roh	**hasContactInfo**	vcard:Organization	vivo	freeTextKeyword	xsd:string	
			roh	**hasAccreditation**	roh:Accreditation				
			roh	**hasRole**	obo-bfo:Role				
			foaf	**mBox**	owl:Thing				
			vivo	relatedBy	vivo:Relationship				
	foaf	**Organization**	roh	hasKnowledgeArea	skos:Concept	vivo	identifier	xsd:string	
			vivo	**affiliatedOrganization**	foaf:Organization	vivo	abbreviation	rdfs:Literal	
			vivo	**hasSuccessorOrganization**	foaf:Organization	roh	description	xsd:string	
			vivo	**hasPredecessorOrganization**	foaf:Organization	roh	researchLine	xsd:string	
			obo-ro	hasPart	foaf:Organization	roh	**foundationDate**	xsd:string	
			roh	hasInfrastructure	roh:Infastructure				
			foaf	homePage	foaf:Document				
			roh	participates	roh:Activity				
			roh	produces	roh:ResearchObject				
			roh	grantedBy	roh:FundingAmount				
			vivo	dateTimeInterval	vivo:DateTimeInterval				
			gn	locatedIn	gn:Feature				
		roh AccreditationIssuer	roh	issues	roh:Accreditation				
		roh FundingOrganization	roh	**promotes**	roh:FundingProgram or roh:FundingSource				
			roh	funds	roh:Funding				
		roh ResearchGroup				roh	excellenceLabel	xsd:boolean	
		vivo University	roh	**awards**	vivo:AwardedDegree				
	foaf	**Person**	roh	hasKnowledgeArea	skos:Concept	vivo	identifier	xsd:string	
			vivo	relates	vivo:AwardedDegree	vivo	**researcherId**		
			roh	spends	roh:PersonExpense	roh	birthdate	xsd:string	
			roh	hasContract	roh:PersonContract	vivo	**eRACommonsId**		
			roh	**hasCV**	roh:CurriculumVitae	roh	description	xsd:string	
			roh	**hasPosition**	vivo:Position	roh	**firstName**	xsd:string	
			roh	participates	roh:Activity	roh	**gender**	xsd:string	
			roh	elegibleFor	roh:Accreditation	roh	researchLine	xsd:string	
			foaf	homePage	foaf:Document	foaf	**surname**	xsd:string	
			foaf	**image**	foaf:Image	foaf	name	xsd:string	
			roh	**correspondingAuthor**		foaf	nickname	xsd:string	
			roh	**supervisorOf**	bibo:Thesis	roh	**taxID**	xsd:string	
						roh	title	xsd:string	
						roh	**ORCID**	xsd:string	
						vivo	**scopusId**		
						rohes	secondFamilyName	xsd:string	

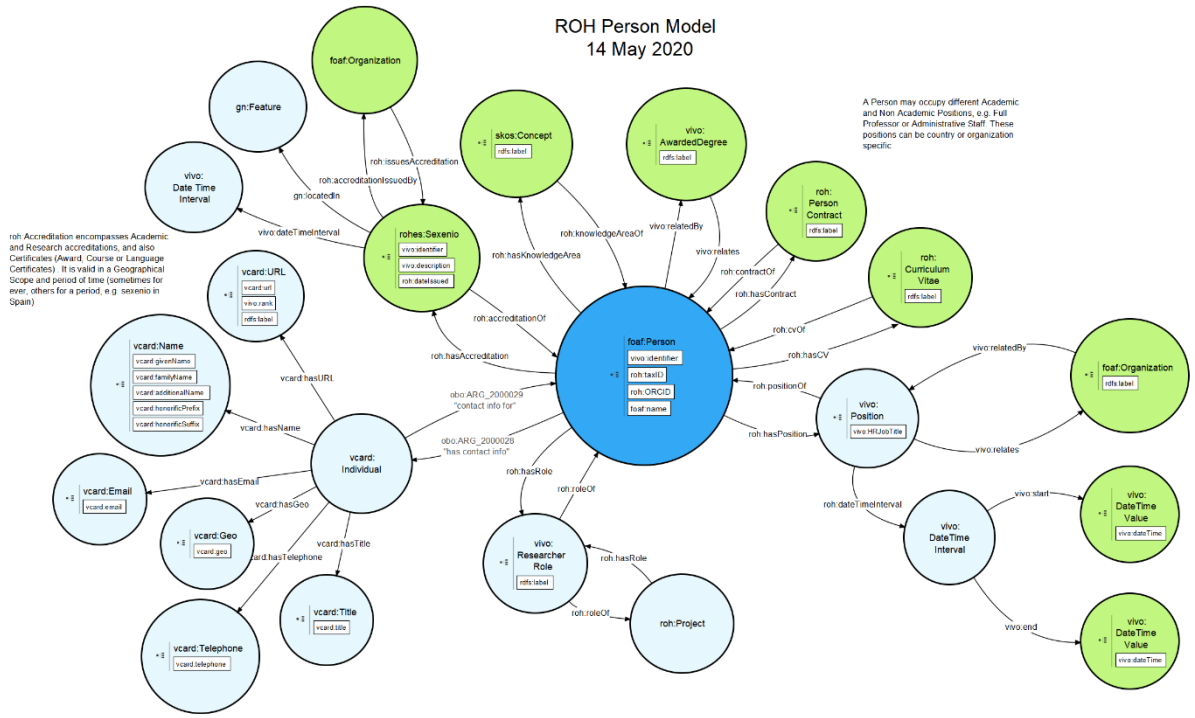

Figura 3. Ontological Diagram for entity `Person`.

1.4. Organization entity

An Organization in ROH (see Figura 4) is a `foaf:Organization` which carries out several `vivo:Project`. It is a child of `foaf:Agent`. Some organization can emit `roh:Acreditation` (e.g. ANECA or CENAI in Spain), those belonging to subclass `roh:AccreditationIssuer`, or award degrees (`vivo:AwardedDegree`), those of subclass `vivo:University`. An Organization may receive several `roh:FundingAmount`, corresponding to a `roh:Funding`, obtained through a `roh:FundingProgram` provided by a `vivo:FundingOrganization` through a `roh:FundingSource`. As a `foaf:Agent` an Organization may be involved in several `roh:Actitity`, has several instances of attribute `roh:researchLine`, is associated through `roh:hasKnowledgeArea` with `roh:KnowledgeArea` and bound to a geographical scope through `gn:locatedIn` with `gn:Feature`, it may also have a time span through `vivo:dateTimeInterval` linking it with an instance of `vivo:DateTimeInterval`.

Based on FOAF [10], the `foaf:Organization` entity takes into account the data properties (attributes: `vivo:abbrevation`, `foaf:homepage`) and data properties (links) defined by the `Organization Unit` in CERIF. It also takes into account and supports the relationships of CERIF Equipment (via entity `vivo:Equipment` and object property `roh:hasInfrastructure`), Event (`roh:Activity`), Expertise and Skill (via `vivo:freeTextKeyword` and `roh:hasKnowledgeArea`), Facility (`roh:Facility` and `roh:hasInfrastructure`), Funding (`roh:Funding`), Organization Unit (kinship relationships between organizations can be established with `vivo:hasPart` and `vivo:partOf`), Prize Award (through `roh:Accreditation`), Result Patent, Result Product, Result Publication and Service - all of them through `roh:ResearchObject` which can be obtained through the `roh:produces` relationship from the Projects in which an organization participates by playing a declared role through `roh:hasRole`, Person (through `roh:hasPosition`). Therefore, the CERIF data model for Organization is covered.

An exhaustive hierarchy of organizations is included, e.g. `roh:AccreditationIssuer`, `vivo:Company` or `vivo:University`, among many others.

Besides, an instance of a `foaf:Organization` is associated to the following entities through object properties:

- `roh:Accreditation`, where an organization of type `roh:AccrediationIssuer` issues (`roh:issues`) accreditations, e.g. `roh:ResearchAccreditation` or `roh:AcademicAccreditation`.
- `roh:Activity`, where an organization may play `vivo:OrganizerRole` through `roh:hasRole` in an activity or may through its participation role in a project participate (`roh:participates`) in an activity.
- `vivo:AwardedDegree`, where a `vivo:University` may `roh:awards` degrees which are related to both a concrete `vivo:AcademicDegree` and an instance of `foaf:Person`.
- `skos:Concept`, where an organization through `roh:hasKnowledgeArea` may be associated to several knowledge areas, defined as instance data of thesaurus created with SKOS ontology.
- `vivo:DateTimeInterval`, where an organization may exist during a given time interval
- `gn:Feature` through relationship `gn:locatedIn`, where an organization may be associated a geographical scope.

- `roh:FundingAmount` where an organization may receive several funding amounts part of a `roh:Funding` through `roh:grants` object property.
- `vcard:Organization`, where an organization `obo:hasContactInfo` described through ontology vcard.
- `roh:Infrastructure`, where an organization may `roh:hasInfrastructure`, belonging to any of its subclasses, e.g. `roh:Equipment` or `roh:Facility`.
- `foaf:Organization`, where a `foaf:Organization` may be linked through `vivo:hasSucessorOrganization` or `vivo:hasPredecessorOrganization` with another `foaf:Organization` or may be part of (`vivo:partOf`) or include (`vivo:hasPart`) other several `foaf:Organization`.

See table in section `foaf:Person` for more details on object and data properties.

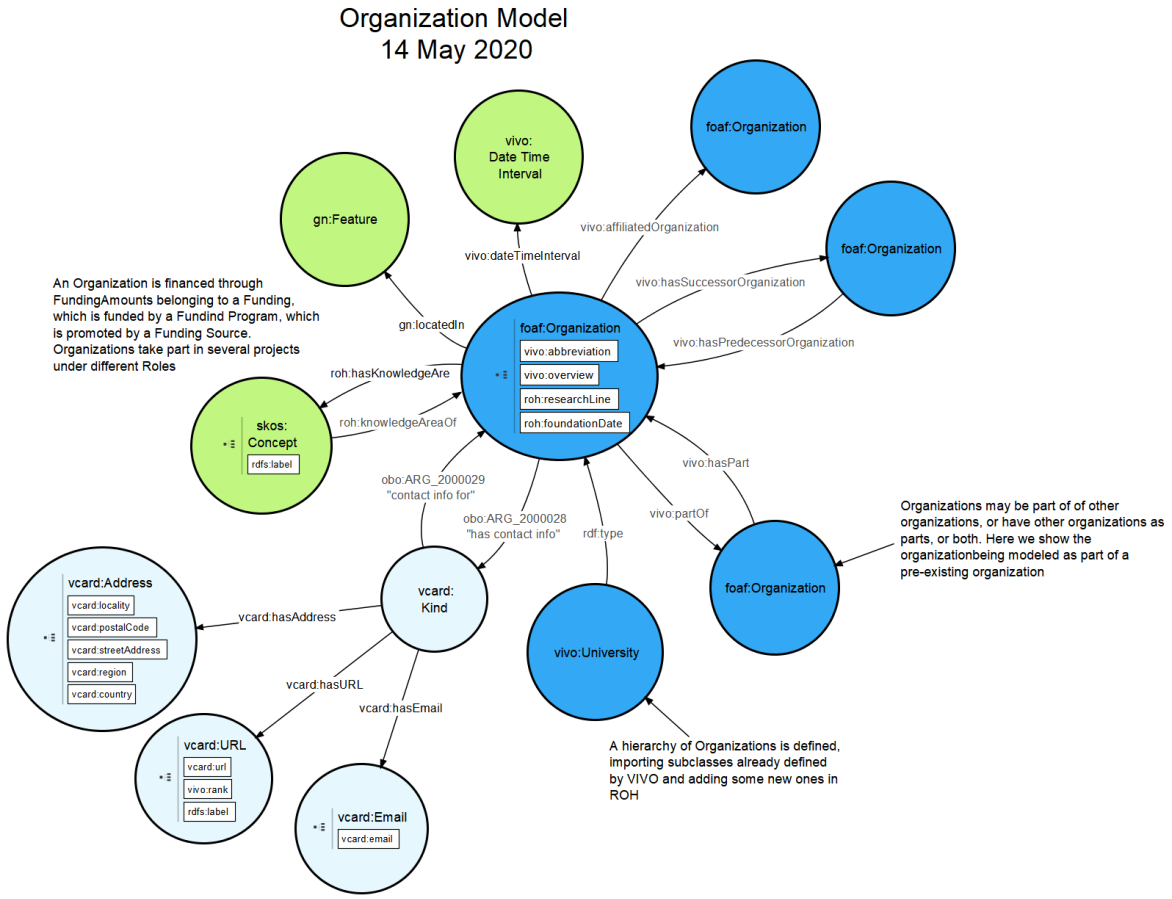

Figura 4. Ontological diagram for entity `Organization`.

1.5. Funding entity

The `roh:Funding` entity (see Figura 5), new in ROH, represents the funding associated with a project (`vivo:Project`) whose funding is associated with a funding program (`roh:FundingProgram`) and comes from a (`roh:FundingSource`), which in turn is associated with a funding organization (`vivo:FundingOrganization`). A funding is divided into several amounts (`roh:FundingAmount`), associated with the different entities that participate in a project and the annuities in which they do so. Funding gathers information about the total funding received for a project and its currency through the `roh:monetaryAmount` and `roh:currency` properties.

A funding can be marked as public through property `roh:publicFunding` and classified into `roh:Grant`, `roh:Loan`, `roh:Outsourcing` or `roh:RefundableAdvance`.

The funding organization (`vivo:FundingOrganization`) (see Figura 5), imported from VIVO [1], inherits from `foaf:Organization`, finances (`roh:funds`) through different funding aids (`roh:Funding`) to projects (`vivo:Project`). A `roh:Funding` is associated with `roh:FundingAmounts` through object property `obo-ro:hasPart`. A `roh:FundingProgram` funds (`roh:funds`) a `roh:Funding` which is promoted by a `roh:FundingSource`. Notice that a `roh:Funding` is divided into several `roh:FundingAmounts` associated with different `foaf:Organizations` through the `roh:grants` relationship.

The Funding Program entity (`roh:FundingProgram`) (see Figura 5), new in ROH, defines the funding initiatives promoted (`roh:promotedBy`) by a Funding Source (`roh:FundingSource`) which is, likewise, promoted by a `roh:FundingOrganization`. A funding is in operation during a time interval (`vivo:dateTimeInterval`) and is usually linked to a geographical scope (`geonames:Feature`).

The following table illustrates the object and data properties associated to entities dealing with the funding concept in ROH.

Prefix	Class		Prefix	Object property (bold indicates explicit Domain, otherwise a Restriction)	Range Class	Prefix	Datatype Property (bold indicates explicit domain; otherwise a restriction)	Range Datatype (if typed)	Range values
roh	**Funding**		obo-ro	hasPart	roh:FundingAmount	vivo	identifier	xsd:string	
			roh	**fundedBy**	roh:FundingProgram	vivo	description		
			vivo	dateTimeInterval	vivo:DateTimeInterval	vivo	freeTextKeyword		
			roh	**financedBy**	roh:FundingSource	roh	**publicFunding**	xsd:boolean	
			roh	hasContract	vivo:Contract				
			roh	**supports**	roh:PersonContract or roh:Project				
			roh	hasKnowledgeArea	skos:Concept				
			vivo	dateTimeInterval	vivo:DateTimeInterval				
	roh	**Grant**							
	roh	**Loan**							
	roh	**Outsourcing**							
	roh	**RefundableAdvance**							
roh	**FundingAmount**		roh	**grants**	foaf:Organization	roh	currency	xsd:string	
			obo-ro	partOf	roh:Funding	roh	monetaryAmoung	xsd:float	
			vivo	dateTimeInterval	vivo:DateTimeInterval				
roh	**FundingProgram**		roh	**promotedBy**	roh:FundingSource	vivo	identifier	xsd:string	
			gn	locatedIn	gn:Feature	roh	title	xsd:string	
			vivo	dateTimeInterval	vivo:DateTimeInterval	vivo	description	xsd:string	
			obo-ro	hasPart	roh:FundingProgram				
roh	**FundingSource**		roh	**promotedBy**	vivo:FundingOrganization				
			roh	funds	roh:FundingProgram				

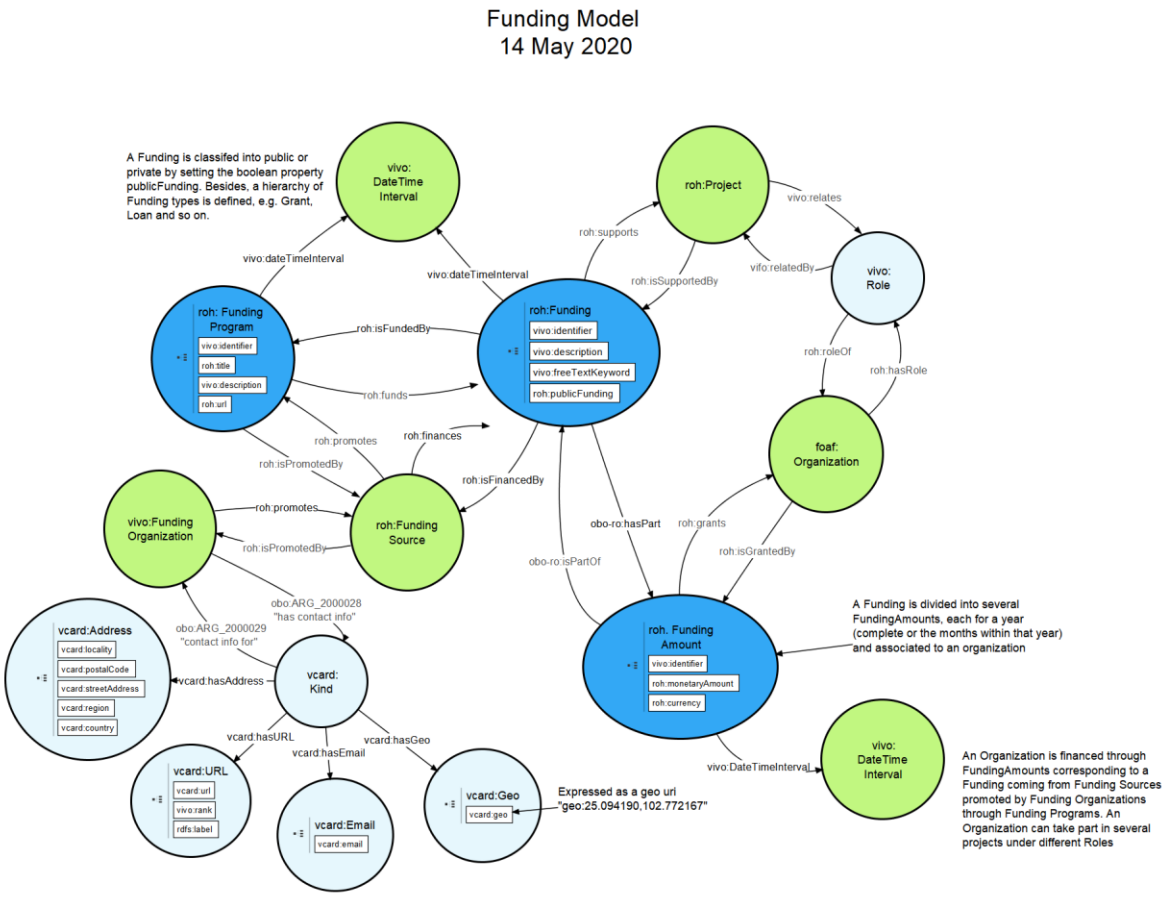

Figura 5. Ontological diagram for `Funding`.

1.6. Research Object Entity

The research object entity (`roh:ResearchObject`) is a new entity defined in ROH (see Figura 6) that corresponds to a research result generated by a person (researcher), usually through work on a project. A `roh:ResearchObject` is associated with several `foaf:Person` through the `bibo:authorList` property. Usually a `roh:ResearchObject` results from working on a `vivo:Project` (`roh:produces`). This entity defines a complete taxonomy of research objects mostly imported from BIBO [4], covering all kinds of publications, patents, software and web pages. Some examples are: `bibo:Collection`, `bibo:Journal`, `bibo:Article`, `bibo:Book`, `bibo:Chapter`, `bibo:Patent`, `bibo:Thesis` and `bibo:Webpage`. The primary author of a research object is accessible through the `roh:correspondingAuthor` property. A `roh:ResearchObject` may have several knowledge areas bound to it through `roh:hasKnowledgeArea`.

The most important research result is represented by the concept publication and is defined mainly through the imported entity `bibo:Document`. Currently, the following sets of entities related to the publication concept are supported: `bibo:Collection` (Newspaper, Magazine) and `bibo:Document` (Article, ConferencePaper, EditorialArticle, Book, Proceedings, ConferencePaper, Chapter, Thesis) and `obo:Software`. `bibo:Thesis` has been refined into `roh:DegreeThesis`, `roh:MasterThesis` and `roh:PhDThesis`.

Two entities worth mentioning that belong to the hierarchy of classes associated to the `roh:ResearchProject` are: `bibo:Report` and `roh:Dossier`. A `bibo:Report` has been refined to include subclasses `roh:EthicalReport` (which includes `roh:EthicalAudit` and `roh:EthicalValidation`), `roh:EvaluationSummary`, `roh:Justification` and `roh:ResearchProposal`. This implies that a report may correspond to ethical validation and auditing needs of a project, correspond to the evaluation of the project, its proposal or the set of documents corresponding to its justification.

On the other hand `roh:Dossier` represents a collection of reports related to a roh:Project, which may include all the types of reports above mentioned.

The below table shows the data and object properties, as well as subclasses, of entity roh:ResearchObject.

Prefix	Class				Prefix	Object property (bold indicates explicit Domain, otherwise a Restriction)	Range Class	Prefix	Datatype Property (bold indicates explicit domain; otherwise a restriction)	Range Datatype (if typed)	Range values
roh	**ResearchObject**				roh	hasKnowledgeArea	skos:Concept				
					roh	correspondingAuthor	foaf:Person				
					roh	**producedBy**	roh:Project				
	bibo	**Collection**						bibo	oclcnum	rdfs:Literal	
		roh	**Dossier**		vivo	relates	roh:ProjectContract or bibo:Report or roh:Project	vivo	identifier	xsd:string	
					vivo	dateTimeInterval	vivo:DateTimeInterval	roh	title		
								vivo	description		
		bibo	**Periodical**		vivo	publisher	foaf:Organization	bibo	eissn	rdfs:Literal	
								bibo	issn	rdfs:Literal	
			bibo	Journal	vivo	dateIssued	vivo:DateTimeValue	vivo	abbreviation	rdfs:Literal	
			bibo	Magazine							
	bibo	**Document**			vivo	publishedIn	bibo:Collection or bibo:Book	bibo	doi	xsd:string	
					bibo	**authorList**	rdf:Seq	bibo	abstract	xsd:string	
					vivo	dateIssued	vivo:DateTimeValue	bibo	**pageStart**		
					bibo	**editorList**	rdf:Seq	bibo	**pageEnd**		
								bibo	**volume**	rdfs:Literal	
		vivo	**Abstract**								
		bibo	**Article**					bibo	**issue**		
			bibo	**AcademicArticle**							
				obo-iao: JournalArticle	roh	**hasMetric**	roh:PublicationMetric				
			vivo	**ConferencePaper**	bibo	presentedAt	bibo:Conference				
				roh: WorkshopPaper							
			vivo	**EditorialArticle**							
		bibo	**Book**		vivo	publisher	foaf:Organization	bibo	edition	rdfs:Literal	
								bibo	isbn	rdfs:Literal	
								vivo	placeOfPublication	rdfs:Literal	
								bibo	iccn	rdfs:Literal	
			bibo	Proceedings							
		vivo	**ConferencePoster**								
		vivo	**Dataset**		cito	isCitedAsDataSourceBy	foaf:Document				
		bibo	**DocumentPart**		vivo	publisher	foaf:Organization	vivo	placeOfPublication	rdfs:Literal	
			bibo	**BookSection**							
				bibo: Chapter							
		bibo	**Patent**		vivo	publisher	foaf:Organization	vivo	identifier	xsd:string	
					gn	locatedIn	gn:Feature	roh	modality	xsd:string	
					vivo	dateIssued	vivo:DateTimeValue				
					roh	**ownerOrganization**	foaf:Organization				
		bibo	**Report**		vivo	distributor	foaf:Organization	roh	**status**	xsd:string	{"ACCEPTED", "REJECTED"}
					vivo	publisher	foaf:Organization				
			roh	**EthicalReport**							
				roh: EthicalAudit							
				roh: EthicalValidation							
			roh	**EvaluationSummary**				roh	evaluationStatus	xsd:string	{"FINAL", "PROVISIONAL"}
			roh	**Justification**	vivo	relates	roh:Project				

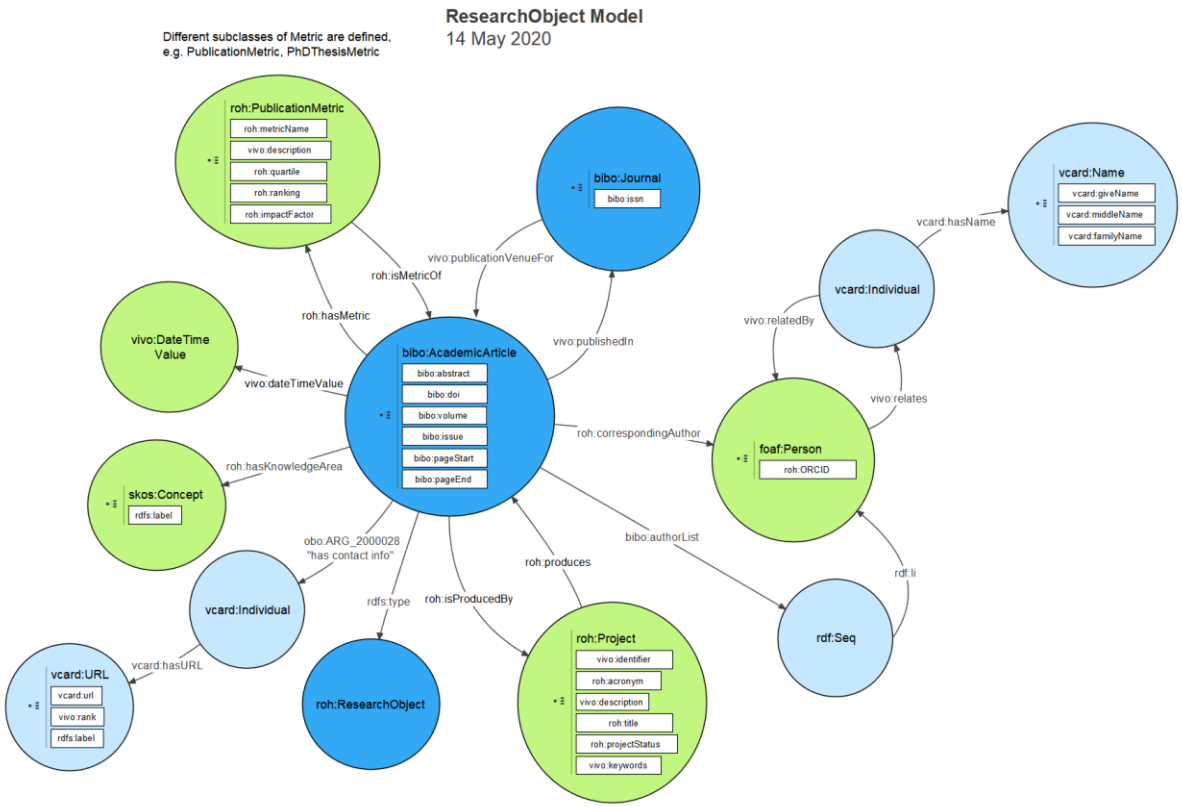

Figura 6. Ontological diagram for `ResearchObject`.

1.7. Activity entity

The entity research activity (`roh:Activity`), new in ROH and visualized in Figura 7, represents the activities in which People participate (`roh:participes`) and organized by Organizations (`foaf:Organization`) reflected through the `roh:hasRole` relationship that connects with the intermediary entity `vivo:OrganizerRole`. Each activity is usually linked to a project through the relationship (`roh:participes`) and causes a project expenditure linked through (`vivo:relates`). A detailed hierarchy of activity subtypes is defined as `roh:Activity`: `bibo:Conference`, `vivo:Internship` or `roh:ThesisViva`.

Related to Activity, it is also important to describe `roh:Expense`, which denotes the expenses incurred either by a project (`vivo:Project`) or person (`foaf:Person`) and linked through `roh:spends`. Every expense has a time instant of associated expense (`vivo:DateTimeValue`) and other properties that qualify it as (`roh:monetaryAmount`,

`roh:currency`, `roh:title` or `vivo:description`. It should be extended with more types of expenses, such as personnel costs, subcontracting, travel, equipment, research infrastructure and other goods and services. Currently, a distinction is made between `roh:PersonExpense` and `roh:ProjectExpense`.

The following table illustrates the class hierarchy, object and data properties defined by roh:Activity.

Prefix	**Class**		**Prefix**	**Object property** (bold indicates explicit Domain, otherswise a Restriction)	**Range Class**	**Prefix**	**Datatype Property** (bold indicates explicit domain; otherwise a restriction)	**Range Datatype** (if typed)	**Range values**
roh	**Activity**		roh	**participatedBy**	foaf:Agent	vivo	identifier	xsd:string	
			bibo	presents	bibo:Document	roh	description	xsd:string	
			vivo	relates	roh:Expense or obo-bfo:Role	vivo	freeTextKeyword	xsd:string	
			obo-bfo	realizes	obo-bfo:Role	vivo	contactInformation	rdfs:Literal	
			vivo	hasSubjectArea	skos:Concept	roh	title	xsd:string	
			vivo	dateTimeInterval	vivo:DateTimeInterval				
			gn	locatedIn	gn:Feature				
	vivo	Competition							
	bibo	Conference				vivo	abbreviation	rdfs:Literal	
	vivo	Course	obo-ro	partOf	vivo:AcademicDegree	vivo	courseCredits	xsd:int	
						vivo	courseHours	xsd:string	
	vivo	Exhibit							
	bibo	Hearing							
	vivo	Internship							
	vivo	Interview							
	vivo	Meeting							
	bibo	Performance							
	vivo	Presentation							
	vivo	InvitedTalk							
	roh	PanelTalk							
	roh	ThesisViva							
	bibo	Workshop							

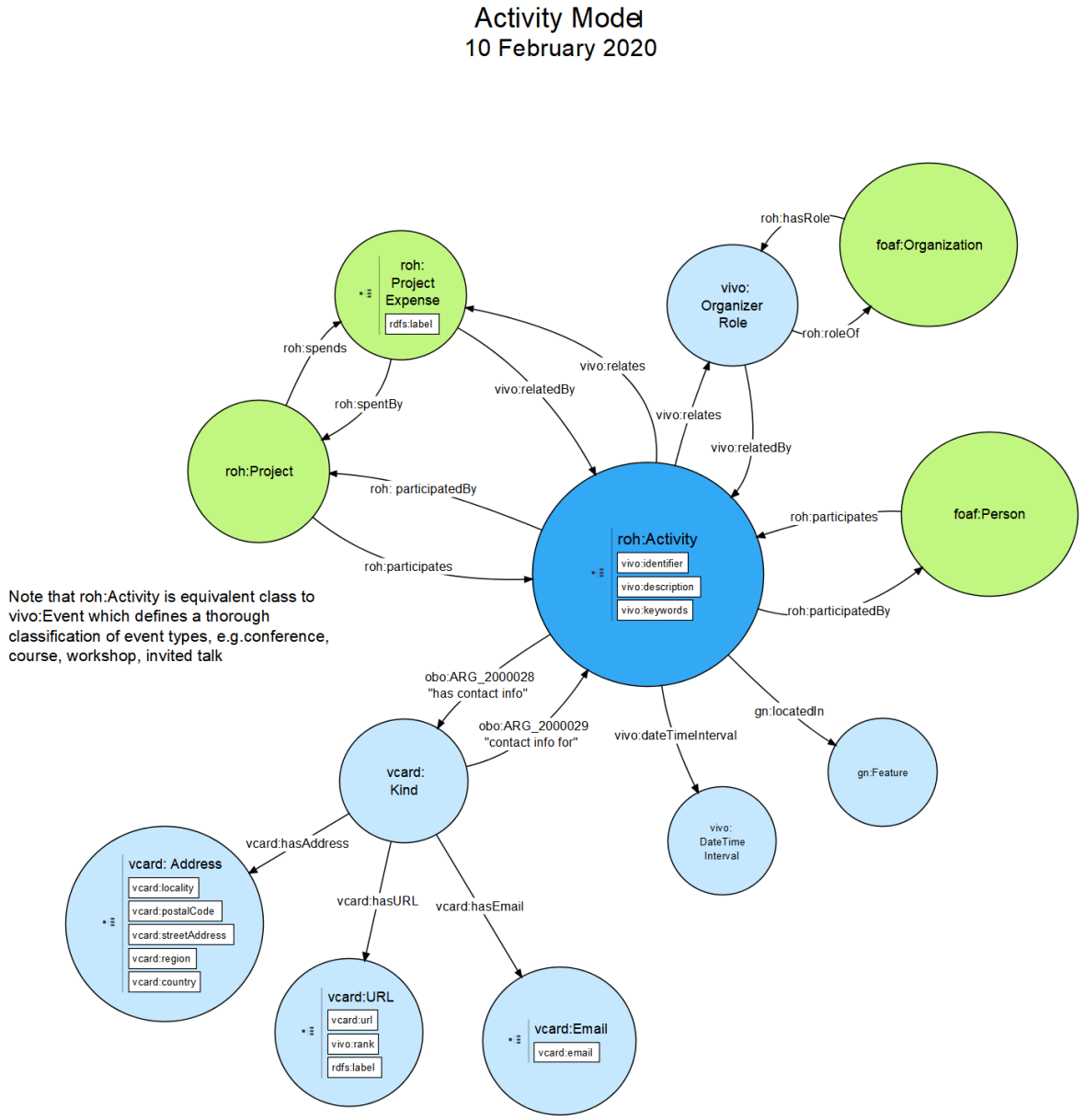

Figura 7. Ontological diagram for entity `Activity`.

1.8. Other entities in ROH

For more details on other entities in ROH check the tables detailing class hierarchies, object and data properties for all entities defined in ROH at the following PDF file: https://github.com/HerculesCRUE/GnossDeustoOnto/blob/master/Documentation/OntologyDocumentation.pdf

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