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Bilbao, Marzo de 2021

ONTOLOGY DOCUMENTATION

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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, Information 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 Organization 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 Organizations | 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.

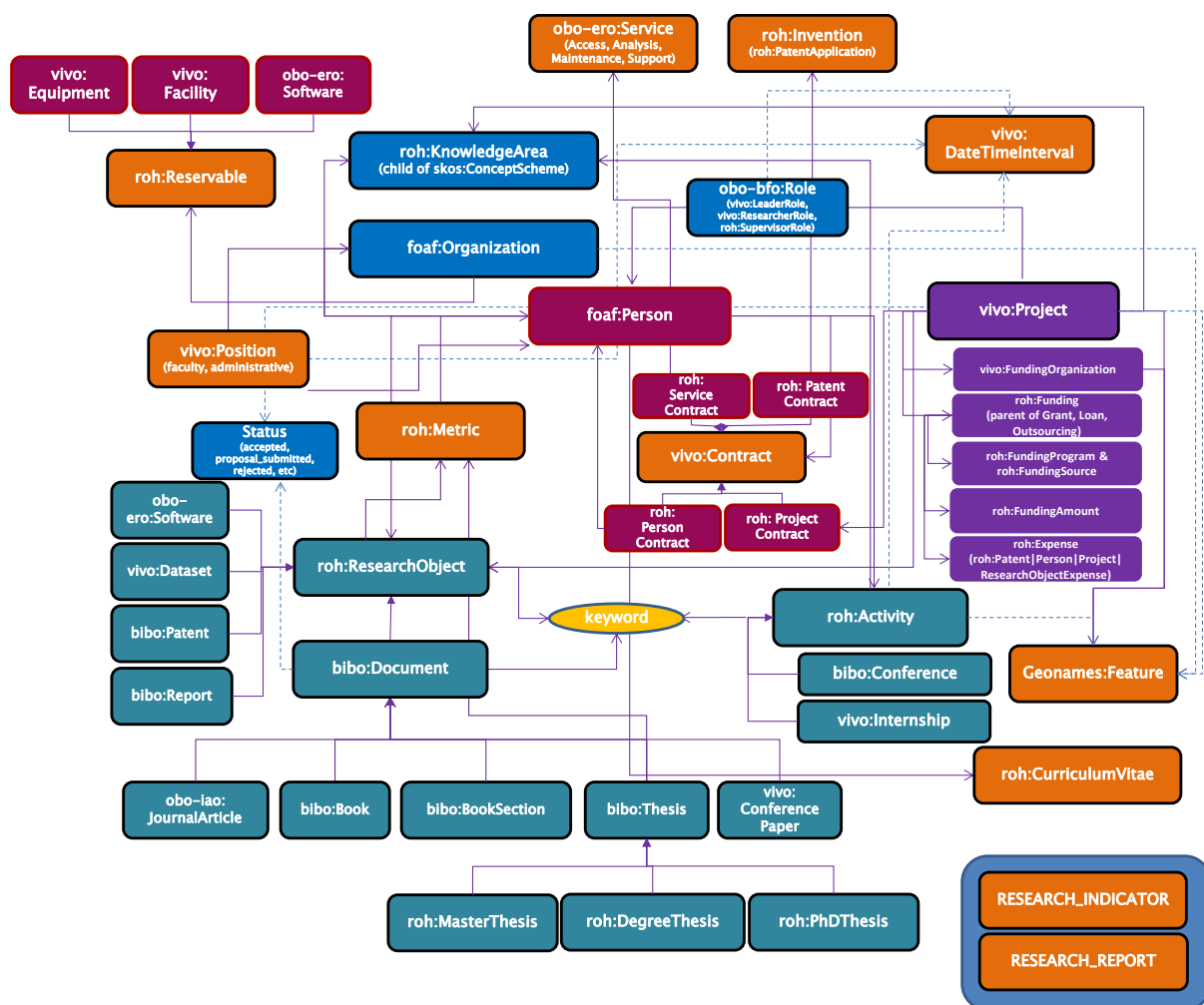


Figura 1. High level diagram of ROH –Red de Ontologías Hércules.

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 `roh: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`.

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- `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`:

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| 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 | | | | |

Project Model 12 March 2021

Notice that different Projects categorizations may exist, binding a project through `roh:hasProjectCategorization` with a `roh:ProjectClassification`, e.g. `roh:European`.

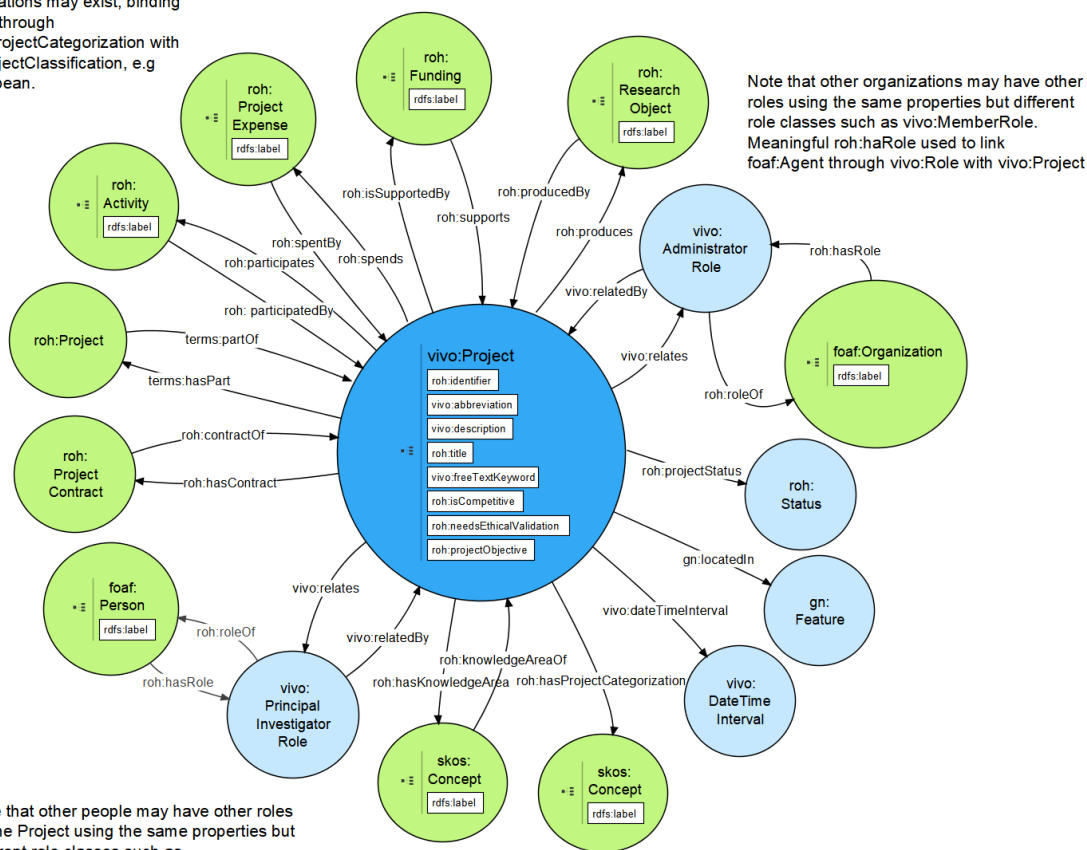


Figura 2. Ontological diagram for entity Project.

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

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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 preferably 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.

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- `vivo:Position`, where a researcher `roh:hasPosition` usually in an organization linking it to any of the `vivo:Position` subclasses 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 subclasses 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 | <code>vcard:Organization</code> | vivo | <code>freeTextKeyword</code> | <code>xsd:string</code> | |
| | | roh | hasAccreditation | <code>roh:Accreditation</code> | | | | |
| | | roh | hasRole | <code>obo-bfo:Role</code> | | | | |
| | | foaf | mBox | <code>owl:Thing</code> | | | | |
| | | vivo | relatedBy | <code>vivo:Relationship</code> | | | | |
| | | roh | hasReservable | <code>roh:Reservable</code> | | | | |
| | foaf Person | roh | hasKnowledgeArea | (<code>skos:Concept</code> and (<code>skos:inScheme</code> some <code>roh:KnowledgeArea</code>)) | vivo | identifier | <code>xsd:string</code> | |
| | | vivo | relates | <code>vivo:AwardedDegree</code> | vivo | researcherid | | |
| | | roh | spends | <code>roh:PersonExpense</code> | roh | birthdate | <code>xsd:string</code> | |
| | | roh | hasContract | <code>roh:PersonContract</code> | vivo | eRACommonsId | | |
| | | roh | hasCV | <code>roh:CurriculumVitae</code> | roh | description | <code>xsd:string</code> | |
| | | roh | hasPosition | <code>vivo:Position</code> | roh | firstName | <code>xsd:string</code> | |
| | | roh | participates | <code>roh:Activity</code> | roh | gender | <code>xsd:string</code> | |
| | | roh | elegibleFor | <code>roh:Accreditation</code> | roh | researchLine | <code>xsd:string</code> | |
| | | foaf | homePage | <code>foaf:Document</code> | foaf | surname | <code>xsd:string</code> | |
| | | foaf | image | <code>foaf:Image</code> | foaf | name | <code>xsd:string</code> | |
| | | roh | correspondingAuthor | | foaf | nickname | <code>xsd:string</code> | |
| | | roh | supervisorOf | <code>bibo:Thesis</code> | roh | taxID | <code>xsd:string</code> | |
| | | roh | teaches | <code>roh:AcademicSubject</code> | roh | title | <code>xsd:string</code> | |
| | | roh | reviews | <code>bibo:Document</code> | roh | ORCID | <code>xsd:string</code> | |
| | | roh | hasMetric | <code>roh:AuthorMetric</code> | vivo | scopusid | | |
| | | | | | roh | dedication | <code>xsd:string</code> | ("PARTIAL", "TOTAL") |

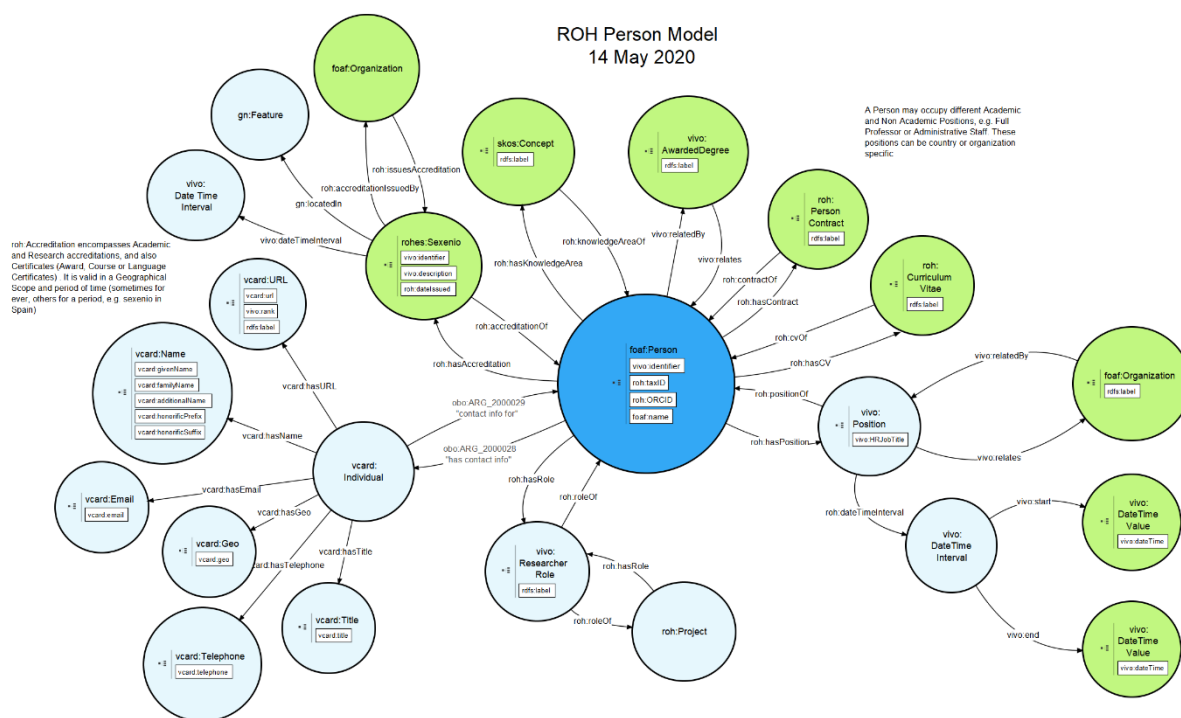


Figura 3. Ontological Diagram for entity Person.

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:Accreditation` (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:Activity`, 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`.

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Based on FOAF [10], the `foaf:Organization` entity takes into account the data properties (attributes: `vivo:abbreviation`, `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:AccreditationIssuer` 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.

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- `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`.

Check the following table for more details on object and data properties for `foaf:Organization`.

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| 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 | | | | |
| | | roh | hasReservable | roh:Reservable | | | | |
| foaf | Organization | roh | hasKnowledgeArea | (skos:Concept and (skos:inScheme some roh:KnowledgeArea)) | vivo | identifier | xsd:string | |
| | | vivo | affiliatedOrganization | foaf:Organization | vivo | abbreviation | rdfs:Literal | |
| | | roh | foundationDate | vivo:DateTimeValue | roh | description | xsd:string | |
| | | vivo | hasSuccessorOrganization | foaf:Organization | roh | researchLine | xsd:string | |
| | | vivo | hasPredecessorOrganization | foaf:Organization | | | | |
| | | terms | hasPart | foaf:Organization | | | | |
| | | roh | hasReservable | roh:Reservable | | | | |
| | | roh | hasSpinOff | vivo:Company | | | | |
| | | foaf | homePage | foaf:Document | | | | |
| | | roh | ownerOrganizationOf | roh:Patent Application or bibo:Patent | | | | |
| | | roh | participates | roh:Activity | | | | |
| | | roh | produces | roh:ResearchObject | | | | |
| | | roh | provides | obo-ero:Service | | | | |
| | | roh | grantedBy | roh:FundingAmount | | | | |
| | | roh | hasSpinoff | vivo:Company | | | | |
| | | vivo | dateTimeInterval | vivo:DateTimeInterval | | | | |
| | | gn | locatedIn | gn:Feature | | | | |
| | roh | AccreditationIssuer | issues | roh:Accreditation | | | | |
| | vivo | Center | | | | | | |
| | vivo | Company | hasCompanyClassification | (skos:Concept and (skos:inScheme some roh:KnowledgeArea)) | roh | isStartup | xsd:boolean | |
| | | | isSpinoffOf | foaf:Organization | roh | publicCompany | xsd:boolean | |
| | roh | LargeEnterprise | | | | | | |
| | roh | MediumEnterprise | | | | | | |
| | roh | MicroEnterprise | | | | | | |
| | roh | SmallEnterprise | | | | | | |
| | vivo | Consortium | | | | | | |
| | vivo | Department | | | | | | |
| | roh | EthicsCommittee | produces | roh:EthicalReport | | | | |
| | vivo | Foundation | | | | | | |
| | roh | FundingOrganization | promotes | roh:FundingProgram or roh:FundingSource | | | | |
| | | | funds | roh:Funding | | | | |
| | vivo | GovernmentAgency | | | | | | |
| | vivo | Institute | | | | | | |
| | roh | ManagementInstitute | | | | | | |
| | roh | ResearchGroup | | | roh | excellenceLabel | xsd:boolean | |
| | vivo | University | awards | vivo:AwardedDegree | | | | |
| | roh | Company | hasCompanyCategorization | roh:CompanyClassification | roh | isStartup | xsd:boolean | |
| | | | | | roh | publicCompany | xsd:boolean | |

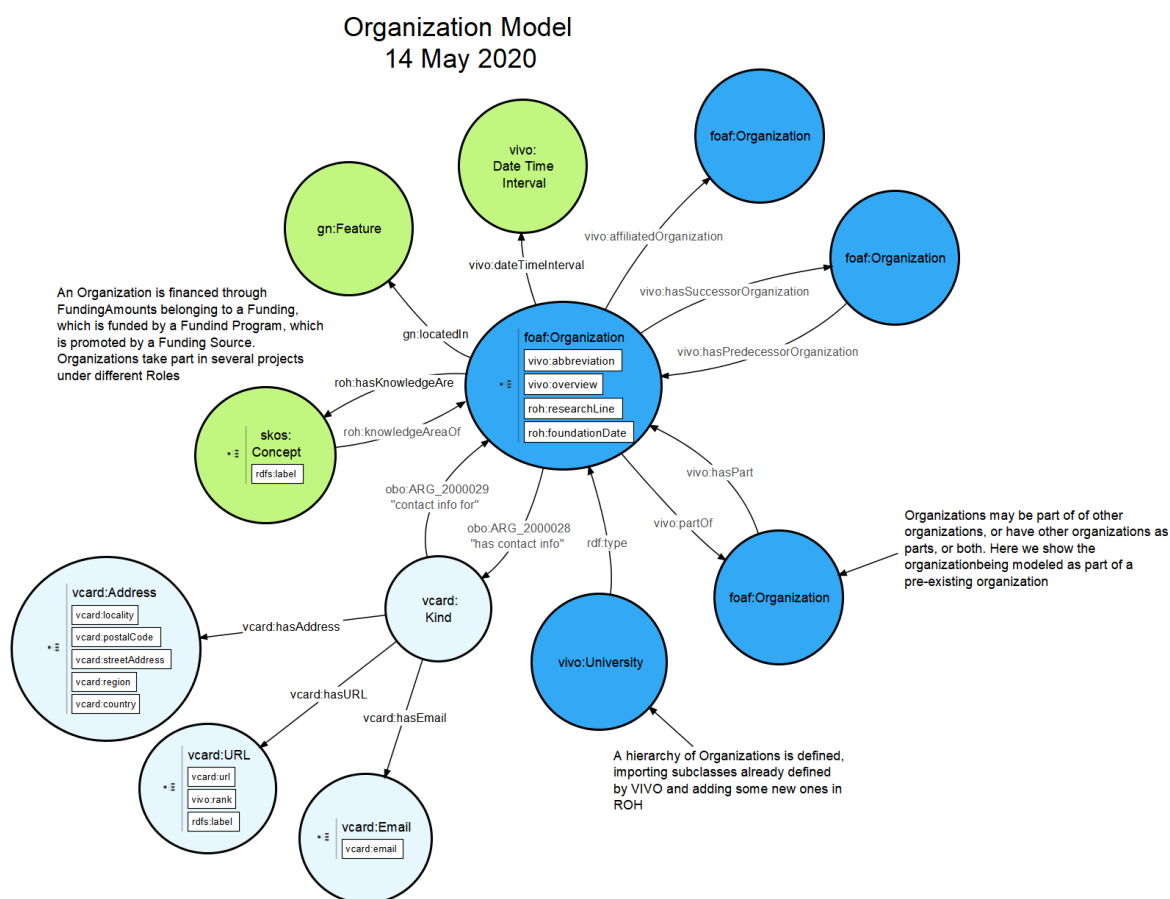


Figura 4. Ontological diagram for entity Organization.

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.

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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.

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| 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 | monetaryAmount | 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 | | | | |

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 | | | | | | | |
| | bibo-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 Justification | vivo | relates | roh:Project | | | | |

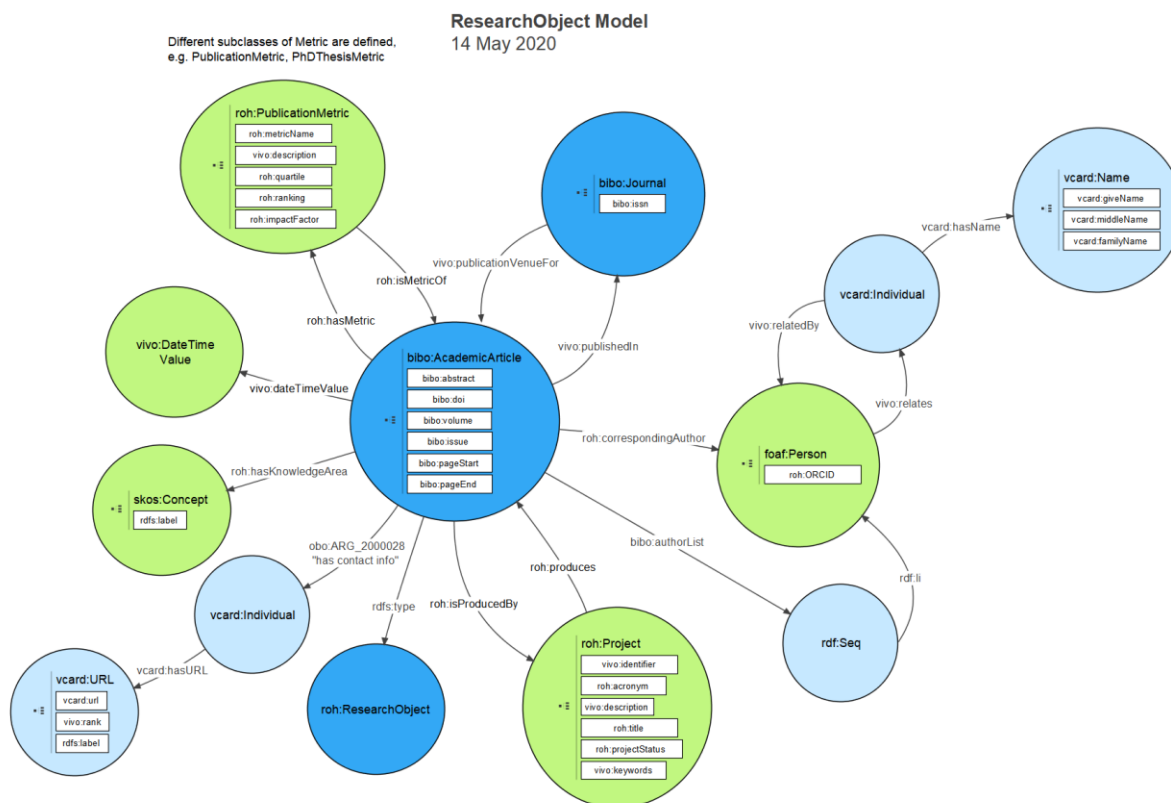


Figura 6. Ontological diagram for ResearchObject.

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**,

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`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, otherwise 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 | 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 | | | | | |

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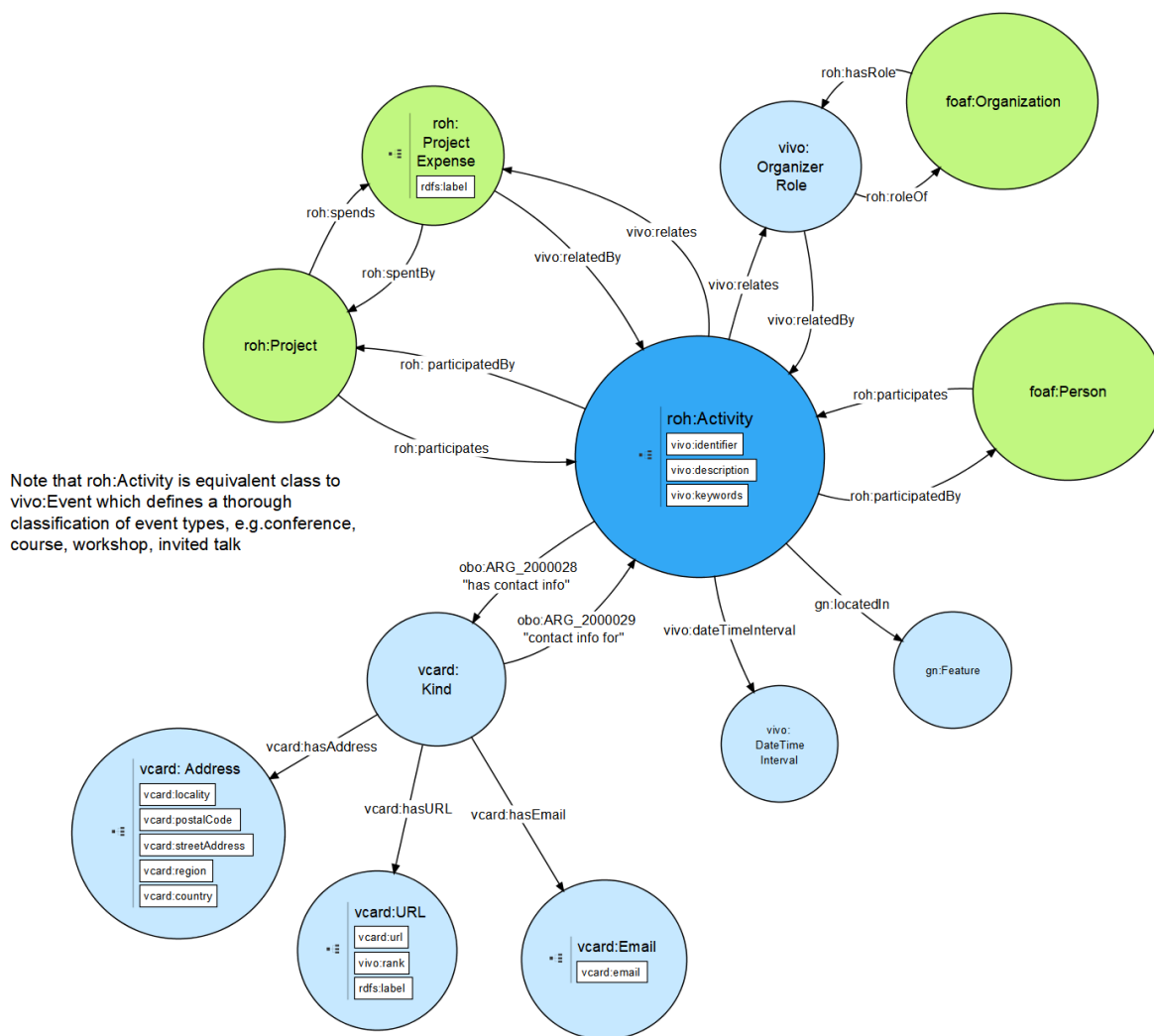


Figura 7. Ontological diagram for entity Activity.

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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