

Towards an Ontology for Knowledge Management in Communities of Practice

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Abstract. The work presented in this paper is about learning in Communities of Practices (CoP). It is situated in the context of Knowledge Management (KM) services that we are developing in the Palette project dedicated to learning in CoPs. The approach is based on several models detailed in this paper. These models constitute the theoretical grounding upon which the KM services will be based; they are organized in order to constitute a generic meta-ontology, from which a CoP-dependent ontology can be built, so as to annotate the CoP's knowledge resources.

Keywords: Knowledge Management, Communities of Practice, Learner Profile, Competency, Collaboration, Process/Activity, Lessons Learnt.

1 Introduction

According to Wenger [1], CoPs are groups of people who share a passion for something that they know how to do, and who interact regularly in order to learn how to do it better. CoPs can be found within businesses, across business units or across company boundaries [2], still they differ from business or functional units, from teams and networks: people belong to CoPs at the same time as they belong to other organizational structures. An effective organization comprises a constellation of interconnected CoPs, as these are privileged nodes for the exchange and interpretation of information. CoPs preserve the tacit aspects of knowledge that formal systems cannot capture. CoPs can be considered as a means by which knowledge is “owned” in practice. Indeed, such groups allow the functions of creation, accumulation and diffusion of knowledge in organizations.

Acknowledging CoPs emerging significance in KM, this paper presents a set of models enabling the formalization of core aspects related to CoP's every day work. More specifically, the work presented in this paper is carried out in the framework of the Palette IST project (<http://palette.ercim.org/>). Several CoPs on three domains

(management, engineering and learning) are involved and studied in the Palette project. Our work is situated in the context of KM services, our aim being to facilitate the efficient and effective management of the CoP's knowledge resources. In order to reach this objective, we studied the theoretical grounding upon which the foreseen services will be based. This theoretical grounding is composed of models necessary for the service tools to exploit the knowledge properly. These models will be organized in order to constitute a generic meta-ontology, from which a CoP-dependent ontology can be built, so as to annotate the CoP's knowledge resources. The CoP-dependent ontology could then be instantiated for the different CoPs involved in the Palette project. The ontology plays two roles: enabling to model a group in general and a CoP in particular, and enabling to annotate the CoP's resources.

The paper is organized as follows: first, we present our approach based on several models. Then, we detail successively each of the proposed models (community, actor and learner profile, competency, collaboration, process / activity, and lessons learnt) and do a comparison with related works. An example illustrating the use of the models is also presented. Last, we conclude by a summary of our contributions and the further work planned.

2 The Palette Approach

Fig. 1 summarizes the models we identified as the most significant. They concern the following main concepts: community, actor, learner profile, competency, collaboration, process/activity and lessons learnt.

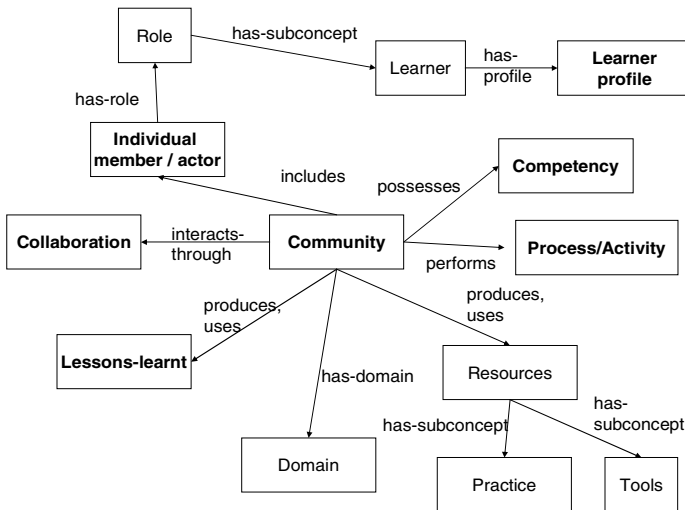


Fig. 1. Models linked to the concept of Community

Different actors can participate in a CoP as members: experts in a domain, students, or professionals. Actors can be characterized by their various roles in the CoP, and by their individual competencies, linked to the domain of the CoP. According to their competencies, actors can learn more or less about a practice and can participate more or less actively in an activity. Therefore, competency is one of the major concepts useful to define KM services appropriate to CoPs.

Collaboration is an important concept since the objective of a CoP is to deepen members' knowledge and expertise in the CoP's domain by interacting on an ongoing basis [3]. Participation is one of the two fundamental principles of negotiation of meaning in a CoP [4], the other one being reification.

Activities are central to the life of a CoP. They are the place and moment where and when interaction is made visible and fruitful. Specifically, activities are organized in order to exchange experience about a practice but also to enlarge knowledge of different members.

Learning is one of the key reasons why CoPs are being created and cultivated [3]. Every member of a CoP is at one moment or another involved in a learning process. Being able to define and characterize learners' profiles is an important aspect of KM within CoPs. Indeed, it is important to know how learners react, exposed to a piece of knowledge in order to provide services personalized to their cognitive profiles.

One key activity of a CoP is to share and exchange about the CoP's practice. This sharing of knowledge can lead to the definition of best practices, this is considered as lessons learnt. Lessons Learnt allow us to determine the behavior that is appropriate to a given situation. They lead to identification and qualification of best practices.

Let us detail each of these models.

3 Community and Actor Models

3.1 Presentation of the Palette Community and Actor Model

Wenger [2] distinguishes three dimensions along which a CoP defines itself. Firstly, its *joint enterprise* indicates what the CoP is about, as understood and continuously renegotiated by its members. The second dimension concerns the *mutual engagement* that indicates how the CoP functions and binds members together into a social entity, while the third, so called the *shared repertory of common resources* (routines, artifacts, vocabulary, styles...) indicates what capability the CoP has produced and is developed by the CoP's members over time.

As stressed in [1], a CoP can be characterized by its domain, meaning the area of knowledge that brings the community together, gives it its identity and defines the key issues that the CoP's members need to address. Furthermore, the community is another characteristic of CoPs. A CoP involves people who interact and who develop relationships that enable them to address problems and share knowledge. Community builds relationships that enable collective learning. Another aspect characterizing a

CoP is its practice. A CoP brings together practitioners who are involved in doing something. Practice anchors the learning in what people do.

The community is thus composed of members: these actors can play different roles, according to the activities of the CoP and to the CoP's stage of development. They interact, collaborate and learn by doing. They may also interact with the CoP's external environment. As far as the activity of knowledge sharing is concerned, we can distinguish the roles of knowledge provider and of knowledge recipient. On the other hand, for the social structure of the CoP, we can distinguish different roles of leaders, as suggested in [2]: inspirational leadership by thought leaders and recognized experts, day-to-day leadership by those who organize activities; classificatory leadership; interpersonal leadership; boundary leadership by those who connect the community to other communities; institutional leadership by those who maintain links with other organizational constituencies (in particular the official hierarchy); cutting-edge leadership.

Taking all the above into account, in our proposed model, a *Community* is characterized by: (1) its *Domain*; (2) its *Practice*; (3) its *Members*: these *Individual Actors* will be characterized by their individual competency, their *Social Relationships* in the CoP, their modes of participation in the CoP and of *Collaboration*, their *Roles*, their *Learning Profile*, their *Activities* inside and outside the CoP; (4) its *External Environment* that can be constituted by other actors (e.g. stakeholders in the organization that play a role of support to the CoPs, other CoPs, etc.); (5) its *Resources*: we can distinguish on the one hand the resources or outcomes developed by the CoP (artifacts, stories, routines, documents) and that constitute the *Practice* of the CoP, and on the other hand, the resources used by the CoP (e.g. the CoP's *Tools* that, according to [5], we classify into publishing tools, tools ensuring individual participation, tools ensuring community cultivation, tools for asynchronous interaction and tools for synchronous interactions); (6) its *History* and its *Life*: in particular, its life status corresponds to its current stage of development (potential, coalescing, active, disperse or memorable according to [2]).

3.2 Presentation of the Palette Learner Profile Model

Given the fact that learning is a major part of a CoP's activities, one of the most significant roles undertaken by almost all CoPs' members is the role of a learner. Acknowledging the importance of enhancing learning within an organization, in our approach we focus on learners, i.e. actors whose main objective is learning. More specifically, we present a generic Learner Profile model that aims at exposing the learners' cognitive characteristics when exposed to a piece of knowledge. The proposed model has derived after the common consideration of existing approaches on learners' profile models, learning activities and learners *per se* [6] [7]. The selection of the specific notions and relations used in the proposed model was driven by our aim to design a learner profile that could serve the ontologies development for both individual and group learners. Furthermore, in developing the proposed model, our aim was to provide a model for representing the static as well as the dynamic aspects of a learner's profile.

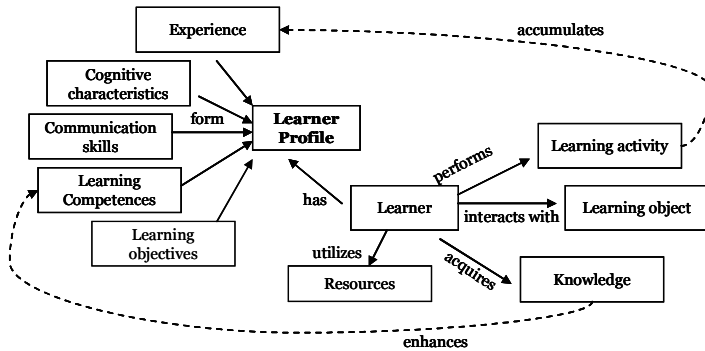


Fig. 2. The Palette Learner profile model

Fig. 2 presents the proposed *Palette Learner Profile* model. In this model, the notion of *Experience* refers to the knowledge of or skills in or observation of some thing or some event gained through involvement in or exposure to that thing or event. *Cognitive characteristics* comprise intelligence, perception, memory capabilities, creativity, organizing skills. *Communication skills* refer to the individuals' abilities in interacting with their environment. A *Learning objective* is a statement establishing a measurable behavioral outcome. The statement must include how the measurement is accomplished. *Learning competences* refer to academic background, education, training, working experience etc. *Learner* is the person who learns or takes up knowledge or beliefs. A learner is an actor's role that can be undertaken by an individual or a group of actors. *Learning activity* is every activity performed that intentionally or non-intentionally resides to knowledge acquisition. *Learning object* is every piece of knowledge. *Knowledge* refers to a fluid fix of verbal and/or manual skills brought about through training, instruction or practice that denote familiarity with facts, truths, concepts or principles. The *Resources* notion refers to every means a learner utilizes to perform a learning activity. All arrow connections appearing between the *Palette Learner Profile* model concepts express the relations occurring between them. For instance, the relation between learner and knowledge is the topic acquisition. It should be noted that the interactions among notions are not exhaustively defined, these are indicative and further relations or amendments to the proposed ones may occur according to findings of our future work.

Related research about learners' modeling proves that due to the complexity of human actors and the diversity regarding the learning context it is a thorny task to develop a commonly accepted learner profile [7]. For instance, in [8] a learner is depicted as a concept hierarchy that does not refer to issues such as the learning object, or the learners' interactions with their environment. The conceptual model in [9] comprises various types of information, yet it includes only the minimum information necessary to satisfy the functional requirements and it lacks information about dynamic aspects. The learner specification in [10] is a collection of information that addresses the interoperability of internet-based Learner Information Systems that support the Internet learning environment. Still, this like all the above cannot be employed for the representation of a community as a learning entity.

4 The Competency Model

The goal of our competency model is to represent the competency in the context of CoPs, specially the acquisition/exchange of competencies. We take it into account through the distinction of different roles that actors can play in their relation with competency. We also need to define the competency, and we choose to make the distinction between three types of resources that characterize the competency. The last aspect that this model allows us to represent is the link between a competency and its context of use that is represented by the environment in which it is involved.

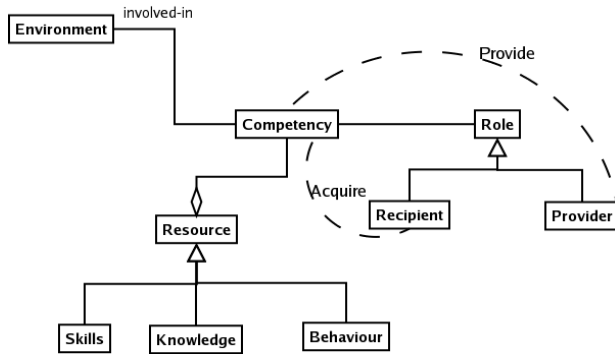


Fig. 3. The Palette Competency model

The competency model we propose involves the following concepts: *Environment*, that describes the situation in which the Competency is involved: solving a problem, achieving an objective or a task; *Competency* which is defined as a set of Resources provided or to be acquired by an Actor that plays a particular Role in the Environment to perform an Activity; *Role* that is used to link Competency to the actors. An actor can be *Provider* or *Recipient* of a Competency; *Resource* which is the set of items that compose a Competency. It can be of three types: *Knowledge* (theoretical knowledge (declarative or procedural)), *Skills* (capabilities of an actor to do something), *Behavior* (the way of behaving of the actor in a group or in a given situation).

Many models of competency were proposed in the literature, they give different points of view of competency. Our work can be compared to two main approaches: on one hand, an internal point of view that characterizes or defines the competency - thus [11] [12] make an interesting distinction between objective kinds of knowledge involved in a competency and subjective ones that provide important information on how people use their competencies; on the other hand, an external point of view that considers the competency in its context of use and acquisition [13] [14]. The KmP model [14] makes it possible to deal with both individual and collective competency and allows us to search the space of existing competencies. Since these two points of view are complementary and we need both of them to represent competency in the context of CoPs, our model tries to unify them.

5 The Collaboration Model

Collaboration is represented as a relation between four main concepts: the actors involved, the linked activities, the objectives of the collaboration and finally the resources it needs or produces.

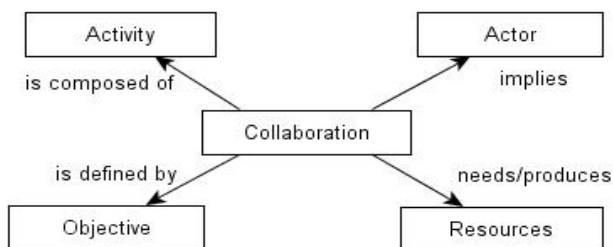


Fig. 4. The Palette collaboration model

Actor is a member participating in the collaboration, whatever his/her level of commitment or his/her knowledge. He may have several roles during collaboration, as he inherently possesses various competencies that allow a participation in several activities. *Activity* is the means to achieve the aim of collaboration. It can be planned (such as a meeting) or impromptu (such as chats or mail exchanges). Its observation and analysis can lead to best practices definitions, a decision, the creation of a document, etc. *Collaboration* arises from a goal that is common to each actor: the realization of a particular *Objective*. Each actor can have personal aims he wants to reach during collaboration. Finally, *Resources* represent anything that is used or produced by collaboration: documents, theories, software, instruments, etc.

In order to build our model of collaboration, we studied the theories of Engeström [15], Laferrière [16] and Montiel [17]. In his theory, Engeström presents the activity as a relation between the subject, the object and an artifact that could be an instrument, a tool, or a product from another activity. In the same way, Laferrière's model of collaborative learning shows that the objective of collaboration is important in order to have a precise vision of collaboration. In [17], several definitions of collaboration are presented. They all rely on the same main concepts, i.e. actor, activity, artifacts and objective, that is the reason why we proposed a unified model in Palette.

6 The Process/Activity Model

The Process model within the Palette context aims at describing sequences, roles, objectives, inputs and outputs of transformations, be they knowledge transformations within the CoP or transformations being part of the CoP's objective or core processes.

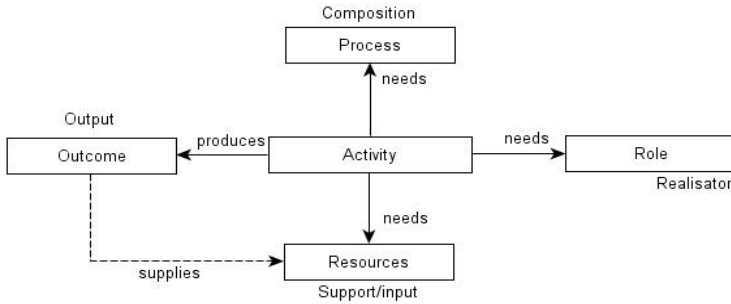


Fig. 5. The Palette process/activity model

A *Process* is a set of activities that need roles and resources in order to transform input objects into output objects, called outcome. An *Activity* is considered as a transformation of an input resource by a role during a process. An activity is seen as a ternary relation: a process, a role and resources. It needs these three elements in order to be performed. In a process, the activities are planned. A *Role* represents the responsibilities ensured by a function. It refers to a specific level of competency and to specialized skills. A *Resource* enables or helps the realization of an activity. A resource can be a tool or a product: software, a document, a competency, a practice, a method. The *Outcome* is the output of the activity. It can be part of resources needed to perform another activity.

In their Coordination theory [18], Crowston and Osborn describe “processes as sequences of activities performed by organizational actors that produce and consume resources”. The Palette Process/Activity model is inspired from this theory [18]. After having defined the main elements describing a process and an activity, the terms have been adapted to be understandable and sufficiently explicit. The Activity System Model (ASM) of Engeström [15] refers to the activity theory, and allows to define activity in a context of community. In the ASM, an activity is a systemic whole. Each element has a relationship to others, each relation is also mediated. This model is complex and presents a lot of relations between the elements. It can be used in various contexts and enables to see the relations with the other models.

7 Lessons Learnt Model

Since one of the main objectives of a CoP is to enable and foster collective learning, this last model was a crucial one to build. In the model, a *Lesson Learnt* is considered as the result of a process, collectively performed by the CoP’s members; this process consists of analyzing ones’ practices in given situations, and of drawing useful recommendations from this analysis that the CoP’s members can refer to when encountering similar situations of practice.

The Lessons Learnt model that we propose, in the context of the Palette project, includes the following concepts: the *Environment* represents the context or situation in which Lessons Learnt are used or produced, it relates to the concepts of Competency and Collaboration; *Activity* relates to the individual objectives of the actors, that is to

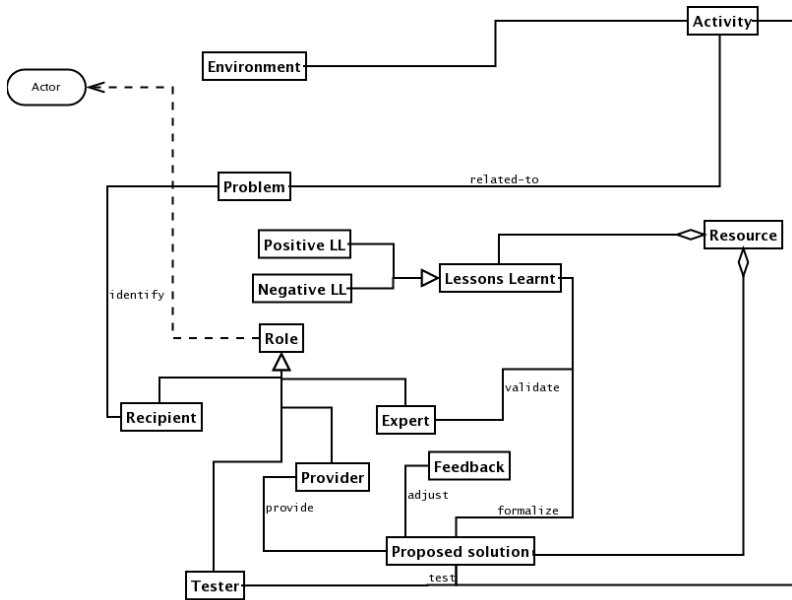


Fig. 6. The Palette Lessons Learnt model

say the tasks they have to accomplish in the organizations they belong to, the activity requires the use of Lessons Learnt in order to be performed. *Problem* is one of the main concepts linked to Lessons Learnt; it describes, in the context of an activity or practice, a point at issue whose related solutions are analyzed so as to determine the best way to figure it out; a *Proposed solution* represents the proposal of a solution to the Problem, or a clue to solve it; *Role* is the status of each Actor involved in the processes related to the Lessons Learnt, four main dynamic roles have been identified: the *Recipient* (who submits a Problem to be solved), the *Provider* (who offers a solution or a clue to the Problem), the *Tester* (who makes experimentation on the Proposed solutions and gives his/her feedback) and the *Expert* (who assesses the Proposed solutions, using his/her expertise on the domain and, at the same time, taking into account the feedback of the Testers); a *Resource* includes the different types of knowledge resources used to produce Lessons Learnt (knowledge, know-how, etc.) and which form a competency; and finally *Lesson Learnt* represents the knowledge gained and produced as a result to the Activities of sharing, exchanging and analyzing knowledge. It is the synthesis and formalization of the Proposed solutions to the Problem. A typology of Lessons Learnt can rely on their nature; for example, we distinguish: the *Positive Lessons Learnt* which consist of the activities recommended in the problem solving, they relate to the good practices of the CoP; and the *Negative Lessons Learnt* which describe the activities that are unadvised or to avoid, they relate to the bad practices of the CoP.

A survey of the works related to Lessons Learnt and experience capitalization modeling enabled us to deal with aspects specific to Lessons Learnt, such as the definition of the different operations to achieve (through the diverse roles we identify)

and the description of the context in which lessons are learnt. Weber's model [19] describes the life-cycle of Planning Lessons Learnt within an organization. Weber's work was used by [20] as a basis for identification and representation of use cases in the framework of Lessons Learnt systems. Considering experience capitalization, the REX¹ method [21] [22] consists of constituting "experience cards" stemming from any activity, and containing information about the context, comments and recommendations. These knowledge elements are then stored in a corporate memory in order to be retrieved and reused by members of the company. MEREX² method [23] [24] also deals with experience capitalization, and aims to make explicit Good Practices to be stored in a project memory, through the use of "knowledge forms" containing the same kind of information as in REX method, but deals more explicitly with the actor's aspect.

8 Example of Use of the Models for a CoP

Let us consider the use case of a semantic portal, within Learn-Nett (Learning Network for Teachers and Trainers), a CoP involved in Palette: this CoP is focused on a shared course and aims at preparing future teachers or trainers for educative uses of Information and Communication Technologies. The models proposed will be useful for annotating the CoP itself, the CoP's members and the resources they produce or use through the portal. The model of the community enables to emphasize the practice of this CoP and the model of actors to describe the various possible roles of the actors involved: coordinator, teachers, animators and tutors, The learner profile can depict the way a new member of the CoPs learns throughout his/her interactions in the CoP. The competency model allows us to describe the competencies needed for the different roles and the concrete competencies of the CoP's members, as well as the potential competencies useful for the different CoP's activities. The collaboration model enables to describe how the members collaborate for exchanging about their activities (see below). The resources produced or used are documents (e.g the pedagogical guide and the technical guide for the course; the charter of the CoP to be transmitted to newcomers) and tools (e.g. the videoconferencing system and the virtual environment Moodle). The activity model allows us to describe the various activities of the teachers, of the tutors and of the members inside the CoP: (1) the administrative and pedagogical preparation of the course (with the pedagogical guide and the technical guide as outcome), (2) training of tutors (in this case, the outcome will be learning activities, shared views on the tutor's interventions profile), (3) regulation of the tasks of the tutors during the course, (4) evaluation and regulation of the course itself. The Lessons Learnt model will enable to represent the positive and negative lessons learnt for example from reflective analysis of the supervision methods of the tutors throughout their effective experiences of tutoring students.

9 Conclusions

This paper proposed several models useful for describing a CoP: community, actor, learner profile, competency, collaboration, process/activity, and lessons learnt. These

¹ REX: Retour d'Expérience.

² MEREX: Mise en Règle de l'Expérience.

models were built by adaptation of some existing models; they propose a unified view of some common models. We illustrated our models through several examples of CoPs studied in Palette³ project: a semantic portal for Learn-Nett, a CoP of researchers and teachers in the field of educational technology; a meta-journal for Did@ctic, a CoP in training of faculty members in Higher Education and Educational Technology; an e-learning platform for UX11, a CoP of engineer students. The proposed models are structured in an ontology that will be later on extended and specialized according to the analysis of the other CoPs involved in Palette.

The link between CoPs and ontologies was studied in some recent work. In [25], the authors present a method based on analysis of the relationships between instances of a given ontology in order to identify potential CoPs in an organization. In [26], the authors develop an ontology aimed at enabling services among a civil servant CoP; [27] studies the design of situated ontologies for knowledge sharing in a CoP. But the role of all these ontologies is quite different from our ontology that aims at both modeling the notion of CoP, and at annotating CoP's resources.

As a further work, we will analyze other CoPs involved in the Palette project, in order to extend the ontology and develop several KM services based on this ontology.

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³ Some examples can be viewed at <http://www-sop.inria.fr/acacia/project/palette/PAKM06>

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