Detection and Quantification of Flow Consistency in Business Process Models (Extended Abstract)

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Abstract: Process models represent business processes using graphical notations. Their layout, which is determined by the modeler, can have an effect when these models are used. Such effect, however, is currently not fully understood. In order to systematically study the effect of layout, a basic set of measurable key features has been proposed, reporting layout properties meaningful to the human user. The aim of this research is to report how such features can be quantified into computational metrics, applicable to business process models. We analyze in details one specific feature, the *consistency of flow direction*. We describe three different metrics and the results of an empirical evaluation, showing which one is closer to the human perception. The work summarized in this extended abstract has been published in [Bu17].

Keywords: BPM, Visual layout, Metrics, Qualitative empirical study, Consistency of flow

1 Introduction

Process modeling refers to the representation of organizational or business processes in a graphical manner, usually as a flow of activities. Model quality – important for designing and improving business processes, analyzing industry goals and outcomes – can be classified as syntactic ("correctness" of a model), semantic (the extent to which the model captures the behavior of the domain), and pragmatic (usefulness) [KSJ06]. Existing research addressed various factors influencing model understandability and readability in the context of business process models. Visual features of elements in a model [RM11] have been studied, specifically the effect of what is sometimes called "secondary notation" on model understandability [KSJ06, Ri06]. Specific layout properties of a model, in turn, have received little attention. [Bu17, BS15] describe the outcomes of an experiment eliciting relevant layout features. These are grouped according to the visual aspects involved: edges, models' structure, and model's direction. In this paper we focus on one particular property, i.e., the model's direction.

2 Automatic identification of flow consistency

We present 3 metrics capable of automatically inferring the consistency of the flow of a process model. We assume that the model has a *predominant* flow direction that we have to determine. Possible directions are: North, East, South, and West. In our approach, the predominant flow direction is given by majority voting (e.g., the direction most edges belong to). We calculate the overall consistency dividing the number of edges belonging to the predominant flow direction by the total number of edges.

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The first metric, *M-E1*, starts from the coordinates of the start and end points of an edge and, using the arctangent function with two arguments, it gets the actual angle of the connection. By dividing the radius into 4 equal parts of 90° (one for each direction), the metric assigns the edge to the corresponding direction.
The second metric, *M-E2*, assigns exactly two directions to each edge. In this case, the radius is still divided in 4 parts, but each of them now covers 180°. Therefore, each direction overlaps with two others (e.g., North overlaps with East and West). For each edge, the angle is computed as in the previous metric, but it contributes to 2 directions.
The third metric, *M-BP*, emphasizes activities rather than edges: it determine the extent to which the layout of the graphical representation is consistent with the temporal logical ordering of the business process. To achieve that, it computes the behavioral profile [WMW11] and, for each strict order relation, it checks whether the source node (i.e., the node that must occur first) is "graphically before" (i.e., it is placed wester or norther) the target node (i.e., the node that must occur later). The consistency score is computed dividing the number of graphically before relations by the total number of strict relations.

3 Experimental evaluation

To assess to what extent the metrics we defined are consistent with human perception, we performed an empirical study in which we asked human readers to rate a set of models regarding their flow consistency.[1] We then computed correlations between the average human assessment and our metrics. Results, reported in Table 1, suggest that the metric based on behavioral profiles, M-BP, best reflects human assessment, with a strong Pearson correlation score of 0.719 and significance of 0.004.

	M-E1	M-E2	M-BP
Correlation	0.263	0.567	**0.719**
Significance	0.364	0.034	**0.004**

Tab. 1: Pearson correlations with average scores assigned by subjects.

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[1] All the material and raw results are available at `http://bpm.q-e.at/experiment_flow_consistency`.