A Tool for Assessing Quality of Rescue Plans by Combining Visualizations of Different Business Process Perspectives

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Abstract. Rescue plans for crisis situations such as natural or made disasters are mostly presented in a textual format to the relevant authority. Assessing the quality of a rescue plan requires analyzing different perspectives, such as plan complexity, resources costs, service time, allocation strategy and organization efficiency. Unfortunately, textual rescue plans lack a formal structure to ease the reading and navigation through the document. To address this problem we are composing tailored visualizations, each visualization representing a particular perspective. We provide a domain specific language to describe domain specific visualizations of processes. We validate our approach using static and dynamic analysis of the Ho Chi Minh city rescue plan in case of a tsunami. Our approach provides recommendations that are useful for the authority to improve the original rescue plan.

Keywords: Rescue plans assessments · Business process modeling · Visualization · BPMN

1 Introduction

Disaster situations including natural disasters, man-made disasters or combined natural and man-made disaster with environmental consequences, require the efficient coordination of various stakeholders (public sectors, private sectors, as

N. Bellamine Ben Saoud et al. (Eds.): ISCRAM-med 2015, LNBIP 233, pp. 155–166, 2015.
DOI: 10.1007/978-3-319-24399-3_14

well as citizens) in order to minimize damages. When the Hurricane Katrina stroke the United States in 2005, it has been estimated that the lack of efficient coordination caused the death of more than 1200 people in Louisiana, Mississippi and Alabama, left hundreds of thousands homeless and caused tens of billions of dollars in damage [1]. In the context of crisis resolution, rescue plans unfortunately are mostly expressed in textual guidelines. It has been shown that textual guidelines suffer drawbacks [2–4]. Ambiguities make the coordination among stakeholders difficult and error prone. Moreover, textual guidelines are not easy to analyze and simulate.

An alternative to textual plans is to use Business Process Modeling (BPM) as we did in our previous work [2–4] with a BPMN (Business Process Model and Notation) diagram. This diagram, built by examining an official textual plan, supports subsequent formal analysis: process complexity, end-to-end process time, resources costs, allocation strategy, process simulation, transformation to multi-agent simulation, etc.

Rescue plans cost resources and lives. Even expressed as a business process, the quality of rescue plans is still difficult to be accurately assessed. A rescue plan is generally validated during the recovery phase, after a disaster occurred. Moreover, the process has to be assessed from multiple points of view that could induce an information overload for the rescue plan expert.

This papers has two contributions. First, it presents a new modeling of rescue plan based on Business Processes. This modeling reproduces the results we have previously obtained [4]. Second, we explore multiple perspectives on processes using interactive, expressive, and domain specific visualizations. We build a tool named A4BP (Assessment for Business Processes) that will allow rescue experts to evaluate the quality of these processes. The originality of our approach is summarized as follows:

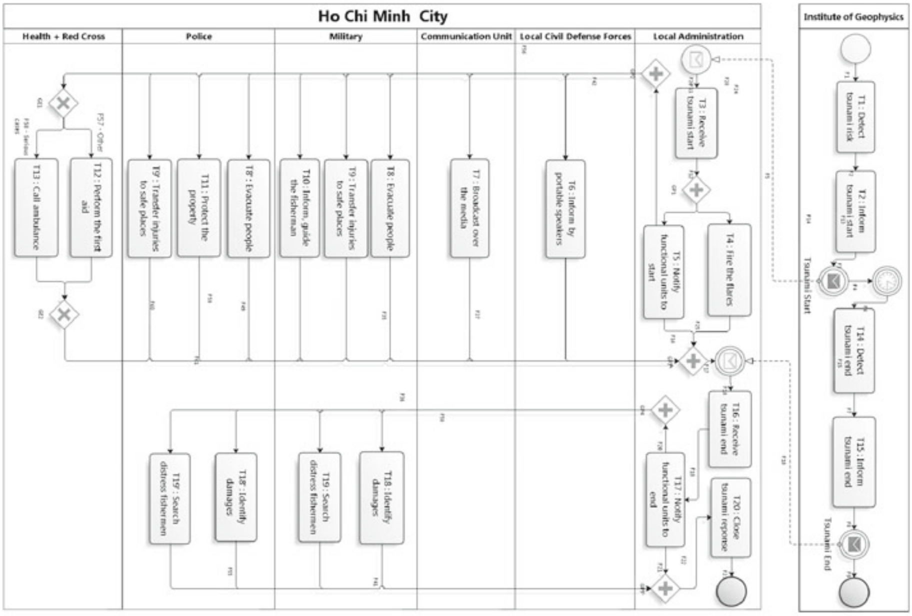
- We use a model-based approach: BPMN models may be imported and represented as a set of objects; queries and metrics may be formulated on BPMN models to specify visualizations.
- Rescue plans can be visually assessed with specific visualizations.
- Visualizations are interactive and explorable in order to reduce the feedback loop when the end-users adapt the initial rescue plan.

The paper is organized as follows. First we model a rescue plan as business processes using BPMN diagrams (Sect. 2). We use the rescue plan of Ho Chi Minh City (HCMC) tsunami as the running example along this paper. Second, our approach is detailed using two visualizations of the HCMC tsunami rescue plan (Sect. 3). After briefly presenting the related work (Sect. 4) the paper concludes (Sect. 5).

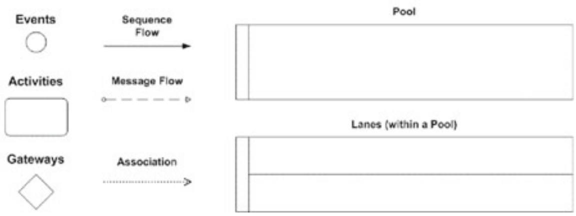
2 Model Rescue Plans as Business Processes

Today, BPMN 2.0 is the standard notation for modeling business processes. Developers, business analysts, enterprise architects could effectively use this graphic notation to express business rules. A great deal of existing open-source and commercial Business Process tools are available (*e.g.,* jBPM[1], BonitaSoft, Camunda[2], Activiti Modeler[3], Bizagi Modeler[4]).

In our previous work, we presented a BPMN modeling of the Ho Chi Minh City Tsunami rescue plan from textual plans. These plans were provided by the Vietnamese authorities [2] (Fig. 1).



(a) BPMN Model



(b) BPMN Elements

Fig. 1. BPMN representation for Tsunami response plan

[1] https://www.jboss.org/products/bpmsuite/overview.
[2] https://camunda.com.
[3] http://activiti.org/components.html.
[4] http://www.bizagi.com.

In the BPMN process model, eight actors are represented by rectangular boxes, called swimlanes. These actors are two pools (Ho Chi Minh City and Institue of Geophysics) and six lanes (Health + Red Cross, ..., Local Administration). Besides, in order to visualize the task, we use the activity notation (like T1: Detect tsunami risk), depicted by a rounded-corner rectangle. These activities are connected by the Connectors (Sequence Flow and Message Flow), and the Flow Objects like Start Event, Intermediate Event, End Event. Furthermore, the control structures help to coordinate the different activities using parallelism (diamond including "+") or alternatives (diamond with "X").

Quality of rescue plans is assessed in a number of different ways. For example, in our previous work [4], we show the benefice of combining two different levels of analysis of rescue plans: a BPMN diagram that provides a graphical view easily understandable by end-users and a multi-agent perspective that provides an aggregate representation of the behavior of the actors involved in the plan. The first level allows one to analyze the rescue plan from the complexity of the workflow and may be used in a simulation, while the second level focus on dependencies between roles and enable the analysis of the robustness, flexibility and efficiency of the organization.

In order to analyze rescue plans, different perspectives have be taken into account at the various phases of the disaster (Fig. 2). The analysis during the preparedness, when pre-disaster strategic planning is done and when all the resources are not completely known, is not the same that we will be done during the response phase just after the disaster.

Another specificity of a rescue plan is to be modified at run time depending of the crisis current situation to be adapted to new actors appearing in the scene, excess or lack or resources, etc.

Our proposition in this paper is to use visualizations to provide a convenient and practical means for the end-users to analyze complex rescue plans with

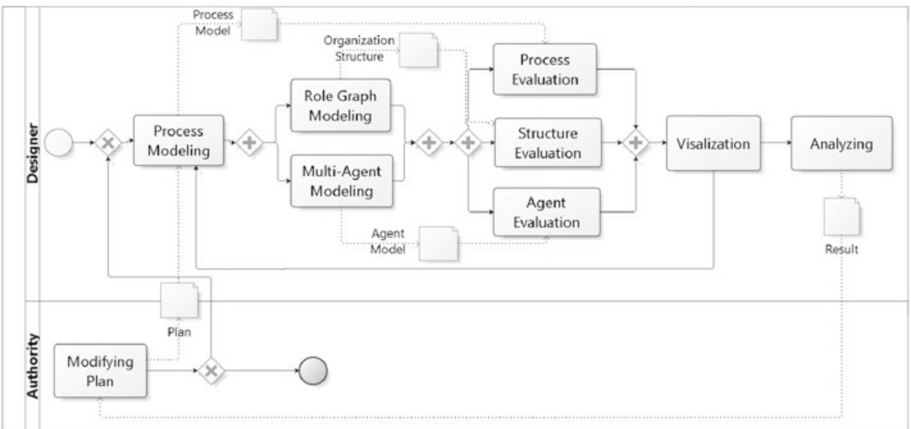


Fig. 2. Lifecycle of rescue plan assessments

different perspectives. Visualizations also allow us to combine different perspectives in a compact graphical and contextually pertinent presentation. For example, we can reuse the common blueprint of a BPMN diagram and add on top of each BPMN elements some information related to the simulation (time or resources needed for this element).

Another useful feature of visualization is to be able to view flaws or defaults using graphical patterns. This feature has already been used in the context of software process modeling by Alegria *et al.* [6].

Visualizations allow us to have a very short feedback when the rescue plan is modified in order to see the consequences. Visualizations further allow us to have an explorable way to test different rescue plans among all the possible scenarios.

3 Assessing Rescue Plans with Visualizations

We first describes the A4BP tool that allow us to model, analyze and visualize multiple perspective on Business Processes (Sect. 3.1). Subsequently, two examples of assessments done on the HCMC tsunami plan are shown and we give the code of the domain-specific language use to do the visualizations (Sect. 3.2).

3.1 *A4BP Tool Description*

A4BP (Assessment for Business Processes)[5] is a platform based on the Pharo[6] programming environment. Its purpose is to craft custom analysis of Business Process models (like BPMN 2.0). A4BP allows developers, engineers, process managers and end-users to import, transform and navigate Business Process meta-models descriptions.

The main idea of A4BP is to provide a tool to navigate the entire business process definition including relation between process and technological services related to process execution. It provides multiple perspectives to measure and visualize business process code to identify quality and design problems.

The top architectural level (*e.g.,* Fig. 3) is composed by *(1) a meta-model process engine* to parse the process definition, build an object model of BPMN instances and calculate quality metrics; *(2) a simulation engine* based on BPSim[7], a standard to configure simulations, defines scenarios and captures results according to five dynamic perspectives: Time, Control, Resources, Cost and Task priority; *(3) a front end environment* using Roassal[8] [15], an agile visualization engine to produce dynamic visualization using elements of the Business Processes.

[5] http://www.a4bp.com.

[6] A Smalltalk-inspired live programming environment to edit, manipulate and execute objects interactively: http://pharo.org.

[7] http://www.bpsim.org.

[8] http://objectprofile.com/Roassal.html.

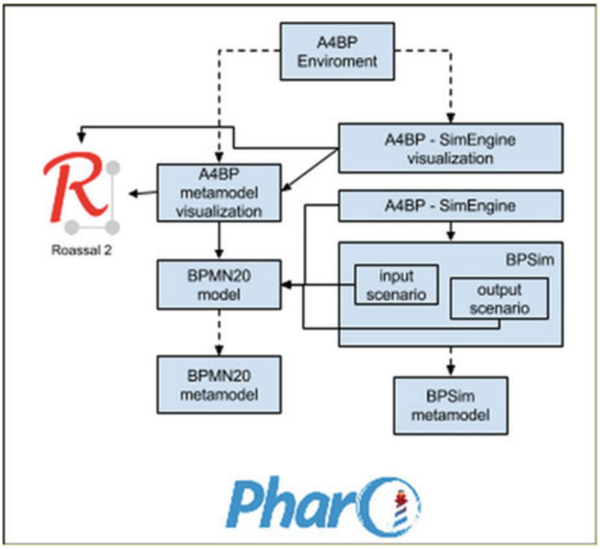


Fig. 3. A4BP layered architecture

A4BP includes the following metrics:

Metric	Description
Numbers of elements	Counting the number of element defined in the formal meta-model description
Control Flow Complexity (CFC) [9]	Using Cardoso proposal for control flow complexity in business process
Control Flow Complexity Absolute (CFCAbs)	A variant of CFC used to find the complexity when the elements have more related split elements. The basic idea is to sum all CFC in oder to have the absolute value
Process Length [8]	$N = n_1 \times log_2(n_1) + n_2 \times log_2(n_2)$
Process Volume [8]	$V = (N_1 + N_2) \times log_2(n_1 + n_2)$
Process Difficulty [8]	$D = (n_1/2) \times (N_2/n_2)$

where: n_1 is the number of unique activities, splits &joins, and control-flow elements of business process; n_2 is the number of unique data variables manipulated by the process and its activities; N_1 and N_2 are respectively the total number of elements and data occurrences.

3.2 *A4BP Assessments Scenarios*

A4BP may be used by a rescue plan analyst in two different ways:

1. Using the default predefined visualizations provided by the tool,

2. Building their own visualization with the scripting engine provided by A4BP, based on the ROASSAL agile visualization engine. We will focus only on this way in the rest of the section.

The usual workflow for process modeler is to load a process model in A4BP, explore the interface navigator, and decide which element has relevant information to make a custom visualization (See Fig. 4 for the navigation interface used in the modeler).

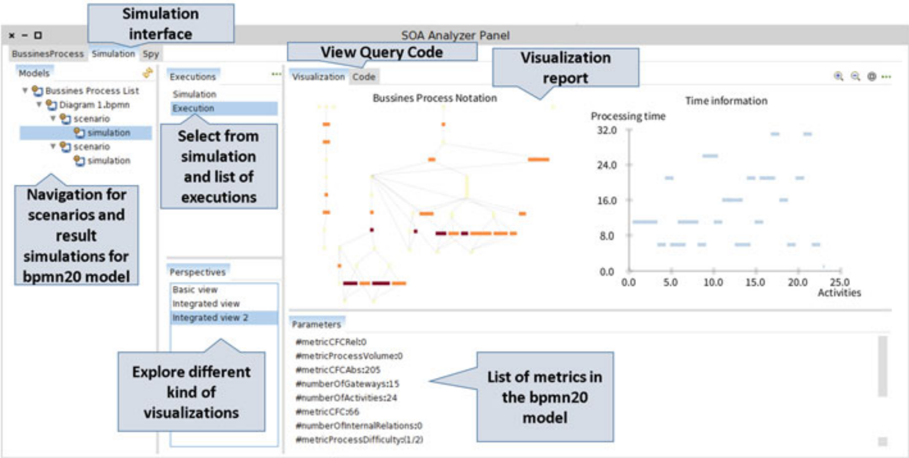


Fig. 4. A4BP model navigation interface

In order to illustrate the workflow that end-users could follow to assess a rescue plan, we show first how to build a static visualization from the HCMC tsunami rescue plan (Fig. 5) with all flow elements and their relations. We evaluate each element with the flow complexity and flow absolute complexity using rectangle width (CFC metric) and height (CFCAbs metric) to identify which element has more complexity in the model.

We obtain a visualization that is roughly similar to Fig. 1(a) with more information regarding each element. This information is more valuable for end-users than just plain BPMN diagrams.

The visualization given in Fig. 5 is obtained by executing the following script. The main part of the script is to select the nodes from the BPMN model that will be displayed and given to these nodes. The suitable shapes and colors depend on the metrics that business analysts want to examine.

This script may be built interactively and incrementally by the user during the exploration of the model.

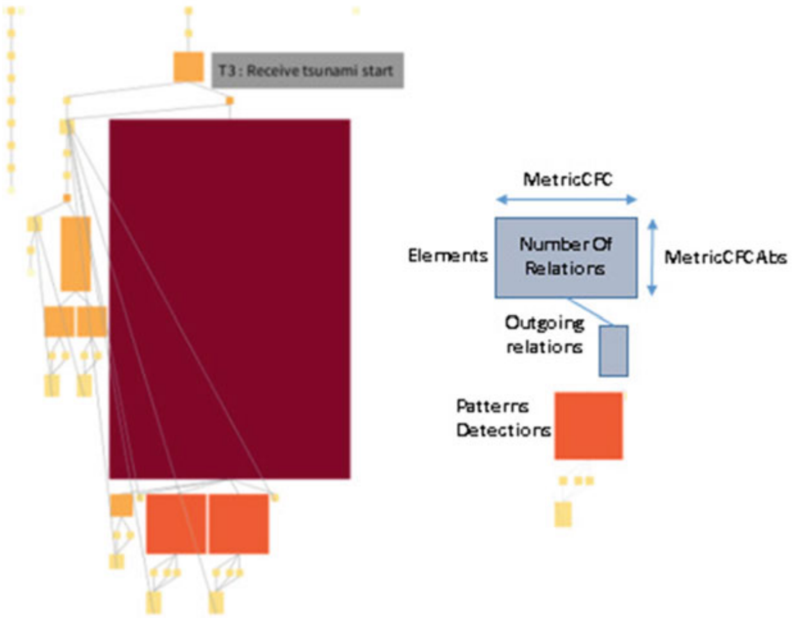


Fig. 5. Visualization of HCMC rescue plan process complexity

```
"Start Scripting visualization, using flowElements as main imput"
 values := model flowElements.
"Configure each node in the view with the metrics, using visual properties"
view shape rectangle
    "Add control flow complexity metric"
    width: [: nn | (nn metricCFC + 1) * 10 ];
    "Add control flow complexity absolute metric"
    height: [: nn | ( nn metricCFCAbs + 1 ) * 10 ].
view nodes: values.
"Add number of relations metric to normalize the color"
view normalizer
    normalizeColor: #numberOfRelations
    using: (ColorPalette sequential colors: 9 scheme: 'YlOrRd') using: #value.
"Connect the elements depending on the outFlows relationship"
eb := view edges.
eb shape line color: (Color lightGray alpha: 0.2).
eb connectFrom: #yourself toAll: [:n | n outFlows ].
"Generate a tree layout to organize using outFlows references"
view layout tree.
"Execute the visualization"
 view build.
```

Thanks to this visualization, the end-user might gain insights from the process. For example, it is apparent that one element (a parallel gateway element) has a very high complexity (width) and a high number of relations with other elements (color). This element corresponds probably to a critical task in the rescue plan. Another fact that we discover is that there are some recurrent patterns not only in terms of structure but also in terms of complexity.

From the output of first assessment, the rescue plan analyst might decide to enrich this first visualization with some information provided by another perspectives, like the simulation one.

The visualization is an output result after executing BPSim engine with time and resource as input parameters used to simulate real execution process. The visualization uses static meta-model to paint elements and dynamic BPSim meta-model to capture time processing, then set width and height values for each rectangle (Fig. 6).

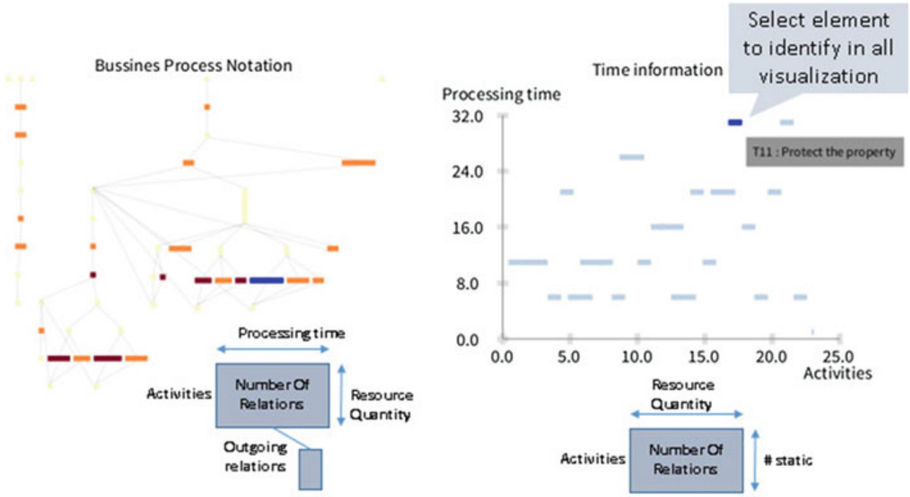


Fig. 6. Visualization of HCMC process time information

The standard BPMN view combines static BPMN diagram on the left with dynamic visualization of the BPMN simulation (time chronograph) on the right.

In the following script, the end-user adapts the shape size of BPMN elements according to some metrics (like processing time) coming from the simulation model:

```
"Script on the left side"
"Using color builder to find color for each element"
cv := A4BPUIBVFactory color.
values := model flowElements
"Find the result scenario to explore"
out :=  bpSimExecution fullOutputScenario.
view shape rectangle color:[: n | (n accept: cv)].
"Configure each node in the view with the metrics, using visual properties"
view shape rectangle
    "Add processing time value result"
    width: [:n | (out getParameterAt: n) processing vv ];
    "Add control flow complexity metric"
    height: [:n | ( n metricCFC  + 1 ) ].
view nodes: values.
"Add quantity of resource necessary to do the activity using normalize the color"
view normalizer
    normalizeColor: [:n | (out getParameterAt: n ) quantity vv]
    using: (ColorPalette sequential colors: 9 scheme: 'YlOrRd')
    using: #value.

"Script on the right side"
"each simulation is a scenario to display"
b := RTGrapher new.

cv := Dictionary new.
cvv := A4BPUIBVFactory color.
"Find the result scenario to explore"
scenario :=  bpSimExecution fullOutputScenario.
"Prepare the datasource to put in the graph"
ds := RTStackedDataSet new.
"Configure the element inside the graph"
ds dotShape rectangle
    width:[ :el | ( scenario getParameterAt: el ) quantity vv )];
    height: 5.
"Insert the elements in the dataset"
ds points: bpSimExecution processModel allActivities.
"capture the processing time from scenario results"
ds y: [ :el | (scenario getParameterAt: el) processing vv ].
"Add the dataset in the graph"
b add: ds.
"Configure details"
b axisX title: 'Activities'; axisY title: 'Processing time'.
b build.
```

By combining these two perspectives together, the rescue plan analysis, could understand the relationships between the complexity of each activities of the Business Process according to the time needed to process each element. Selecting an element in one these views highlights the corresponding element in the other one.

4 Related Works

In the context of software process modeling [6] proposed model blueprints for visualizing and analyzing different perspectives of a software process model. These blueprints are used to identify process anomalies like exceptional entities and recurrent errors [14]. Error patterns are identified with process elements that are graphically "abnormally different" from the remaining elements. We are doing something similar by decorating elements like tasks with information from others perspectives.

This is also possible to assess a business process from the organizational point of view. Grossi *et al.* [7] proposed a set of metrics in order to evaluate organizational structure based on the role graph with three dimensions: power, coordination and control. We already implement these metrics in a previous paper [3]. Cardoso *et al.* [8] presented a set of metrics such as *Process Length, Process Volume, Process Difficulty* in order to assess the complexity of process model. A4PB offers these metrics making them easy to be combined in exploratory visualizations.

Cardoso *et al.* [9] presented a metric to measure control-flow complexity of a work-flow or a process. He also suggested other metrics such as: *Activity Complexity, Data-Flow Complexity, Resource Complexity.* These metrics, combined with the equations of Role Graph [7], can help us determine the quality of a coordination plan according to two points of view: process and organization.

5 Conclusion

Modeling rescue plans with business processes eases their engineering, including formalization, simulation, analysis, quality assessment activities. To be accepted by end-users and authorities in charge of disaster management, quality assessment has to be based on understandable graphical artifacts. To this end, our paper has presented different graphical perspectives of a plan on top of which static and dynamic analysis are possible. For that purpose the A4BP visualization tool has been implemented and experimentations on a Ho Chi Minh City rescue plan have been conducted. However, our tool remains general enough to deal with any other type of application domain including complex processes. The only constraint is that processes should be expressed in the BPMN standard notation. Regarding our case study, our tool should now be evaluated by users to have real feedback on its usability and the understandability of graphics produced. A process includes three dimensions: control structure, organization, and information. This paper focussed on the process control structure dimension but does not take into account the two others. As future work, we plan to provide additional visualizations and metrics to measure the quality of the organization (structure and communication). Analyzing actor interactions is likely to be the base of our future analyses.

Acknowledgment. We gratefully acknowledge the financial support of the European Smalltalk User Group (http://www.esug.org). This work has been partially founded by Lam Research and FONDECYT project 224857 (Chile).

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