A View-based Approach to Software Adaptation

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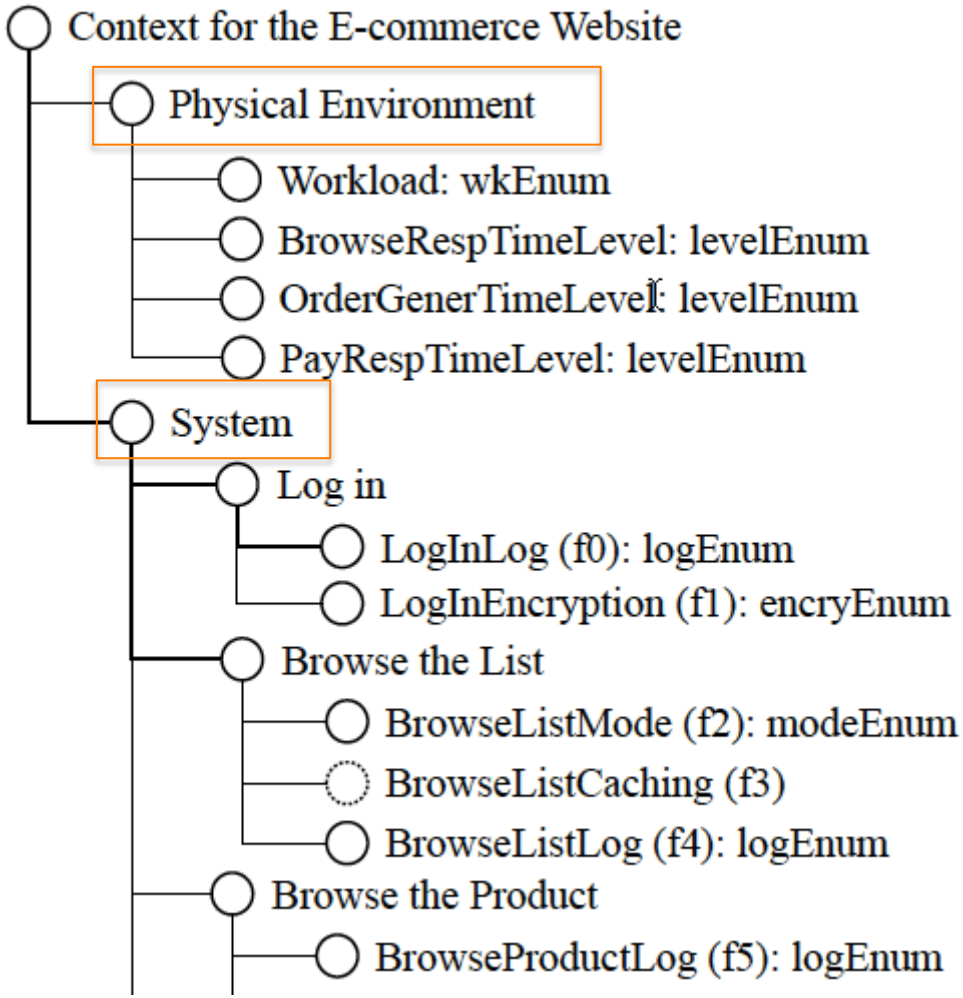
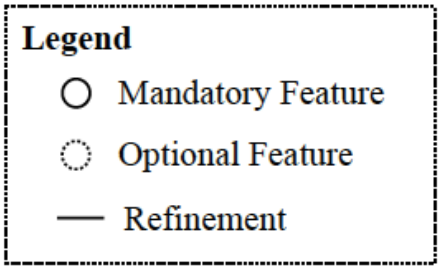
Joint work with Tianqi Zhao (PKU), Tao Zan (NII), Haiyan Zhao (PKU), **Zhi Jin (PKU)**

E-Commerce System: Context Feature Model





Chen, Bihuan; Peng, Xin; Yu, Yijun; Nuseibeh, Bashar and Zhao, Wenyun (2014). Self-adaptation through incremental generative model transformations at runtime. In: 36th International Conference on Software Engineering (ICSE 2014), 31 May-7 June, 2014, Hyderabad, India, ACM/IEEE.

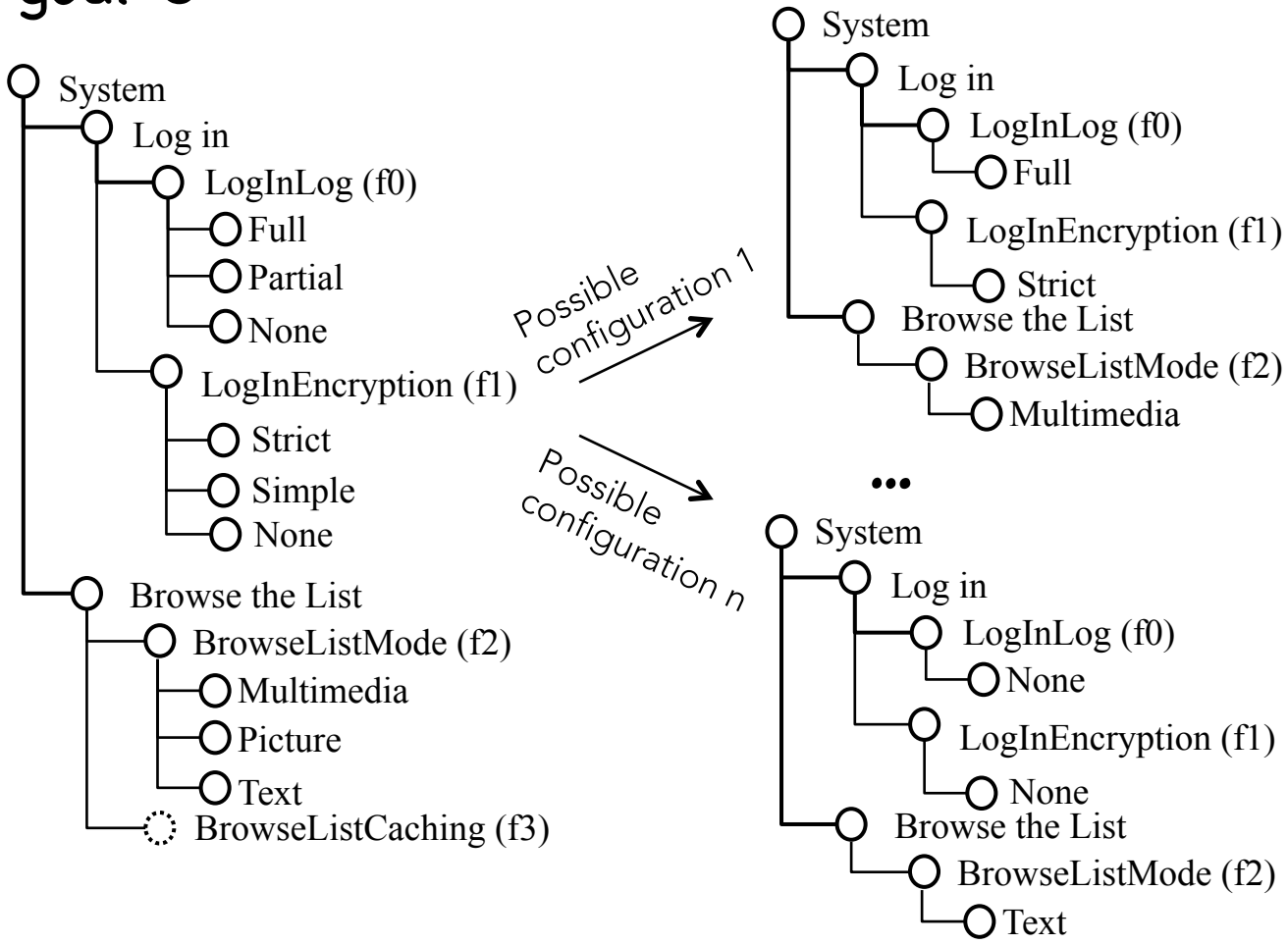
E-Commerce System: Goals

- quick browse response (g1)
- quick order generation (g2)
- quick payment response (g3)
- high usability (g4)
- High security (g5)
- high reliability (g6)

$$G = \sum_{i=1}^{6} w_i g_i$$

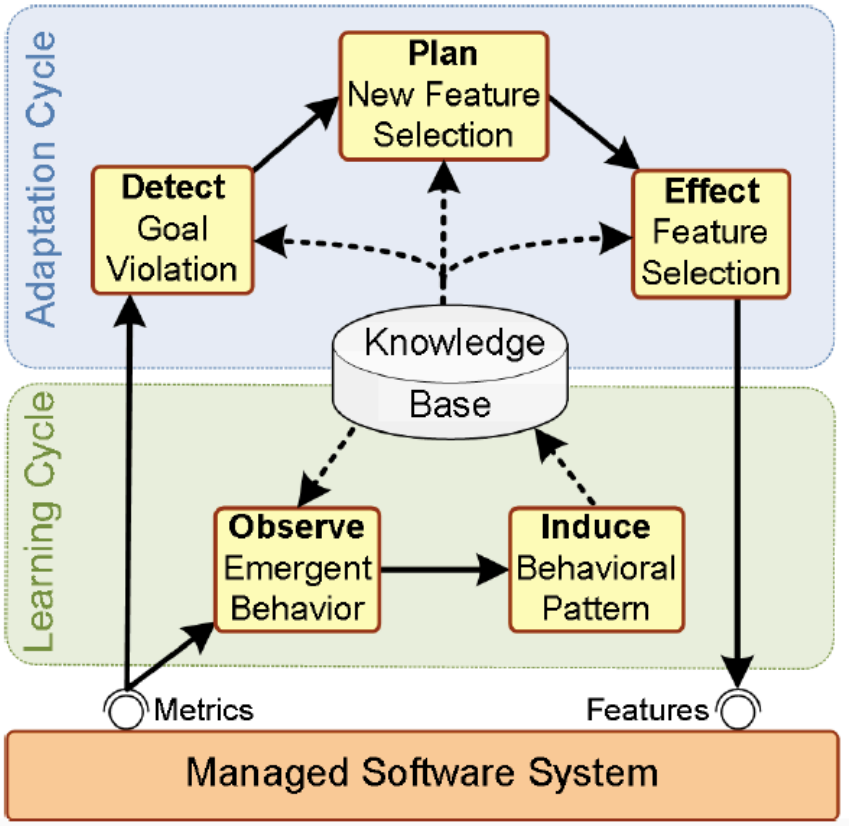
Goal-Oriented Adaptation

- reduces the dynamic adaptation as an optimization process to find a configuration that maximizes the goal G



Goal-Oriented Adaptation

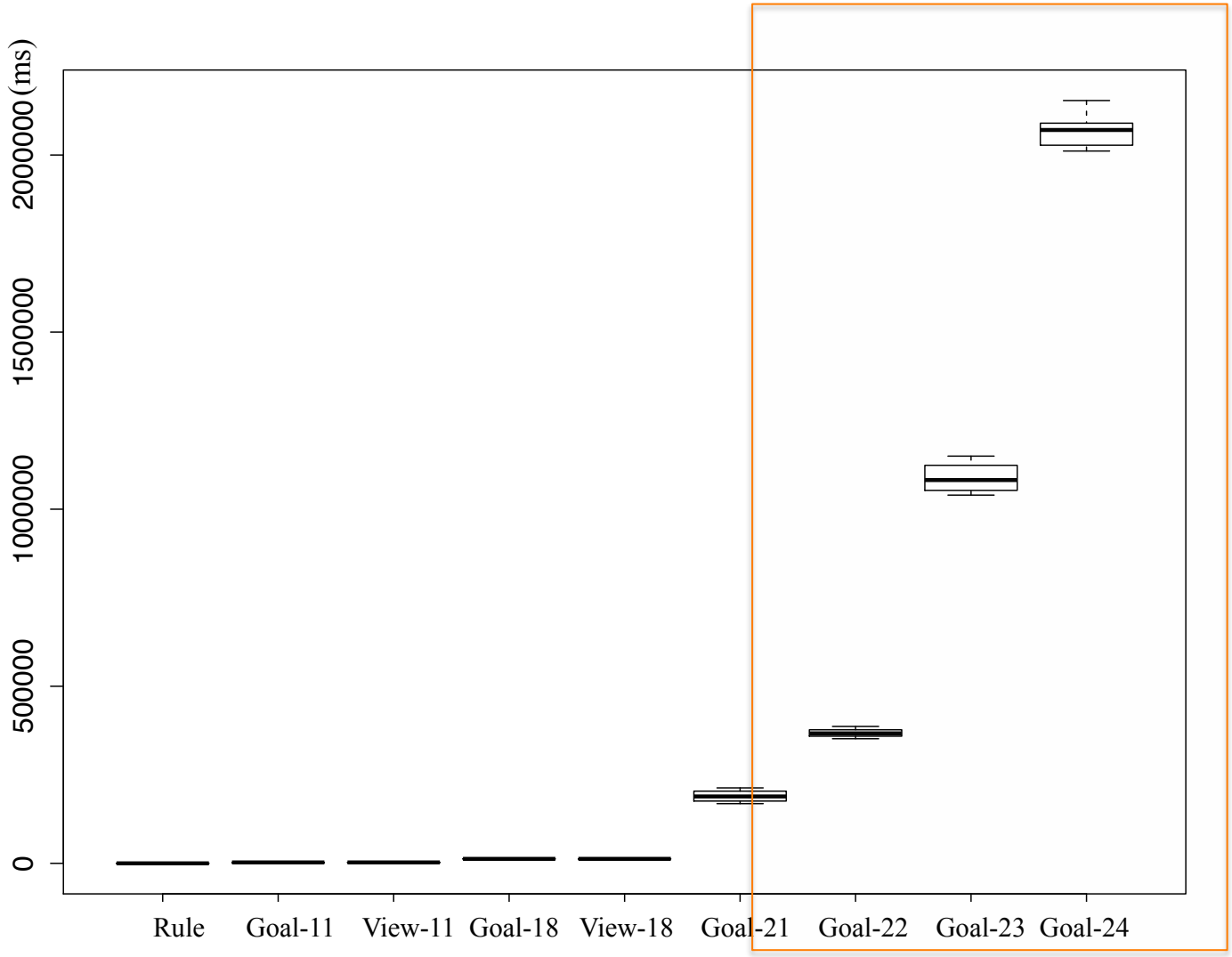
- can be well combined with online learning process



		User goals	
		Quick Browse Response	High Security
Login Log	Full	-1.6	+3.1
	Partial	-1	+2.2
	None	+3	-0.7
LogIn Encryption	Strict	-4	+3.7
	Simple	-3.5	+1.6
	None	+4	-1.1

Esfahani N, Elkhodary A, Malek S. A Learning-Based Framework for Engineering Feature-Oriented Self-Adaptive Software Systems[J]. IEEE Transactions on Software Engineering, 2013, 39(11):1467-1493.

The Efficiency Problem



Rule-based Adaptation

- Encoding the adaptation logic as a set of rules:

condition

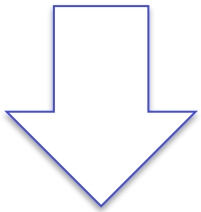
$$VerificationType = Strict \ \wedge \ Workload = High$$
$$\Rightarrow PayLog := None; \ PayEncryption := None$$

Action

👍 Efficient

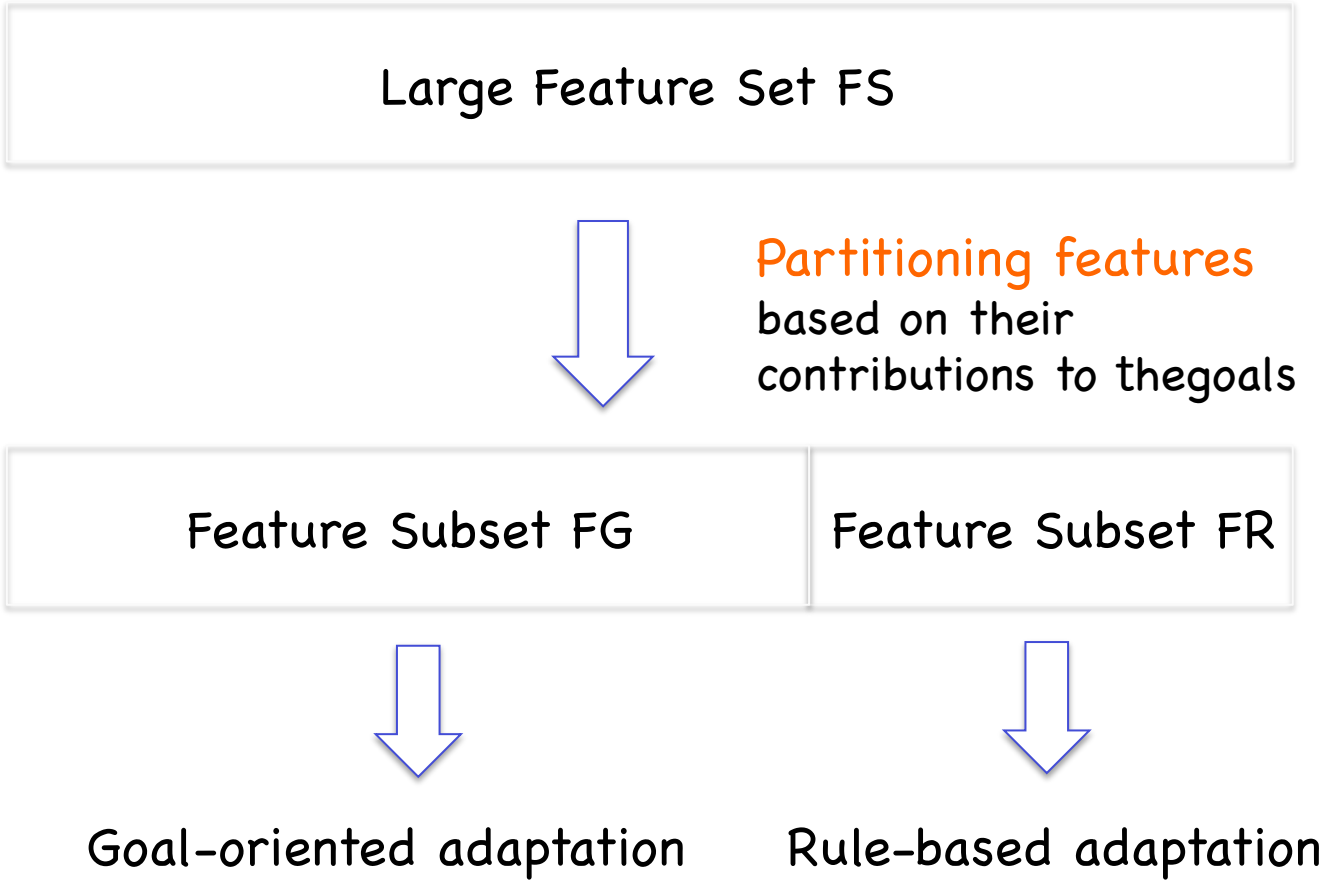
👎 May conflict with the goal

- Can we combine the advantages of both goal-oriented (guaranteeing goal satisfactory) and rule-based adaptation (being efficient) ?



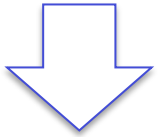
View-based Approach

Basic Idea


Large Feature Set FS
Partitioning features
based on their
contributions to thegoals
Feature Subset FG
Feature Subset FR
Goal-oriented adaptation
Rule-based adaptation

A Challenge

- How to guarantee that the rule-based adaptation can keep the goal satisfactory achieved from the goal-oriented adaptation?



Introduce *view* to bridge the gap between goals and rules.
(*view* denotes a state that captures a specific user intention)

View-based Rules (vRules)

- Introduce invariant views to rules

$$v \wedge C \Rightarrow \dot{A}$$

- State v is preserved by A
- A; A = A

$$v \vdash C \Rightarrow A$$

To preserve view v, if C then do A.

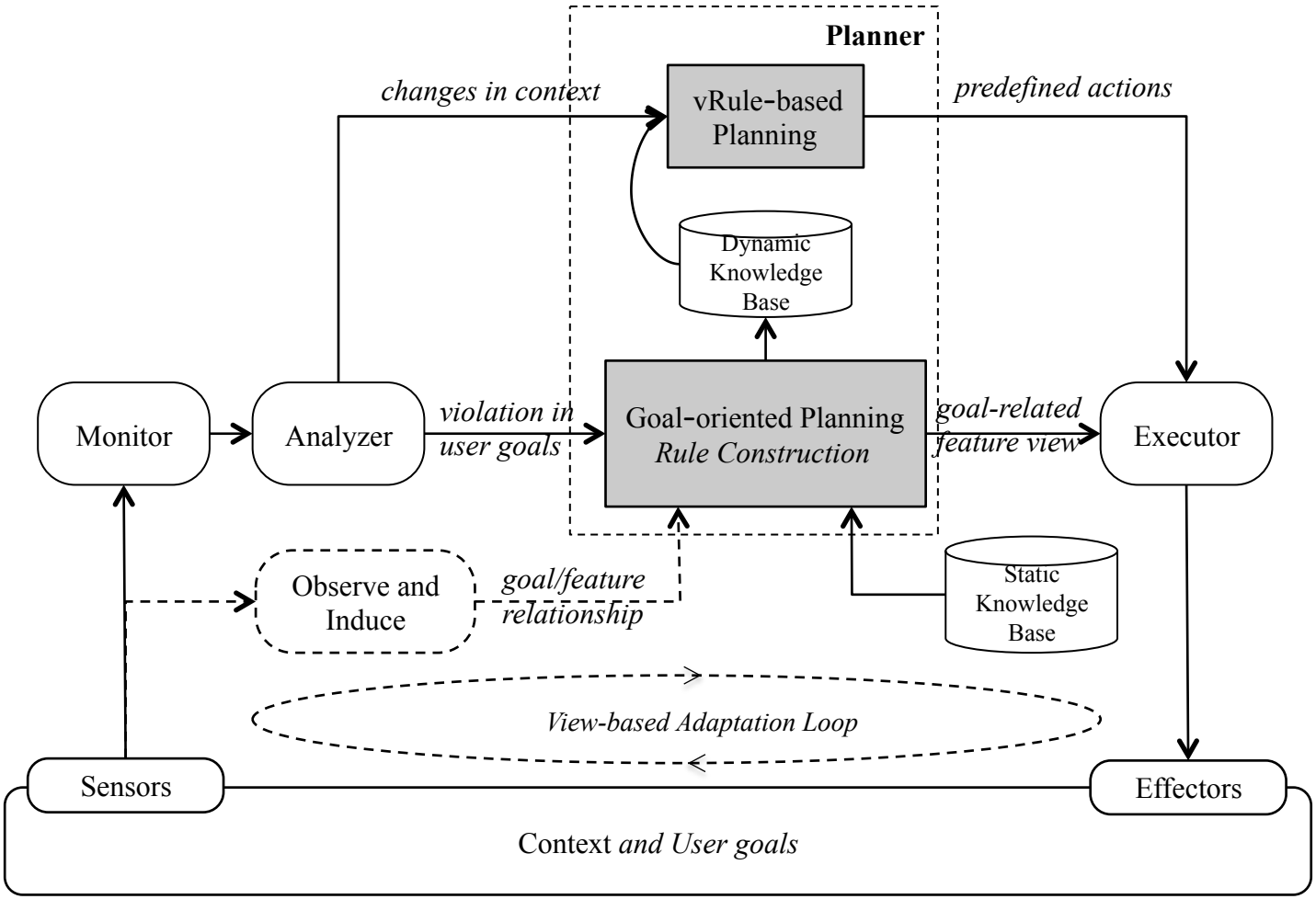
View-based Rule Examples

$$VerificationType = Strict \vdash PayRespTimeLevel = 5 \ \wedge Workload = High \Rightarrow VerificationDesign := Parallel; PayLog := None$$

$$VerificationType = Strict \vdash VerificationDesign = Sequential \ \wedge Workload = High \Rightarrow VerificationType := Simple; PayLog := None$$

$$VerificationDesign = Sequential \vdash VerificationType = Strict \ \wedge Workload = High \Rightarrow VerificationType := Simple; PayLog := None$$

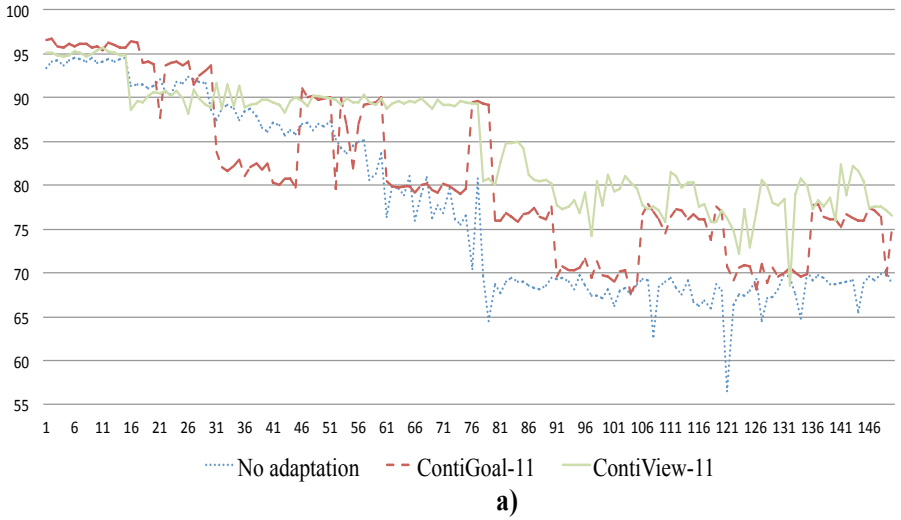
View-based Adaptation Framework



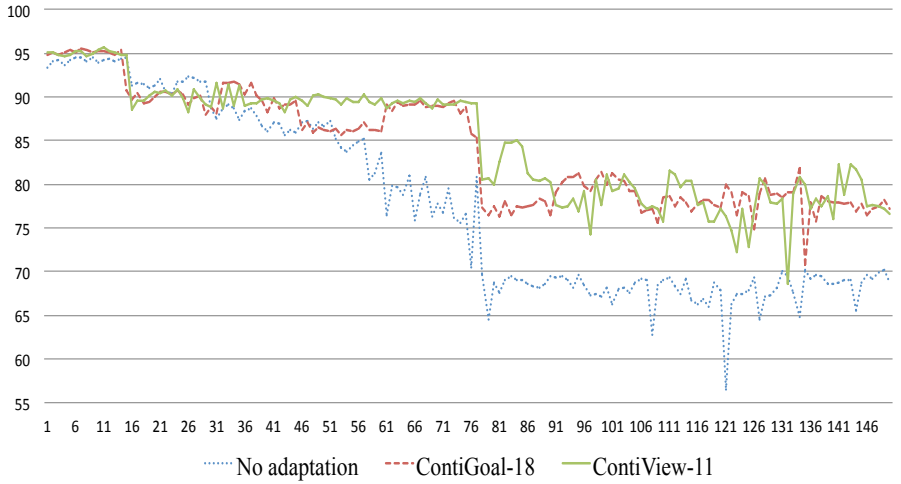
Evaluation

- We have implemented the e-commerce website in Java, and imposed different adaptation logics into the same website:
  - The traditional goal-oriented approach
  - The traditional rule-based adaptation approach
  - The view-based approach

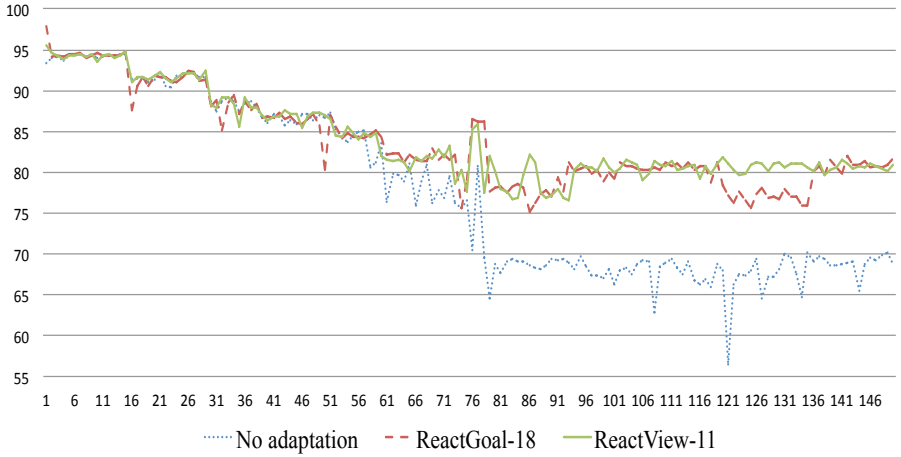
Experimental Results



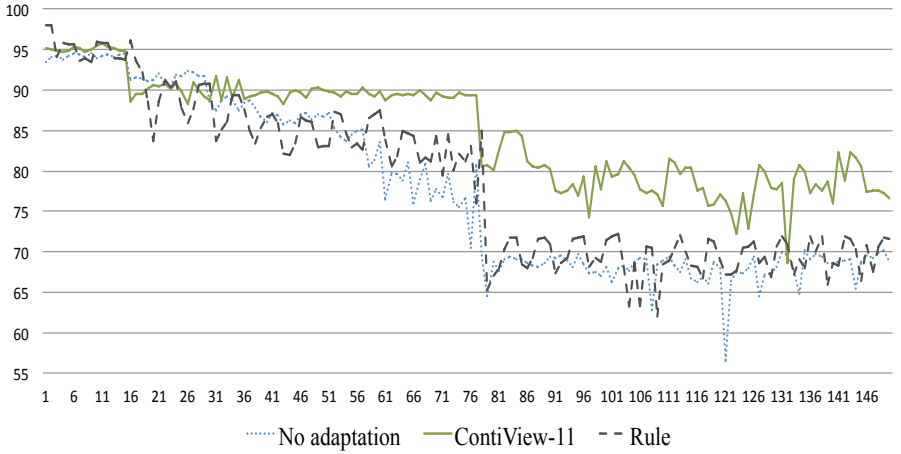
a)



b)



c)



d)

Conclusion

- A new view-based adaptation framework
  - combine the advantages of both learning-based goal-oriented adaptation and the rule-based adaptation
- A novel concept of view-based rules
  - an invariant view is introduced for structuring traditional adaptation rules and relating them with goals.
- Two newly developed algorithms
  - One is for the automatic derivation of views, and the other is for dynamic construction of well-behaved goal-related view-baed rule set.
- A self-adaptive ecommerce website
  - confirm the usefulness of the new approach

Where is the view-based idea originated?

0th Shonan Meeting on Bidirectional Transformation, 2008

Krzysztof Czarnecki, J. Nathan Foster, Zhenjiang Hu, Ralf Lammel, Andy Schurr, James F. Terwilliger, Bidirectional Transformations: A Cross-Discipline Perspective, International Conference on Model Transformation, ETH Zurich, Switzerland, June 29-July 3 2009.