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Change Propagation for Assessing Design Quality of Software Architectures

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Outline

- ◆ Introduction
- ◆ Change Propagation Probabilities (CP)
- ◆ Methodology and Rationale
- ◆ Case Studies
- ◆ Comparing CP w.r.t. other OO Metrics
- ◆ Conclusion and Future Work



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Introduction

- ◆ The study of Quantitative Assessment of **software architectures** is gaining importance due to its role in assessing the quality of architecture enhancements
- ◆ With the increasing emphasis **on design patterns**, the traditional practice of ad-hoc software construction is slowly shifting towards pattern-oriented development.



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Introduction

- ◆ In this paper, we show that **change propagation probability (CP)** is helpful and effective in assessing the design quality enhancements of software architectures.
- ◆ We study two different architectures (**one that employs patterns versus one that does not**) for the same application.
- ◆ We analyze and compare change propagation metric with respect to other coupling-based metrics.



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Change Propagation Probability

- *Change Propagation Probabilities* matrix

$$CP = [cp_{ij}]$$

cp_{ij} is the conditional probability that a change in C_i due to corrective/ perfective maintenance requires a change in C_j while maintaining the overall function of a system S

$$cp_{ij} = P([C_j] \neq [C_j'] \mid [C_i] \neq [C_i'] \wedge [S] = [S'])$$



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Change Propagation: Usage

Component B (does it have to change?)

Probability that B changes given that A does

Component A (where change originates)

		B										
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
A	C1	1	0.11	0.15	0.3	0.76	0.73	0	0	0	0	0
	C2	0.37	1	0	0	0	0	0	0.52	0	0	
	C3	0.03	0.32	1	0	0	0	0	0	0	0	
	C4	0.03	0.19	0	1	0	0	0	0	0	0	
	C5	0	0.67	0	0	1	0	0	0	0	0	
	C6	0	0.28	0	0	0	1	0	0	0	0	
	C7	0.32	0	0	0	0	0	1	0	0	0	
	C8	0	0	0	0	0	0	0	1	0	0	
	C9	0	0	0	0	0	0	0	0	1	0	
	C10	0	0	0	0	0	0	0	0	0	1	

alarm!!!



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Change Propagation: Usage

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Probability that B changes given that A does

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	C8	0	0	0	0	0	0	0	1	0	0
	C9	0	0	0	0	0	0	0	0	1	0
	C10	0	0	0	0	0	0	0	0	0	1

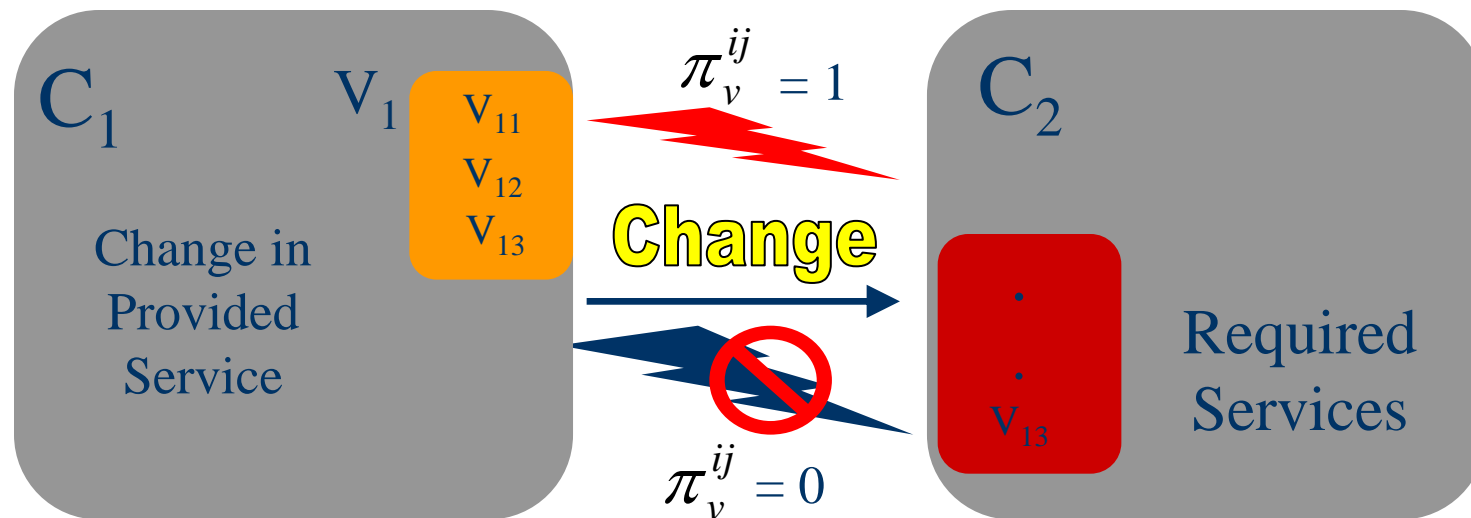
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Estimating Change Propagation



- cp_{ij} is estimated by

$$cp_{ij} = \frac{1}{|V_i|} \sum_{v \in V_i} \pi_v^{ij}$$



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Change Propagation Coefficient(CPC)

- ◆ The Change Propagation Coefficient *CPC* is a scalar that reflects the potential of an architecture to insulate its components from each other's changes.
- ◆ The idealistic change propagation coefficient corresponds to an identity matrix *I*.
- ◆ At the other extreme, the worst possible *CPC* is one for which all cells of the CP matrix are 1s.

$$CPC = \frac{\sum_i \sum_{j \neq i} cp_{ij}}{N^2 - N}$$



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Methodology and Rationale

- ◆ Enhance an architecture with a design pattern.
- ◆ Compute CP metric on both architectures before and after enhancement.
- ◆ Compute object oriented metrics like CBO, RFC, MPC,.. etc on these architectures.
- ◆ Analyze and compare results.

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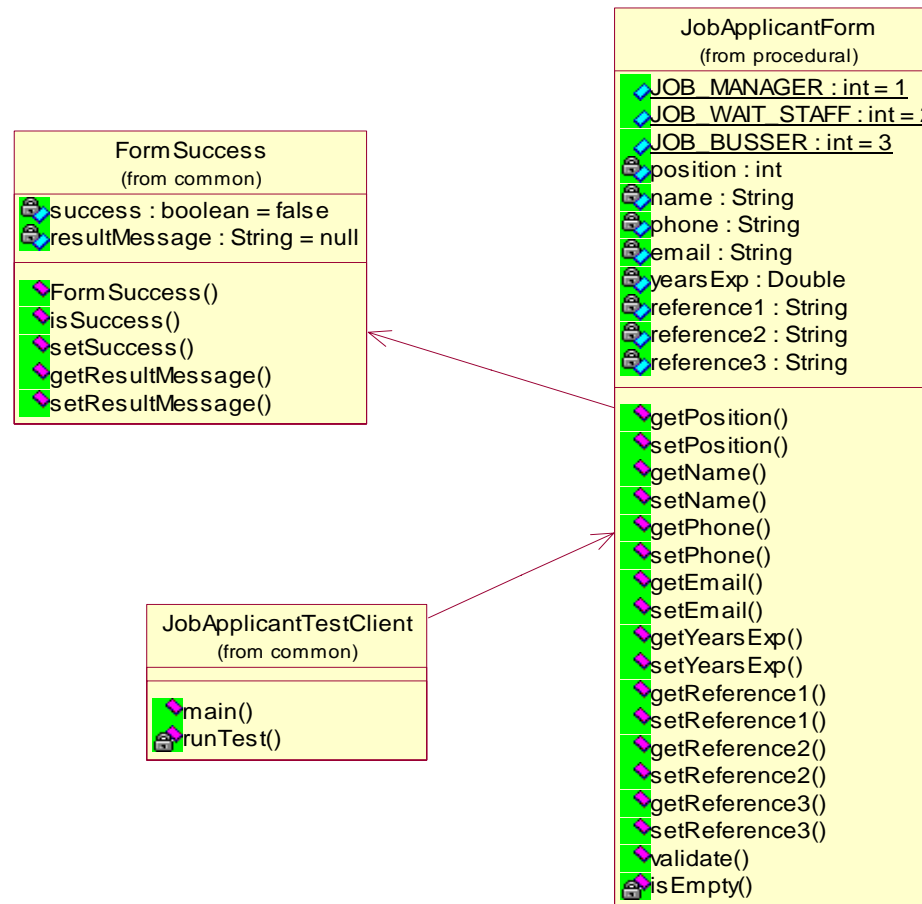


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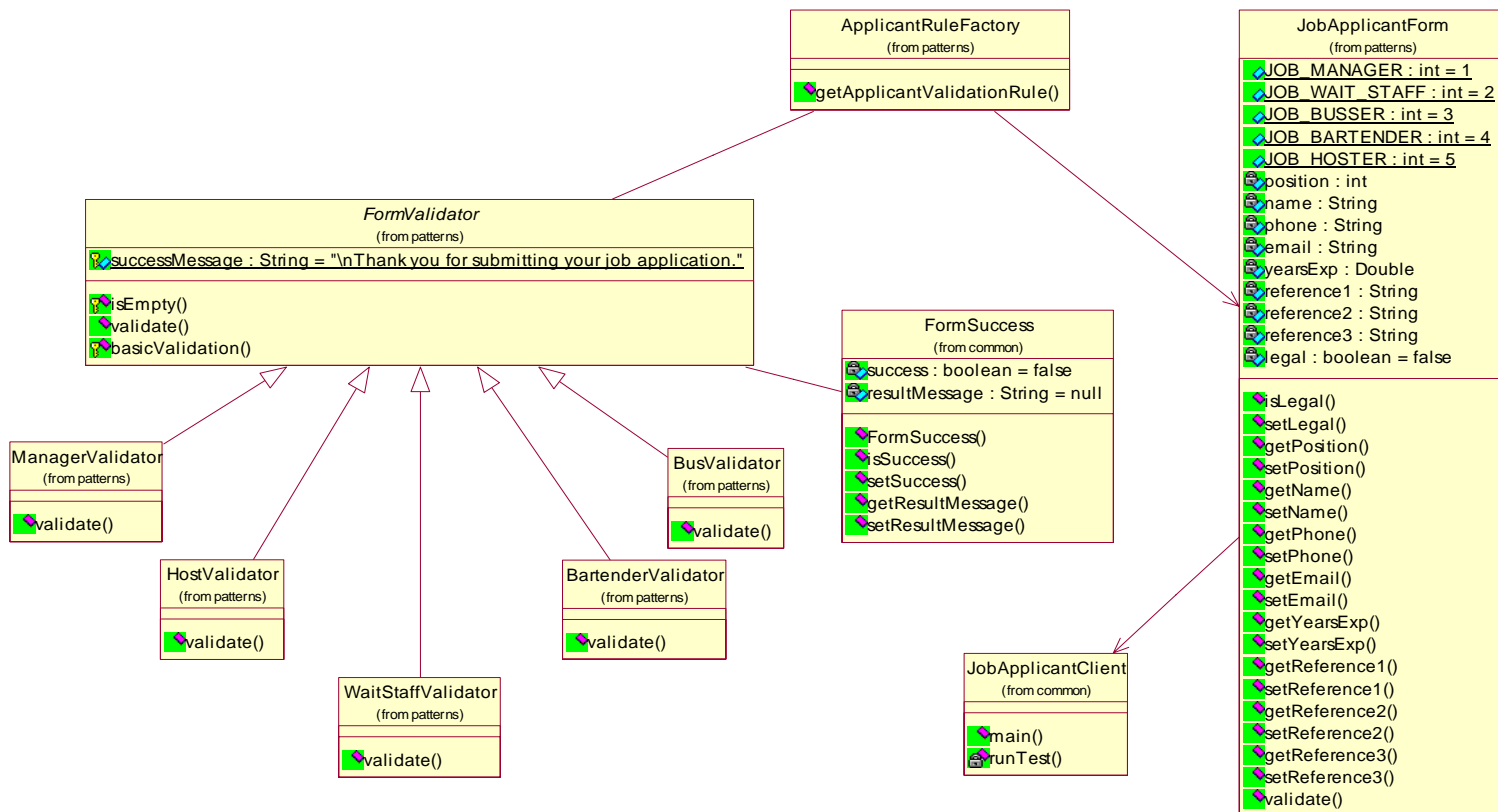
Case Study-Job Application

Class Diagram before applying pattern



Case Study-Job Application

Class Diagram after applying strategy pattern

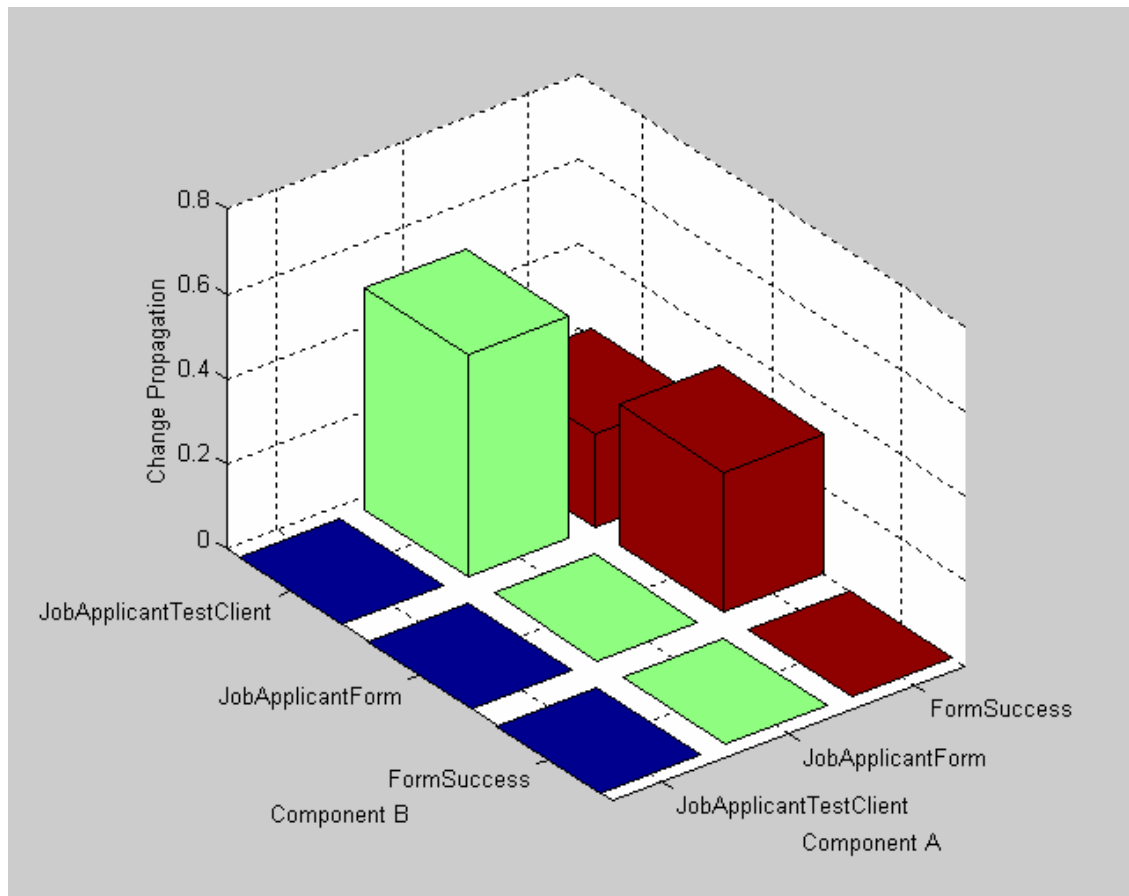




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CP of Job Application before applying strategy pattern.



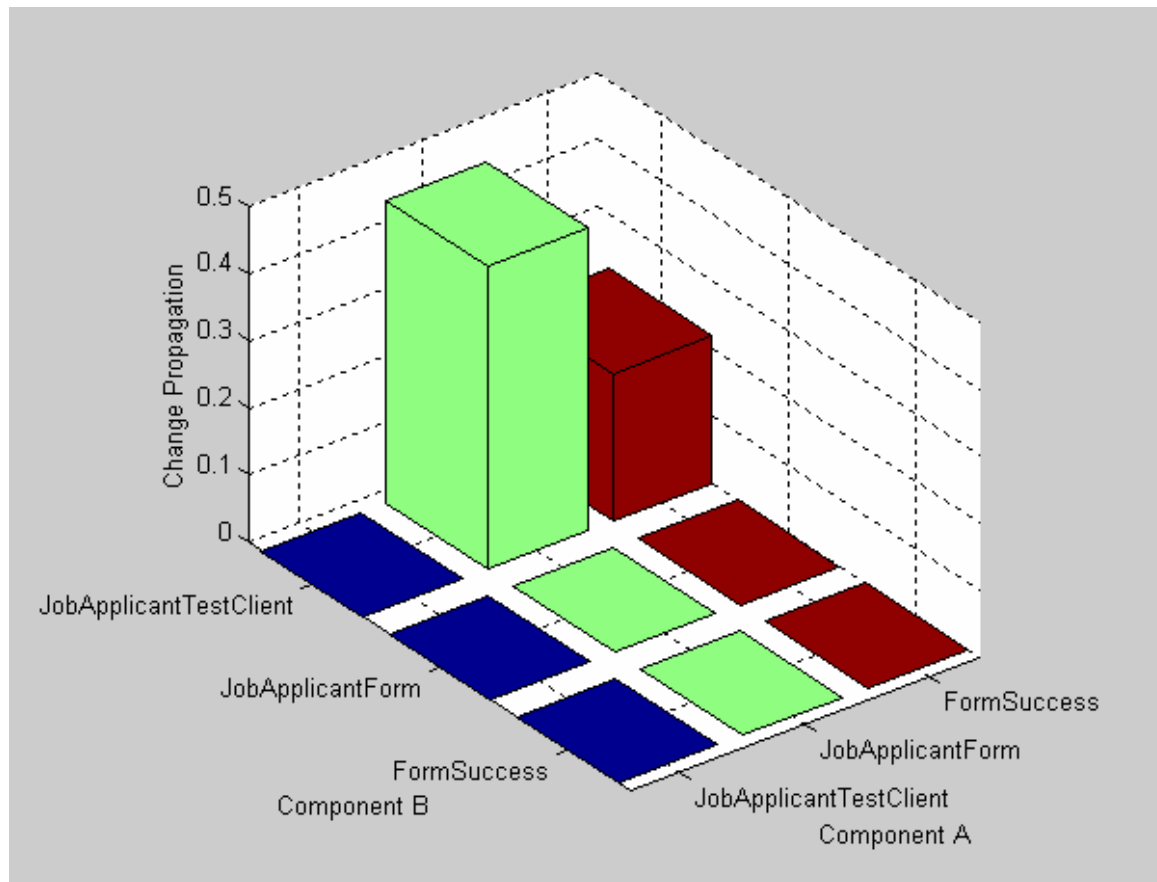
CPC = 0.18



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CP of Job Application after applying strategy pattern



CPC = 0.11

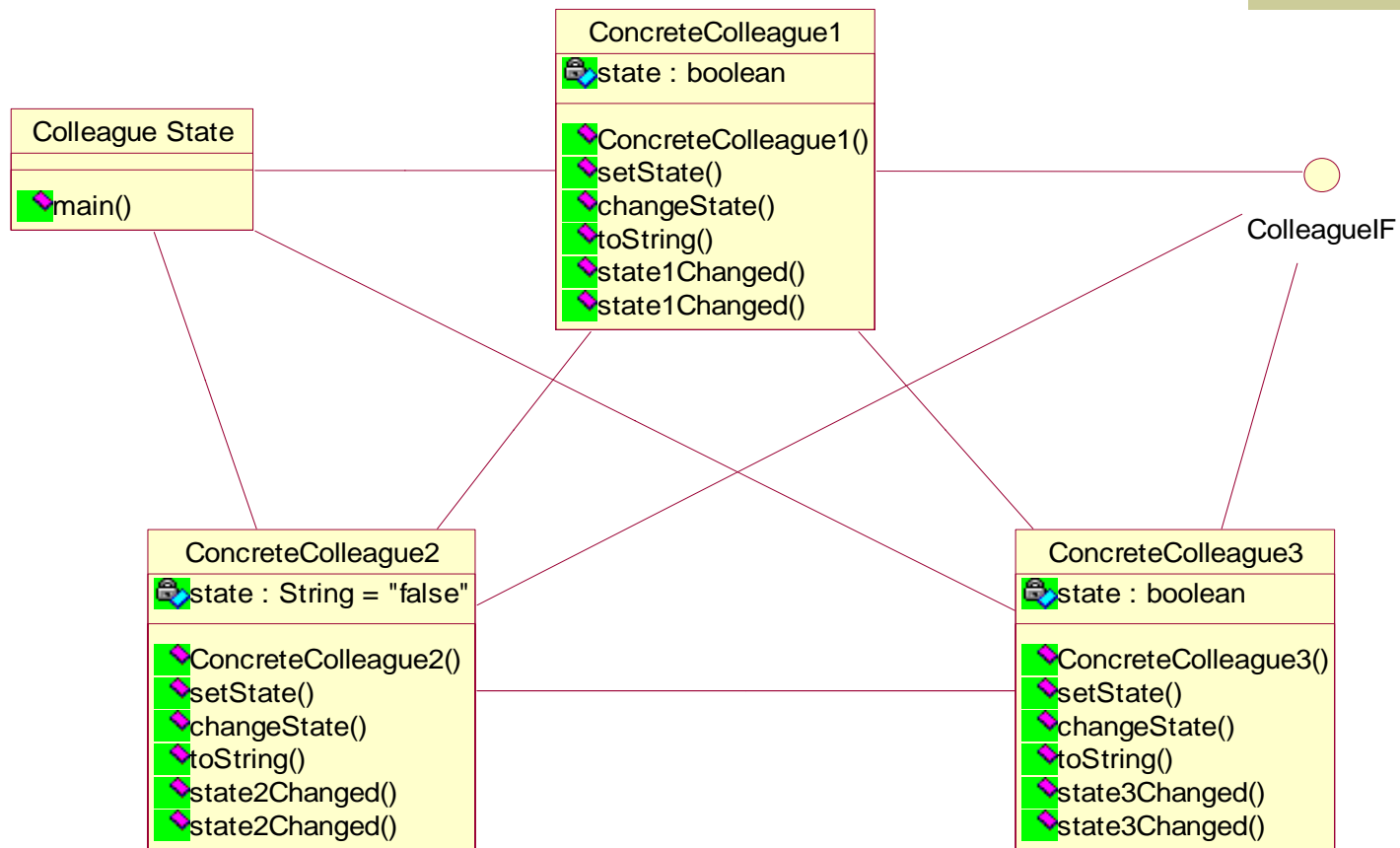


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Case Study- Colleague States

Class Diagram before applying mediator pattern



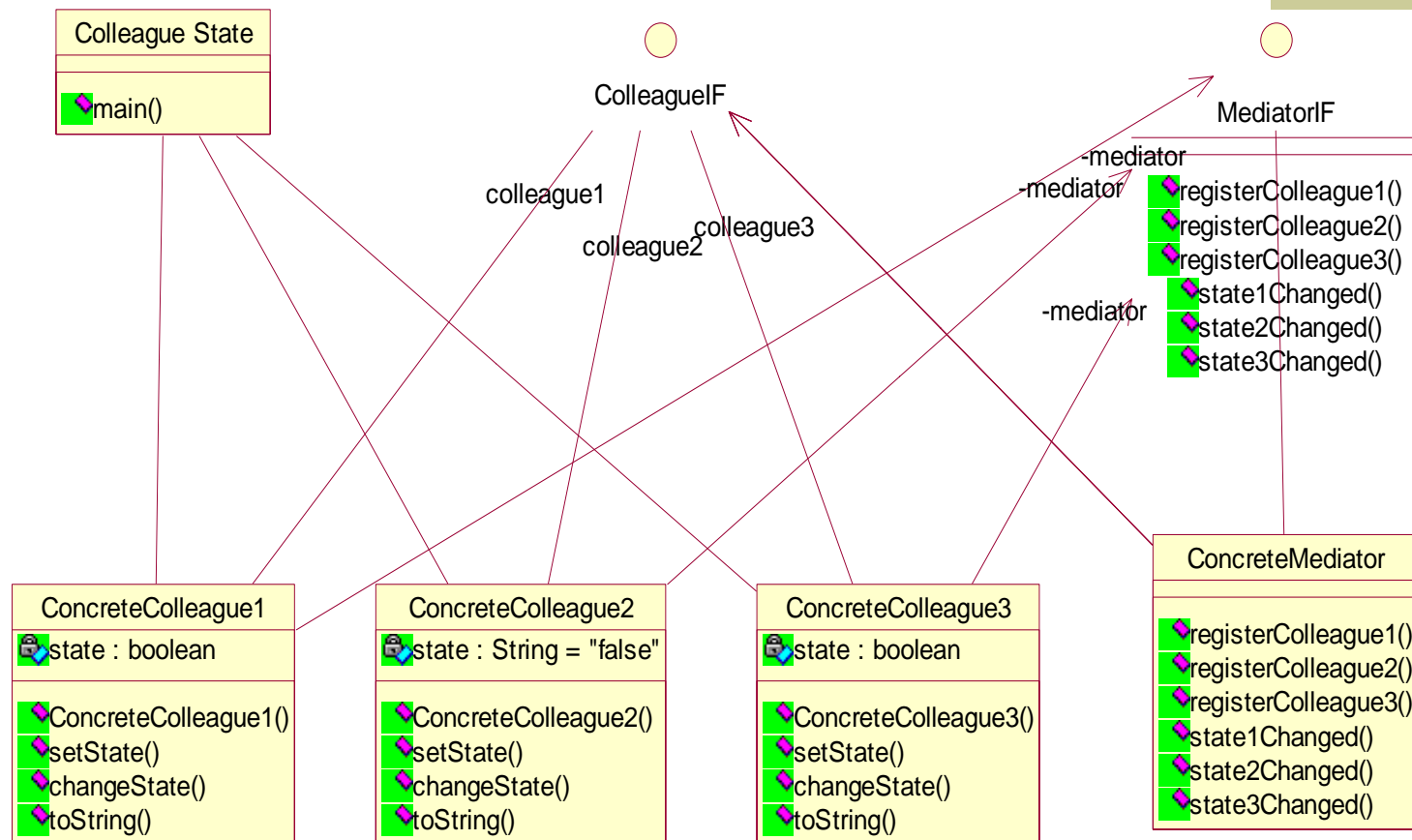


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Case Study- Colleague States

Class Diagram after applying mediator pattern

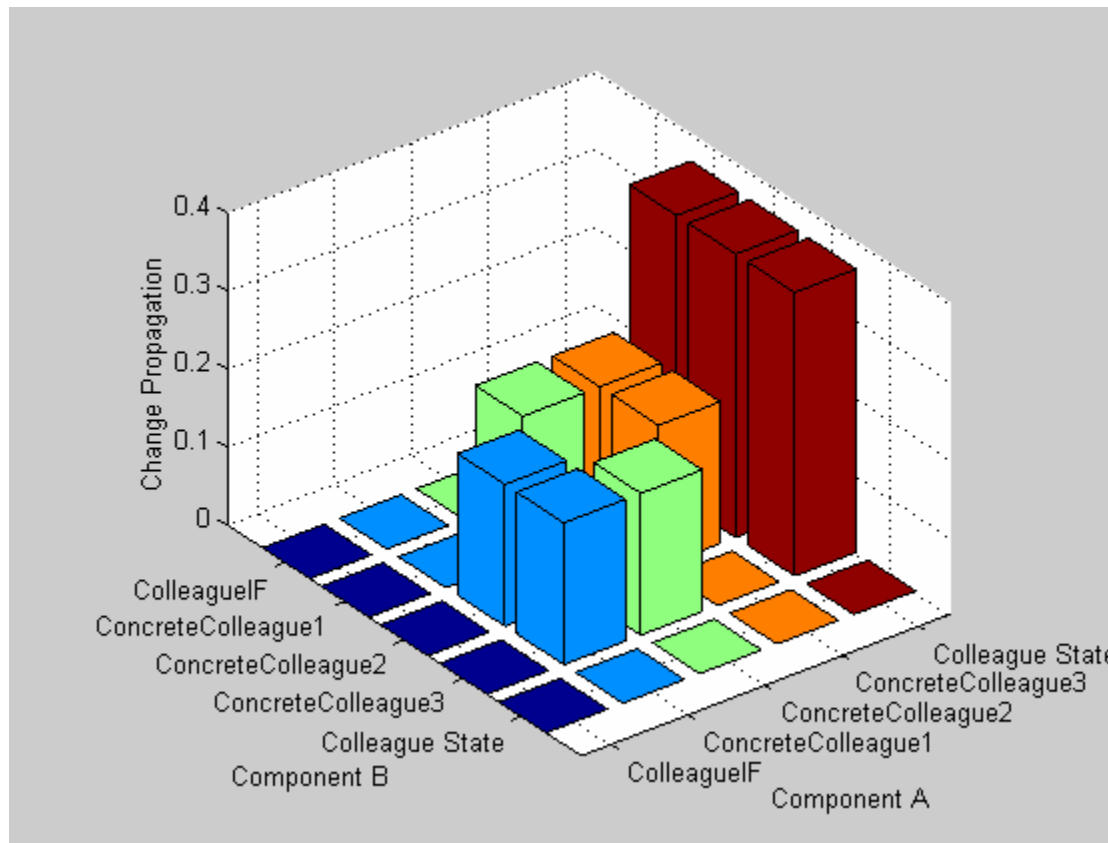




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CP for Colleague States before applying the mediator pattern



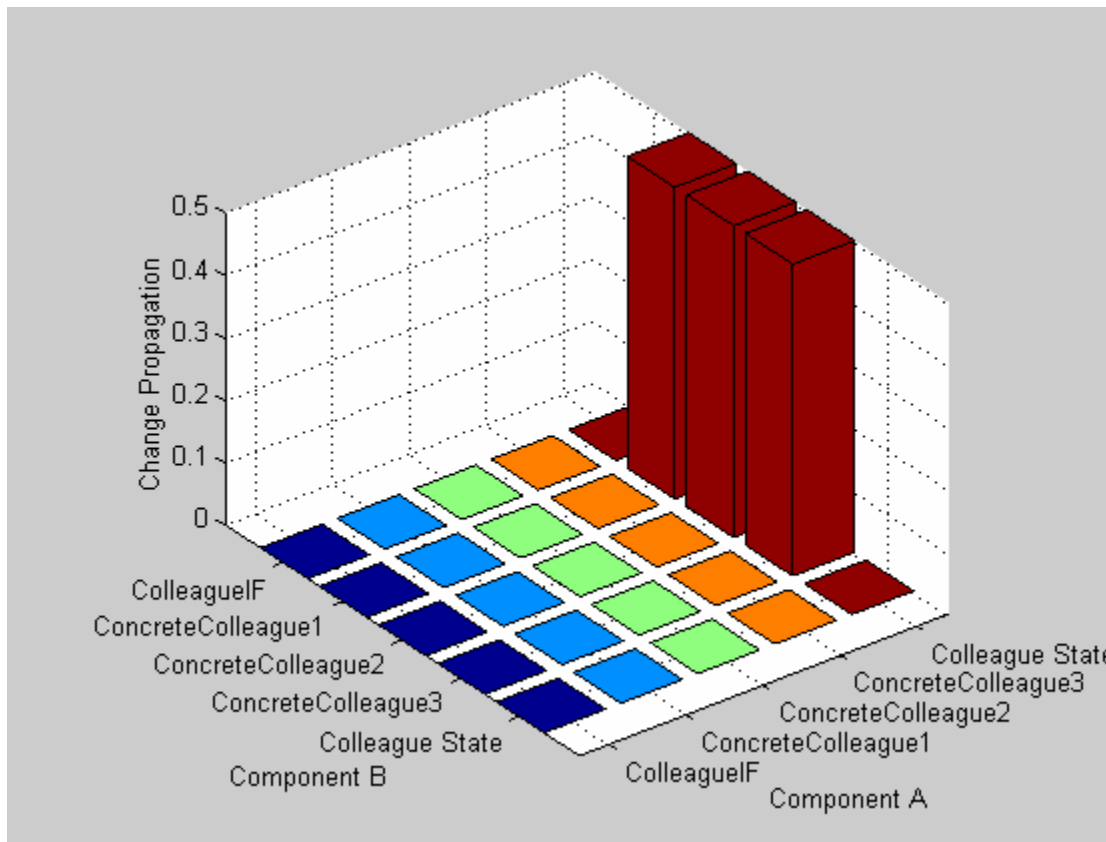
CPC = 0.11



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CP for Colleague States after applying the mediator pattern



CPC = 0.05

Outline

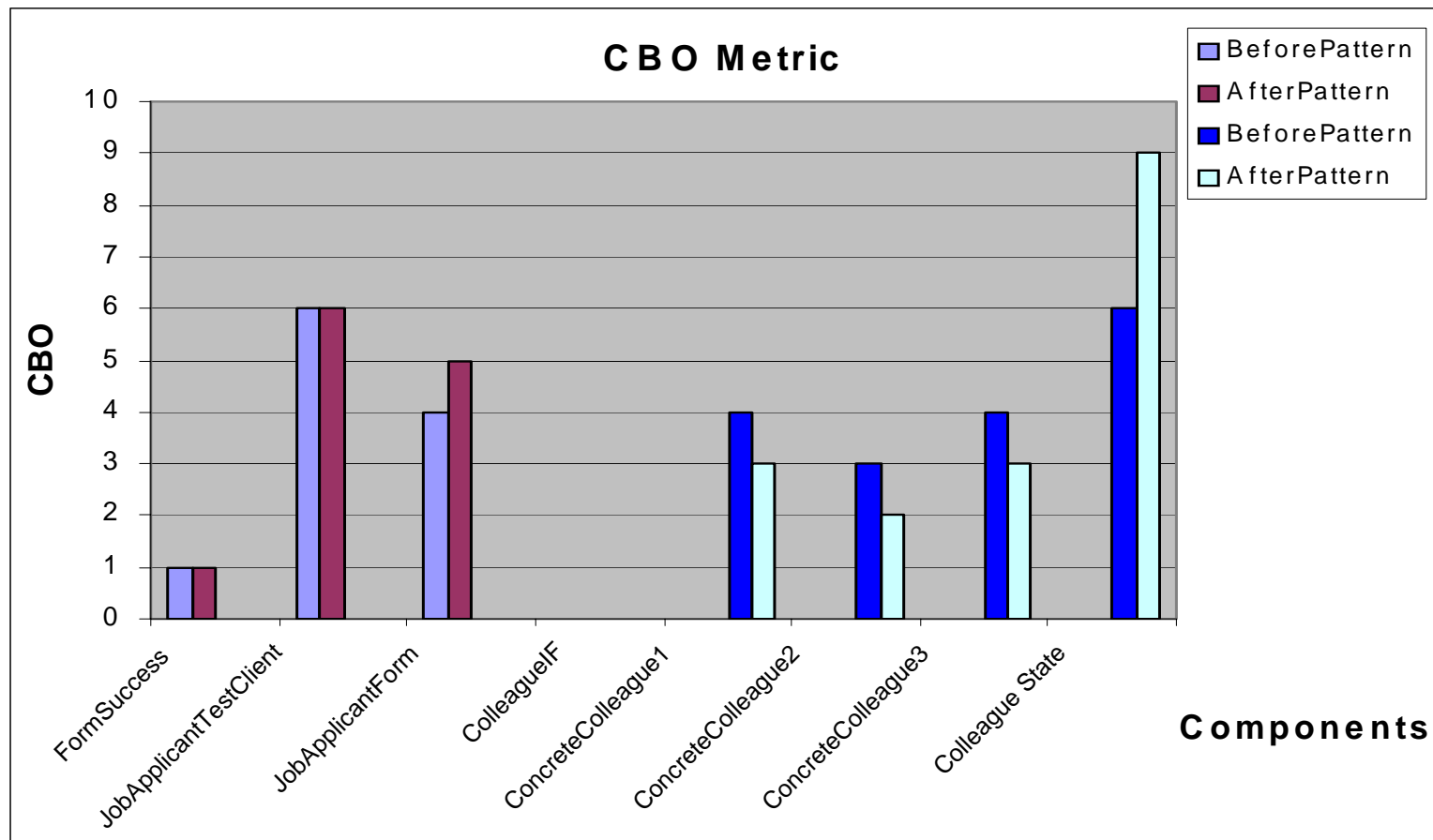
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- ◆ Change Propagation Probabilities (CP)
- ◆ Methodology and Rationale
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CBO metric for the two case studies

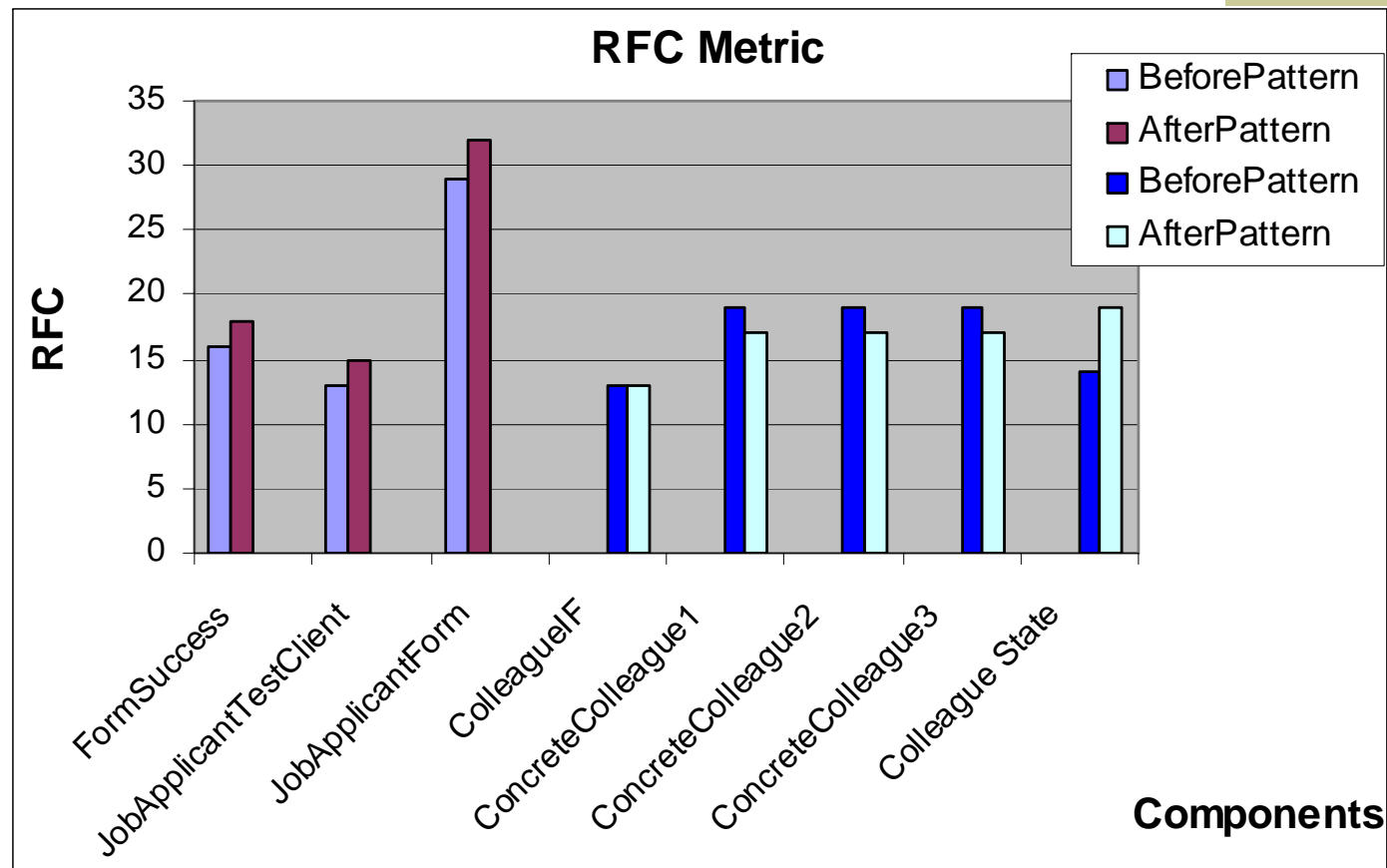




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RFC metric for the two case studies

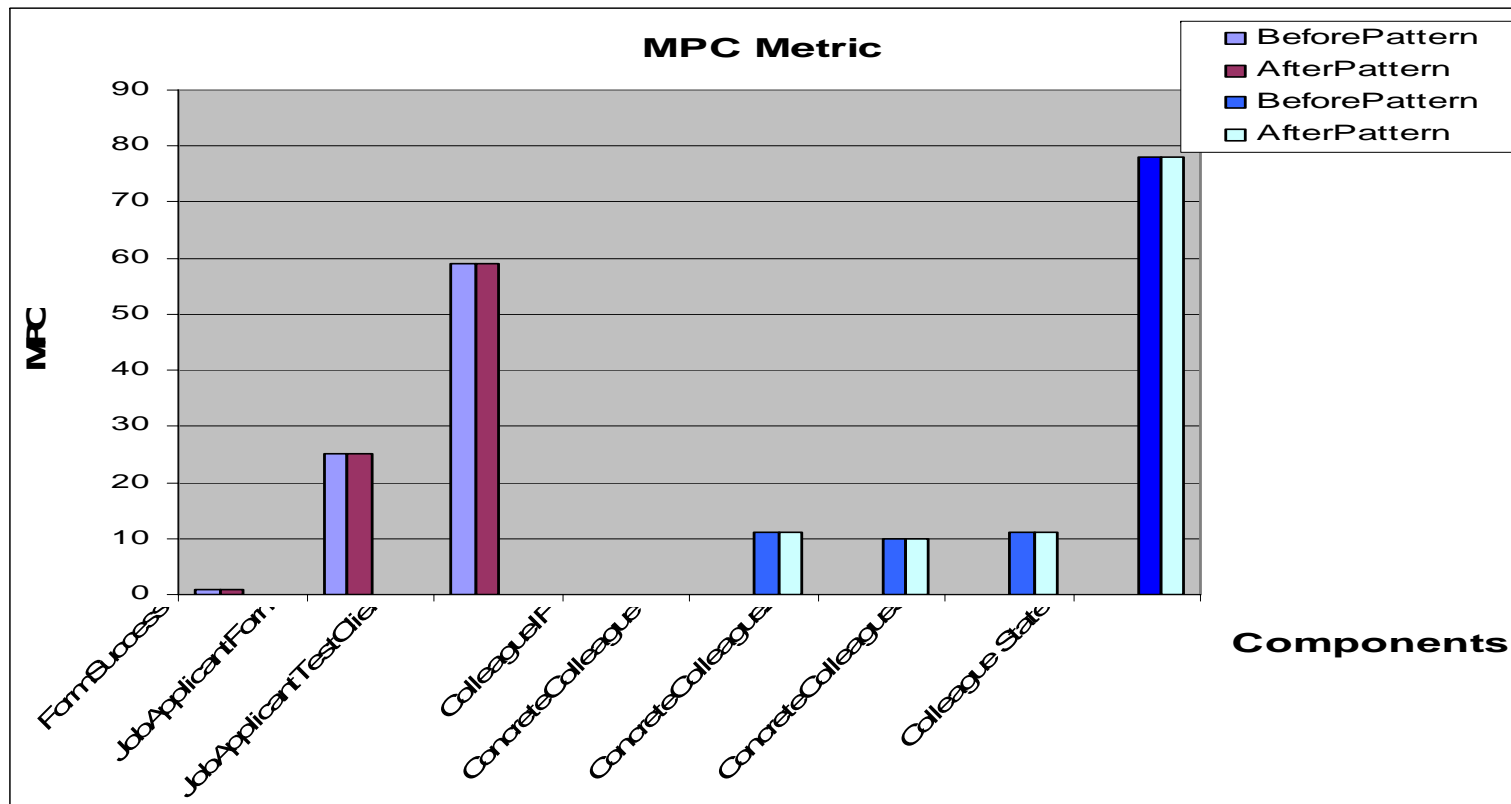




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MPC metric for the two case studies



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Conclusion

- ◆ In this paper we presented
 - the applicability of change propagation (CP) in assessing design quality of software architectures.
 - The different perspective provided by CP with respect to other OO-metrics.
- ◆ This study is conducted as part of a larger project exploring a wide range of architecture-level attributes, including Error Propagation Probabilities , and Requirements Propagation Probabilities



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Future Work

- ◆ We plan to
 - Study larger case studies to validate applicability of change propagation CP.
 - Automate the steps of the methodology.
 - add more architectural attributes, other than change propagation, such as error propagation, coupling and cohesion, diagonality,.....etc in the methodology.



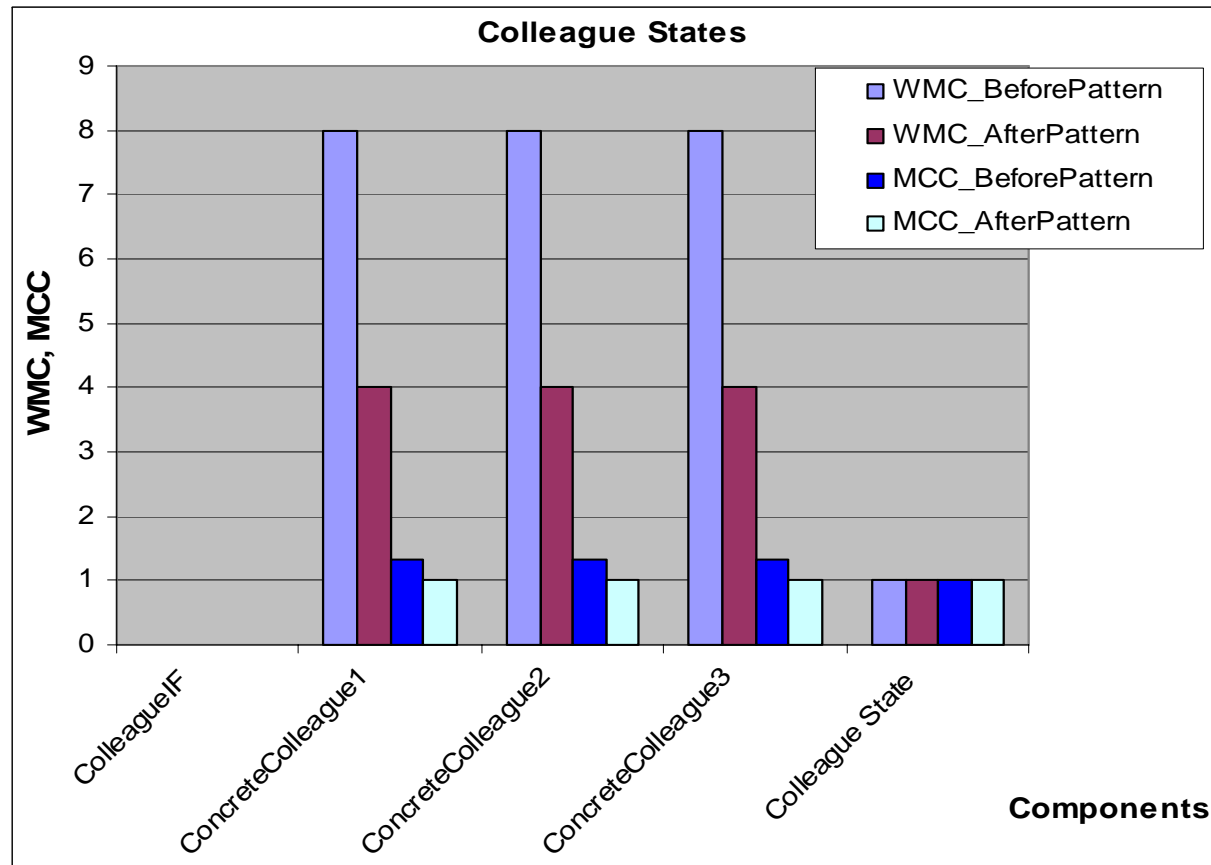
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Questions



WMC and MCC metrics for case study- Colleague States





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WMC and MCC metrics for case study-Job Application

