

On the use of Machine Learning

to Defeature CAD models for simulation

Importance of the work and related state-of-the-art

- CAD 모델의 단순화 작업은 현재 전문가에 의해 진행.(Defeaturing 단계 포함)
- 특정 목표에 대한 시뮬레이션 결과의 실현 가능성과 정확성을 기초하여 전문가가 Defeaturing 할 특징 후보를 선택해야 하지만, 어떠한 특징이 시뮬레이션에 영향을 미치는 지 알지 못하는 경우가 많다.
- 따라서 기계학습을 사용하여 Defeaturing 단계에서 도움을 받을 것이다.
- 기계학습을 통해 얻고자 하는 변수 두 가지

- 숫자 변수들

- : 준비나 시뮬레이션에 대한 비용과 기간

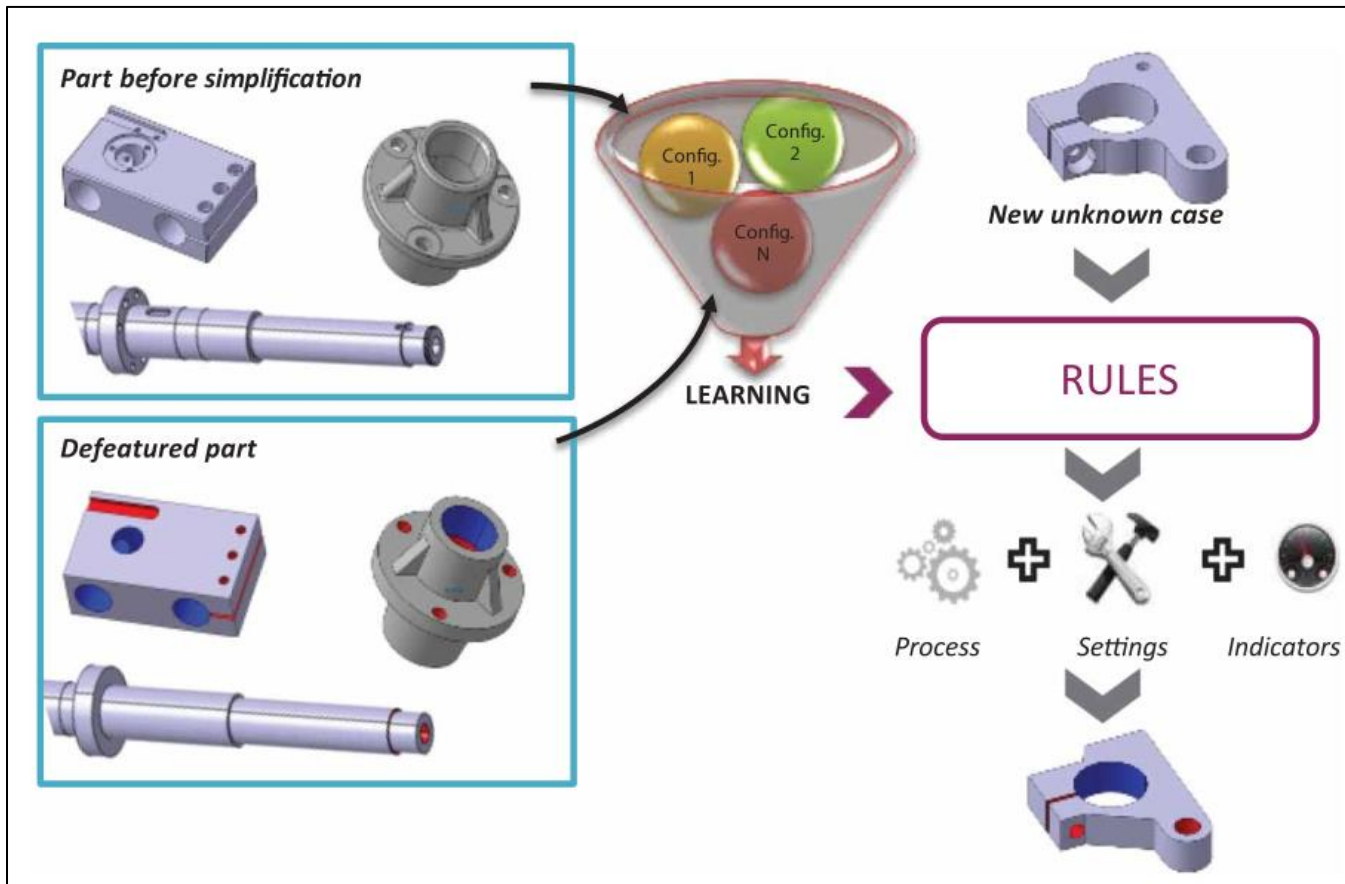
- 정성적 변수들

- : 크기에 의존하는 특징 분류, 경계 조건과의 상대적

- 예시: (대/중/소) , (경계조건과 가깝다, 멀다, 일치한다)

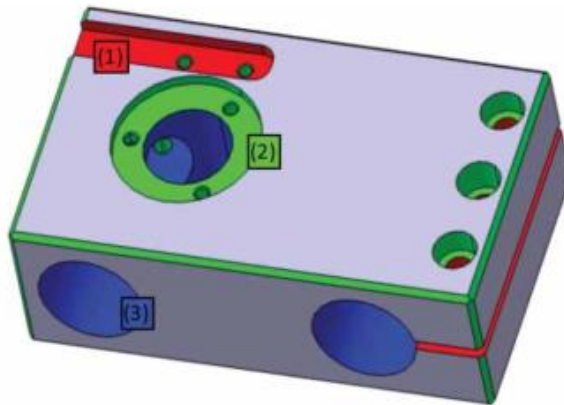
Proposed FrameWork

- 전체 프로세스



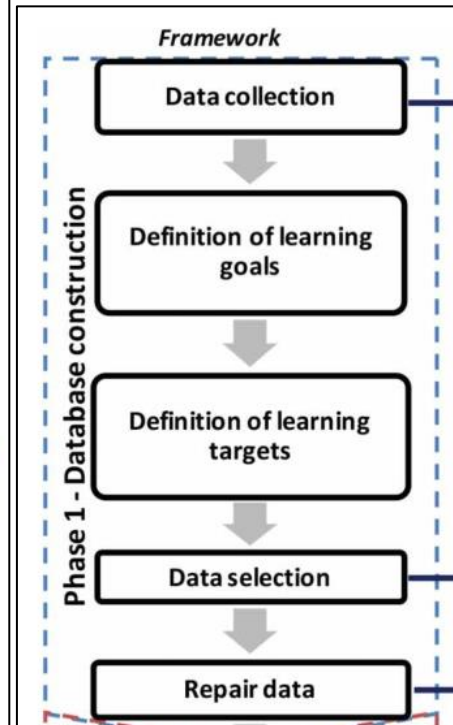
Database Construction

- CAD 모델 특성은 CAD 모델의 유형, 형식, 재료, 구성요소, 치수 수량 등이 있다.



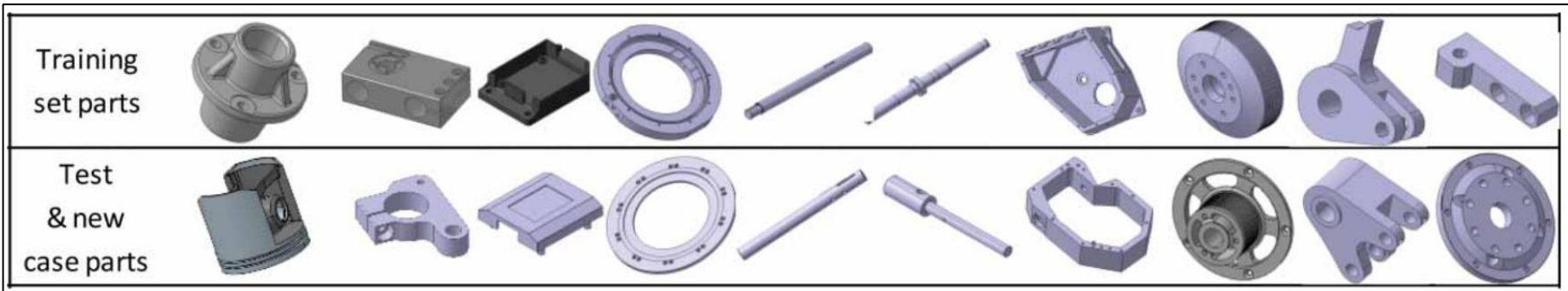
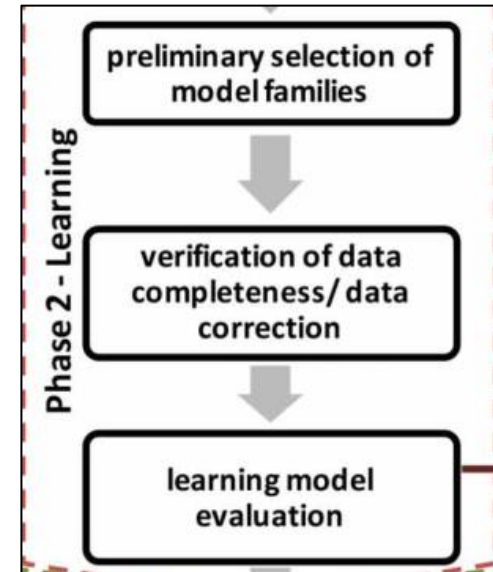
(1) Feature to delete
(2) Feature to retain
(3) Feature with boundary conditions

Feature id.	Part Triangles	Part Volume	Part Area	Feature Triangles	Feature Volume	Detail Surface	Ratio distance-BC	Feature-Part Ratio triangle	Feature-Part Ratio Area	Feature-Part Ratio Volume	Part triangles gain	Part volume gain	Part Area gain	Feature deleted
1	462	25.5	9.9	438	25.8	10.0	11.86	5.19	2.56	2.68	0.95	1.02	1.01	yes
2	Feature to retain			398	35.3	10.5	0.00	13.85	28.67	98.19	0.86	1.39	1.05	no
3	462	22.0	9.9	422	26.9	9.9	0.00	8.66	6.78	13.38	0.91	1.06	1.00	no
4	Feature to delete			422	25.8	9.7	4.47	8.66	3.13	3.38	0.91	1.01	0.98	yes
5	462	347.3	9.9	320	26.8	9.4	4.47	30.74	3.17	4.06	0.69	1.05	0.95	no
Entity id.	Explanatory input variables						Explanatory transformed variables				Explanatory intermediate variables			Variable to estimate
10	328	15.4	6.2	272	16.1	6.0	0.00	17.07	7.70	12.17	0.83	1.04	0.97	no



Learning

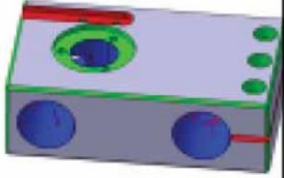
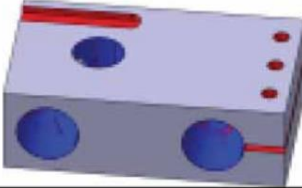

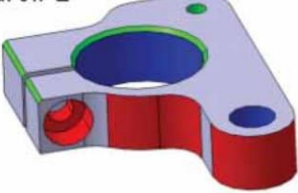
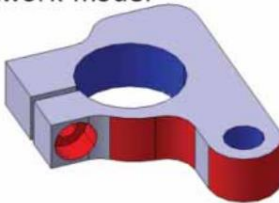
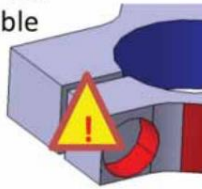
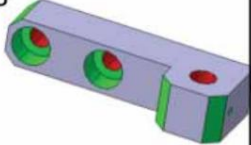
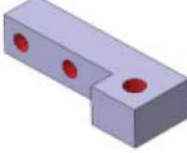
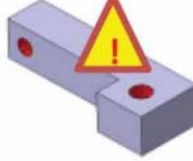
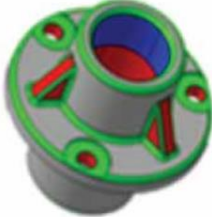
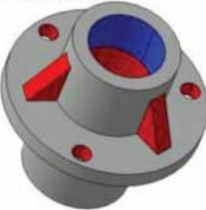
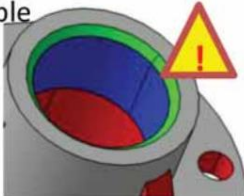
- 학습 데이터세트(66%)와 테스트 데이터세트(33%)로 나눈다.
- 예측 모델로는 의사결정트리, 로지스틱 회귀, 신경망, 베이시안 분류기 및 서포터벡터머신 이다.
- 대략 200개의 특징을 가지는 20개 부품을 사용
- Training과 Test set의 데이터베이스는 100 case를 포함
- Output: 제거할 특징의 목록



Data Corrections

- 세 가지 오류: 허용 오류, 불허용 오류, 입력 오류
 - 허용 오류: 모델이 “삭제”라고 분류해야 할 것을 “보존”으로 분류
 - 불허용 오류: 모델이 “보존”이라고 분류해야 할 것을 “삭제”로 분류
 - 입력 오류: 모든 학습에 대해 반복되는 실수, 즉, 전문가가 제공한 값의 오류
(입력 오류는 제외되거나 더 현실적인 값으로 대체된다.)

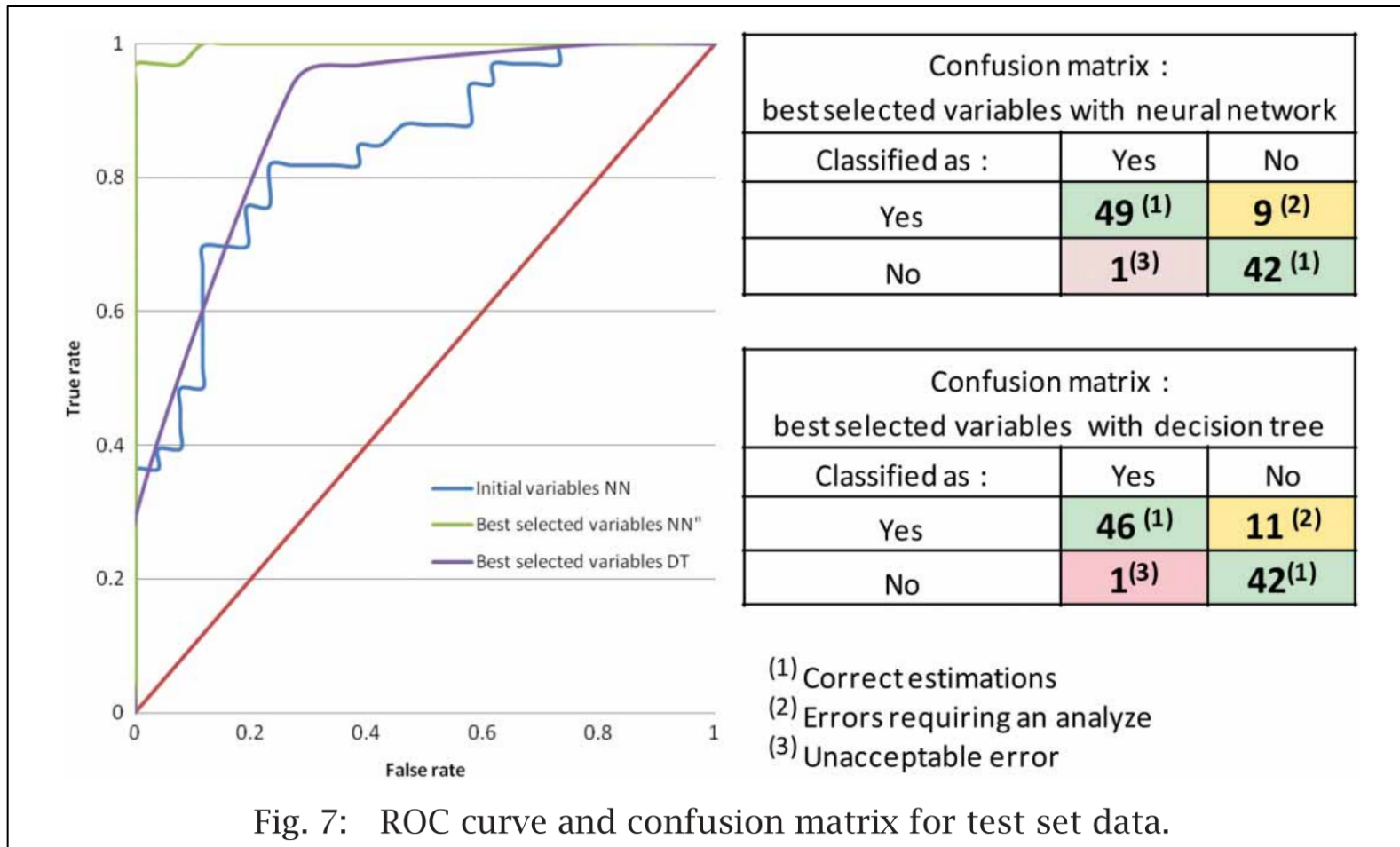
Data Corrections

Initial CAD model	Optimal simplified model verified by simulation and proposed by:	Error	Correction
Part # 1 	-Decision Tree -Experts 	neural network : unacceptable error 	adding a new family feature "thin pocket"
Part # 2 	-Neural network model -Experts 	Decision Tree : Unacceptable error 	Learning model rejected
Part # 3 	All learning models 	Input Expert error 	Input variable modified
Part # 4 	-Neural network model -Experts 	Decision Tree : Acceptable error 	None

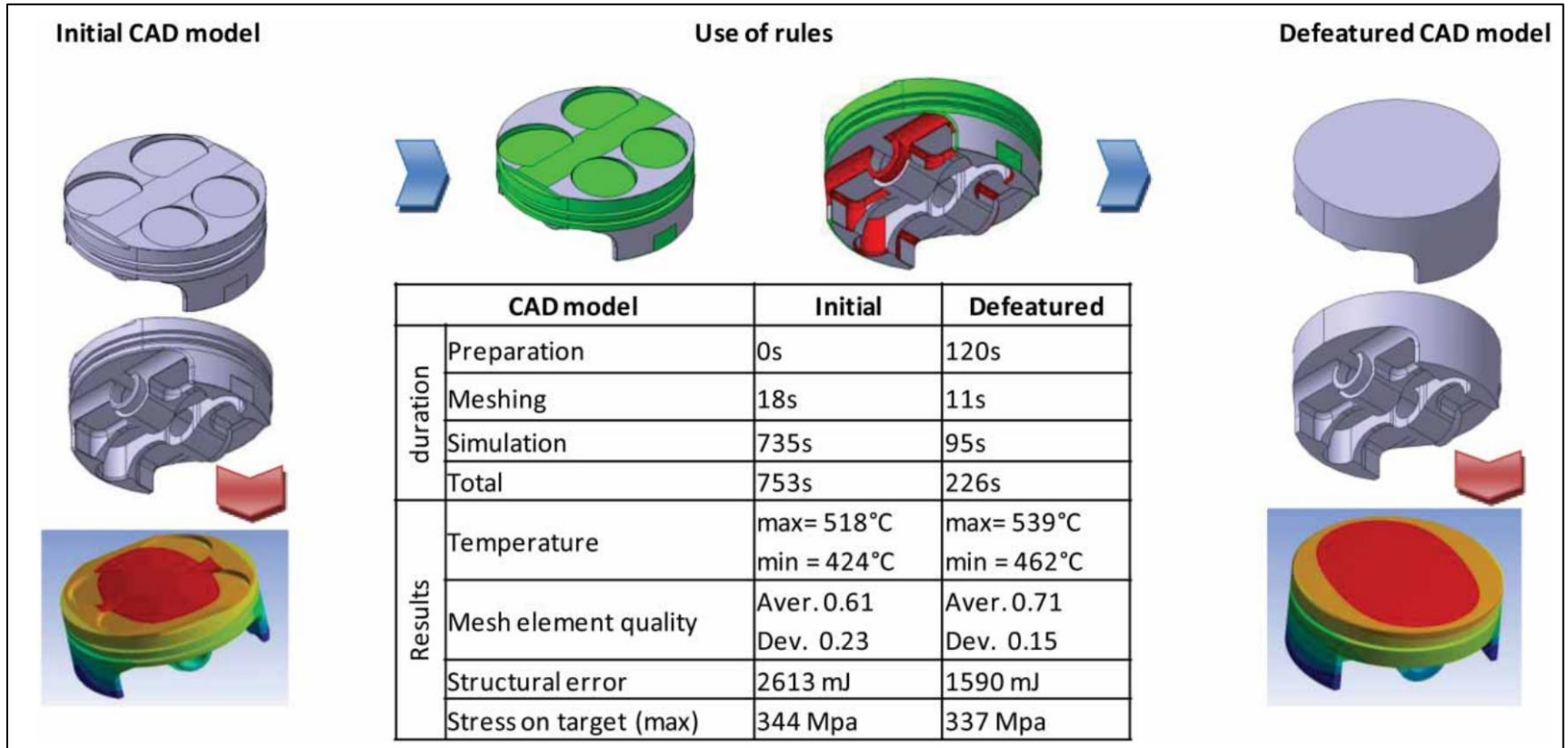
Achievements and Validation of the Results

Cross validation tests	<i>Explanatory variables =</i>	% of correctly classified instances		Unacceptable errors		<i>Learning model acceptability</i>
		training set	test set	NY	IP	
Neural networks	Initial data	76.2	50.8	15	12	No
	Ranking selected + ratio transformation variables	98.3	64.4	1	1	No
	Repaired variables	96	68.4	1	1	No
	Grouping variables	99.2	91.2	0	1	Acceptable
support vector machine	Initial data	57.6	47.5	17	13	No
	Ranking selected + ratio transformation variables	71.2	56	8	2	No
	Repaired variables	66.7	61.4	9	1	No
	Grouping variables	68.4	54.3	2	1	No
Decision tree	Initial data	61	51	14	9	No
	Ranking selected + ratio transformation variables	94.9	67.8	1	1	No
	Repaired variables	84.2	70.2	2	1	No
	Grouping variables	93.5	87.7	1	0	Acceptable

Achievements and Validation of the Results



Achievements and Validation of the Results



On the use of Machine Learning

to Defeature CAD models for simulation

감사합니다