EKE-Electronics Ltd.

IRIS® Certification

Designing Effort Estimation Process for Embedded Software Projects

Master's thesis presentation
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23/09/2024

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Smarter trains. Better future.

EKE

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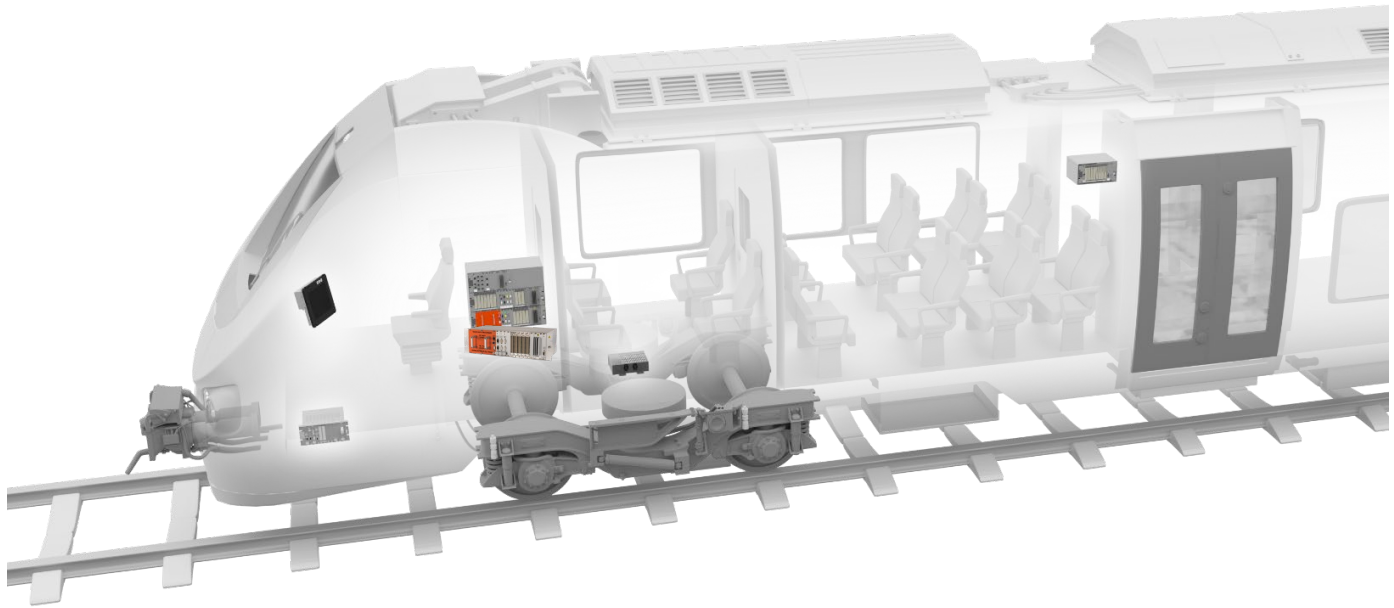
EKE-Electronics

1986
Established

100
Employees

35 000+
Train automation systems

6
Continents



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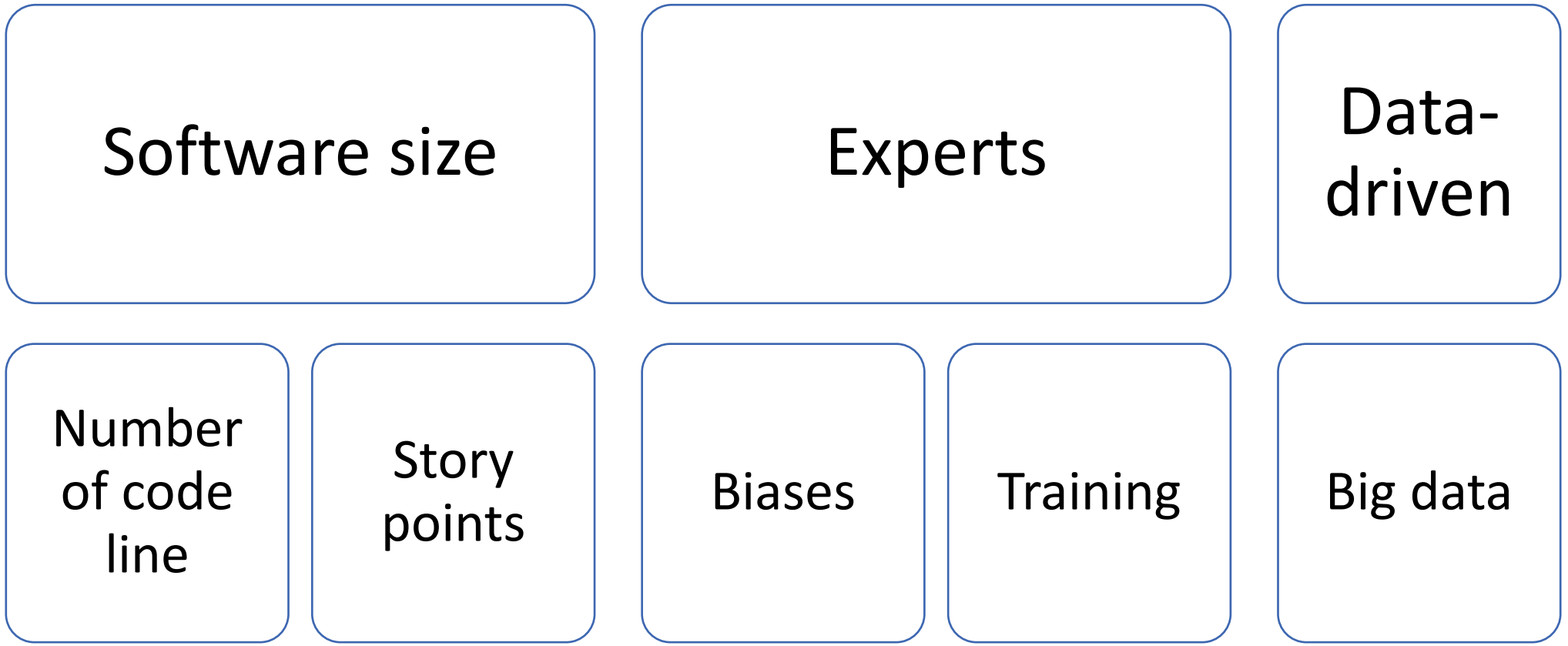
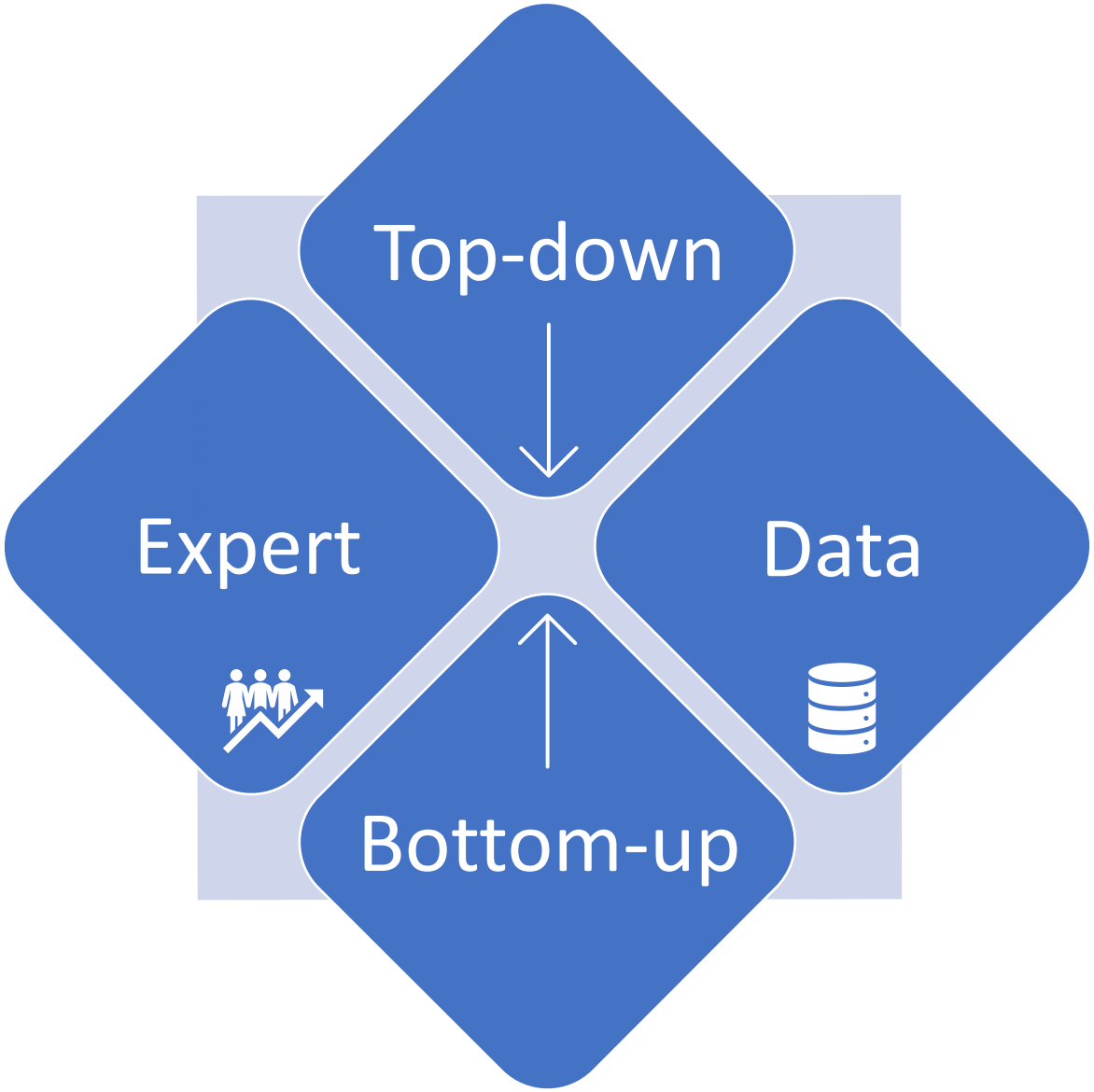
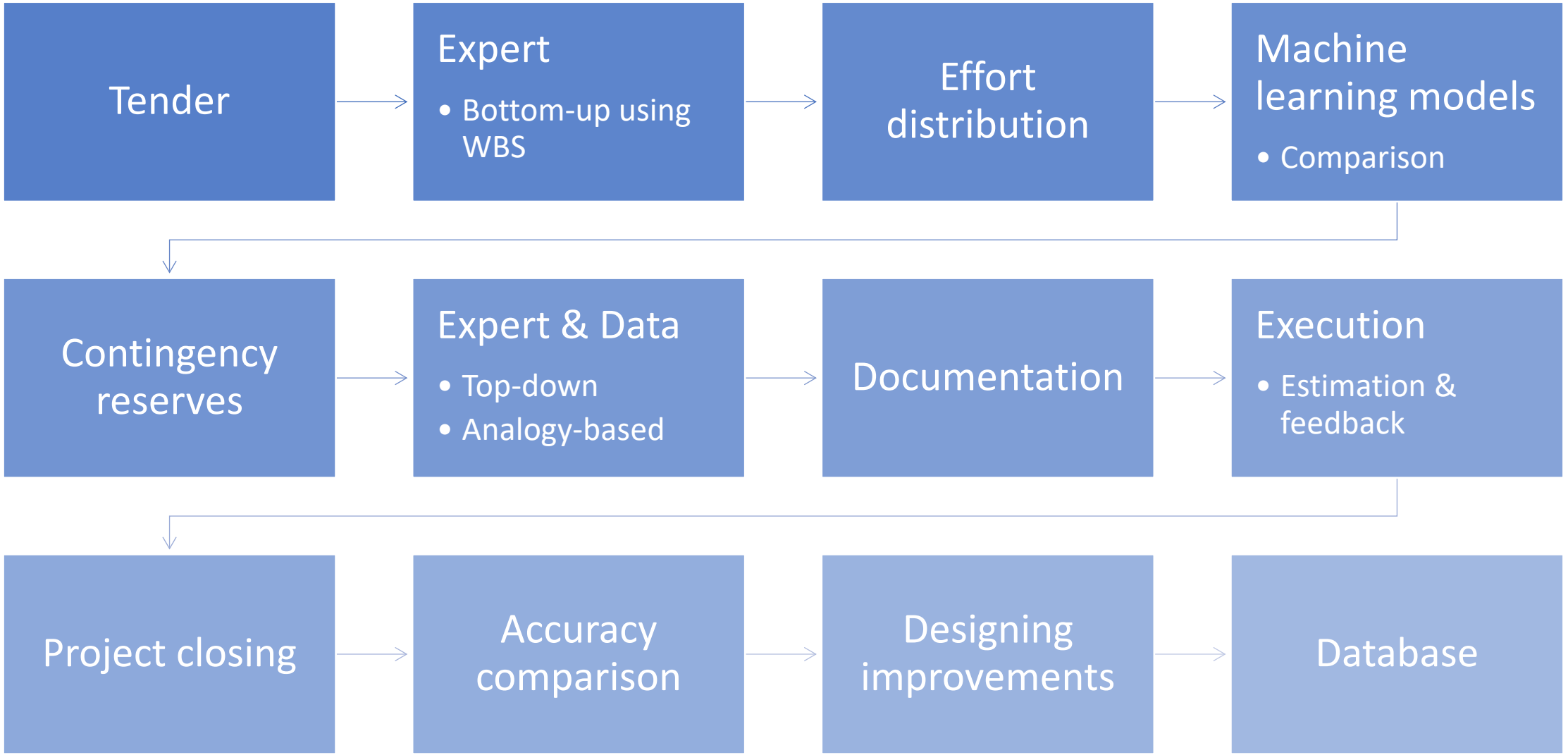
Estimation challenges



Proposed approach



Process overview



Method selection

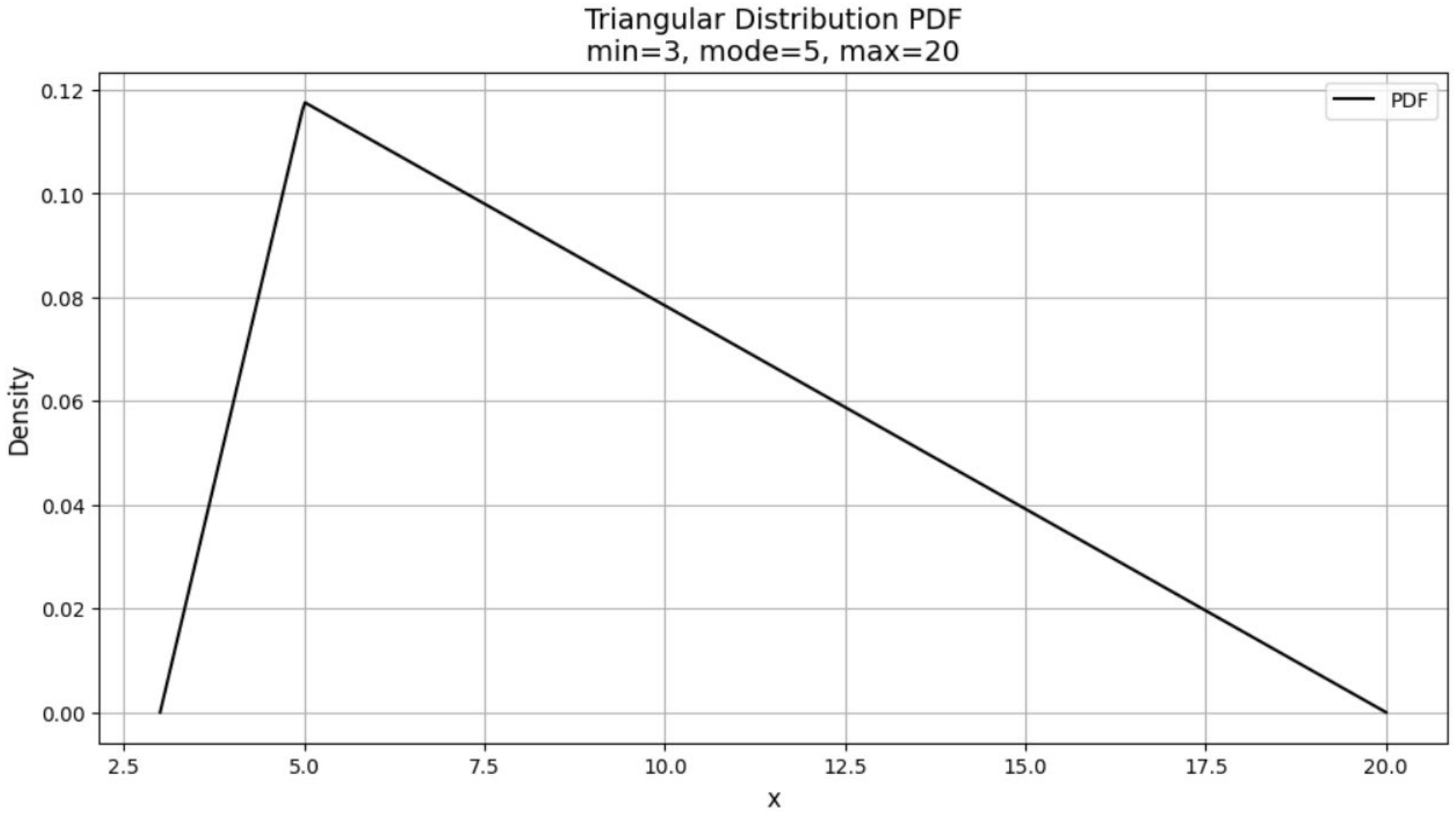
Criterion	Expert involvement	Required data	Robustness	Flexibility	Complexity	Support	Reusability	Predictive power	Informative power	Handling uncertainty	Comprehensiveness	Empirical evidence
Expert involvement		2	2	3	5	6	4			5	8	7
Required data			2	2	5	5	3			4	7	6
Robustness				2	4	5	2			3	6	5
Flexibility					3	4	2			2	5	5
Complexity						2					3	2
Support											2	2
Reusability					2	3				2	5	4
Predictive power	2	3	4	5	7	8	5		2	6	9	8
Informative power	2	2	3	4	6	7	5			5	8	8
Handling uncertainty					2	2					4	3
Comprehensiveness												
Empirical evidence											2	

Criterion	Normalized weight	Classical Model	IDEA	Wideband Delphi	Planning Poker	CBR	Regression	Random forest	Catboost / XGBoost	ANN	COCOMO
Expert involvement	0,15	3	2	1	1	4	5	5	5	5	4
Required data	0,11	4	4	5	5	1	1	2	2	2	4
Robustness	0,08	3	3	2	2	4	1	3	4	4	3
Flexibility	0,06	5	5	5	5	4	3	4	4	4	1
Complexity	0,03	2	2	5	5	4	4	3	2	2	3
Support	0,02	4	4	5	5	4	5	5	4	4	5
Reusability	0,05	1	1	1	2	3	4	4	4	4	5
Predictive power	0,24	3	4	2	2	4	1	2	4	4	1
Informative power	0,19	4	4	2	2	3	5	4	3	3	2
Handling uncertainty	0,04	5	5	3	3	2	1	1	1	1	1
Comprehensiveness	0,02	5	5	5	5	4	4	4	4	4	1
Empirical evidence	0,02	2	2	5	5	5	3	4	2	2	5
Sum	1	3,4	3,5	2,6	2,7	3,4	2,9	3,2	3,5	3,5	2,5

Expert-based bottom-up estimation

Cat A	Cat B	Cat C
2-3 engineers	2 engineers	1 engineer
Lowest plausible value?		
Highest plausible value?		
Likely value?		
How confident are you?		

Data distributions



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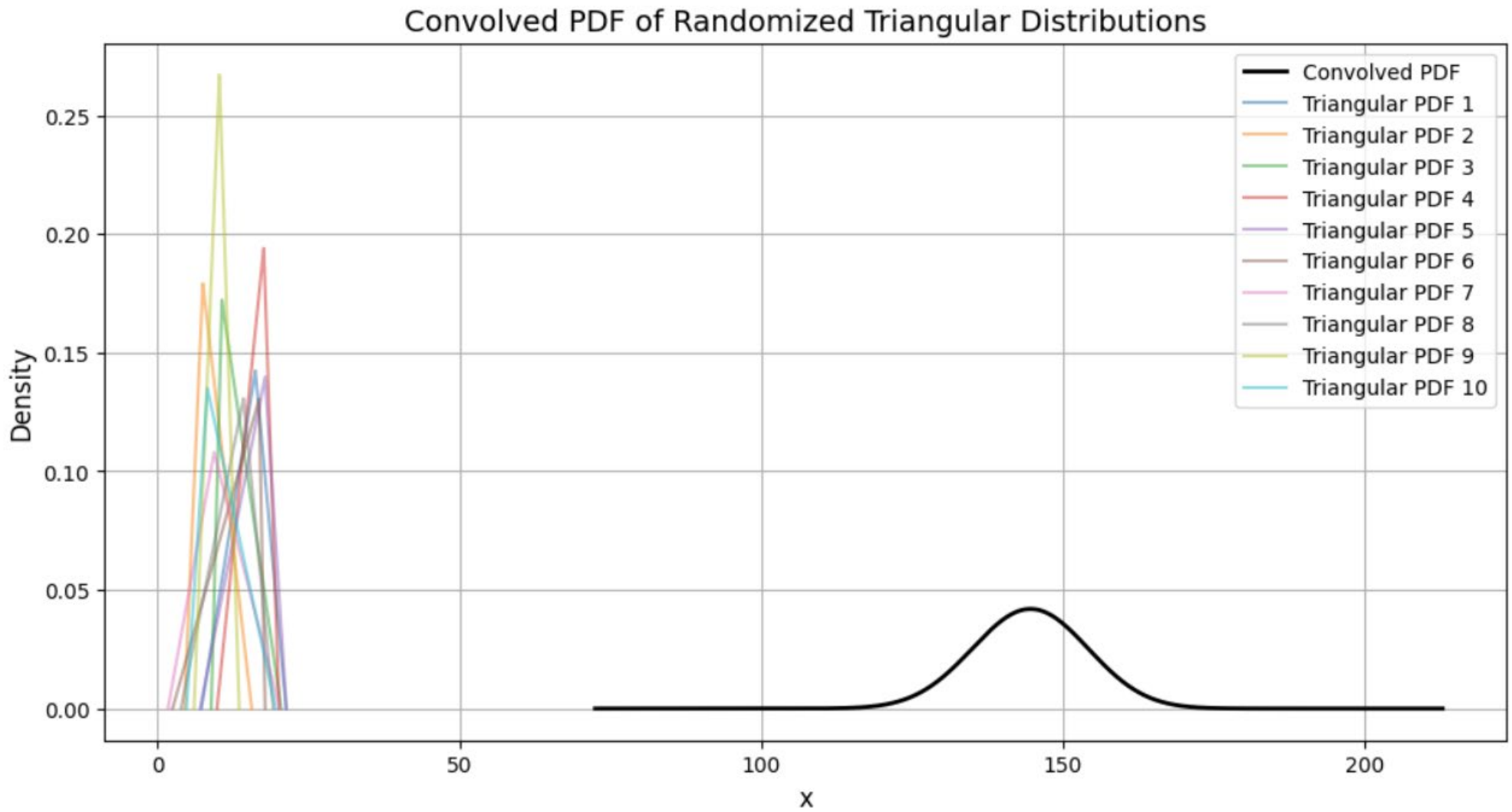
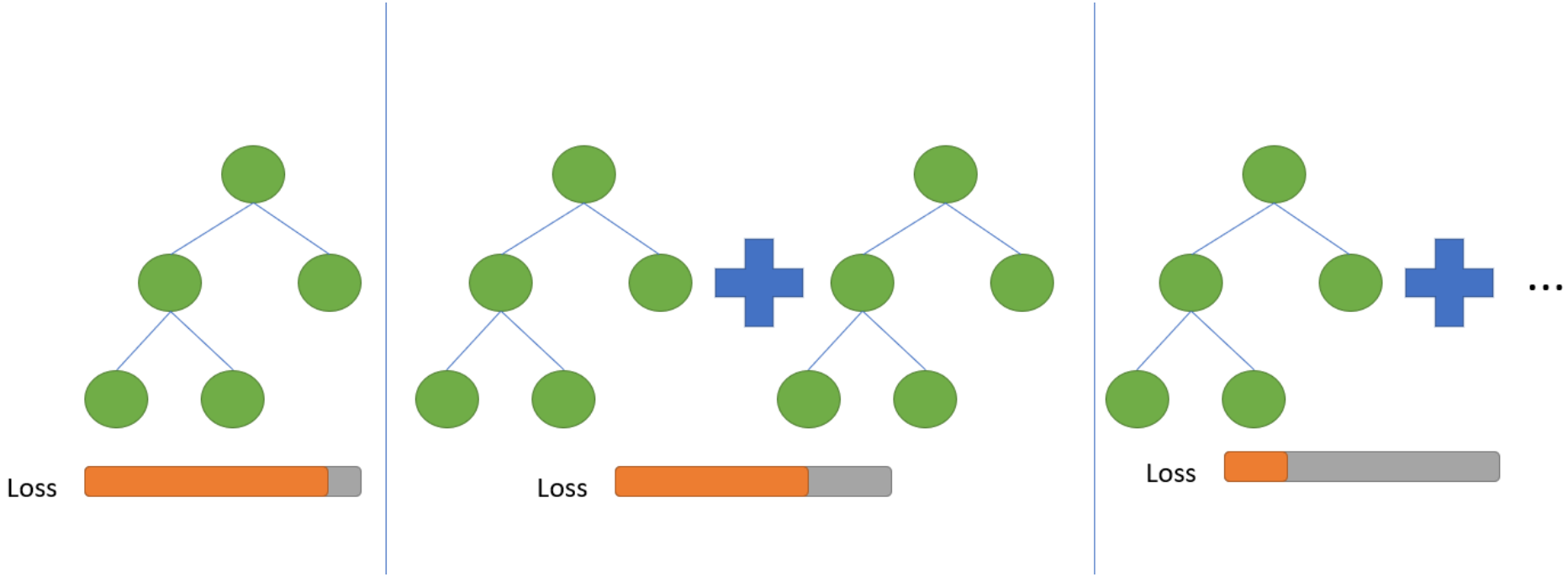


Machine learning models

- CatBoost, Extreme Gradient Boosting (XGBoost), artificial neural network
- Automatic tuning with Optuna
- Model structure explanation using Shapley Additive Explanations (SHAP)



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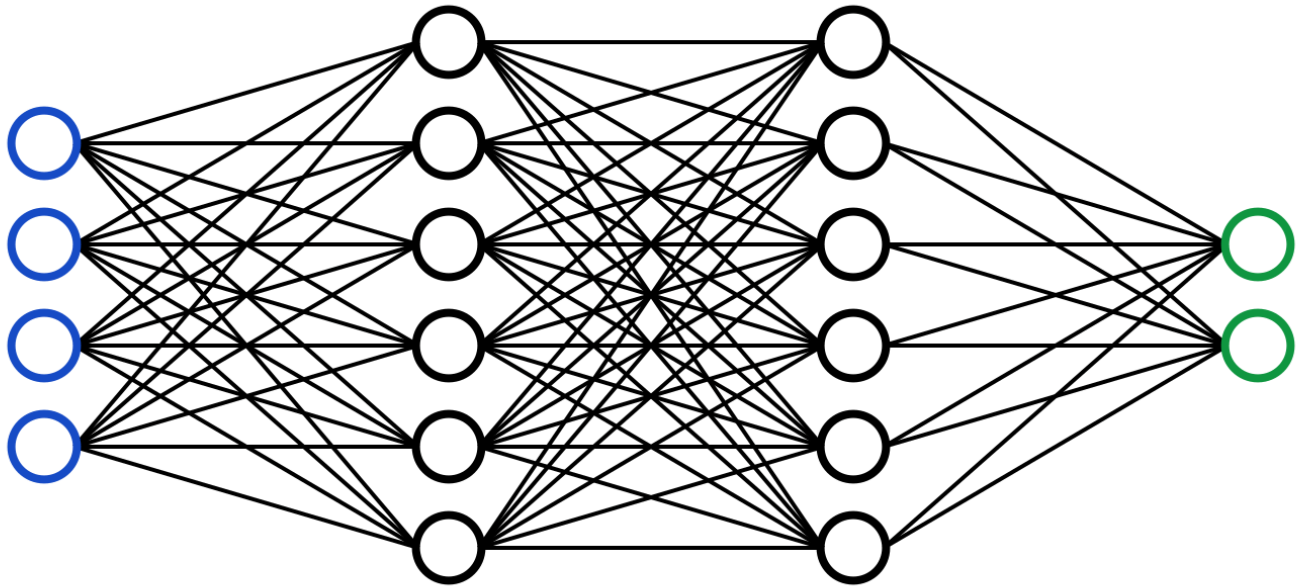

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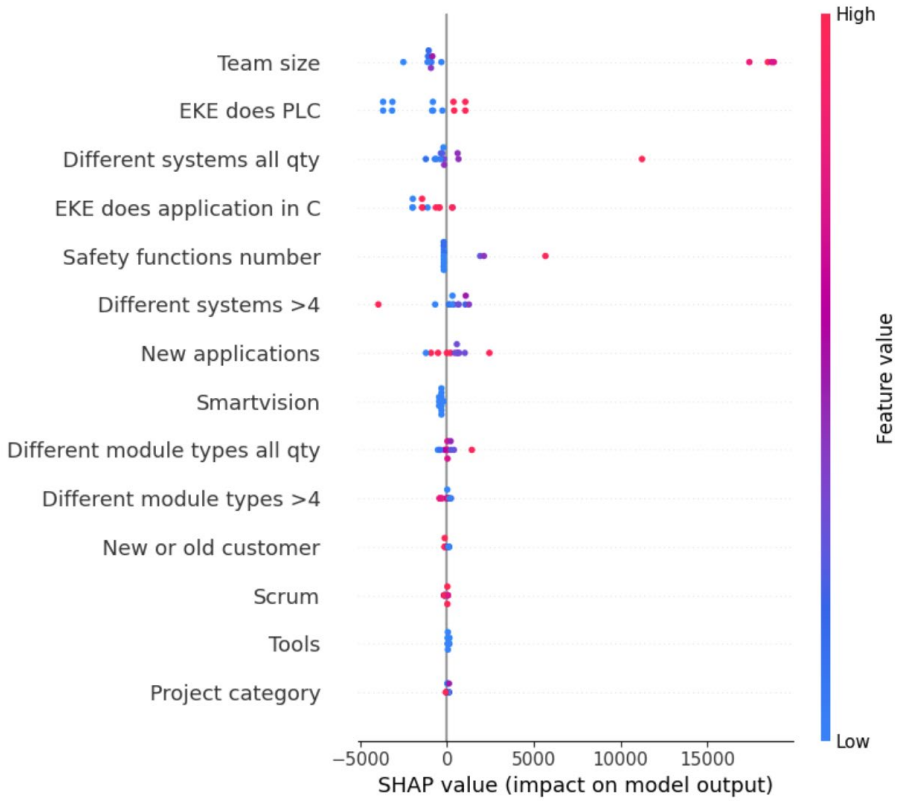

Machine learning results & Process implementation

Metric	CatBoost	XGBoost	ANN	Current
MSE	3*10^7	2*10^7	10^8	
MSBRE	8	7	1	
PRED(25%)	17 %	17 %	17 %	20 %
PRED(50%)	67 %	50 %	50 %	30 %

- Kotter's 8-stage process