







"The Internet of Things (IoT) refers to the connectivity of physical objects, equipped with sensors and actuators, to the Internet via data communication technology, enabling interaction with and/or among these objects."

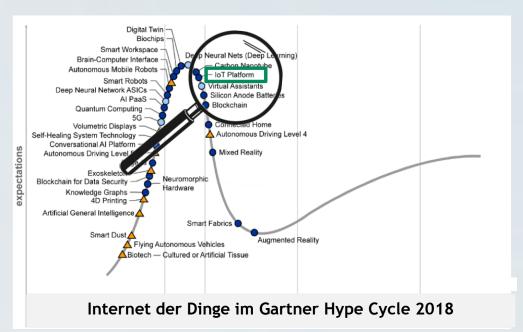






MOTIVATION



















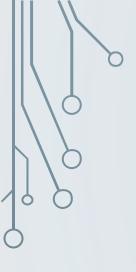












PROJEKT-FRAGE?

Welche Smarten Produkte sind besonders erfolgreich?

Um welches Produkt-Typen handelt es sich?

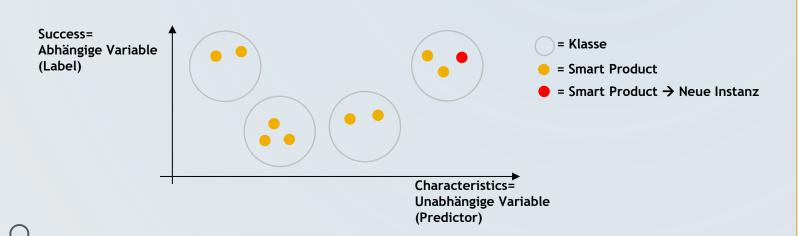
Wie kann Unternehmen eine Entscheidungshilfe an die Hand gegeben werden?



Prognose des Erfolgs mit Hilfe von Machine Learning



PROGNOSE MITTELS SUPPORT VECTOR MACHINE



Erklärung / These

- SVM trainiert aufgrund von Characteristics und Markterfolg (Success) der Smarten Produkte
- Je nach dem welche Characteristics das Smarte Produkte hat, wird es einen bestimmten Erfolg haben
- Erfolg ergibt sich aus Google-Suchanfragen
- Anwendung SVM auf gänzlich neues Objekt/Instanz

WAS BRAUCHEN WIR DAZU?

DIE VORARBEITEN!

Taxonomie

Allgemeingültige Beschreibung Smarter Produkt

	Dimension			Charac	teristics			
e	Ecosystem Integration	No	ne	Proprieta	ary	Open		
Service	Value Proposition		Thing-cer	ntric	Service-centric			
Š	Offline Functionality		None		Limited			
Data	Data Usage	Transa	ctional	Analytic (basic)		Analytical (extended)		
^	Data Source	Thing State Thin		ng Context Thi		Usage	Cloud	
ion	Interaction Partner	Use	r(s)	Business	(es)	Thing(s)		
Interaction	Interaction Multiplicity		One-to-o	one	One-to-many			
Int	Interaction Direction		Unidirecti	onal	Bi-directional			
D	Autonomy	No	ne	Self-Contr	olled	Self-Learning		
Thing	Acting Capabilities		Own				ary	
	Sensing Capabilities		Lean		Rich			

Datensatz

Ca. 200 klassifizierte Smarte Produkte, deren Erfolgskennzahlen und Typ-Zuordnung

4	Α	В	С	D	Е	F	G	Н
1	sensing	acting_own	acting_inter	autonomy	direction	multiplicity	partner_use	partner_t
2	0.00	0.50	0.50	0.50	0.00	1.00	0.33	0.00
3	0.00	0.00	0.50	0.00	0.00	0.00	0.33	0.00
4	0.00	0.00	0.50	0.00	0.00	1.00	0.33	0.33
5	0.00	0.50	0.00	0.00	0.00	1.00	0.33	0.00
6	1.00	0.50	0.50	0.50	1.00	0.00	0.33	0.00
- 7	0.00	0.50	0.50	1.00	1.00	1.00	0.33	0.00
8	0.00	0.50	0.50	0.00	0.00	0.00	0.33	0.00
9	1.00	0.50	0.50	0.00	1.00	0.00	0.33	0.00
10	1.00	0.50	0.50	0.00	1.00	1.00	0.33	0.00
11	0.00	0.00	0.50	0.50	1.00	1.00	0.33	0.00
12	0.00	0.50	0.50	0.50	0.00	1.00	0.33	0.00
13	1.00	0.00	0.50	0.50	0.00	1.00	0.33	0.00
14	1.00	0.50	0.50	0.50	0.00	0.00	0.33	0.00
15	0.00	0.00	0.50	0.00	0.00	0.00	0.33	0.00
16	0.00	0.00	0.50	0.00	0.00	0.00	0.33	0.00
17	0.00	0.50	0.50	0.00	1.00	1.00	0.33	0.00
18	0.00	0.50	0.50	0.50	0.00	1.00	0.33	0.00
19	0.00	0.50	0.50	0.00	1.00	1.00	0.33	0.00
20	0.00	0.00	0.50	1.00	1.00	0.00	0.33	0.00
21	1.00	0.00	0.50	0.00	0.00	1.00	0.33	0.00
22	1.00	0.00	0.50	0.00	0.00	0.00	0.33	0.00

UMSETZUNG: DREISCHICHTEN ARCHITEKTUR Evaluation Administration **Smart Product** ML-Approaches **User Interface** Frontend Component **Backend Component** Machine Learning Machine Learning Processing Approach 1 Approach n Data Input **Application Logic Smart Product** Train and Test Data Data **Data Storage**



Administration: Machine Learning Approach	_		\times
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Delete Database

Create Database

Load Data

Feature Reduction

Train Data

			Without Cluster		With Cluster	Target Value
RMSE with Train and Test Data (F	oly):					0
RMSE with Cross Validation (Poly	·):					0
Accuracy with Cross Validation (F	oly):				1	
	С					
Grid Search (Poly):	d					
	γ					'
	r					
Grid Search (RBF):	С					4
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	С					
Grid Search after	d					
Feature Reduction (Poly):	γ					l '
	r					
Grid Search after	С					1
Feature Reduction (RBF):	Υ					'

Train Data

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Grid Soorah (DRE):	С	1		4
Grid Search (RBF):	γ			•



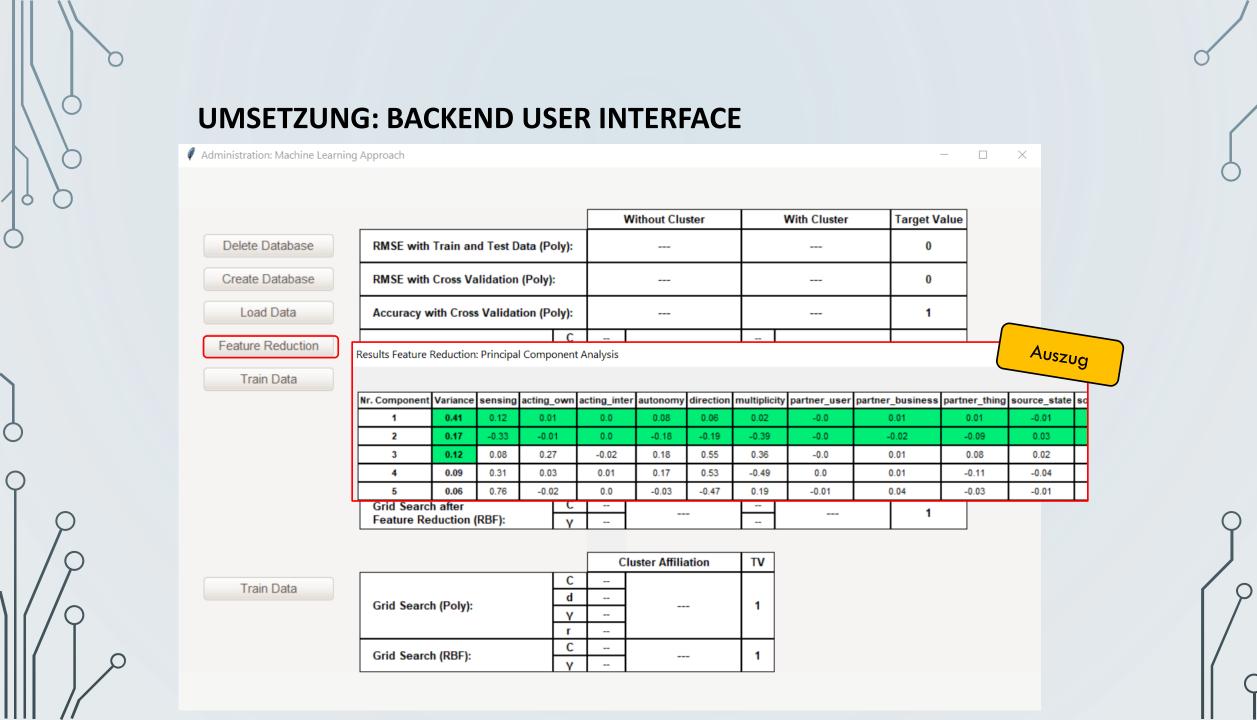
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				Without Cluster	₩	With Clust	er	Target Value
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e Database	RMSE with Cross Validation (P	oly):						0
ad Data	Accuracy with Cross Validation	n (Poly):						1
e Reduction		С						
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		C			OK -			
	Grid Search after	d	1					1 1
	Feature Reduction (Poly):	Υ						1 '
		r						
	Grid Search after Feature Reduction (RBF):	C					-	1
	reduction (RDI).	Y						
				luster Affiliation	TV	1		
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	Grid Search (Poly):	Y			1			
		r						
	Grid Search (RBF):	С			1			
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Administration: Machine Learning	g Approach							_	×
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				Without Cluster		With Clus	lei		
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Create Database	RMSE with Cross Validation (Poly):							0	
Load Data	Accuracy with Cross Validation	ation (Poly):						1	
Feature Reduction		С							
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		C			cessfully created!				
	Grid Search (RBF):	Υ		Database succ				1	
		С						1	
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nistration: Machine Learnir	ng Approach						_
				Without Cluster	I	With Cluster	Target Value
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ature Reduction Train Data	Grid Search (Poly):	C d Y				×	1
	Grid Search (RBF):	C Y	1 1	Data succes	sfully lo	aded!	1
	Grid Search after Feature Reduction (Poly):	d Y			(ок	1
	Grid Search after Feature Reduction (RBF):	C					1
		•	С	Cluster Affiliation	ΤV		
Train Data	Grid Search (Poly):	C d Y			1		
	Grid Search (RBF):	C			1		



Administration: Machine Learning Approach

Niedrige Güte aufgrund unzureichender Datenbasis with Cluster

Delete Database

Create Database

Load Data

Feature Reduction

Train Data

		Without Cluster			With Cluster	Datenbas	
RMSE with Train and Test Data (Poly):		1.51		1.51	0	
RMSE with Cross Validation (Poly	RMSE with Cross Validation (Poly):				1.36	0	
Accuracy with Cross Validation (Poly):		0.32		0.3	1	
	С	24		24			
Grid Search (Poly):	d	1	0.42	1	0.4	4	
Grid Search (Poly):	Υ	5		4		'	
	(Poly): γ 5 r 2 C 1		2				
Grid Search (RBF):	С	1	0.38	2	0.39	1	
ond search (KBI).	Υ	35	0.00	85	0.00		
	С	20		18			
Grid Search after	d	3	0.41	1	0.35	4	
Feature Reduction (Poly):	Υ	5	0.41	3	0.35	'	
	r	0		0			
Grid Search after	С	200	0.39	6	0.32	4	
Feature Reduction (RBF):	γ	65	0.39	100	0.32	'	

Train Data

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Crid Sparah (Daly)	d	-		
Grid Search (Poly):	γ	1		' '
	r	-		
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Grid Search (RBF):	γ			<u> </u>



			\	Without Cluster		With Cluster	Target Value
Delete Database	RMSE with Train and Test Date	a (Poly):					0
Create Database	RMSE with Cross Validation (Poly):						0
Load Data	Accuracy with Cross Validation	idation (Poly):					1
eature Reduction		С					
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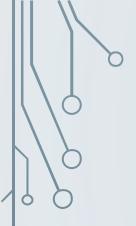
UMSETZUNG: FRONTEND USER INTERFACE

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Service	Ecosystem Integration	None		Propr	ietary Open		Open	ME
	Value Proposition	Thing-Centric			Service-Centric			ME
	Offline Functionality	None			Limited			ME
Data	Data Usage	Transactional		Analytica	al (basic)	Analytical (extended)		ME
Data	Data Source	Thing State	Thi	ng Context	Thing Usa	age	Cloud	Non E
Interaction	Interaction Partner	User		Busi	usiness		Thing	Non E
	Interaction Multiplicty	One-To-One			One-To-Many			ME
	Interaction Direction	Uni-Directional			Bi-Dire	ectional	ME	
Thing	Autonomy	None		Self-Controlled		Self-Learning		ME
	Acting Capabilities	Own			Intermediary			Non E
	Sensing Capabilities	Lean			Rich			ME

Submit





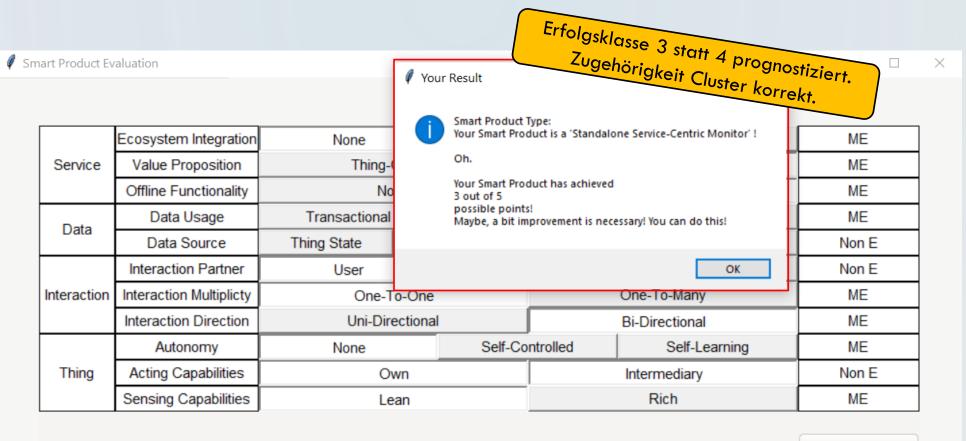
SHOW CASE AM BEISPIEL "FITBIT"

	Dimension	Characteristics							
Service	Ecosystem Integration	None		Proprietary		Open			
	Value Proposition		Thing-cen	tric	Service-centric				
	Offline Functionality		None		Limited				
Data	Data Usage	Transactional		Analytical (basic)		Analytical (extended)			
	Data Source	Thing State Thi		ng Context Thin		Usage	Cloud		
Interaction	Interaction Partner	Use	r(s)	Business(es)		Thing(s)			
	Interaction Multiplicity		One-to-o	ne	One-to-many				
Int	Interaction Direction		Unidirection	onal	Bi-directional				
Thing	Autonomy	No	one	Self-Controlled		Self-Learning			
	Acting Capabilities		Own		Intermediary				
	Sensing Capabilities		Lean		Rich				

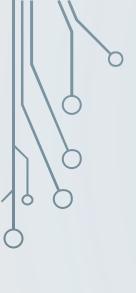
Erfolg: Klassen 1 bis 5. Geräte in Klasse 5 am erfolgreichsten. Fitbit in Klasse 4, war nicht Bestandteil des Trainingsdatensatzes.



UMSETZUNG: FRONTEND USER INTERFACE



Submit

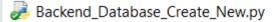


FAZIT

Learnings

- Verbesserung Gütemaße für den Erfolg von Smart Things notwendig
- Mögliche Gründe für unzureichende Ergebnisse:
 - Zu viele Features (d.h. Charakteristika)
 - Erweiterung des Datensatzes um weitere Smart Things, um repräsentative Stichprobe zu erreichen
 - Geräte mit ähnlichen Eigenschaften sind unterschiedlich erfolgreich
- Gütemaße für die Cluster-Zuordnung erzielen gute Ergebnisse. Somit ist eine Zuordnung aufgrund von Nutzereingaben möglich
- Evaluierung im **Vergleich mit anderen Verfahren** (z.B. Neuronale Netze)

ÜBERSICHT DATEIEN DIE IM PROJEKT ENTSTANDEN SIND



Backend_Database_Load.py

Backend_Database_Read.py

Backend_Feature_Reduction.py

Backend_Support_Vector_Machine_Administration.py

Backend_Support_Vector_Machine_Evaluation_User_Input.py

Backend_User_Interface.py

Frontend_Database_Create_New.py

Frontend_Database_Write.py

Frontend_Smart_Product_Class.py

Frontend_User_Interface.py

Principal_Component_Analysis_Results.csv

smart_product.db

Smart_Product_Data_float.csv

Smart_Product_Data_float_ex_fitbit.csv