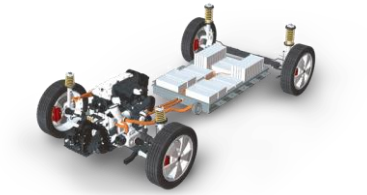
Automated Testing in Production Planning in Test based Engineering

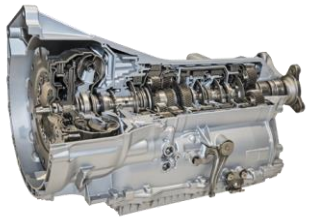
Hackathon 2021 Problem Statement

SIEMENS

(H) EV Powertrain Component categories



Powertrain sensors
Powertrain current sensors
Powertrain exhaust sensors
Powertrain fluid concentration sensors
Powertrain knock sensors
Powertrain position sensors



Transmission
Automatic transmission
Drive line components
Electric drive
Shifter system

Engine
Diesel engine
Engine fan
eTurbo/charger
Gasoline & diesel engine platform
Gasoline engine
Ignition
Pump

Power Steering
Electric power steering (EPS)

Test IDs and time taken to perform tests (* All the data is anonymous)

Engine
Diesel engine
Engine fan
eTurbo/charger
Gasoline & diesel engine platform
Gasoline engine
Ignition
Pump

Training Data: All parts are randomly shuffled

Test ID	Time taken to perform test	Variables						
		Categorical Variables		Continuous Variable			Binary Variables	
ID	y	X0	X1	X9	X10	X16	X17	X18
0	130.81	k	v	0.207113	0.102098	0.777778	0	1
6	88.53	k	t	0.504978	0.017506	0.777778	0	1
7	76.26	az	w	0.392335	0.003765	0.777778	1	0
9	80.62	az	t	0.474729	0.008185	0.333333	0	0
13	78.02	az	v	0.10188	0.00549	0.111111	0	0
18	92.93	t	b	0.554858	0.023466	0.444444	0	0
24	128.76	al	r	0.213276	0.096429	0.111111	0	0
25	91.91	o	l	0.198462	0.022033	1	0	0
27	108.67	w	s	0.664776	0.049814	0.111111	0	0
30	126.99	j	b	0.253765	0.091677	0	0	0

Data Exploration and Time prediction

- Pattern Recognition
- Machine Learning approach selection
- Model comparison and Evaluation
- Model comparison and Evaluation

Test Data

Test ID	Variables					
	Categorical Variables		Continuous Variable			Binary Variables
ID	X1	X2	X9	X10	X16	X17
1	az	v	0.260169	0.007526	0.666667	0
2	t	b	0.118023	0.031068	0.222222	0
3	az	v	0.262278	0.009687	0.888889	0
4	az	l	0.184351	0.004481	0.888889	0
5	w	s	0.674921	0.054433	0.555556	0
8	y	aa	0.202338	0.020781	0.666667	0
10	x	b	0.169923	0.052427	0.777778	0
11	f	s	0.41488	0.025004	0.555556	0
12	ap	l	0.363767	0.067247	1	0
14	o	v	0.169764	0.025004	0.888889	0

(H) EV Powertrain Testing

Each test ID is divided into categories (A1 – A6) which resemble a component in powertrain machinery. For successful testing of the powertrain machinery, test IDs from these categories should be tested on specific machines in a specific order of component categories.

113 → 1241 → 7623 → 8091 → 1466 → 4211

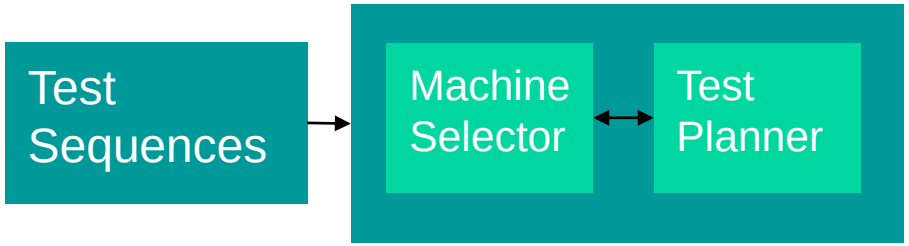
113	N	N	N	N	Y	N
1241	Y	N	N	N	N	N
7623	N	N	Y	N	N	N
8091	N	N	N	Y	N	N
1466	N	Y	N	N	N	N
4211	N	N	N	N	N	Y

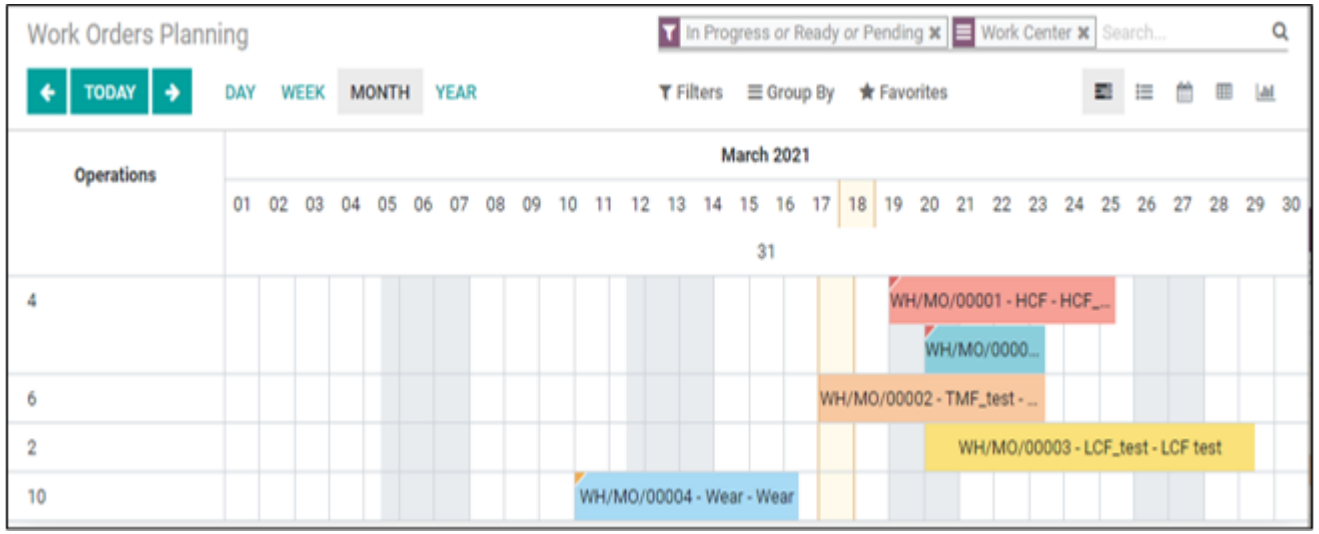
SIEMENS

Test Planning and Scheduling tool output

Test Sequence 1 – Machine used, time for execution, resources used, resources available
Test Sequence 2 – Machine used, time for execution, resources used, resources available

All the test sequences should be in the increasing order of start date and total time required



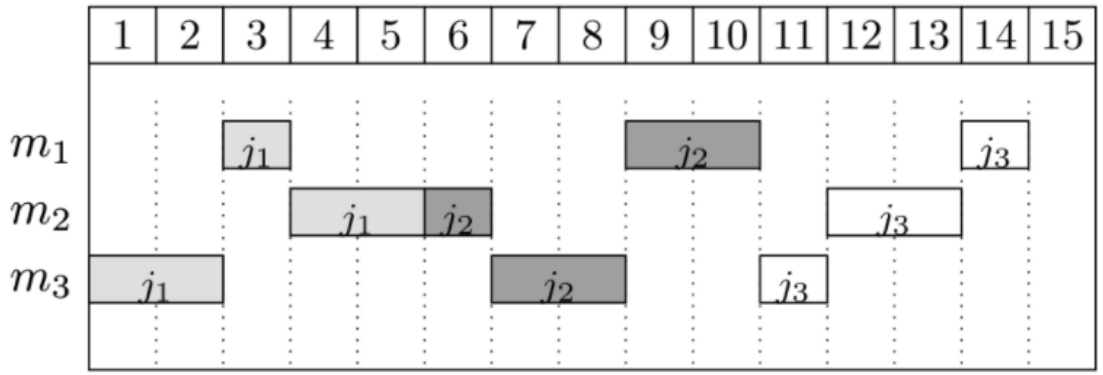


Scheduling Problem – 2 approaches

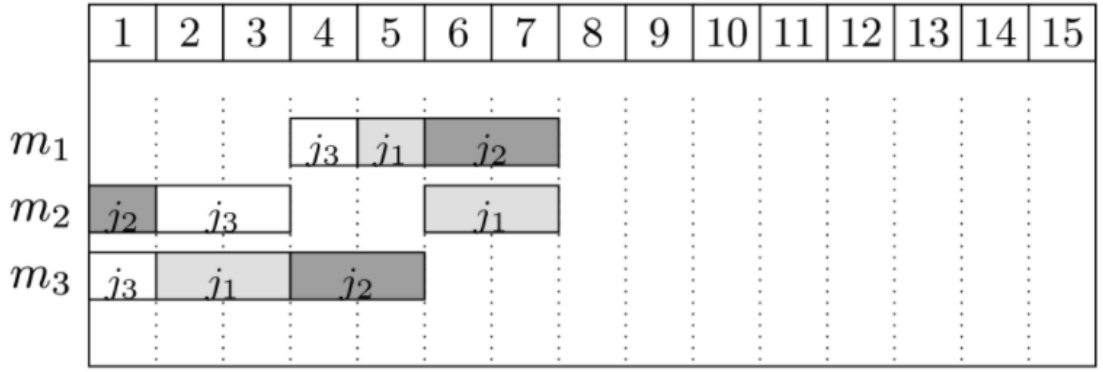
test t1: m3 (2) → m1 (1) → m2 (2)
test t2: m2 (1) → m3 (2) → m1 (2)
test t3: m3 (1) → m2 (2) → m1 (1)

The first schedule shows a naive solution: jobs are processed in a sequence and machines stay idle quite often

The second solution is the optimal one, where jobs execute in parallel.



First Solution



Second Solution

SIEMENS

Summary

Task 1:

- Data Exploration and Analysis
- Data Modelling and Approach comparison
- Predict testing time per Test ID using machine learning techniques
- Performance Analysis using R2 score

Task 2:

- Map Machines with Test IDs and testing time
- Write logic to schedule tests on machines with predicted test times
- Minimize the makespan, i.e. minimize the maximum completion time among all tests
- Keep count of resources available