



Wrocław University of Science  
and Technology

# We all collect many trends – how can we make use of it for automatic prognosis

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**PREDICON**  
we extend  
the life of machines



This activity has supported under the Marie Skłodowska Curie programme through the ETN MOIRA project (GA 955681) by European Commission.

# Agenda

- **Introduction**
- **Prognosis and diagnosis**
- **Model**
- **Results**
- **Conclusion**



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# Machines in industries

- Automation
- Efficiency and Speed.
- Innovation and Advanced Capabilities.



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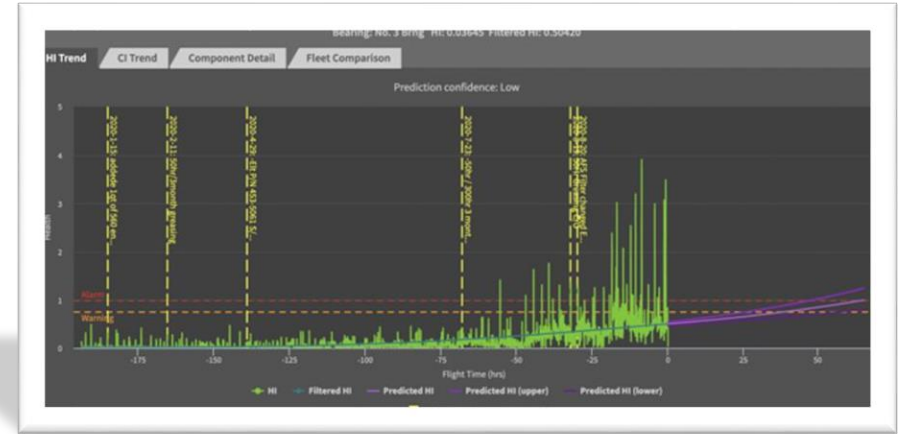
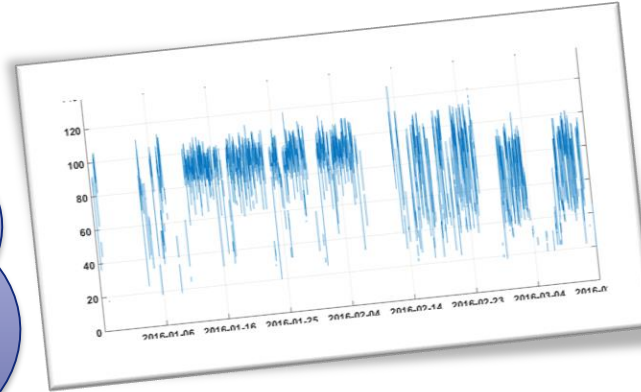
# Prognosis and diagnosis

- **Preventive Maintenance**
- **Optimal Performance**
- **Cost Reduction**

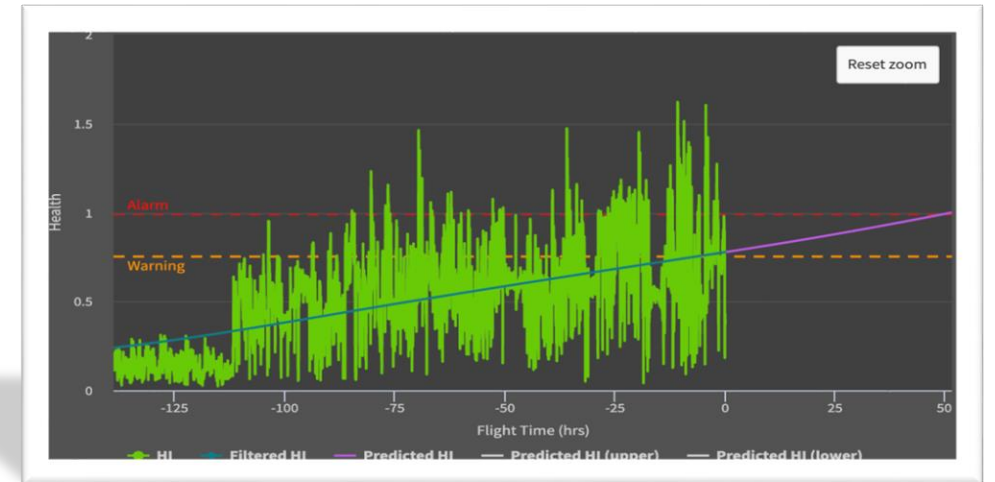


# Collecting signal

We have collected a vast amount of data over the course of hours, days, months, and even years. However, I am unsure how to extract meaningful information from this data in order to enhance our company's performance.



Do not worry we are here to answer these questions!



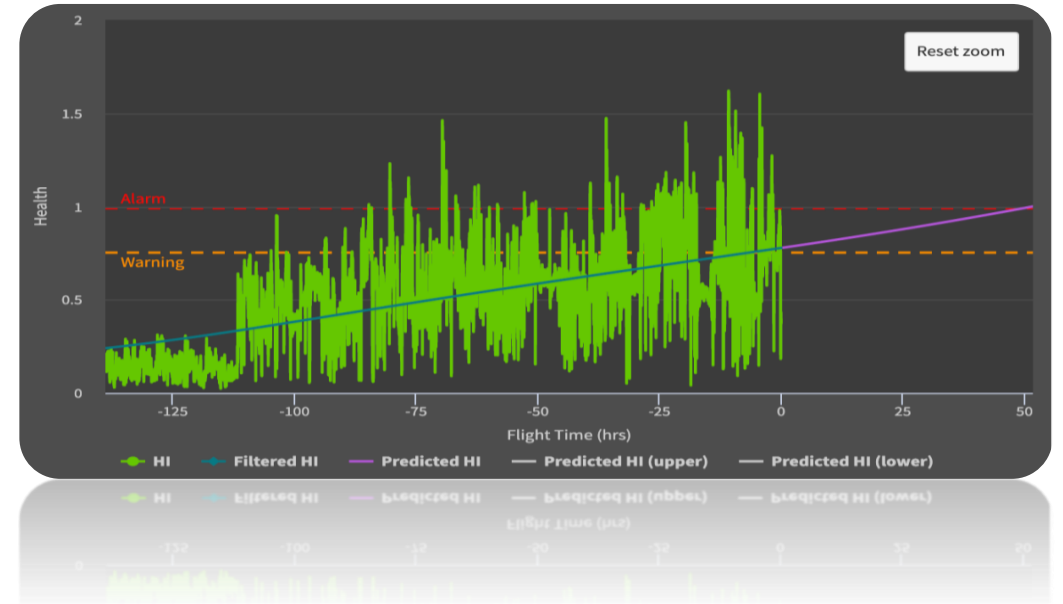
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# Challenges



These kind of machines  
1- works in harsh area  
2- workings under time  
varying condition  
3- They influence by  
impulsive noise

How much the  
classical approach is  
useful for such  
signals and trends?



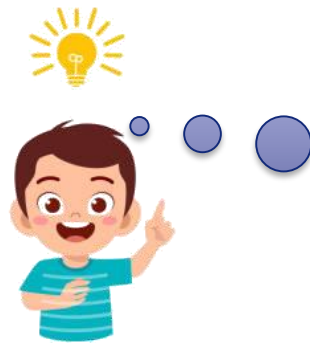
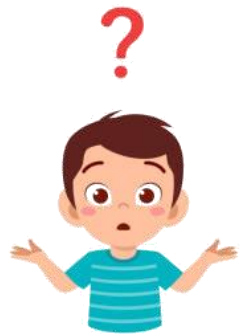
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# Important question?

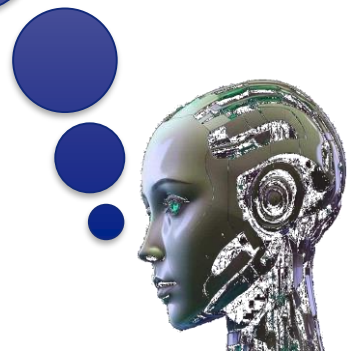
What we should do for such a signal?



- I. Statistical Analysis
- II. Machine Learning Techniques
- III. Frequency Analysis
- IV. Pattern Recognition



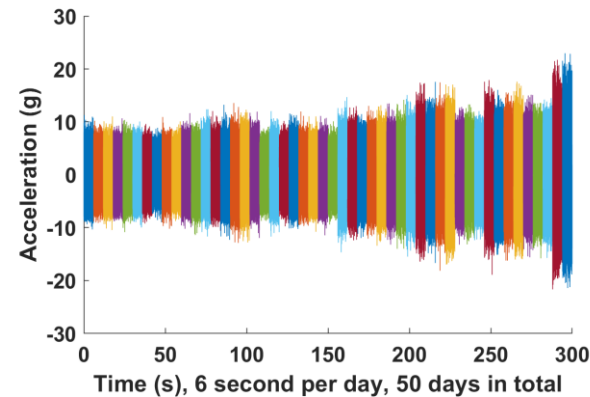
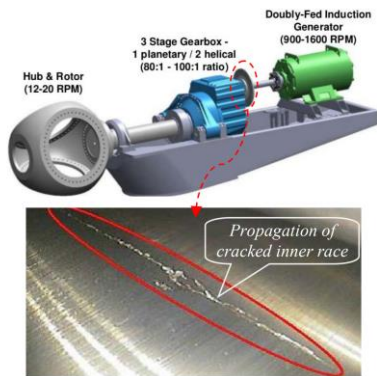
Ask from chat GPT!!!



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# Statistical Analysis

**Statistical Analysis:** SA utilizes statistical techniques to monitor and control processes, including vibration condition monitoring. It analyzes the statistical properties of data over time, such as control charts, to identify deviations from normal behavior.





# Identification and modeling

Here we proposed a framework to identify and modeling such kind of signal for prognosis purpose

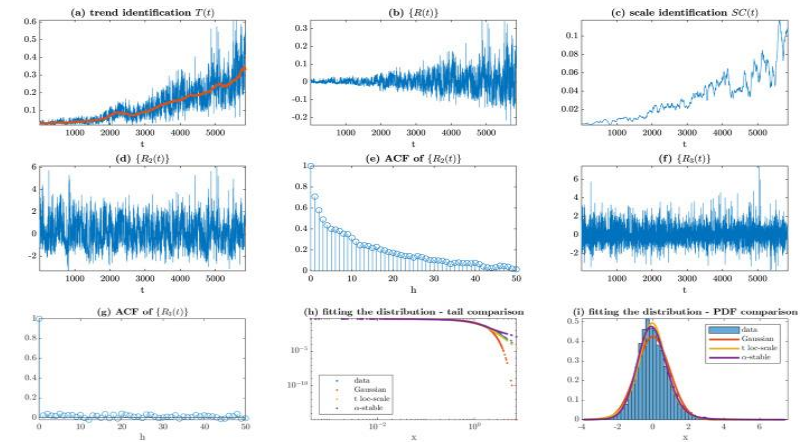
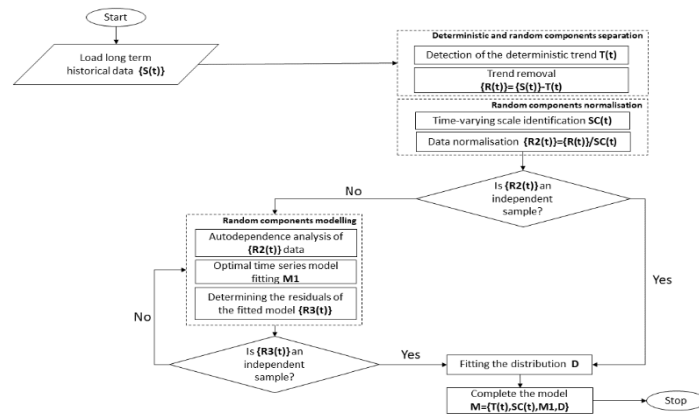
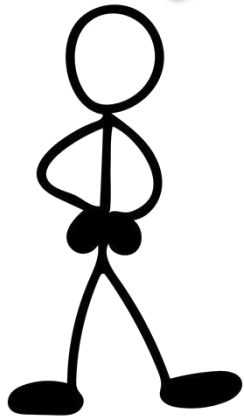
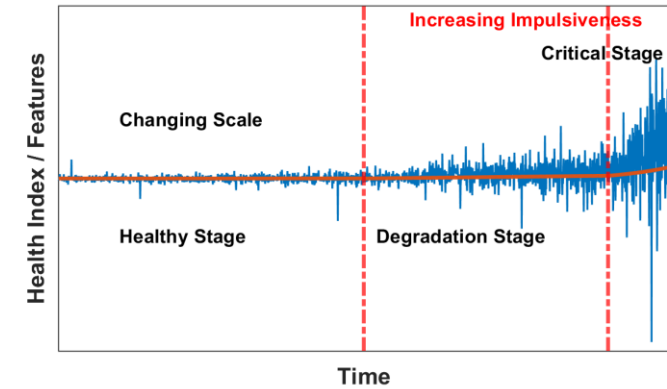


Table 1: Main characteristics of the data for three regimes indicated in Fig. 3.

	Regime 1	Regime 2	Regime 3
Trend	constant	linear	exponential
Scale	nearly constant	linearly growing	exp. growing
Autodependence of random component	relatively small	significant	significant
Coefficients of the stochastic model	negligible	significant	significant
Distribution of the random component	nearly Gaussian	non-Gaussian	strongly non-Gaussian



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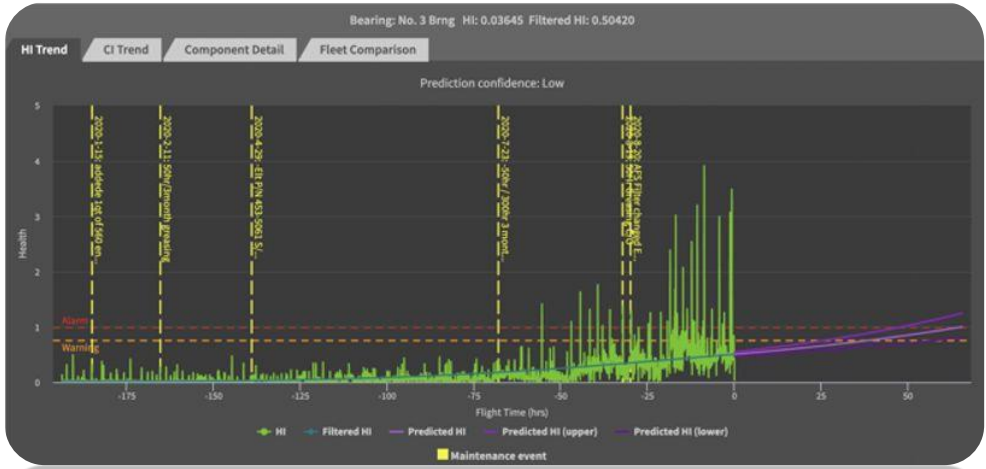

Framework for stochastic modelling of long-term non-homogeneous data with non-Gaussian characteristics for machine condition prognosis

Wojciech Żuławiński<sup>b</sup>, Katarzyna Maraj-Zygmąt<sup>b</sup>, Hamid Shiri<sup>a</sup>, Agnieszka Wyłomańska<sup>b</sup>, Radosław Zimroz<sup>a,\*</sup>



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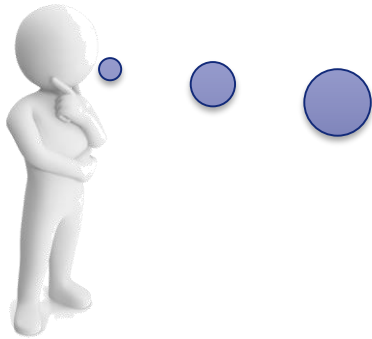
Pretty nice it looks good ! Is it possible to use such model for health stage evaluation



We always use classic approach to vibration monitoring however we usually face with fake warning and alarm

### VIBRATION SEVERITY PER ISO 10816

Machine		Class I small machines	Class II medium machines	Class III large rigid foundation	Class IV large soft foundation
	in/s	mm/s			
Vibration Velocity Vrms	0.01	0.28			
	0.02	0.45			
	0.03	0.71			
	0.04	1.12		good	
	0.07	1.80			
	0.11	2.80			
	0.18	4.50		satisfactory	
	0.28	7.10			
	0.44	11.2		unsatisfactory	
	0.70	18.0			
0.71	28.0				
1.10	45.0		unacceptable		



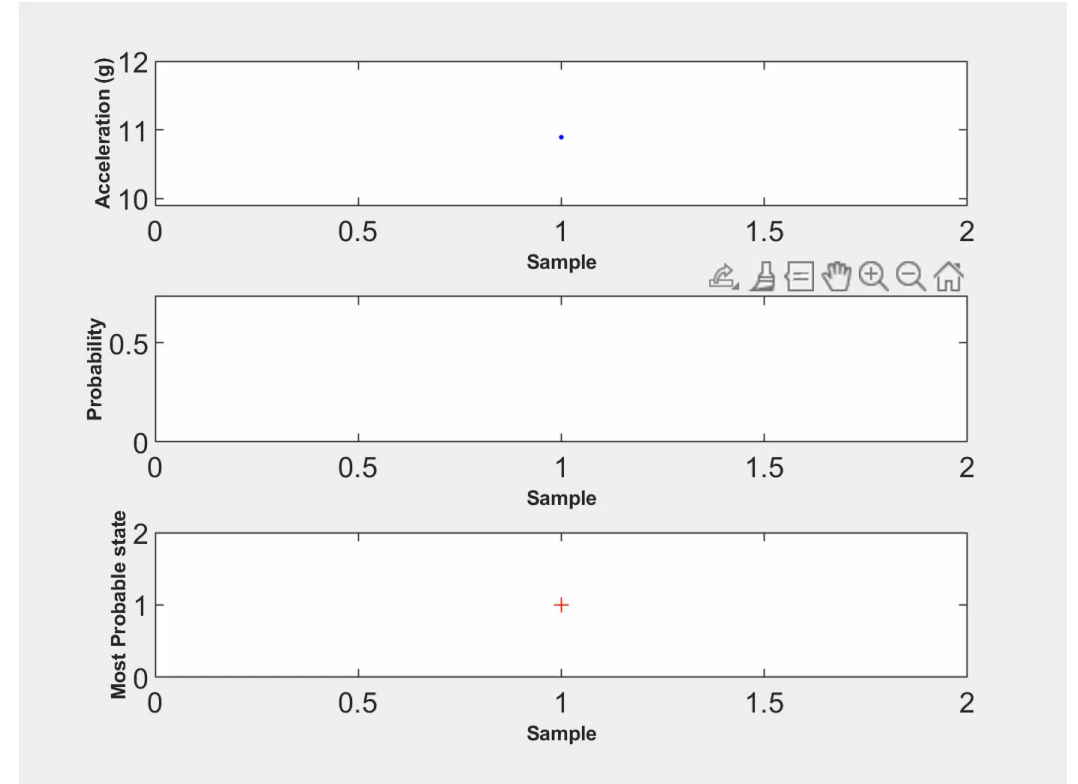
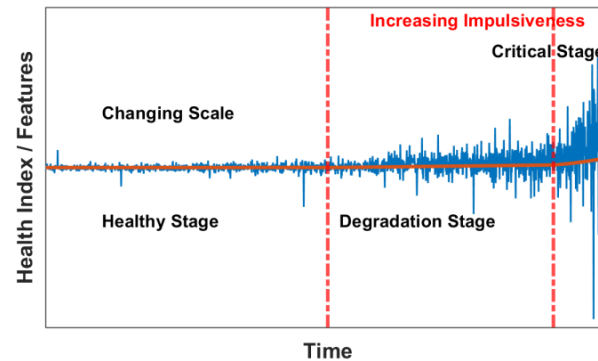
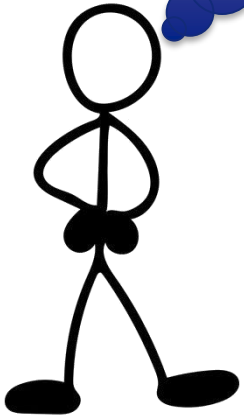
### Permissible acceleration in m/s<sup>2</sup> – according to VDI 3834

Frequency range	≤ 0.1 Hz - 10 Hz	≤ 0.1 Hz - 10 Hz	≤ 0.1 Hz - 10 Hz	10 Hz - 2000 Hz	10 Hz - 5000 Hz
a <sub>rms</sub> m/s <sup>2</sup>	20			12	16
	10			7.5	10
	5				
	3				
2					
1					
0.5	0.5	0.5	0.5		
0.3	0.3	0.3	0.3		
0.2					

Component	Nacelle/Tower NAT	Main bearing MBR	Gearbox GBX	Gearbox GBX	Generator GEN

# Statistical Analysis

Yes it possible at this research we developed approach based on dynamic trend so there is no need threshold



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

**Mechanical Systems and Signal Processing**

journal homepage: [www.elsevier.com/locate/ymssp](http://www.elsevier.com/locate/ymssp)




Using long-term condition monitoring data with non-Gaussian noise for online diagnostics

Hamid Shiri<sup>a,\*</sup>, Pawel Zimroz<sup>a</sup>, Jacek Wodecki<sup>a</sup>, Agnieszka Wyłomańska<sup>b</sup>, Radosław Zimroz<sup>a</sup>, Krzysztof Szabat<sup>c</sup>

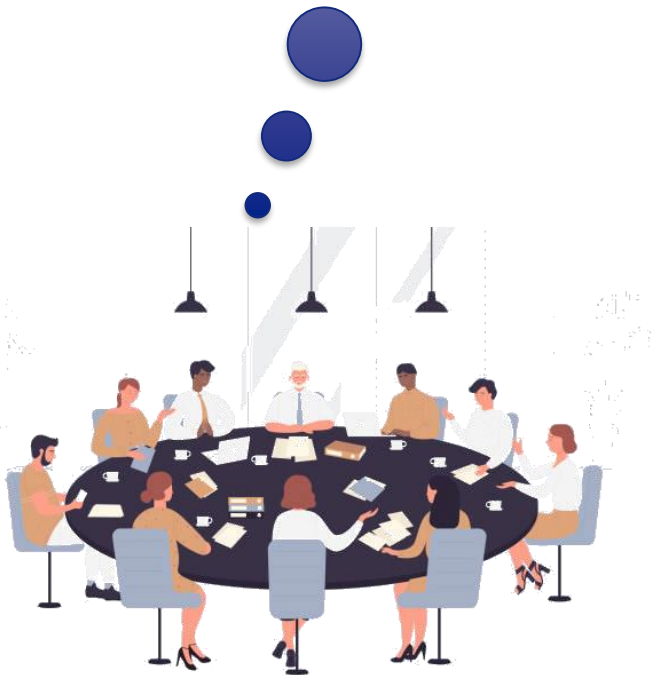
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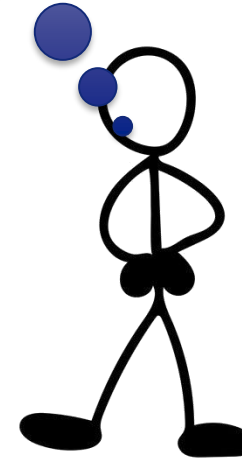
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# What is the next?

Okay, we detected the first point of the last regime. So we should shut down the Machine?  
How long does it take to machine is broken?



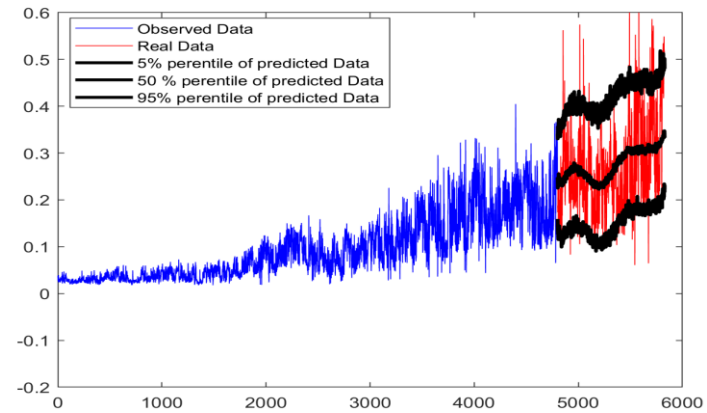
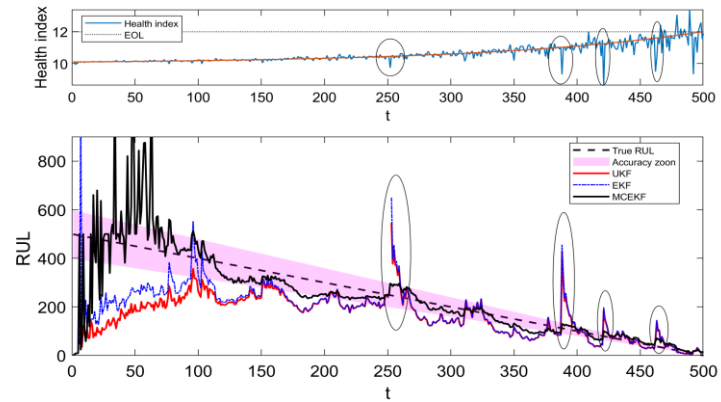
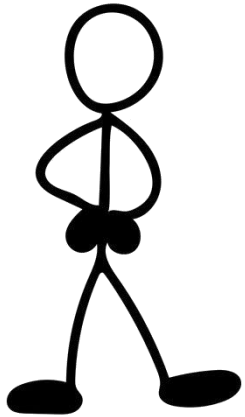
Yes, we have a model that only needs to fit model by identified parameter



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# What is the next?

Here you can see prediction



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Thanks for your attention!



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