



## SIGDIG – Signal Discrimination for Condition Monitoring

A system for condition analysis and  
monitoring of industrial signals

Collaborative research effort of Laboratories of  
Information Processing (Dept. of Information Technology) and  
Digital and Computer Electronics (Dept. of Electrical Engineering).

# Condition monitoring and analysis

- Condition monitoring is important in modern industrial environments requiring high degree of automation:
  - Predict the need of maintenance (from time-based to condition based maintenance)
  - Avoid failures and minimize downtime
- With reliable condition monitoring, machines can be utilized in a more optimal fashion

## Automatic estimation of system condition

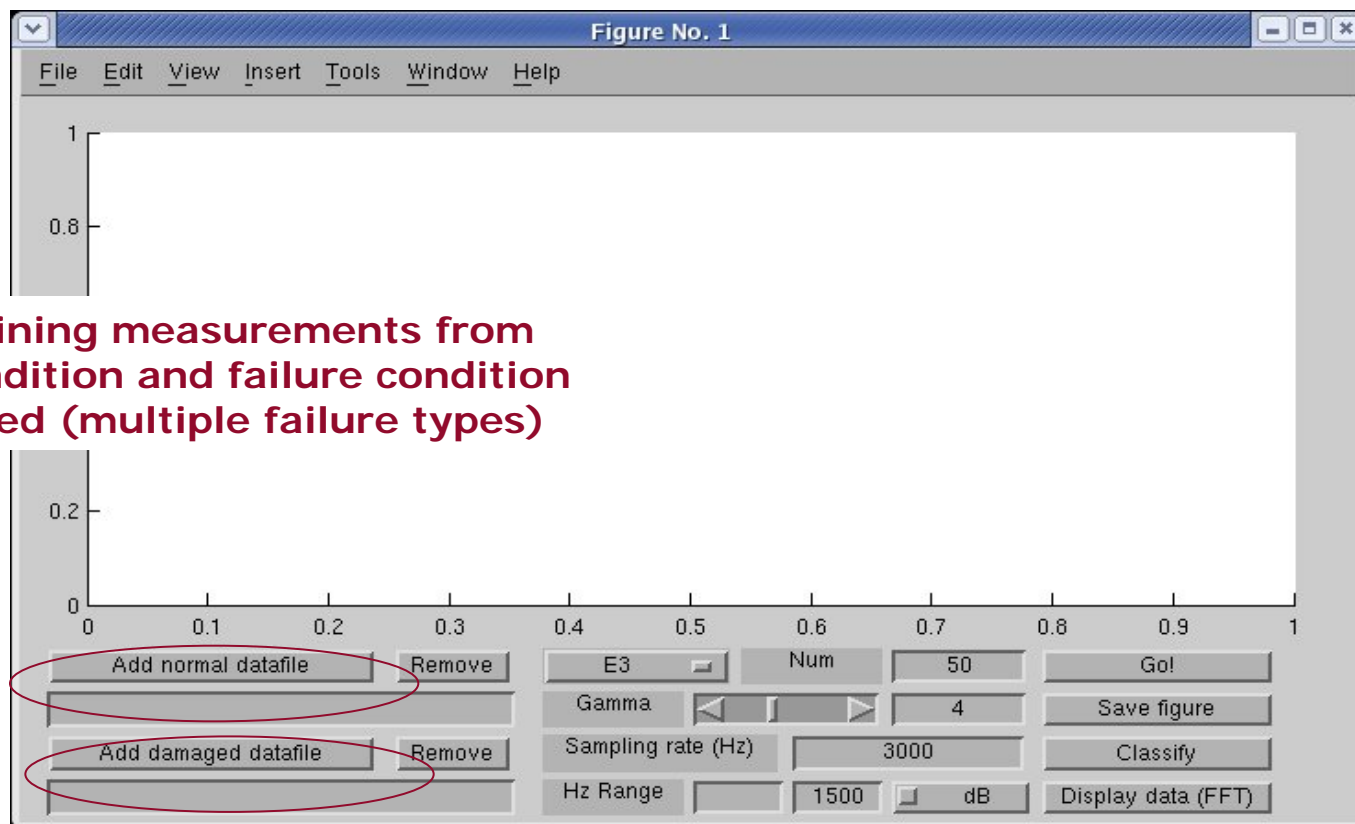
- Physical models can be generated (e.g., bearing faults of electric motors)
  - + often correspond to reality, and thus, interpretable
  - slow and difficult to derive
  - often inaccurate and limited (apply only to specific situations)
- Recorded data can be used to automatically derive models
  - + easy to use
  - data can be difficult to collect

## Current research

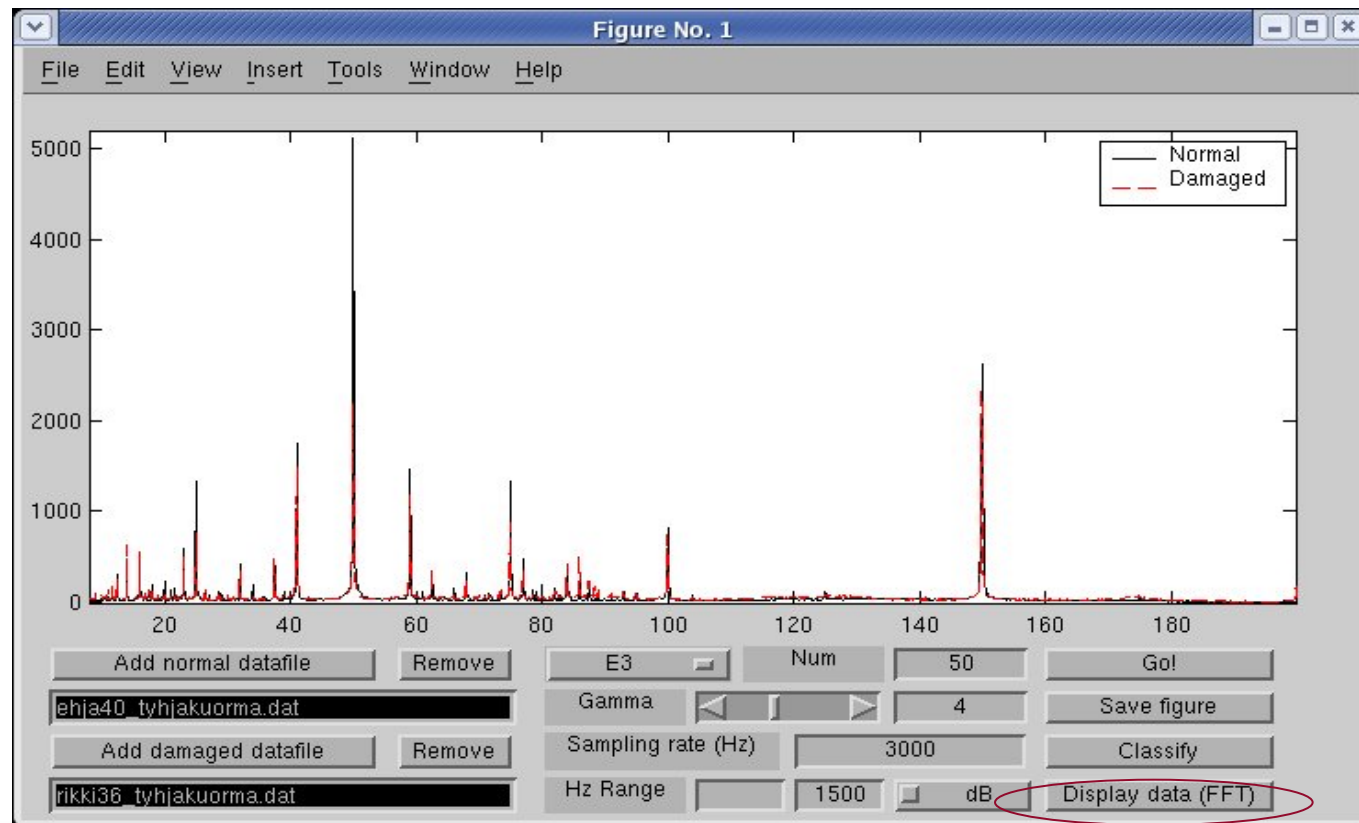
- Theory has been proposed to detect failure conditions when examples from two classes are available (*normal condition* and *failure condition*) and when system mode remains constant (speed, load, etc.)
  - Software has been developed
  - Theory is based on strong statistical principles

# Software - Interface

Files containing measurements from normal condition and failure condition can be added (multiple failure types)

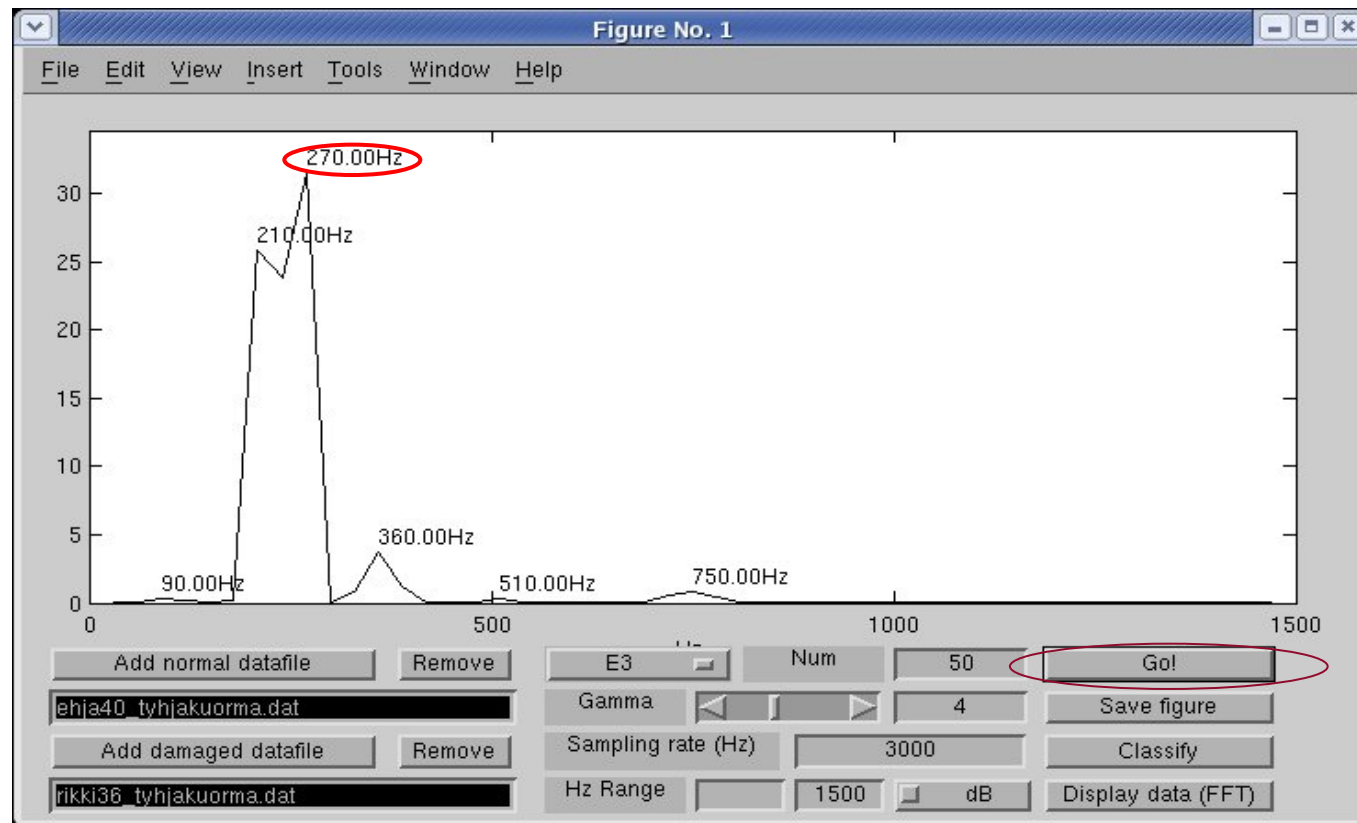


# Software – comparing measurements

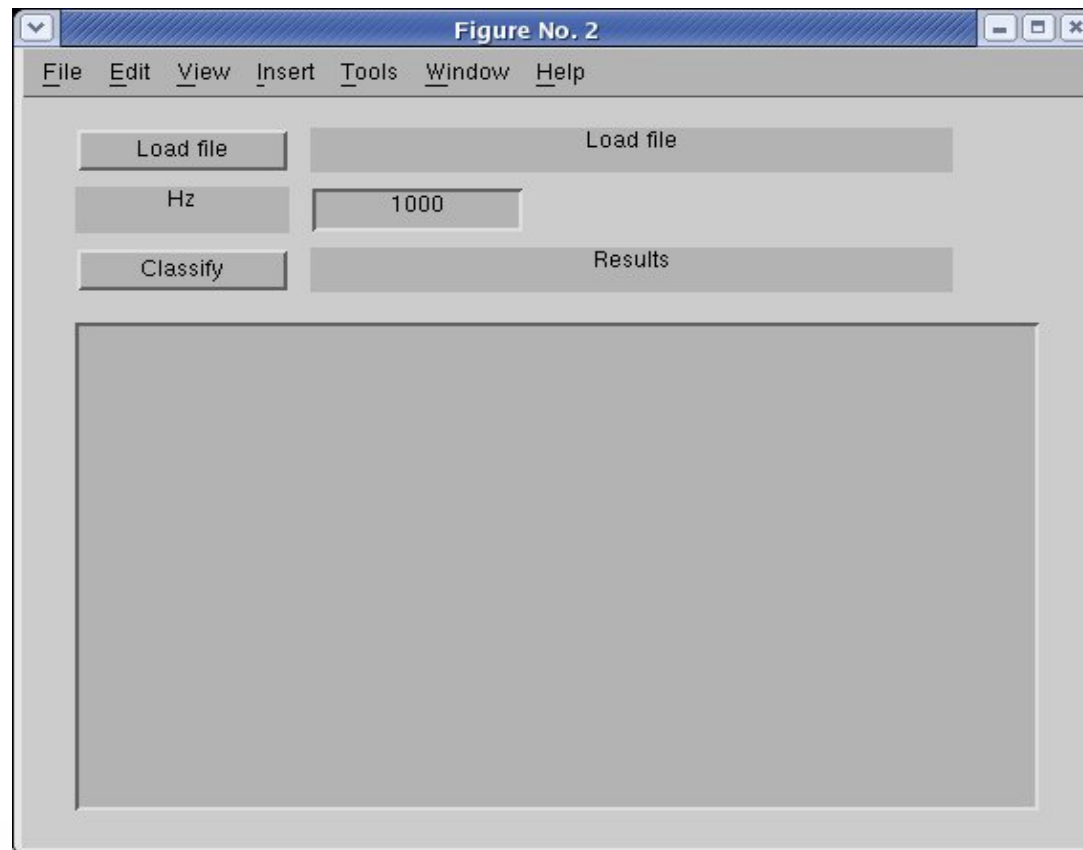


**Mean frequency content of both conditions can be plotted and compared**

## Software – finding discriminative features

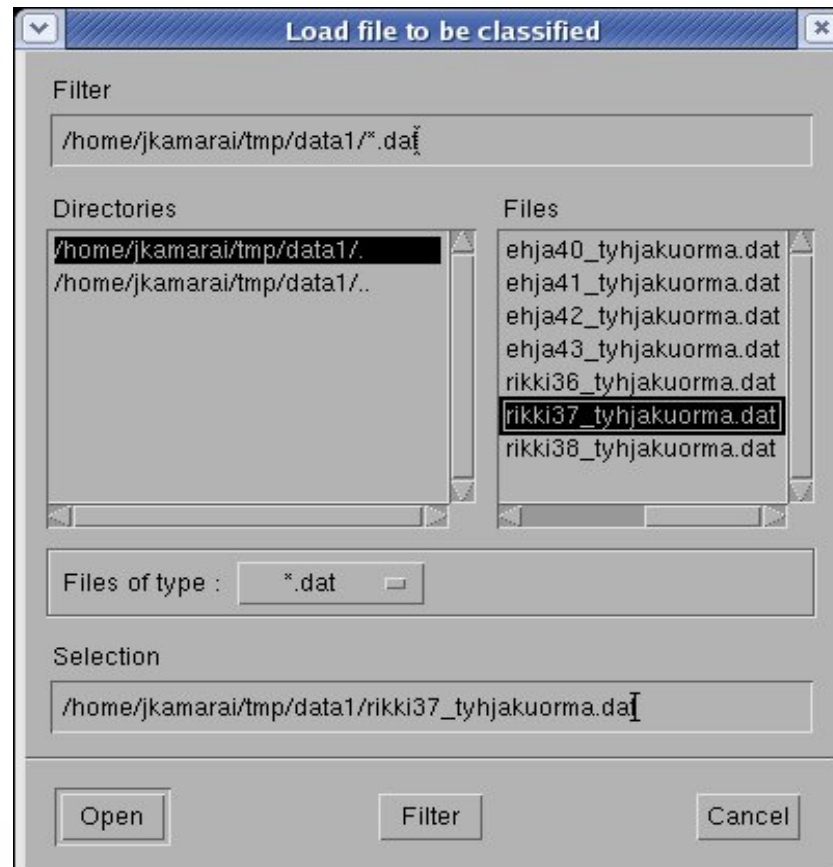


# Software – classifier module



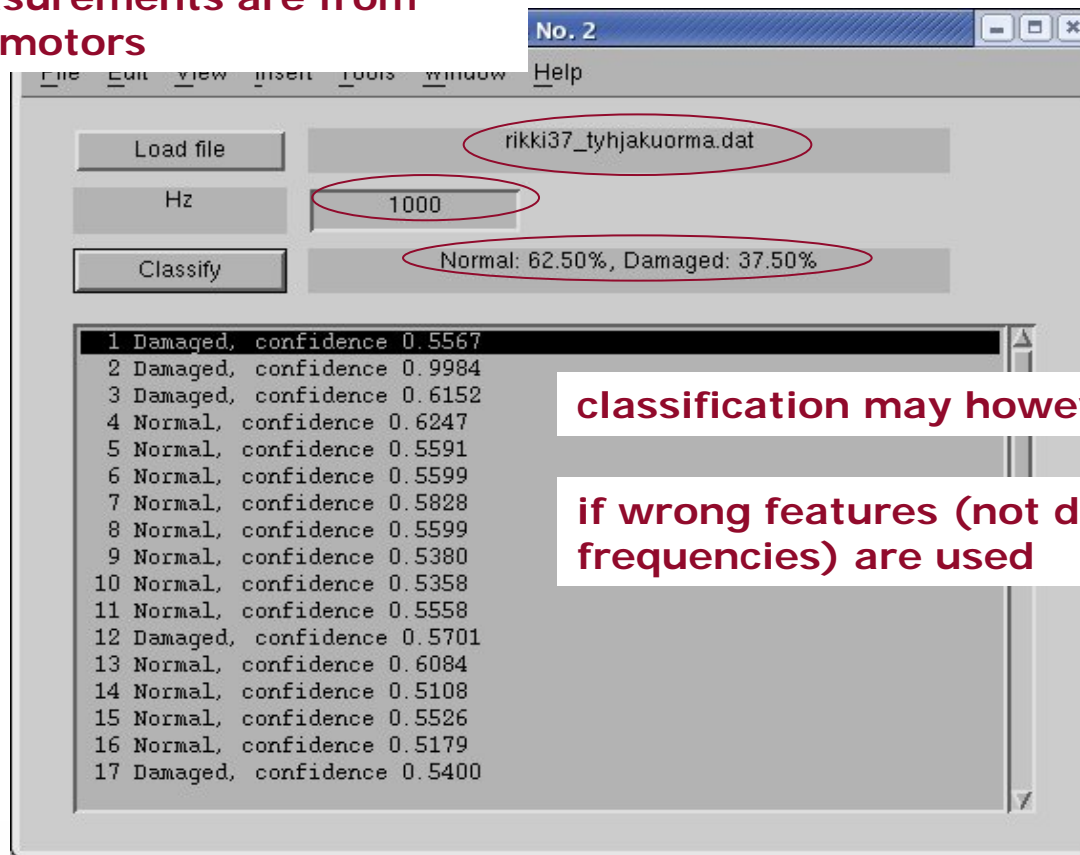


## Software – inspecting new measurements

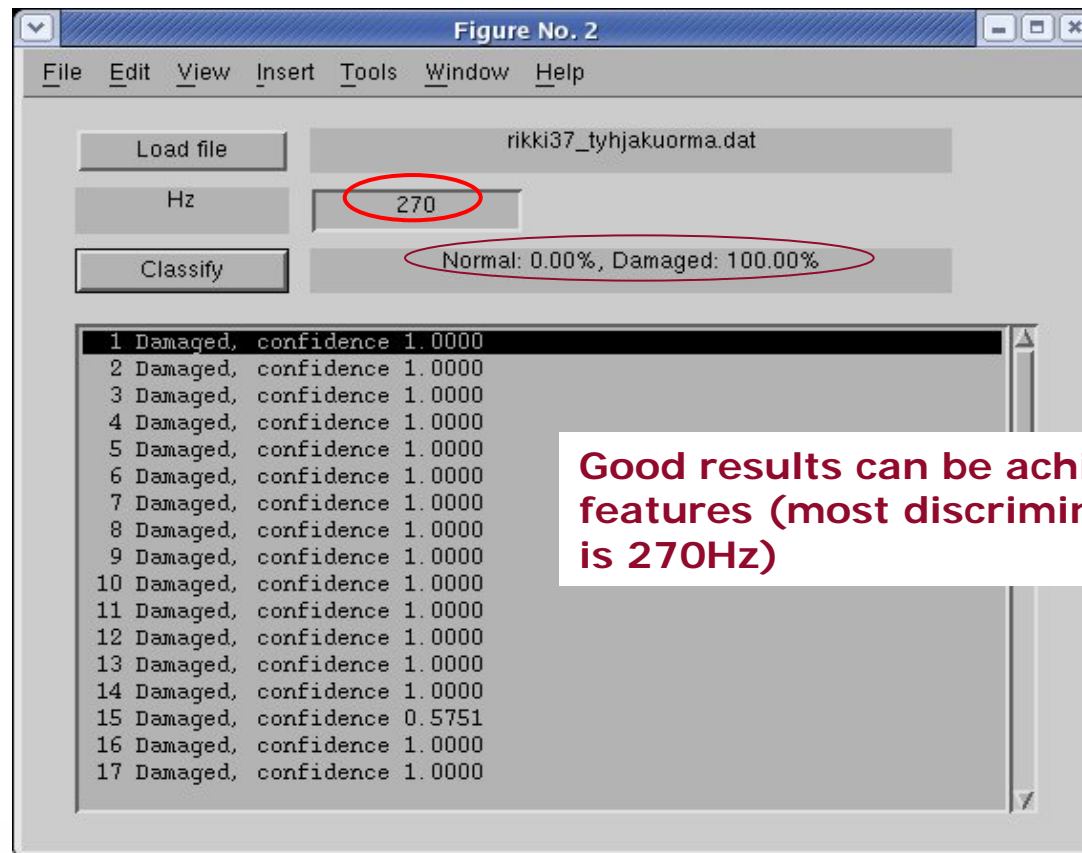


# Software – using classifier module

In this file all measurements are from bearing damaged motors



## Software – utilizing the discriminative features



## Future research

- The system works accurately and reliably in constant operation mode (load, speed, etc.)
  - In future the system should automatically detect the constant mode before classification or utilize features which are robust to changing conditions
- The system requires measurements from failure conditions
  - In future the system should perform classification only based on normal condition measurements (e.g. by utilizing the confidence)
- The system is a laboratory based analyzing tool
  - In future the system should be installed for on-line operation

## References

<http://www.it.lut.fi/project/sigdig>

Ilonen, J., Kamarainen, J.-K., Lindh, T., Ahola, J., Kälviäinen, H., Partanen, J., Diagnosis Tool for Motor Condition Monitoring, *IEEE Trans. on Industry Applications*, 2005.

Lindh, T., Ahola, J., Kamarainen, J.-K., Kyrki, V., Partanen, J., Bearing Damage Detection Based on Statistical Discrimination of Stator Current, In *Proc. of the 4th IEEE Int. Symp. on Diagnostics for Electric Machines, Power Electronics and Drives*, (Atlanta, Georgia, USA, 2003), pp. 177-181.