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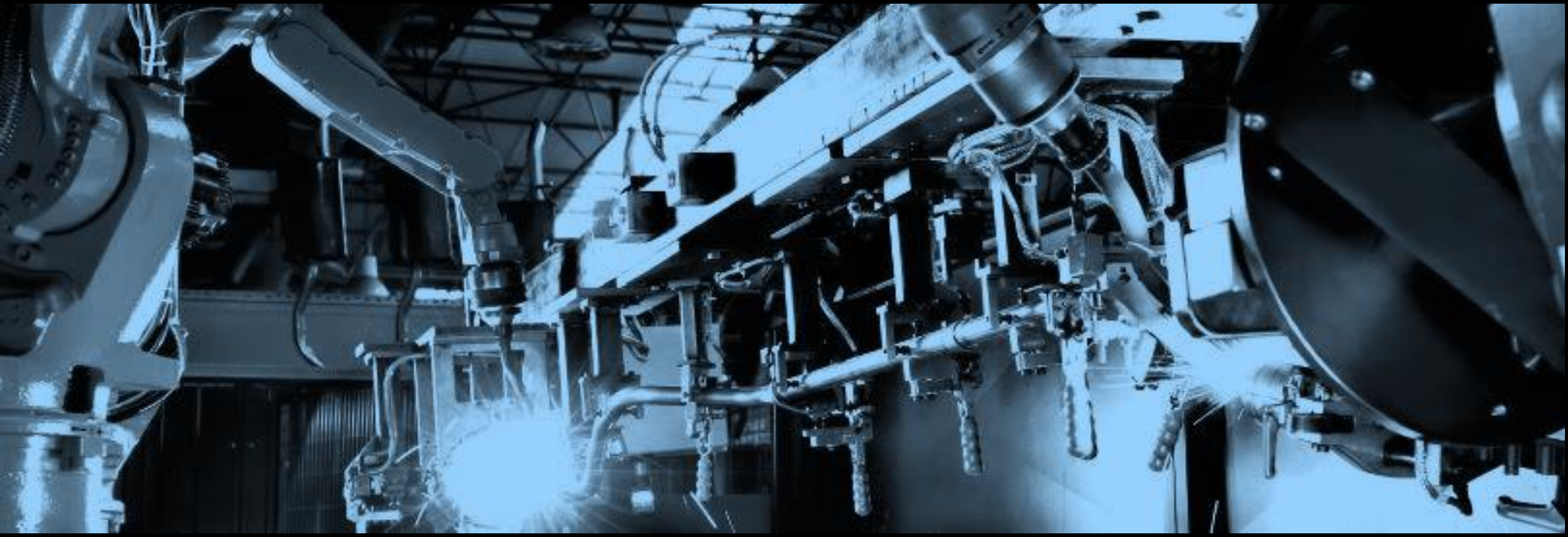
AI 3.0



Sensor and Equipment Analytics for Smart Manufacturing

TRENDALYZE

Micro Patterns Intelligence™

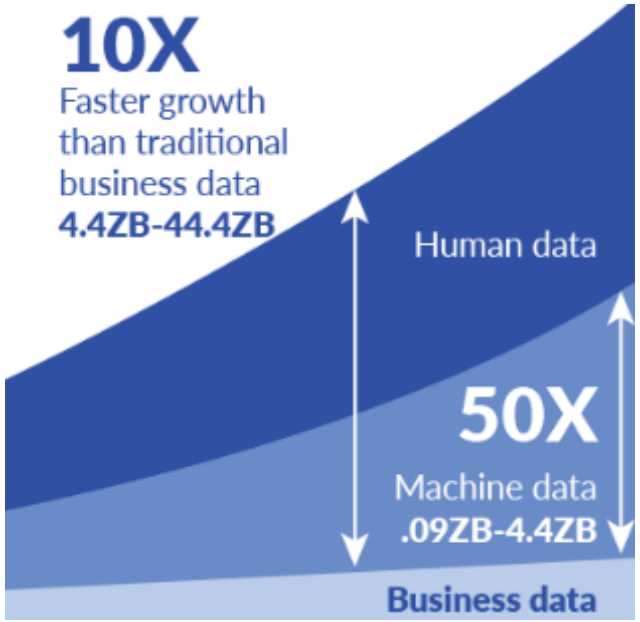
Manufacturing Analytics Turns Data into Profits

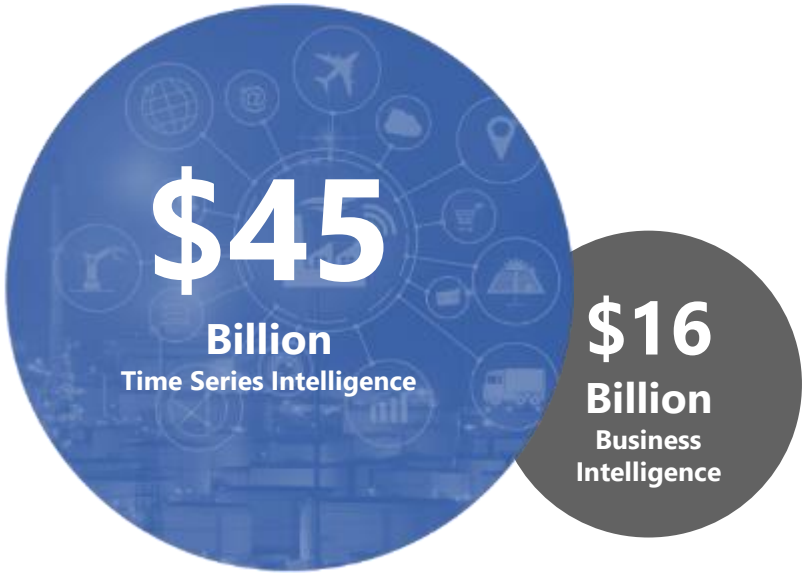
Downtime Reduction | Predictive Maintenance | Quality Analytics | R&D and Testing Analytics

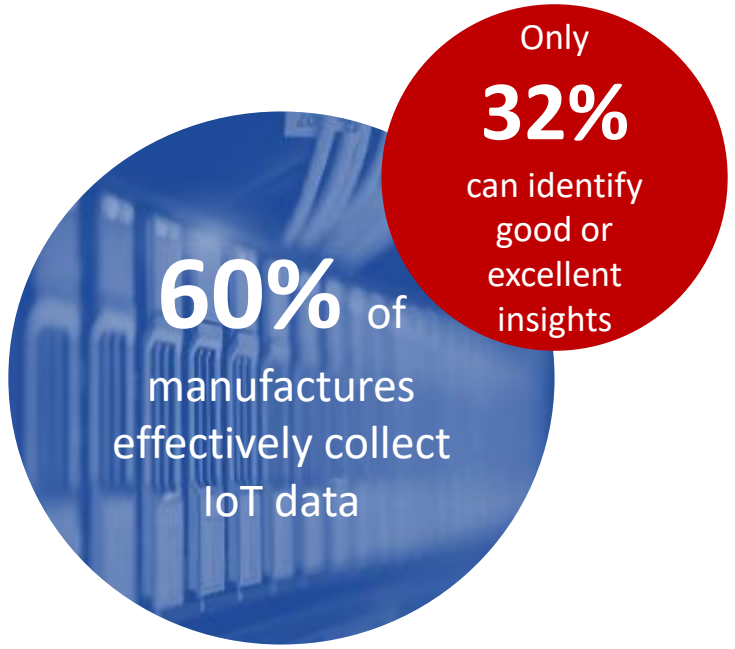
Machine Data Intelligence

All problems have clear patterns in machine generated time series data that can be identified, monitored, and predicted

Big Opportunity. Elusive Gains.







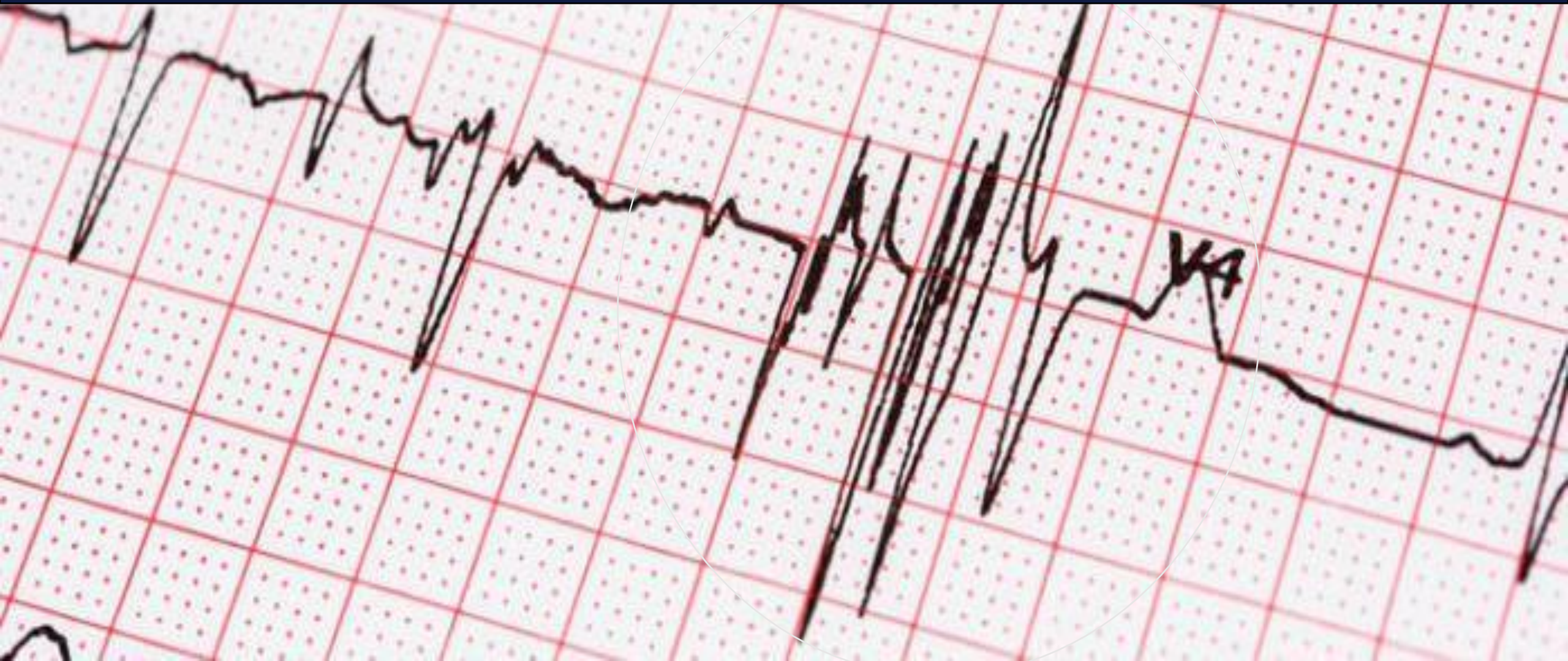
Machine data is growing 10 times faster than business data

Time series intelligence is 3 times bigger than Business Intelligences

Do you have the right tools to extract insights from machine data?

How to Extract Value from Machine Data:

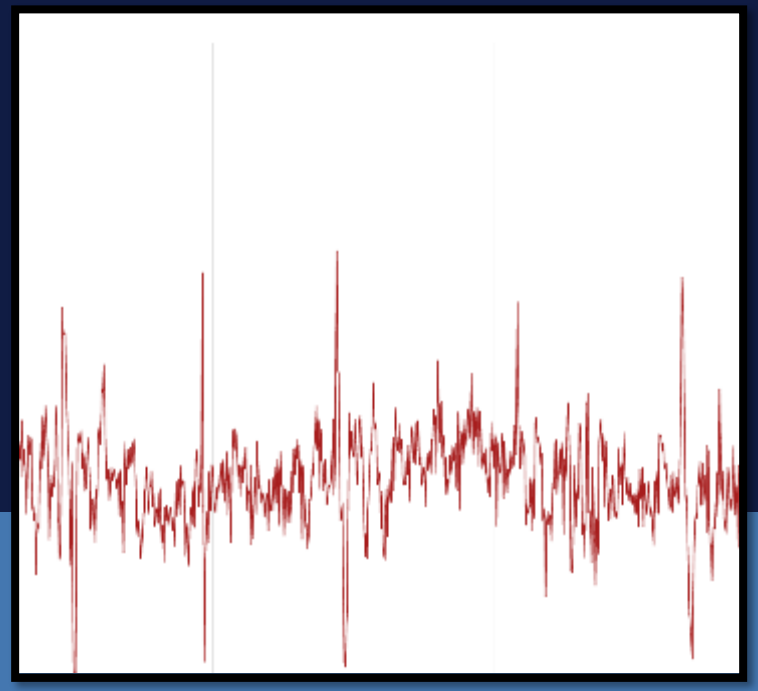
- Sensors collect the “heartbeats” of every process and operation
- Learning and cataloging good and bad patterns is the new gold
- Monetize your machine data by monitoring and predicting patterns



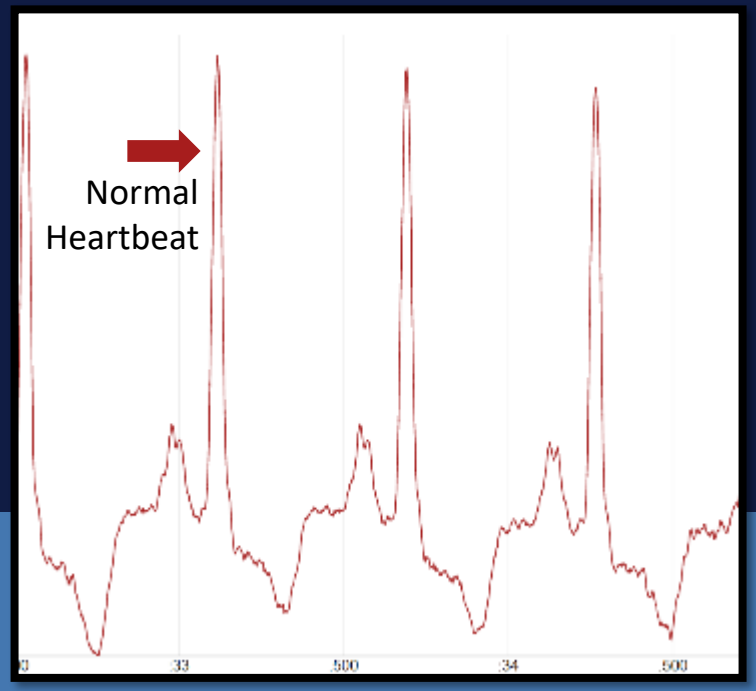
The Value of Identifying Meaningful Patterns

(Granular data reveals signals and root causes)

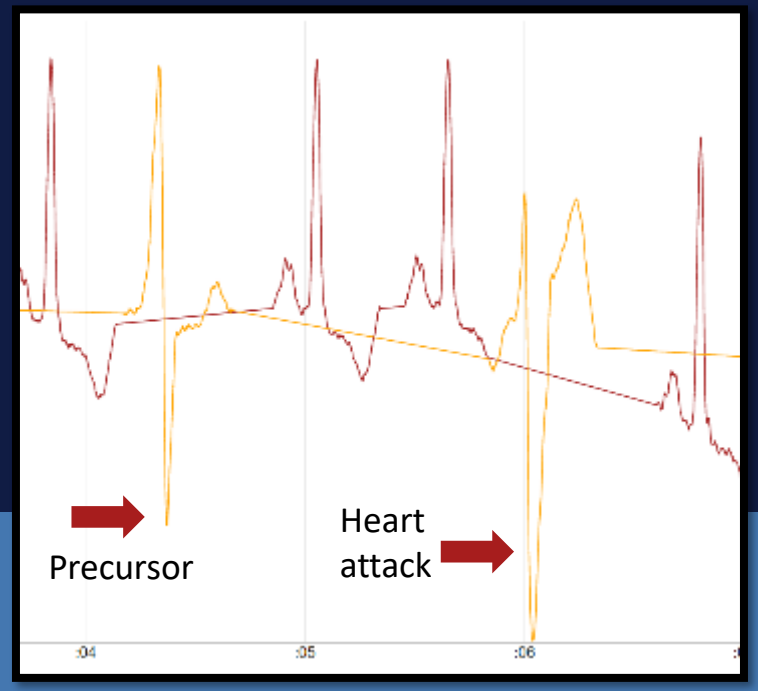
ECG heart rate taken at one second



ECG heart rate take at 360 milliseconds



ECG heart rate take at 360 milliseconds



1 **<u>Meaningless</u>:** An engineer cannot tell where the time series comes from

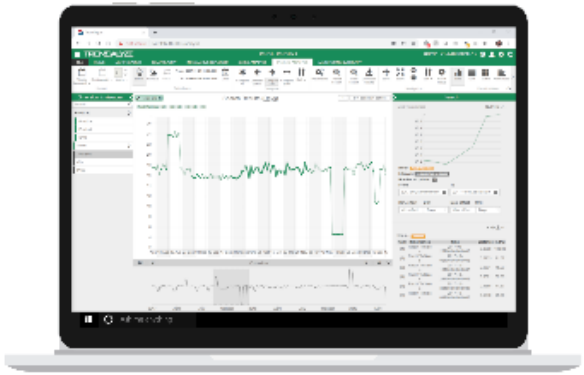
2 **<u>Recognizable</u>:** An engineer knows what the time series is and why it is used

3 **<u>Monetizable</u>:** Meaningful shapes within the time series provide insights and trigger alerts

We Empower the Domain Experts to Do It Themselves

Motif Mining

Automatically discover clusters of distinct motifs in a large number of time-series data



Motif Search

Find similar, dissimilar, or correlated motifs across any number of measures, dimensions, and time-series

Motif Intelligence™

Monitor and configure intelligent predictions to make real-time actionable recommendations

Trendalyze is a self-service platform for business users to mine, search for, monitor and predict patterns, also called motifs, in machine generated time-series data. It works like Google, but instead of searching for sequences or letters, we search for time-series patterns.

Example: Manufacturing Quality Control

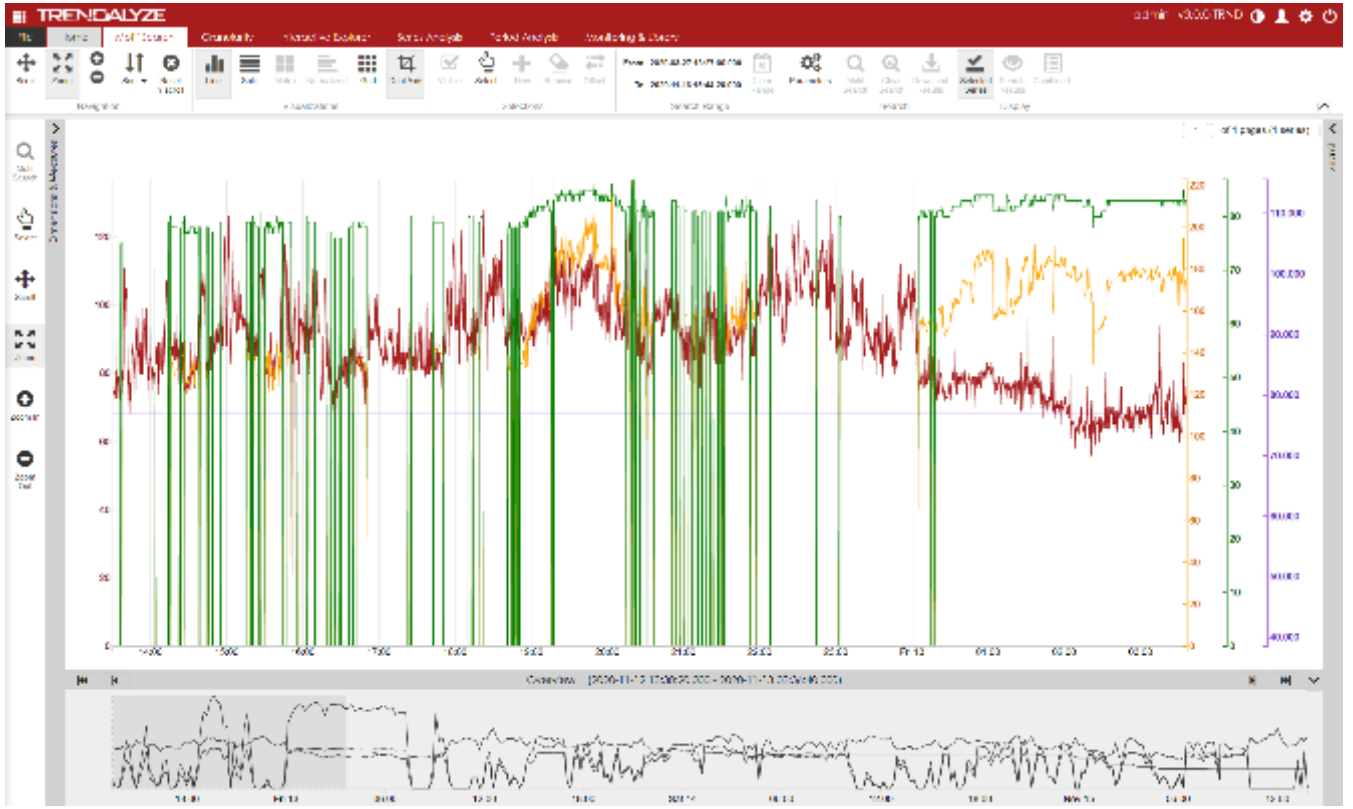
Quality Analysis Using Motif Discovery from Small Data

Amanjeet Singh Bhatia · Lianhua Chi · Rado Korotov

Abstract Manufacturers are increasingly interested in applying machine and deep learning to automate quality control monitoring to save time and costs. A typical approach is the use of Convolutional Neural Networks to assess and classify quality issues in images of the production outputs. However, many companies report project challenges and prohibitive computational costs. The challenges arise because of lack of big data required for machine and deep learning model training and lack of data scientists with domain knowledge to build and run complex models. Today manufactures operate at six sigma levels of quality, and thus have extremely little defect samples. In many cases production changes frequently, and thus the data collection and model training have to be re-done for the new outputs. In this paper we propose two approaches - motif discovery from small sample data and visual motif discovery being simple and intuitive for any engineer to use. We compare them for ease of use and computational efficiency with Convolutional Neural Networks and conclude that our proposed approach significantly improves the existing performance, provides fast and reliable training with small samples, and empowers engineers to do it themselves (DIY).

Fig. 1 A casted plate labeled "ok".

Fig. 2 A casted plate labeled "def".



Trendalyze pioneered an approach for ML that uses small image data sets converted to time series. It is fast to implement by the engineers themselves in our intuitive self-service tools.

Our Differentiators

Our Approach Is New and Proven

Search-like approaches to AI already have proven track record. Word search has changed the web. Our innovative pattern search is changing how businesses use and monetize data.

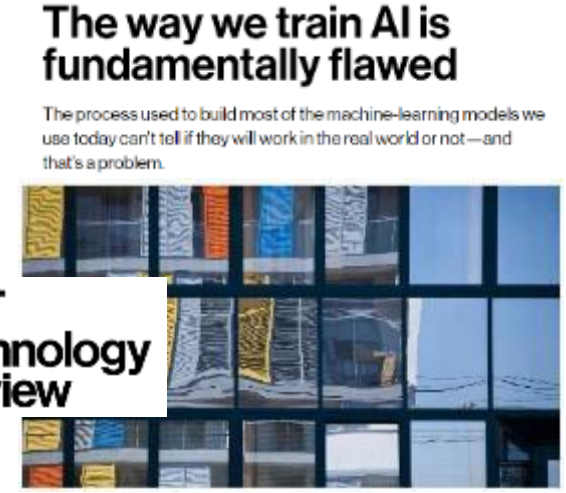
It Works on Small Data

Despite big data hype, most companies do not have enough data to train ML models and cannot afford the costs. Working with small data is fast, efficient and cost effective.

We Put Human in the Loop

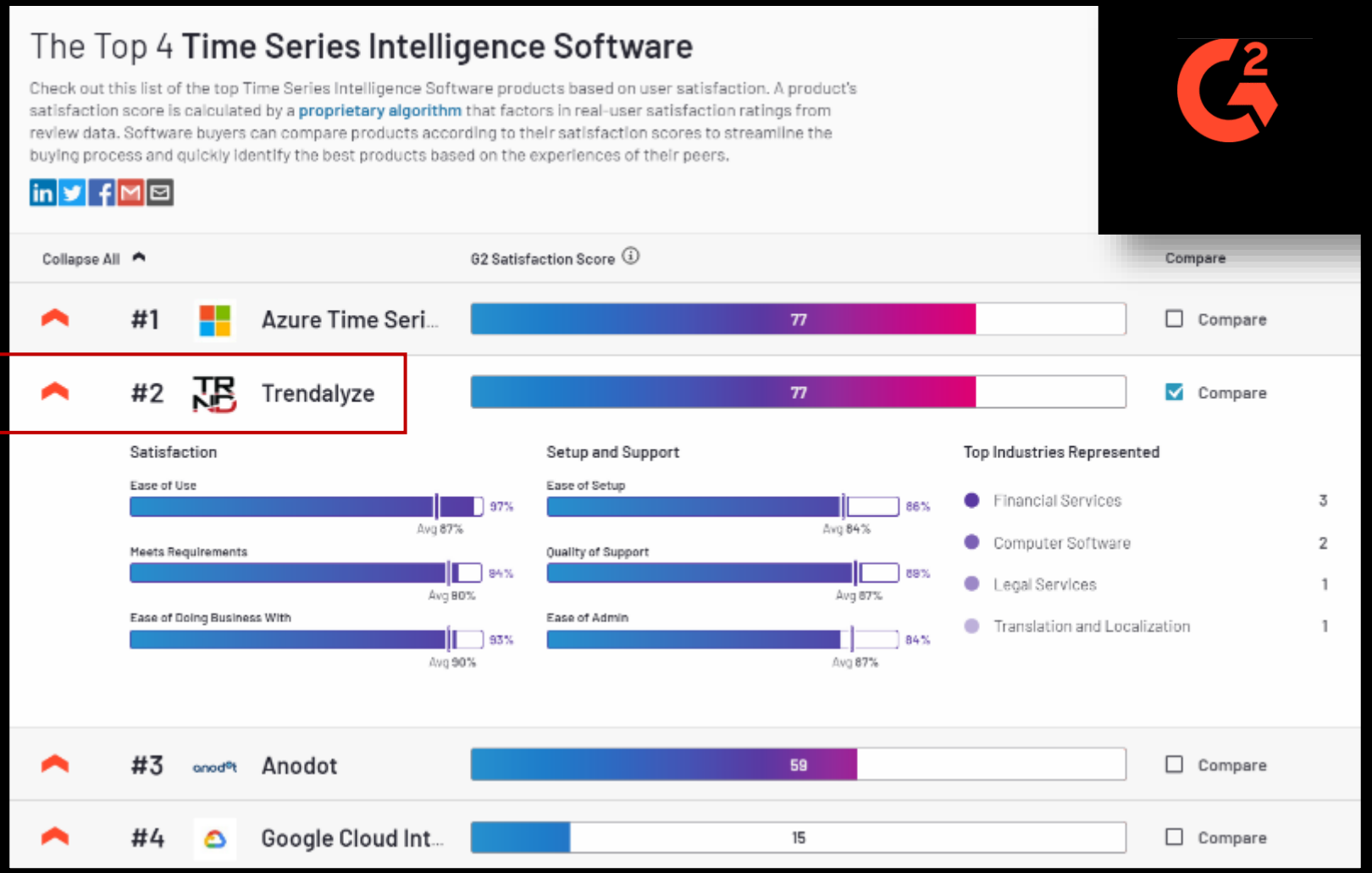
By putting the human in the loop we increase the speed and accuracy of the learning process. By making AI transparent and explainable by the business experts, the models become trustworthy.

Key Research



Our Ranking in the Industry

We are #2



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Our Approach and R&D

Learning the Language of Machine Data

Shape Intelligence:
Shapes Reveal Who or What It Is and Why It Happens

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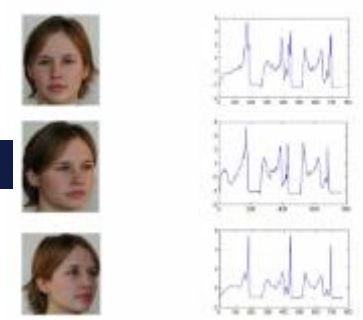
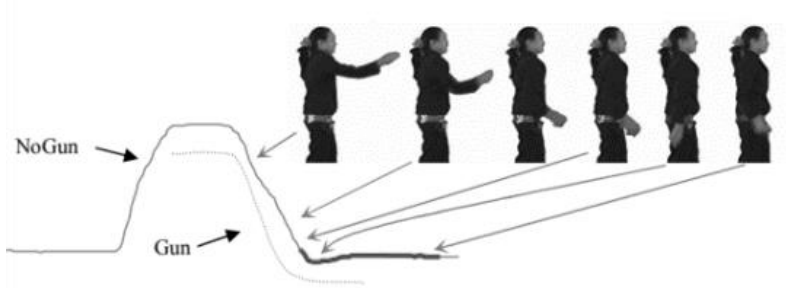
R&D

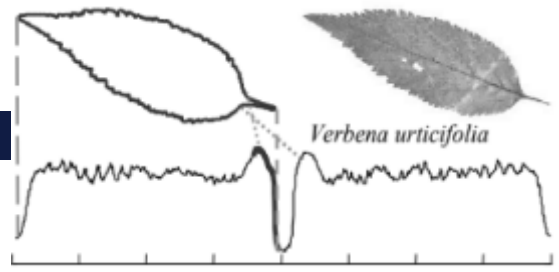
Face Detection





Gesture Detection

Object Detection



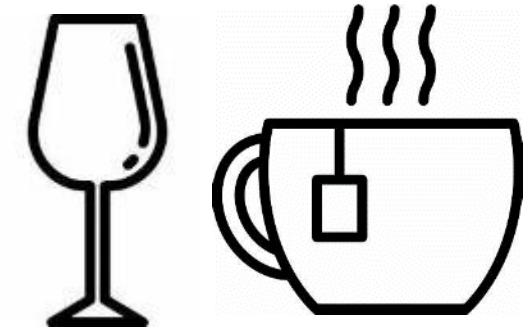
Process Monitoring

DARPA

"Past DARPA AI investments facilitated the advancement of "first wave" (rule and "second wave" (statistical learning based) AI technologies. DARPA is now interested in researching and developing "third wave" AI theory and applications that address the limitations of first and second wave technologies."

Shape Intelligence:
A More Human Like Learning Process

How do humans and machines learn the differences between these two shapes?



Human Learning:

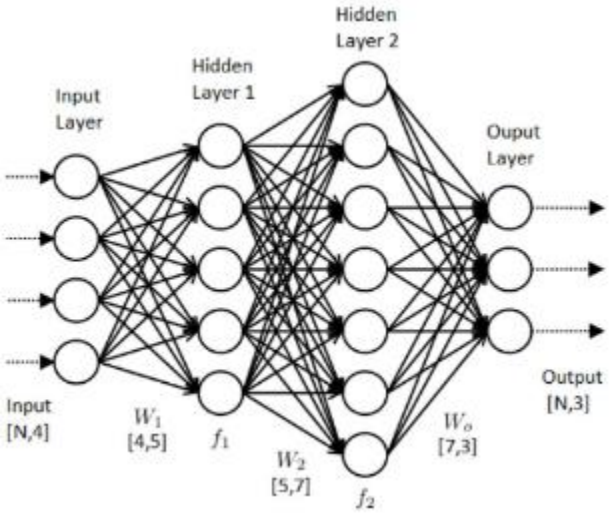
- Humans recognize shape differences immediately
- Humans learn from one or two examples
- Humans Identify known and unknown shapes instantly

Machine Learning:

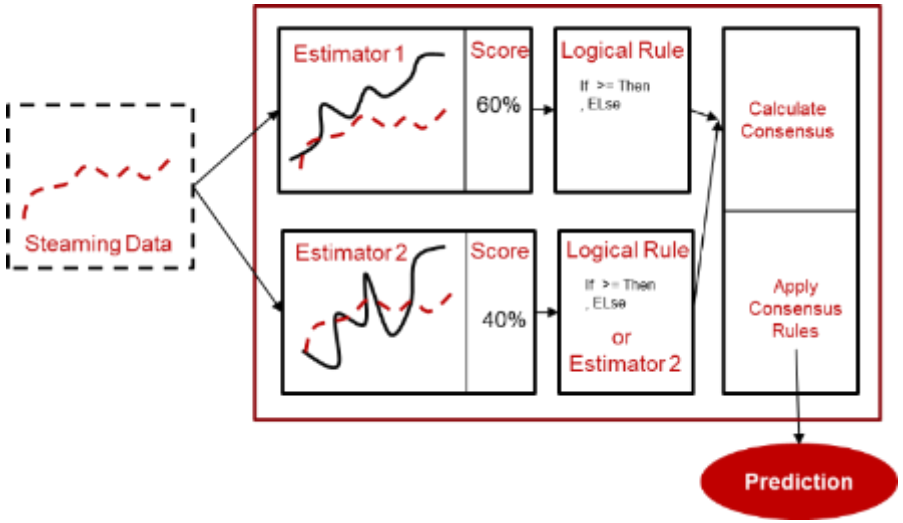
- ML requires thousands of examples to train a model
- Humans have to label all the examples for ML
- Small shape differences confuse machines and requires additional examples

Artificial Logical Networks
Similar but More Intuitive Than Neural Networks

Neural Network



Logical Network (patent pending)



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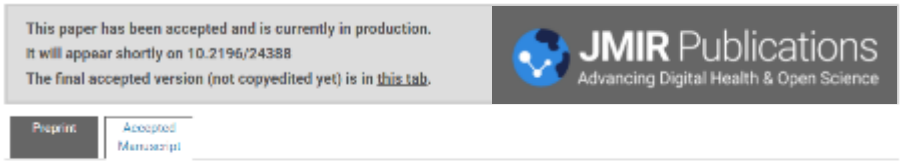
Peer-Reviewed Research and R&D Grants

R&D



This paper has been accepted and is currently in production.
It will appear shortly on 10.2196/24388
The final accepted version (not copyedited yet) is in this tab.

JMIR Publications
Advancing Digital Health & Open Science

Preprint | Accepted Manuscript

A Personalized Monitoring Model for Electrocardiogram (ECG) Signals: Diagnostic Accuracy Study

Rado Kotorov; Lianhua Chi; Min Shen

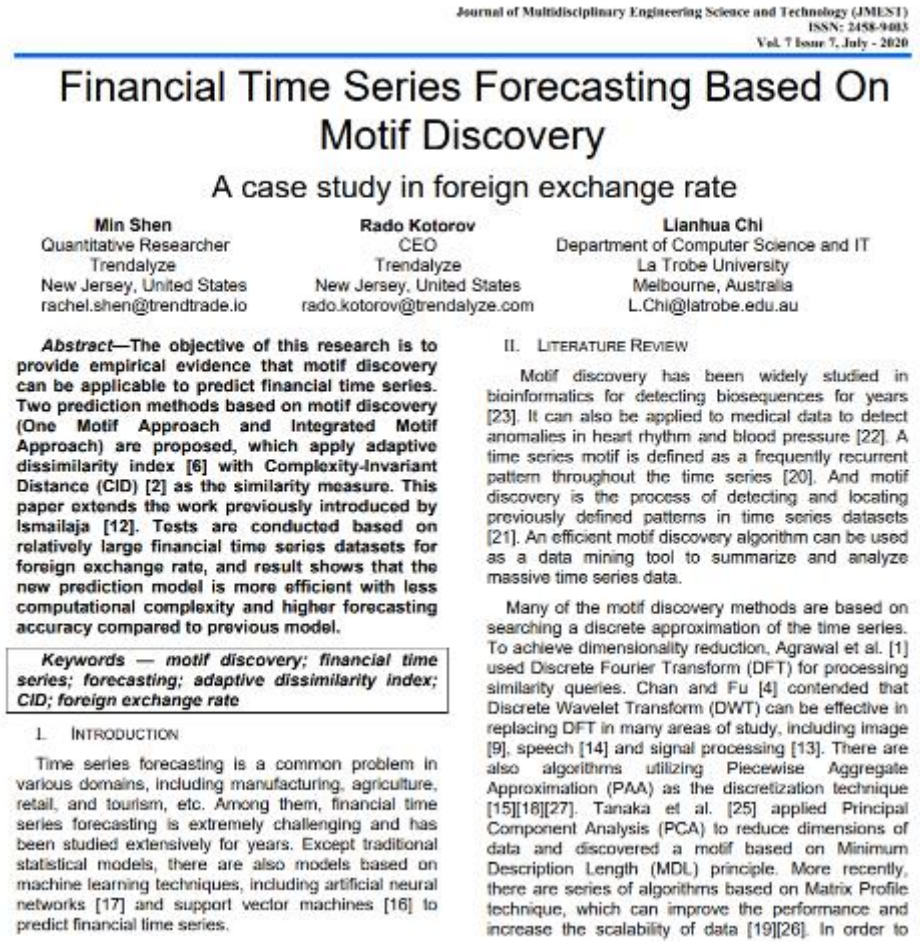
ABSTRACT

Background:

Lately, the demand for remote ECG monitoring has increased drastically because of the COVID-19 pandemic. To prevent the spread of the virus and keep individuals with less severe cases out of hospitals, more patients are having heart disease diagnosis and monitoring remotely at home. The efficiency and accuracy of the ECG signal classifier are becoming more important because false alarms can overwhelm the system. Therefore, how to classify the ECG signals accurately and send alerts to healthcare professionals in a timely fashion is an urgent problem to be addressed.

Objective:

The primary aim of this research is to create a robust and easy-to-configure solution for monitoring ECG signal in real-world settings. We developed a technique for building personalized prediction models to address the issues of generalized models because of the uniqueness of heartbeats [19]. In most cases, doctors and nurses do not have data science background and the existing Machine Learning models might be hard to configure. Hence a new technique is required if Remote Patient Monitoring will take off on a grand scale as is needed due to COVID-19. The main goal is to develop a technique that allows doctors, nurses, and other medical practitioners to easily configure a personalized model for remote patient monitoring. The proposed model can be easily understood and configured by medical practitioners since it requires less training data and fewer parameters to configure.



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Financial Time Series Forecasting Based On Motif Discovery

A case study in foreign exchange rate

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***Abstract*—The objective of this research is to provide empirical evidence that motif discovery can be applicable to predict financial time series. Two prediction methods based on motif discovery (One Motif Approach and Integrated Motif Approach) are proposed, which apply adaptive dissimilarity index [6] with Complexity-Invariant Distance (CID) [2] as the similarity measure. This paper extends the work previously introduced by Ismailaja [12]. Tests are conducted based on relatively large financial time series datasets for foreign exchange rate, and result shows that the new prediction model is more efficient with less computational complexity and higher forecasting accuracy compared to previous model.**

Keywords — motif discovery; financial time series; forecasting; adaptive dissimilarity index; CID; foreign exchange rate

I. INTRODUCTION

Time series forecasting is a common problem in various domains, including manufacturing, agriculture, retail, and tourism, etc. Among them, financial time series forecasting is extremely challenging and has been studied extensively for years. Except traditional statistical models, there are also models based on machine learning techniques, including artificial neural networks [17] and support vector machines [16] to predict financial time series.

II. LITERATURE REVIEW

Motif discovery has been widely studied in bioinformatics for detecting biosequences for years [23]. It can also be applied to medical data to detect anomalies in heart rhythm and blood pressure [22]. A time series motif is defined as a frequently recurrent pattern throughout the time series [20]. And motif discovery is the process of detecting and locating previously defined patterns in time series datasets [21]. An efficient motif discovery algorithm can be used as a data mining tool to summarize and analyze massive time series data.

Many of the motif discovery methods are based on searching a discrete approximation of the time series. To achieve dimensionality reduction, Agrawal et al. [1] used Discrete Fourier Transform (DFT) for processing similarity queries. Chan and Fu [4] contended that Discrete Wavelet Transform (DWT) can be effective in replacing DFT in many areas of study, including image [9], speech [14] and signal processing [13]. There are also algorithms utilizing Piecewise Aggregate Approximation (PAA) as the discretization technique [15][18][27]. Tanaka et al. [25] applied Principal Component Analysis (PCA) to reduce dimensions of data and discovered a motif based on Minimum Description Length (MDL) principle. More recently, there are series of algorithms based on Matrix Profile technique, which can improve the performance and increase the scalability of data [19][26]. In order to

Collaborate to Innovate

European Union
European Regional Development Fund

Joint R&D grant with University College London for robotic surgery gesture detection and optimization

FI-WARE

Grant for chronic pain pattern detection and management

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Peer-Reviewed Research & Books

R&D

Gesture Classification in Robotic Surgery using Recurrent Neural Networks with Kinematic Information

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INTRODUCTION

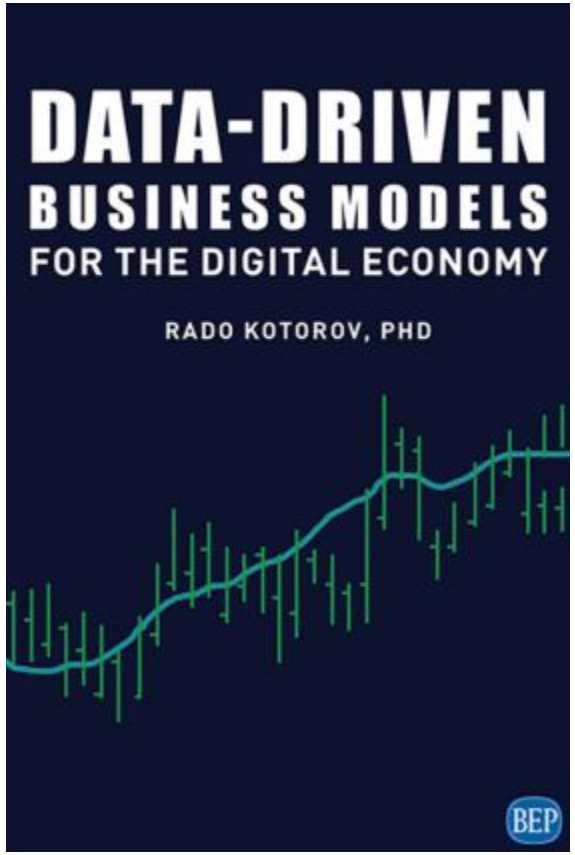
The integration of robotics in minimally-invasive surgery has witnessed remarkable increase over the previous decade. Breakthrough innovations in robotic technology, imaging and sensing facilitated the design of novel surgical systems for a number of different operations (laparoscopy, endovascular surgery). Prime example is the da Vinci Surgical System (dVSS; Intuitive Surgical Inc., Sunnyvale, CA, USA) used nowadays in many laparoscopic resection procedures (prostatectomy, cholecystectomy, nephrectomy) while it is constantly expanding to other surgical domains.

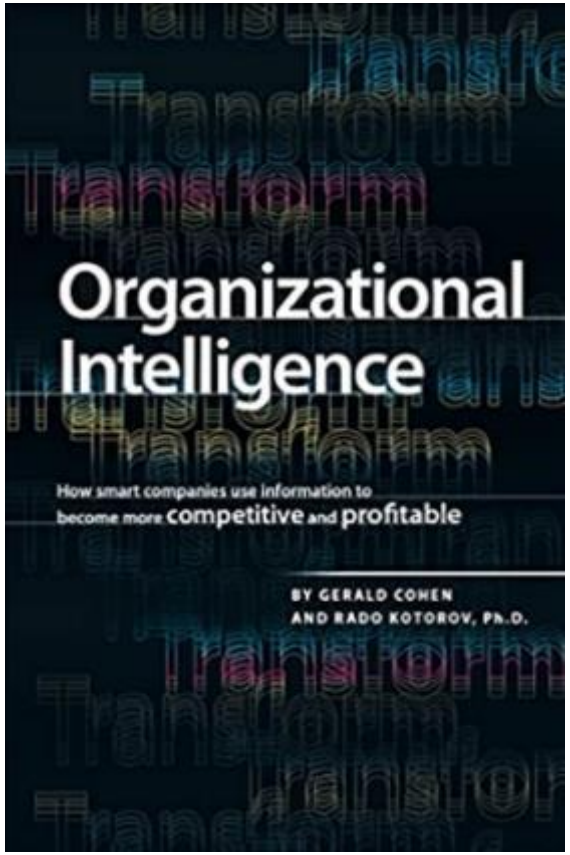
The use of robotic technology offers significant operational advantages like increased maneuverability, reduction of tremor and more precise tool positioning thus minimising intra-operative risk and trauma ultimately leading to a reduction in recovery times [3]. The continuous development of image-guided robotic surgery creates a need for new surgeons to go through analogous training for this type of surgery in order to master the necessary dexterous and technical skills. The currently practiced method of surgical training is heavily based on expert supervision, with faculty surgeons reviewing and evaluating performance through manually assessing global rating scales and task specific checklists. The scoring procedure requires significant amount of time and it is also subjective and prone to interobserver variability. Subsequently, it has been advocated that novel objective methods, focusing on competency metrics should be developed for evaluating average classification accuracy for all three tasks when trained and tested with dVSS kinematic data from the same operator. Our preliminary work indicates that this type of artificial neural networks can be the building blocks in gesture classification systems which can form the basis for further developing automated skill assessment methods in robotic surgery.

MATERIALS AND METHODS

The JHU-ISI Gesture and Skill Assessment Working Set (JIGSAWS) is a publicly available surgical dataset comprising of video and kinematic data from the execution of three basic surgical tasks (suturing, knot tying and needle passing) with the dVSS on bench-top models by eight surgeons (subjects) of varying level of expertise [1, 2]. All subjects performed each task five times. The stereo video output of the dVSS endoscopic camera module was captured at 30fps in 640x480 resolution. The kinematic data contain 3D position, orientation, velocity and gripper angle values from both the master and slave, left and right manipulators totaling 76 motion-related parameters. The two datastreams are synchronised with the same sampling rate.

Figure. 1. The three surgical tasks performed in JIGSAWS: from left to right – Suturing; Needle Passing; Knot Tying.





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We Help Companies Unlock the Value of Machine Data

Team

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Co-Founder & CEO

Former Chief Innovation Officer at IBI, a BI and Data Management company with offices in 40 countries (investor Goldman Sacks). Key clients: Ford, GM, Vermeer, Coty, Honda, Visteon .

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CTO

Lead large scale ML, DL, BI & data integrations projects for global 100 companies in Tokyo, New York and London including Toyota, Nissan, Mazda, Ford .

Lianhua Chi, PhD

Head of R&D

Former Scientist at IBM Research with a focus on AI. Lianhua has won numerous awards for best research papers. She also holds an associate professor position at La Trobe

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