Water / Wastewater Industry Division

Setting the Standard for Automation™

Calendar of WWID Events

Jan-Dec 2022	**WWID Connect Live virtual events**
Apr 26, 2022	ISA112 SCADA Lifecycle Q&A Online WWID Connect Live event
Jun 12-15, 2022	AWWA ACE 2022
Summer 2022	**2022 Energy and Water Automation Conference (EWAC) –** Webinars
Oct 8-12, 2022	WEF WEFTEC 2022 (includes WEF LIFT Challenge (2022)

2022 EWAC WEBINARS – SAVE THE DATE

Tues, Jun 14, 2022 ... Cybersecurity
Tues, Jul 19, 2022 .... Personnel Development, Standards & Certifications
Tues, Aug 16, 2022 .. Digital Transformation

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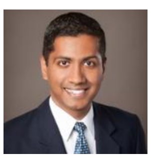
Newsletter
Spring 2022

Director's Welcome

Manoj Yegnaraman, Carollo Engineers, Inc.



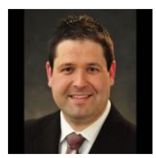
Hello and welcome to our Spring 2022 version of the ISA Water Wastewater Industries Division (WWID) Newsletter! Between technological advancements towards enhanced management / O&M / efficiency and new challenges such as security vulnerabilities, there is a lot going on in the Automation World and in our Water Wastewater Industry.

Thanks to all of you working in the automation discipline and W/WW industry for your everyday diligence and efforts in your services and products towards water treatment and waste management. Please continue to use our Division as a platform to share your experiences and to collaborate/learn from other members. Here are a few updates on our upcoming year:

Energy and Water Automation Conference (EWAC) Committee update – Our 2022 EWAC committee, led by our very own Hassan Ajami, comprises of WWID, POWID and ISA staff. Jason Hamlin and Joe Schaeffer with WWID also joined the committee this year. They will be supporting Hassan and Joe Provenzano on EWAC activities. Currently, this committee is coming up with a list of speakers for this year's webinar series. Similar to the last 2 years, we are planning to have a total of 3 webinars (2 hrs each) this Summer. The goal of the EWAC committee is to share best practices, case studies and current challenges/studies with members worldwide via collaboration between the sectors of… **(continued on page 2)**

Newsletter Editor's Welcome

Graham Nasby, City of Guelph Water Services



Welcome to our Spring 2022 newsletter. Spring is finally here for those of us in the Northern Hemisphere, and that means new beginnings and getting us poised for another season of sunshine and growth. I always enjoy this time of year because I get to wake up to the sounds of birds chirping in the morning, and the spring plants seem to be growing so quickly you can almost see them do it. At my home my rhubarb plants has been growing over an inch a day – I am very much looking forward the first harvest of stewed rhubarb over ice cream. Soon it will also be the start of outdoor concert season.

Getting back to our newsletter, in this issue we are pleased to announce the winners of our 2022 ISA WWID student scholarship program. This year we had a record 43 applicants, so our scholarship committee was kept very busy indeed. Our two winners this year are from Guelph, Ontario, Canada and Pune, India – so ISA is very much living up to its international mission. In this issue we also include two technical articles. The first provides an explanation about the differences between data verification and data validation in SCADA systems, and when data verification is typically done. The second is a comprehensive report on a machine learning (ML) and artificial intelligence (AI) project that longtime WWID member Francisco Alcala has been working on for several years. Feel free to reach out to Francisco if you have any questions about his ML and AI work. Lastly, we also have some information about several upcoming ISA WWID… **(continued on page 2)**

WWID Director's Message
(continued from Page 1)

… W/WW and Power industries.

WWID Newsletters – Graham took lead in putting together our first two newsletters for this year, and we are planning to issue at least two more newsletters with information on various technical articles, upcoming conferences and events, and WWID Division activities.

WWID Connect Live – Colleen Goldsborough worked with our Division leaders to schedule the first WWID Connect Live for 2022. This will be conducted on Tuesday, Apr 26, 2022 on the topic of ISA112 SCADA Standards – Q & A Session – Part 2. Once again, thanks to our session host Graham Nasby, who co-chairs ISA112 standards committee. He will be spending few minutes providing an overview of the standard along with recent updates. We will then open it up to our audience for discussions, comments, questions and ideas associated with this standard. Several WWID members including myself are in this standards committee, with Graham serving as one of the co-chairs for this Standard. Since its inception in 2016, we have already developed an intermediate version of the lifecycle and architecture diagram. These are available on the ISA website for everyone's use. We hope to see you at this Connect Live for your feedback, comments and questions.

WWID Scholarships – Kevin Patel and his scholarship team reviewed and provided scholarships to two Students earlier this year. Thanks to Kevin for his support for the last several years towards WWID Scholarship.

WWID Partnerships AWWA and WEF – I am working with AWWA and WEF to establish Memoranda of Understandings (MOUs) with these associations so that each association can support one another. At this time, ISA WWID is planning to contribute to AWWA's ACE22 conference and WEF's WEFTEC 2022 conference this year. Conversely, ISA WWID will be working with AWWA and WEF to provide involvement opportunities in our EWAC webinar series this year. One of our longtime WWID volunteers, Don Dickinson, is supporting us with this effort. These collaborations allow us to be up-to-date with industry trends, challenges and technologies.

New WWID Board Members – Joe Schaeffer joined us as our new Board member earlier this year, and Steve Valdez assisted us in bringing David Dlugos on board. The contact information of each WWID Board member can be found at the end of this newsletter.

In addition to these newsletters, we are also keeping multiple platforms updated with our Division activities, namely our external WWID website (www.isawaterwastewater.com), our Division homepage on ISA Connect (www.isa.org/wwid) and ISA WWID Group on LinkedIn.

Finally, a big thanks to all ISA members, volunteers, and ISA staff for your content and support over the years. Your efforts have helped our communities in receiving the best water treatment and waste management solutions. Your assistance has also been key in keeping our Division very active.

My best wishes to all of you for a great year ahead.

Regards,

Manoj Yegnaraman, PE
Director, ISA WWID
Vice President, Carollo Engineers, Inc.
myegnaraman@carollo.com

Newsletter Editor's Welcome
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… online events. These include an April 26, 2022 Question & Answer webinar on the ISA112 SCADA Management Lifecycle Standards, and three upcoming webinars in June/July/August associated with our virtual 2022 ISA Energy & Water Automation Conference. Happy reading!

Regards,

Graham Nasby, P.Eng.
WWID Newsletter Editor
graham.nasby@grahmanasby.com

<u>WELCOME</u>

Director Elect's Welcome

Hassan Ajami, PCI-Vetrix

Greetings to all of our WWID members! This year has been flying by. I can't believe we are already into the second quarter. Although we're officially in Spring, most of us in the Great Lakes area were greeted with snowfall today. Climate change is still wreaking havoc and it's a race to get our infrastructure to catch up.

Over the past few years, we've discussed a major issue facing our industry – brain drain. Employees with institutional knowledge built over the years were slated to reach retirement age around this time, with not enough new employees coming in to replace them. Coupled with limited processes for knowledge transfer, the prospect of losing those who knew the ins and outs of their plants and system was worry-some. The COVID-19 situation has not helped in this area. In fact, it has made the issue worse. Companies are struggling to hire new employees, and the "Great Retirement" is in full swing. As an industry, we must focus on better ways to transfer knowledge, whether it is by establishing mentorship programs, creating as-built documentation of the system, or better hands-in training for new employees. Something must be done so that we're not all starting from scratch.

Cybersecurity is another hot topic, not a day goes by without a story about a system being hacked. Utilities are a prime target for cyber-attacks and we must remain up to date on protection strategies and designs. New Federal guidelines are in the works for the Water/Wastewater sector and we are still learning what their requirements and implications will be. New regulations are always a sore topic because of the time and effort required to implement them, but Cybersecurity is not a topic to be taken lightly and is well worth the extra effort.

Our Energy and Water Automation Conference (EWAC), formerly the Water Wastewater Automation Conference (WWAC), is on for 2022. We are pleased to announce we will be presenting thee webinars this summer. Our first, in June, will focus on Cybersecurity. July's focus will be on Personnel Development, Standard and Certifications. And August will focus on Digital Transformation. The webinars will be free to tune into and we look forward to another great year of collaboration with POWID. Hopefully we can return to in-person conferences in the future.

I wish you all the best and look forward to another productive year for WWID.

Warmest Regards,

Hassan Ajami, PE, CAP
2021-2022 Director-Elect, ISA WWID
2021-2022 General Chair, ISA EWAC
Vice President / Lead Technical Officer
hajami@pci-vetrix.com

<u>WWID WEBINARS</u>

ISA & WWID Continue to Provide Virtual Events and Plan for 2022 and Beyond

From the WWID program committee

With the unprecedented cancellations of in-person events due to the COVID-19 pandemic, our industry has had to pivot to providing online events. Both the WWID and ISA as a whole, has been actively working to adapt to this new format.

For the WWID, this has meant providing a series of technical webinars for our members. We organized 4 webinars in 2020, 3 days of multiple webinars in 2021, and have already started planning our 2022 events. The Webinars are free, so we encourage you to register and attend future events. Keep an eye on the ISA website for more announcements.

In addition to WWID-associated events, the ISA has also embarked on providing a wide range online programming:

These include:

- Virtual Conferences
- Cybersecurity Series Webinars
- IIOT & Smart Manufacturing Webinars
- Digital Transformation Webinars
- Process Control and Instrumentation Webinars
- Division-Specific Webinars
- ISA Connect Live Events

Please visit www.isa.org/virtualevents for more information.

UPCOMING WEBINAR

ISA112 SCADA Systems Management Standard – Virtual Q&A Session – April 26

From the WWID Program Committee

Please mark your calendars for **Tuesday,** April **26, 2022** for the ISA WWID Connect Live online presentation of the **ISA112 SCADA Standard – Part 2 – Questions and Answers**

- 7:30am Pacific
- 8:30am Mountain
- 9:30am Central
- 10:30am Eastern (UTC-04:00)

Hosted by Graham Nasby, co-chair of ISA112 SCADA standards committee, the session will begin with an overview of the ISA112 SCADA Management Lifecycle Diagram, and then proceed to a Question & Answer session for attendees.

RSVP on Zoom
https://us02web.zoom.us/meeting/register/tZckf-CqrDgtEtYnENNzt7jOFlzkvG6zIfmH

Webinar Overview: In Summer 2020, the ISA112 SCADA Systems Standards committee release the first draft of its new ISA112 SCADA Systems Management Lifecycle. The Lifecycle is comprised of 8 core phases, each broken down into work processes. The phases are: Continuous Work Processes, SCADA System Standards, Design, System Development, Hardware Fabrication, Installation, Commissioning, and Maintenance/Operations. Together these phases of work processes provide an organized method and framework for the long-term management of SCADA systems. Not surprisingly, the lifecycle places a special emphasis on having clear system standards, standardized workflows, management change processes, and maintaining documentation.

In this session, Mr. Nasby who is co-chair of the ISA112 SCADA systems standards committee, and a past-director of the ISA Water/Wastewater Division will provide a brief introduction to the ISA112 lifecycle, and then host a Question and Answer session with participants.

Since its draft release in 2017, the ISA112 SCADA Systems Standard is now being used by utilities across North America, and around the world, for both project-based and long-term management of SCADA systems. The ISA112 committee currently has over 300 members from around the world and has been active since 2016. The committee is working towards releasing the first part of the written ISA112 standards documents in 2023. More information about the ISA112 committee, including the freely downloadable ISA112 lifecycle diagram, can be found at www.isa.org/isa112.

About the Webinar Host: Graham Nasby, P.Eng, PMP, CAP has 15 years of experience in the water industry. He currently serves at the Water SCADA & Security Specialist at City of Guelph Services in Guelph, Ontario. He also co-chairs the ISA112 SCADA Systems standards committee.

WWID SCHOLARSHIPS

2022 Scholarship Winners Announced Michael Fedenyszen Memorial Scholarship

The ISA Water & Wastewater Industries Division (WWID) is pleased to announce the winners of the 2022 WWID Student Scholarships. This year's recipients are Mary Bergin and Aniruddha Atre. Each received a $1000 USD scholarship prize to help with their school costs. Congratulations!

Elizabeth McKenna
University of Guelph
Guelph, Ontario, Canada

"I sincerely thank the ISA Water/Wastewater Division for selecting me as a recipient of the 2022 ISA WWID Michael Fedenyszen Memorial Student Scholarship. I was excited by the news of my selection and am grateful for the support from the ISA WWID, which will contribute to the completion of my studies."

Biography: Elizabeth McKenna is a third-year student at the University of Guelph in Ontario, Canada who is currently completing a degree in Computer Science with a minor in Mathematics. In 2021, she had the opportunity to do automation and system integration as a SCADA (supervisory control and data acquisition) developer co-op student for the drinking water utility at City of Guelph Environmental Services. Elizabeth enjoyed her time working with the SCADA team at Guelph Water, and will be returning for a second SCADA developer co-op term with City of Guelph in the summer of 2022. In addition to her studies, Elizabeth is also a world-class competitive synchronized skater with the team at Nexxice based out of Burlington, Ontario. She regularly skates as part of the Canadian National team at various international events and the World Championships.

Aniruddha Atre
VIT India
Pune, India

"I am honored and very grateful to be selection as a recipient of the 2022 ISA WWID Michael Fedenyszen Memorial Scholarship. I would like to thank the ISA Water/Wastewater Industries Division for honoring me with this scholarship award."

Biography: Aniruddha Atre is in his final year of Mechanical Engineering at VIT Pune (India), and is hoping to pursue a Master's degree in Robotics. Currently he is in the midst of an internship at Mercedes-Benz R&D in India, where he is working on traction motor design for electric vehicles. During his studies, Aniruddha has undertaken several robotic projects focused on the water sector, including a water monitoring system, robotic water cleaning robot, and an automated beach cleaning system. He looks forward to a future career in the water sector.

Application forms for the 2023 WWID Student Scholarships will be available in Fall 2022.

TECHNICAL ARTICLE

SCADA Data Verification for Commissioning & Operations

By Graham Nasby, City of Guelph Water Services

With any computerized data collection system, it is important to ensure that the data being collected and recorded matches the data being read in from the field instruments by the system.

Data verification is the process of checking that the data that is collected, stored, and reported matches the data from the instrument being monitored.

Data Verification vs. Validation

It is important to make the distinction between "data verification" and "data validation." Data verification is the process of checking that data values match from end-to-end from a technical perspective. Data validation is checking that data values are correctly collected from a regulatory compliance perspective. Though the terms are very similar, it is important to differentiate between them. The most important difference is that validation is a standardized continuous work process that is continually used to prove regulatory compliance for the water utility. Verification on the other hand is usually only done as part of system commissioning, or as part of an infrequent preventative maintenance procedure.

Another difference is that the time-consuming process of doing data validation is usually only done on a smaller subset of "regulated" parameters (or other parameters of interest) in the system. Data verification, when carried out, is usually done on all data points in the part of the system being checked over.

System Commissioning

During system commissioning, the field vs. displayed/logged value of every new and upgraded data point needs to be checked as part of a "data verification" work process. This involves checking the data value of each point from the originating instrument up to into the SCADA systems HMI screen, historian, and reporting functions.

When data verification is performed, it is usually done in the form of either a single pass or double-pass I/O check.

In a single pass I/O check, the value on the originating instrument is compared to the value that is shown on the screen / historian / reporting interface. Thus, the value is checked all the way up from the originating instrument up to the SCADA systems HMI.

In a double-pass I/O check, the transmission of the value from the originating instrument to the PLC Input card's memory address is first checked, and then as a second separate check is done to verify the value from I/O card up to the SCADA systems HMI.

Depending on the project type, it may be more efficient to do either a single-pass or double-pass I/O check -- each is functionally equivalent and equivalently valid. No matter which type of I/O check is done, the testing should be documented on a signed and dated I/O check test form, with any anomalies noted for further follow up.

Also, when doing the "data verification" for an analog data point, it is ideal if more than just than just one value is checked. Often, the values at 0%, 25%, 50%, 75% and 100% of an instruments range, plus one live value, will be checked as part of a "data verification" I/O check.

When designing or upgrading instrumentation, such as process analyzers or transmitters, the use of "blind" instruments (instruments with no local display) should be avoided as much as possible. Having a local display on an instrument makes doing I/O checks on measurement values much easier, as the local instrument reading can readily be seen and checked.

During system commissioning, both regulated and non-regulated parameters will be tested using data verification

System Operation – Periodic Data Verification Checks

As a best practice, the value of data points in the system should be subjected to data verification on a scheduled periodic basis. Often a 1-, 2-, or 5-year verification cycle is used, so that all data points are periodically checked during the operation of the system.

For regulated parameters, it is best practice to do a data verification at least once a year. Often, this periodic data verification can be done in conjunction with the annual calibration activities of field instruments, to avoid having to make additional site visits.

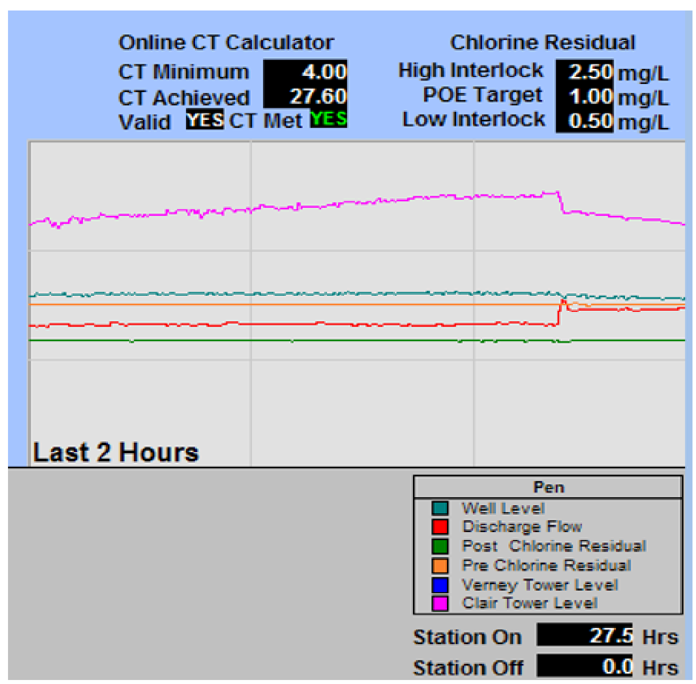


Figure 1- Example of screen indicators and trend lines that will need to have their data links checked and verified when a new site is being added to a SCADA system

System Operation – Data Verification & Data Validation

From an operations point of view, both data validation, and a limited version of data verification, should be carried out on a periodic basis.

From a data validation perspective, in most water districts the water regulator will require certain types of process data be reviewed every so many hours, the check be documented in a log book, and then any data anomalies followed up on. For example, in Ontario Canada, all data for regulated parameters must be checked at least every 72 hours (O.Reg. 170, Sched 6, Section 6.5 Continuous Monitoring under the Safe Water Drinking Act, Ontario Canada)

From a regulatory perspective, the types of data validation checks which are done usually include identifying if/when values drop below regulatory minimums and maximums; missing data, signal dropouts, data gaps, signal outliers, and other data that appears to be out of normal. Checks are also usually done to ensure that data is being logged on at least the minimum intervals specified by the regulator as well. (For example, in Ontario Canada, chlorine values for primary disinfection must be logged every 5 minutes.) Operators will also note in the log when equipment has been taken out of service, so that any false readings from associated instrumentation can be ignored from a regulatory perspective.

At the same time, it is advisable that operations staff also keep an eye on any datapoints they encounter in the SCADA system from a "data verification" perspective. Any data points that are not working properly should be noted, so they can be followed-up on and fixed as needed. Since this is an ad-hoc verification, it does not need the same rigor as the regulation-prescribed data validation work process.

Summary

Data verification is the activity of checking that data from the source instruments up into the SCADA system is being recorded correctly from a technical perspective. Data verification is typically first done as during initial system commissioning and periodically during the lifetime of the system to ensure system integrity.

Data validation is a separate regulatory compliance activity to check that logged process data can be used to prove regulatory compliance and that the process data has been logged in accordance with regulations under the local drinking water regulations and associated license and/or permit conditions.

About the Author

Graham Nasby, P.Eng., PMP has worked in the municipal water sector for 15+ years in a variety of roles, including consulting, operations, and capital projects. Since 2015, he has held the role of Water SCADA & Security Specialist at City of Guelph Environmental Services. He is also co-chair of the ISA112 SCADA systems management committee. Graham lives in Guelph, Ontario. Contact: graham.nasby@grahamnasby.com .

NEW ISA LEARNING MODULES

ISA Launches New Micro-Learning Modules for CSIOs (Chief Security Information Officers)

From ISA news release

As a senior-level executive, the chief information security officer (CISO) plays a pivotal role in establishing and maintaining programs that ensure information technology (IT) and operational technology (OT) assets are adequately protected. This means data protection, risk assessment, cyber incident response, and adherence to standards, policies, and procedures are top priorities. Aside from these responsibilities, keeping up with a cyber landscape that is constantly moving remains at the forefront of many executives' minds. A recent Proofpoint study discovered that roughly 64% of CISOs around the world suspect a material cyberattack will hit their organization within the next 12 months. Based on these findings, the majority of CISOs believe their organizations are unprepared to fend off potential cyberattacks.

With this in mind, ISA is introducing a new set of microlearning modules (MLMs) focused on specific areas of industrial cybersecurity. ISA microlearning modules consist of short, 5- to 10-minute videos that address cybersecurity challenges and help viewers better understand the purpose of the ISA/IEC 62443 series of standards. The first set of MLMs consists of three videos on cybersecurity awareness and three on cyber use-cases.

The awareness videos, entitled, "IACS Cybersecurity for Chief Information Security Officers (CISOs)," are designed to help CISOs gain more insight and understanding of the ISA/IEC 62443 series of standards. With this newfound knowledge, executives can be better prepared when collaborating with automation engineering colleagues to ensure the improved safety, reliability, and performance of physical process operations.

Executives can expect to learn more about:

- The differences between IT and OT systems
- Industrial cybersecurity terminology
- How IT and OT should work together, what should be protected in each environment, and the associated risks
- Consequences of implementing a disjointed cybersecurity program (or not having a program entirely)
- Benefits of implementing ISA/IEC 62443 standards

The use-case MLMs review two cyberattacks on Ukraine in 2015 and 2016, and an attack on a wastewater plant in the United States. These videos examine the causes of the attacks, the ramifications of the attacks, and how a cybersecurity program would have prevented the attacks or mitigated the consequences.

Learn more by visiting the IACS Cybersecurity for CISOs MLM visit: www.isa.org/training-and-certification/isa-training/microlearning-modules/iacs-cybersecurity-for-cisos

To learn about ISA's new Microlearning Modules Program, visit www.isa.org/training-and-certification/isa-training/microlearning-modules

TECHNICAL ARTICLE

An experimental predictive model using machine learning to enhance the situation awareness of the SCADA system

By Francisco Alcala, PE, CDM Smith

SCADA systems have been on the automation market for more than fifty years, with consolidated success. Depending on the industry, the utilization of the data processed by the SCADA systems has been extended to functionalities beyond the real-time control and monitoring, making possible the vertical integration for logistic and planning, enterprises finance, and maintenance through the integration with MRP, MES, and CMSS, etc. AI technology has shown exponential growth as part of the IoT trending but still is not widely implemented in SCADA systems. A substantial number of tools are available on the market, opening many windows of opportunities for the use of artificial intelligence and machine learning algorithms. However, its implementation for real-time control had been mostly circumscribed to advanced control. Improving plant operations may be possible by using predictive analytics based on machine learning algorithms. This article describes the basic concepts of machine learning and the situation awareness model to finally show one practical example of how machine learning can be used for predictive analytics to enhance the operation's situation awareness.

Basic concepts of artificial intelligence & machine learning

Artificial Intelligence (AI) is a field of computer science that develops systems and applications-oriented to resemble human intelligence. Consequently, Machine Learning (ML) is a branch of AI dedicated to developing and implementing algorithms that allow computers to learn without being explicitly programmed to provide predictions and pattern recognitions.

Unlike the typical process control algorithms based on deterministic programming, ML algorithms are intended to use data as a source of training to create executable models that produce predictions over new data.

There are two differentiable groups of ML algorithms, supervised learning and unsupervised learning. Supervised learning is the group of algorithms that map an input to a separate output. This is achieved using labeled datasets. For example, given an injection of two polymers for water coagulation, with supervised learning, the system is trained to recognize the best combination of polymers that produces the best outcome for a given water condition and minimize the polymer usage by labeling the pair dosage (O) vs. (X) that represents good or poor results for the same raw water characteristics. See figure 1.

Unsupervised learning algorithms identify patterns in data sets using data points that are neither classified nor labeled; for example, identifying anomaly behavior of the data on data produced by a raw water source monitor with multiple sensors that may be linked to a contamination event. This can be done by identifying clusters separated from the mean cluster of data.

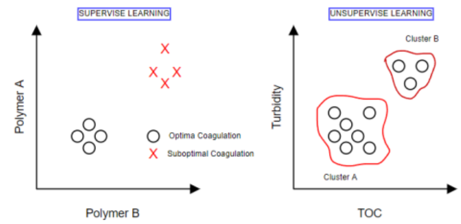


Figure 1 Supervised and unsupervised learning

In general terms, there are two types of ML problems: classification and regression. Classification is the process where ML algorithms group data based on predetermined characteristics, for instance, recognizing the values of dissolved oxygen and TOC that may be correlated to a spike of manganese in the water reservoir. The ML algorithms model the relationship between a dependent (target) and independent (predictor) variables in a regression problem. For instance, to use pH, TOC, DO, and temperature to estimate the magnitude of manganese on the water reservoir.

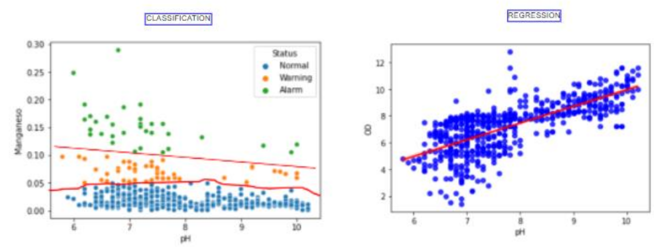


Figure 2 Classification and regression problems

Anomaly Detection (AD) is one of the unsupervised ML algorithms oriented to identifing rare events or observations that are statistically different from the rest of the samples. There are three types of anomaly detections, 1) Point AD, an abnormal point when a particular data instance deviates from the typical data pattern. 2) Contextual AD, when a data instance is uncommon, can be considered in a particular context, for example, seasonality behavior. 3) Collective AD occurs when a group of similar data instances behaves anomalously concerning the entire dataset. The most common AD algorithms are:

Near Neighbors: Normal data instances remain in dense neighborhoods, but the anomalies stay far away from their neighbors.

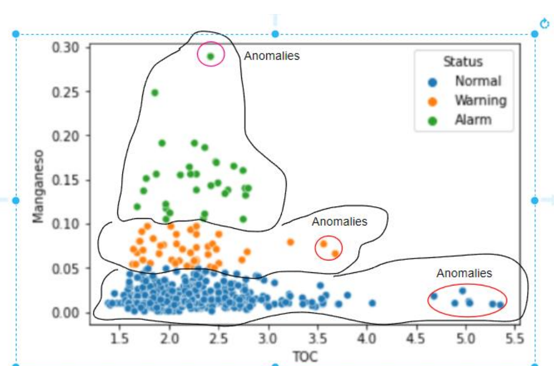


Figure 3 Near Neighbors Anomaly Detection

Clustering: The goal of clustering is to group similar data, and it is used to detect abnormal patterns in a data set

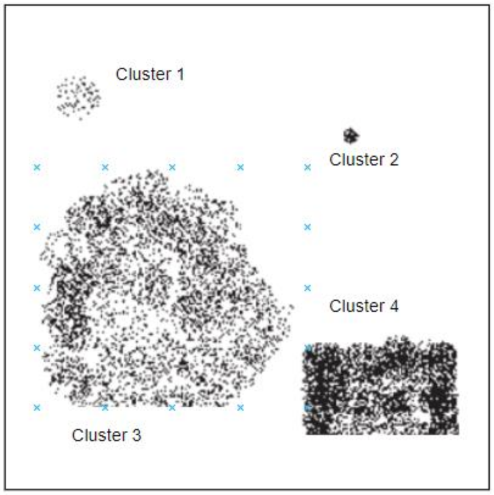


Figure 4 Clustering Anomaly Detection

Statistical: Based on the probability distribution of the data, anomalies have been detected as an outlier for the data that fit a specific distribution model.

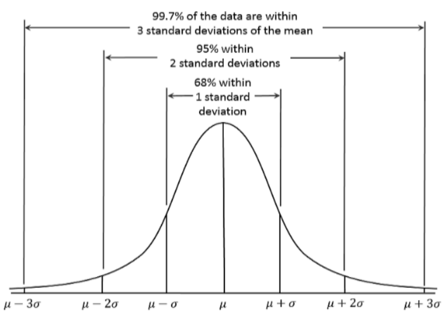


Figure 5 Statistic Anomaly Detection

ML uses statistical models with reducible and irreducible errors. Irreducible error, or inherent uncertainty, is due to data variability.

Bias and variance are components of reducible error. Reducing errors requires selecting models with suitable complexity, flexibility, and appropriate training data. Understanding the difference between bias and variance helps minimize errors and build accurate models.

The training process for an ML algorithm generally began with the formulation of the problem or hypothesis function that defines the data structure that will be used to feed the ML algorithm, the subsequent data gathering and preparation and labeling, for supervised learning, the selection of the ML model to test and the process of splitting the data into three groups, training data, test data, and cross-validation data. The final stage of the ML training includes evaluation and parameter tunning depending on the ML model selected. Finally, the model is programmed to produce results with new data.

Situation awareness model.

The situation awareness concept gained acceptance in the SCADA industry since the book *"The High-Performance HMI Handbook: A Comprehensive Guide to Designing, Implementing and Maintaining Effective HMIs for Industrial Plant Operations"* by Hollifield, Habibi, Oliver, Nimmo, and Renner. High-performance HMI provides best practices for a proper graphics presentation that allows the fast recognition of abnormal situations and reduces the screen element that produces distraction to increase the HMI interaction performance. The idea of situation awareness was introduced in 1983, with the development of a touch-screen navigation prototype to display a vertical and horizontal situation for commercial aircraft to improve situational awareness and reduce the pilot workload *(Biferno 1983).* Mica Endsley introduced the theoretical model of situation awareness *in 1995.* Endsley's model explains situation awareness as a sequence of three cognitive levels (Perception, comprehension, and projection) leading to the decision process and consequent response to a given event. The model also includes the two main factors that affect the state of the environment/system. See figure 6.

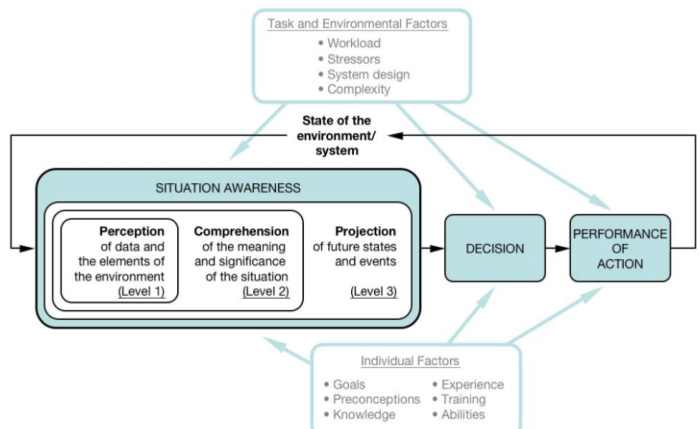


Figure 6 Endsley's model Situation awareness model. (Source https://www.researchgate.net/figure/Endsleys-model-of-situational-awareness_fig3_269112517)

Perception: The first cognitive level of situation awareness is the perception of status, qualities, or changes in any relevant elements in a given environment. Perception involves presenting the field situation as data/information by monitoring, event detection, and alarm presentation.

Comprehension: The second cognitive level is represented by the transition of data/information to knowledge by training, pattern recognition, data interpretation, and data evaluation.

Projection: The third cognitive level comprises the ability to project the upcoming changes of the elements in the environment. The point is accomplished through knowledge, correlation and, extrapolation to predict how it affects future conditions of the operational environment.

Task and Environmental factors: These the group of structural components that are outside of the control of human elements as workload, stressors, system design, and complexity.

Individual factors: Are the set of human conditions that affect the situation awareness capacity, decision-making process, and action execution. These factors are individual goals, preconceptions, personal knowledge, experience, and abilities.

Applications in water/wastewater systems.

Although in the current state of the technology, the processes are controlled in real-time and require less operator interaction, the SCADA operators are the most critical component of the automation system that provides the most valuable tasks that ensure the safety of the process and quality of the final product. At the same time, most water and wastewater processes are limited to reaction times in minutes, hours, and days.

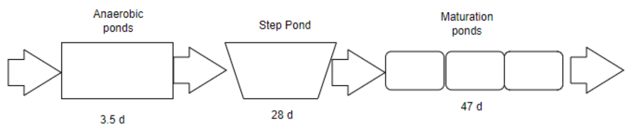


Figure 7 Wastewater retention

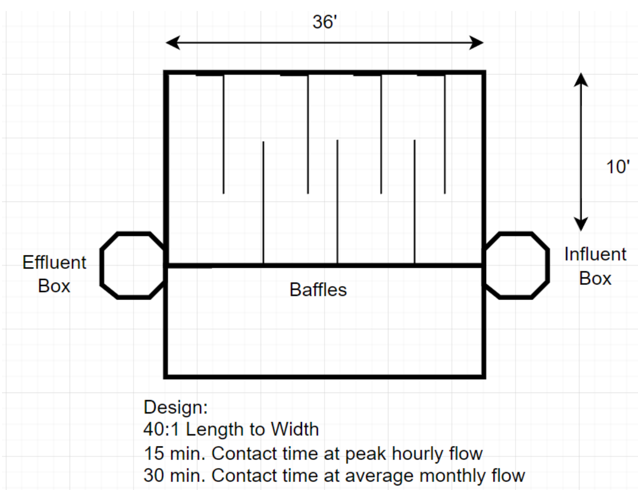


Figure 8 Chlorine contact time

The hydraulic retention time (HRT) in a wastewater treatment plant is the average holding time for the wastewater in a tank. It is also known as hydraulic residence time. For instance, wastewater treatment plants are mainly designed to handle the wastewater at average load & also during peak loads. The wastewater is retained in different treatment units to achieve the desired parameters. The HRT in the homogenization tank can be between 12 to 24 hours, 24 to 48 hours in aeration tanks, 72 to 120 days in Anaerobic Reactors, 5 to 12 hours in secondary clarifiers, 3 to 5 hours in primary clarifiers, 30 Minutes in chlorine contact tanks, 5 to 10 minutes in media filters, etc. See Figures 7 and 8.

One of the essential values of the operator in preserving the safety and the quality of the process resides in their capacity to predict what can go wrong or what could be improved within the limits of the residence time. The operator can also know the particularity of the equipment situation and system behavior that the control system cannot measure.

The machine learning model's predictive knowledge could be associated with the third cognitive level of the situation awareness process, complementing the information provided at the first level to enhance the comprehension of the meaning and significance of the situation that could drive to better decisions and improvement of the operation performance and reduce the mental workload. For example, a plant operator can know that one of two redundant pumps that by design should function identically needs to operate at a different rate to deliver similar performance with the same conditions that the other pump. This situation can be caused by a process or by maintenance reasons. These facts could be acquired by experience, observation, or by training. Machine learning algorithms could be trained to learn the wear-out level of a group of pumps to build real-time models that predict the pumps required to operate at a different rate without explicitly knowing the root-cause conditions.

The operators are able, by the observation of the trending chart, to predict what would be the approximate value of a given process variable, within the resident time, to detect a possible anomaly that may be related to a change of the raw material condition, changes of load or environmental cause. This skill works well for one of two variables and is more difficult when the measured value is affected by multiple process variables. The regression and neural networks are common machine learning algorithms that can be used to predict continuous values with acceptable results for a process that can be estimated using a deterministic model, having the advance of weighing the effect caused by particularities of the plant components, load changes, changes on the quality that cannot be directly measured but may have an impact on the data.

Dryer Burner experiment- Situational Awareness

Most new wastewater solids processing facilities use direct rotary dryers to evaporate water from the wastewater solids. In direct dryers, the wastewater solids come into contact with hot gases, which cause the evaporation of moisture. Retention time, also called residence time, is the amount of time that the material must be processed in the rotary dryer to achieve the desired results. The material produced in the drying process generally has a dry solids content ranging from 75% to 90%. Drying systems may produce a variety of forms of dry material, including fine dust, flakes, small pellets, or larger fragments. The Control system must regulate the heat inside the rotary drum by measuring the outlet product temperature and the dust exhaust processed through the dust collector. Dust overheating must be prevented to avoid fire risk on the dust collection system and ensure the quality of the final product. The drying system is fed by wet sludge and recycled product. Some facilities use additives intended to enhance the nitrogen concentration in the final product. The rate of dry vs. wet product, product feed and output temperature, chamber temperature, and additives play a role in the balance of the heat regulation inside the rotary drum. See figure 9.

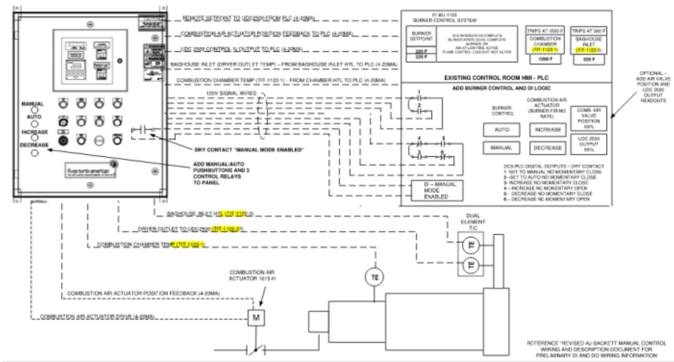


Figure 9 – Rotary Drum System

The dryer burner experiment evaluates machine learning algorithms to estimate the outlet temperature within the residency time to predict temperature overshoots when T > 205 F. See figures 10 and 11.

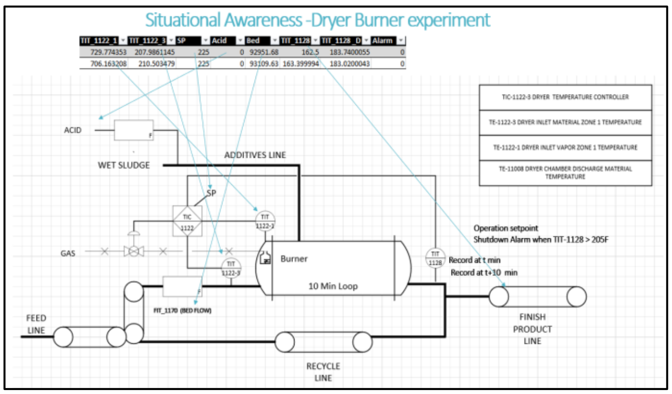


Figure 10 Rotary dryer system.

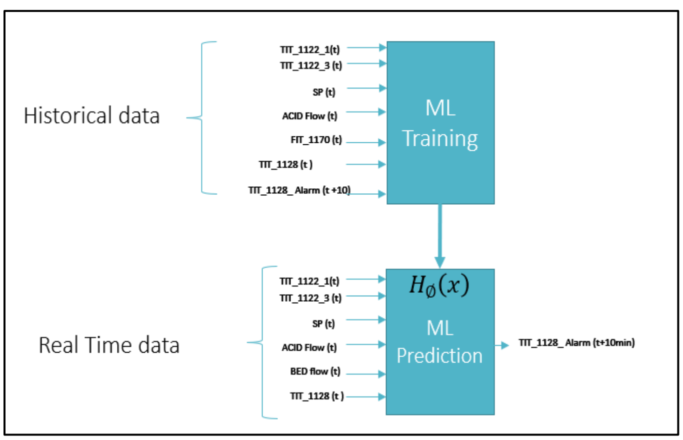


Figure 11 ML Model for Dryer outlet temperature estimation at t+10 min

Training Variables:

Rotary drum chamber temperature at t minute.

$$x_1 = (TIT\_1122\_2)_t$$

Product inlet temperature at t min

$$x_2 = (TIT\_1122\_3)_t$$

Controller Setpoint at t min

$$x_3 = SP$$

Additive flow at t min

$$x_4 = (ACIDFLOW)_t$$

Material bed flow at t min

$$x_5 = (BEDMASSFLOW)_t$$

Product outlet temperature at t min

$$x_6 = (TIT\_1128\_2)_t$$

Product Outlet temperature at t+10 min

$$Y = (TIT\_1128\_2)_{t+10}$$

Model:

$$H_{\emptyset}(x) = \emptyset_0 + \emptyset_1 x_1 + \emptyset_2 x_2 + \emptyset_3 x_3 + \emptyset_4 x_4 + \emptyset_5 x_5 + \emptyset_6 x_6$$

The data gathering and preparation include the historical collection of 51 hours of dryer operation with data sampled every second to produce a CSV file with 190,391 records of 5 variables , x_1 to x_5, Y record was created with the outlet temperature records t+10 min. The data was split into two sets using 80% of the data for training and 20% for testing. See figure 12.

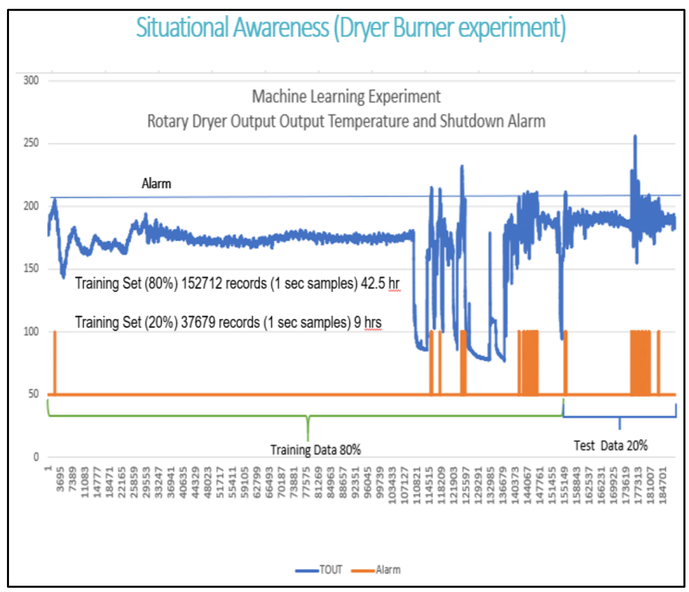


Figure 12 Dryer ML Model data organization.

Before running the training algorithms, statistical analysis is performed to understand statistic characteristics and recognize outliers. A correlation matrix helps to understand at first glans the weighted effect that the process variable has over the target value. See figure 13.

	TIT_1122_1	TIT_1122_3	SP	Acid	Bed	TIT_1128	TIT_1128._D	Alarm
TIT_1122_1	1.00000000	0.86980916	0.050079180	0.61083309	0.64278136	0.62802207	0.6484626	0.044884201
TIT_1122_3	0.86980916	1.00000000	-0.045571811	0.25658764	0.31820332	0.33273294	0.3335921	0.019816157
SP	0.05007918	-0.04557181	1.000000000	0.14614268	0.15568701	0.16309649	0.1586015	-0.008123298
Acid	0.61083309	0.25658764	0.146142682	1.00000000	0.68052562	0.69670326	0.6499262	-0.047782348
Bed	0.64278136	0.31820332	0.155687010	0.68052562	1.00000000	0.85392051	0.8100950	0.034863964
TIT_1128	0.62802207	0.33273294	0.163096489	0.69670326	0.85392051	1.00000000	0.8860626	0.062885848
TIT_1128._D	0.64846259	0.33359205	0.158601522	0.64992624	0.81009503	0.88606257	1.0000000	0.192690028
Alarm	0.04488420	0.01981616	-0.008123298	-0.04778235	0.03486396	0.06288585	0.1926900	1.000000000

Figure 13 training data cross-correlation matrix

In this case, it is possible to observe that the outlet temperature at t+10 minutes strongly correlates to the temperature at t min (0.88) and shows a fair correlation to the bed flow (0.81). The cross-correlation matrix shows medium to good correlation to inlet temperature (0.64) and the additive flow (0.64) and low correlation to setpoint (0.15).

Machine Learning (ML) models.

The predictions models selected for this experiment were the multiple linear regression and neural network.

Linear Regression.

Linear regression is a supervised ML algorithm focus on finding the best fit linear line between the independent and dependent variables. The goal is to find the coefficients $\emptyset_i$ that minimize the square of the sum of residual errors, also known as cost function. See Figure 14.

Linear regression model.

$$H_{\emptyset}(x) = \emptyset_0 + \emptyset_1 x_1 + \emptyset_2 x_2 + \emptyset_3 x_3 + \emptyset_4 x_4 + \emptyset_5 x_5 + \emptyset_6 x_6$$

Cost function.

$$\sum e_i^2 = \sum (Y_i - \widehat{Y}_i)^2$$

Figure 14 shows the performance of the actual system vs. the predicted model using Machine Learning.

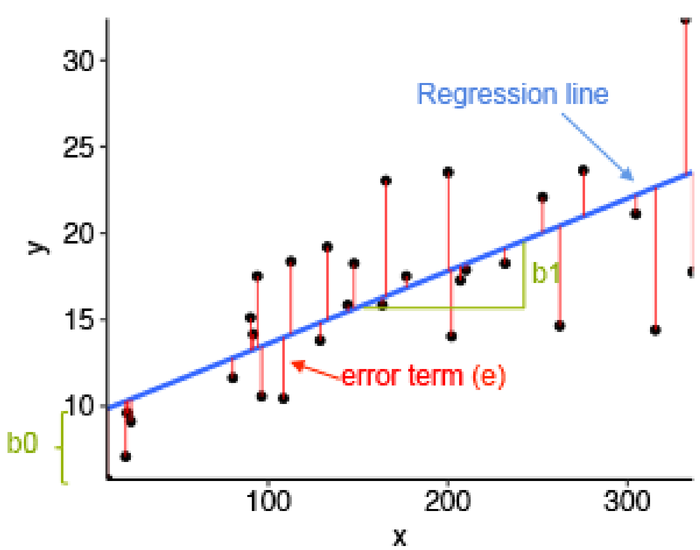


Figure 14 Linear Regression Model

The algorithm minimizes the cost function to achieve the best fitting line with the lowest residual errors. The parameters can calculate using the “Normal Equation” or gradient descent.

Normal Equation and Gradient Descent

The normal equation is as follow:

$$\emptyset = ((X^T X)^{-1}(X^T y)$$

Where:

Ø: Parameters that define the best fit.

X: Input features of each variable.

Y: Output value of each instance.

Gradient descent is a method of changing weights based on the loss function for each data point. The sum of squared errors at each input-output data point until finding a local minimum of a differentiable function. See Figure 15.

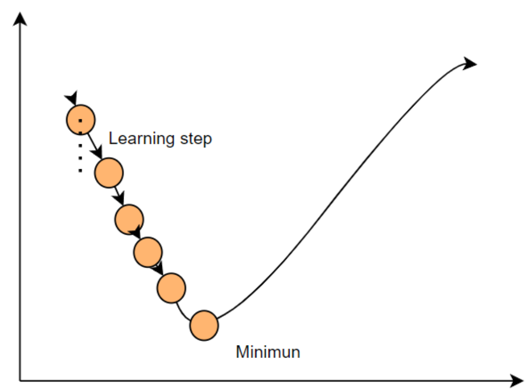


Figure 15 Gradient decent local minimum.

After running the gradient descent algorithms, the coefficients $\emptyset_i$ allow computing the estimated temperature using the test dataset. The mean square error and absolute error are calculated, as long as the R square. R-Squared is a statistical measure of fit that indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model; the closest this value is to 1, the most approach to a good fitting could be obtained. See Figures 16 and 17.

Bias and predictors	Coefficients
Ø(0)	-65.7913
Ø(1)	0.0499819
Ø(2)	-0.0486816
Ø(3)	0.387766
Ø(4)	-2.25804
Ø(5)	-3.69E-05
Ø(6)	0.748099

Figure 16 Dryer model - Linear regression, gradient descent coefficients

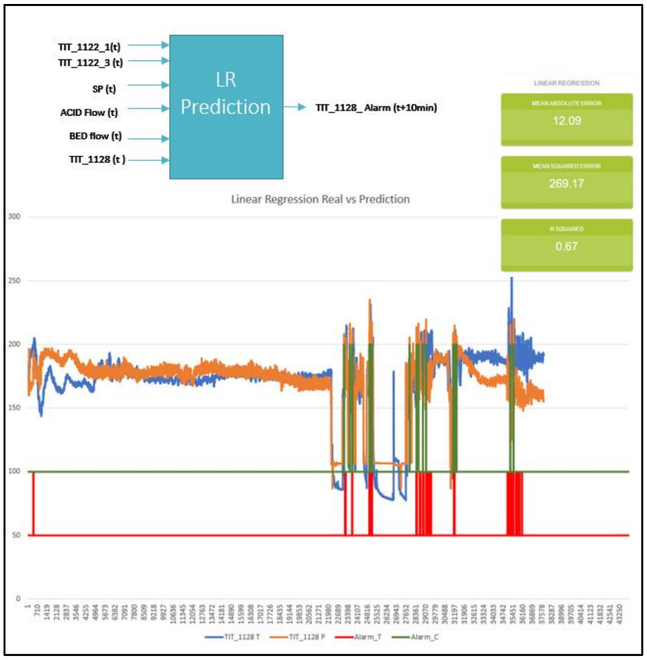


Figure 17 Dryer model of outlet temperature prediction vs. actual value with linear regression/gradient descent.

Neural Networks:

Neural networks are ML models that focus on recognizing causal relationships in a dataset by representing how the brain works. The neuronal network model established the weighted relationship between input, output, and hidden layers through an activation function in each node. See figure 18.

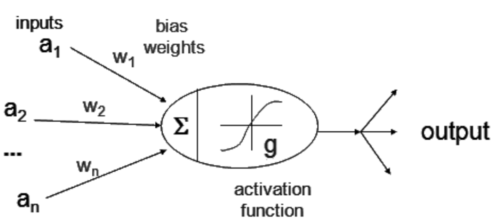


Figure 18 neural network model, (Source https://www.analyticsvidhya.com/blog/2021/04/neural-networks-and-activation-function)

One of the most popular algorithms to train a neural network is backpropagation. Backpropagation is the method of fine-tuning the weights of a neural network based on the error rate obtained in the previous iteration. Proper tuning of the weights reduces error and makes the model reliable by increasing its generalization. The backpropagation algorithm computes the gradient of the loss function for a single weight by the chain rule one layer at a time.

Using machine learning available libraries, backpropagation can be executed with relative simplicity. For this experiment, an R library called "Neuralnet" was used to solve the neural network in one line of code. Neuralnet allows flexible settings through custom-choice of parameters as error and activation function, etc., to calculate generalized weights. See figure 19

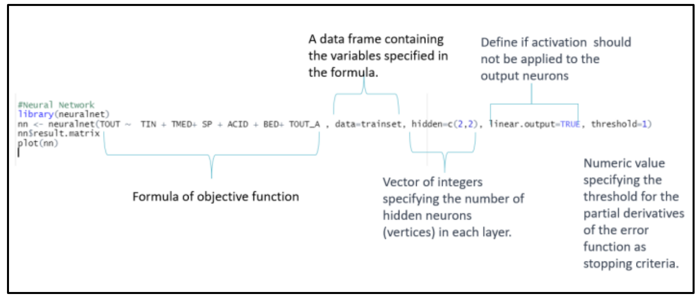


Figure 19 Execution of Neuralnet using R

Using the instruction nn.results <- compute(nn, testset), the neural network object calculates predicted results using "predicted=results$prediction" through the execution of forward propagation through all layers of the neural networks. See figure 20.

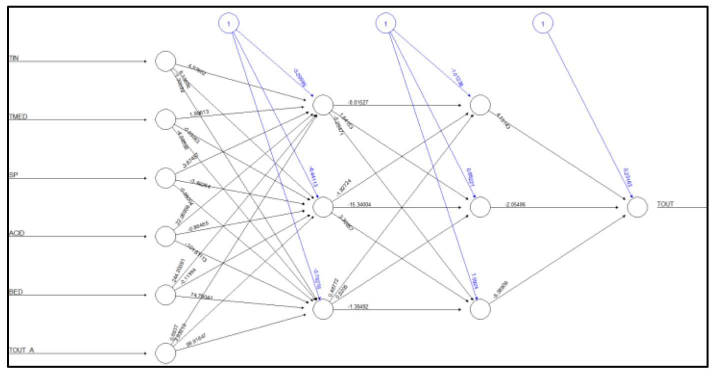


Figure 20 Graphical plot of neural network with three hidden layers for Dryer ML model.

After running the Backpropagation algorithms, the predicted values for the test dataset are calculated along with the mean square error, absolute error, and the R square. In this case, it is observed that the neural network shows a lower error and a better fit for variability with an R-value of 0.95. It is observed that the overtemperature predictions (Alarm_T vs Alarm_C) using the neural network are far more precise than the prediction done using linear regression. See figure 21

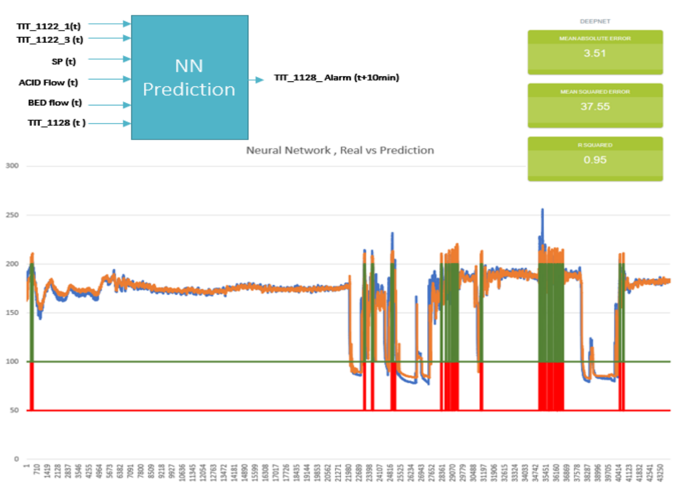


Figure 21 Dryer model of outlet temperature prediction vs. actual value with neural network/backpropagation.

Conclusions

Based on the results of the Machine Learning and Neural Network modelling that was completed, the following observations were made.

1. AI technology has shown exponential growth but still is not widely implemented in SCADA systems.

2. A substantial number of tools are available on the market, opening many windows of opportunities for the use of artificial intelligence and machine learning algorithms.

3. High-performance HMI provides best practices for a proper graphics presentation that allow the fast recognition of abnormal situations, providing support for the cognitive level 1 and 2 (Perception and comprehension) of the situation awareness model.

4. Machine learning can provide tools at the third cognitive level of the situation awareness process (Projection), driving better operational performance and reducing the mental workload.

5. The current state of machine learning technology allows a fast analysis and development of ML training models to be integrated into the SCADA system.

6. The dryer burner machine learning experiment for situational awareness is a suitable example of how machine learning can accurately predict overtemperature within the residence time.

7. Neural networks show a reasonably good result on predicting the over-temperature at the outlet of the dryer burner than multivariable linear regression.

8. More experimentation and cross-validation may be required to ensure the validity of the calculated model.

9. Machine learning modeling is a data-centric approach that may help to solvet a particular problem; however, its results are limited to the amount and quality of the data used for training and circumscribed to the process from which the data was taken.

About the Author:

Francisco Alcala, PE is a member of ISA and an Automation Engineer for CDM Smith. He has a BSEE from Universidad de Oriente Venezuela and an Operation Management MBA from IESA Venezuela. Francisco has 25 years of experience in Instrumentation and Control design, integration, and maintenance in the water/wastewater, petrochemical, and beverage industries. Contact: alcalaf@cdmsmith.com

ISA NEWS

ISA Celebrates Automation Professionals

From an ISA new release

April may be the month of springtime and renewal in the Northern hemisphere or a celebration of Anzac Day in Australia, but ISA –The International Society of Automation has christened it "The Month of the Automation Professional around the world."

All month long, leading up the anniversary of its founding on April 28, 1945, the association that was once known as the Instrument Society of America is celebrating the incredible people who make the world a better place through automation.

“This ever-growing industry is full of amazing talent, inspiring stories, and game-changing innovation,” said ISA President Carlos Mandolesi. To all ISA members, customers, students and automation professionals around the world, he added, “We are so proud to be on this journey with all of you. Thank you for being part of this journey with us, and for making a difference in automation.”

ISA is celebrating with #AutomationProDay social media activities that include stories of automation professionals making a difference, fun quizzes, career advice, social media games and professional development opportunities. Get ready to tell your own automation origin story or thank a mentor who helped make you the pro you are today.

All month long, everyone also gains discounted access the insightful and informative presentations from ISA’s inaugural virtual conference series. The 2022 sessions delve deep into essential automation topics related to upstream data analytics, instrumentation and analysis, and IIoT and smart manufacturing.

ISA promises special #AutomationProDay activities at the end of the month as well, including a one-day Flash Sale on April 28. You’ll find significant discounts on self-paced, modular training courses, authoritative technical resources and more.

Follow ISA on Facebook, Instagram, Twitter, LinkedIn, Pinterest or YouTube to learn more about ISA’s offerings and its #AutomationProDay celebration.

AUTO-QUIZ: BACK TO BASICS

AC Motor Speeds

From the ISA Certification Program

This automation industry quiz question comes from the ISA Certified Automation Professional (CAP) certification program. ISA CAP certification provides a non-biased, third-party, objective assessment and confirmation of an automation professional's skills. The CAP exam is focused on direction, definition, design, development/application, deployment, documentation, and support of systems, software, and equipment used in control systems, manufacturing information systems, systems integration, and operational consulting.

Question:

Considering a 60 Hz power source, at what speed does a four-pole synchronous motor run?

a) 1200 RPM

b) 1800 RPM

c) 2400 RPM

d) 3600 RPM

e) none of the above

Answer:

Synchronous speed in RPM = (two × frequency × 60) / (number of poles). For a 60 Hz, four pole motor that would be = (two × 60 × 60) / four = 1800

The correct answer is B, 1800 revolutions per minute (RPM).

Reference: Webb, Industrial Control Electronics, Merrill Publishing, 1990

ISA CAP and CCST certification programs provide a non-biased, third-party, objective assessment and confirmation of an automation professional's skills.

The CAP exam is focused on direction, definition, design, development/application, deployment, documentation, and support of systems, software, and equipment used in control systems, manufacturing information systems, systems integration, and operational consulting.

Certified Control System Technicians (CCSTs) calibrate, document, troubleshoot, and repair/replace instrumentation for systems that measure and control level, temperature, pressure, flow, and other process variables.

Question originally appeared in the ISA Certified Automation Professional; (CAP) program column of https://blog.isa.org.

Reprinted with permission. (https://blog.isa.org/autoquiz-how-to-calculate-the-speed-of-a-four-pole-synchronous-motor)

SOCIETY NEWS

What does it Mean to be an ISA Volunteer?

By Carlos Mandolesi, 2022 ISA Society President

In a previous article, I talked about my journey at ISA, why I joined ISA, and how I became a volunteer. One of the key benefits in ISA is the opportunity to "practice" leadership through volunteering. Our volunteers have been the backbone of ISA for more than 75 years. Do you know what it means to be a volunteer and the benefits of volunteering at ISA?

From my conversations with our members, I can say that the answer for this question is most oftentimes, "no." So, I will try to answer this important question providing some definitions and examples. First, let's clarify the difference of being a member and being a volunteer:

Member

• If your goal is to have access to ISA member benefits and develop your career, you should join ISA as a Member.

• You'll receive our regular communications and take part in our awesome community of professionals.

There are many definitions for a volunteer, but no universal agreement:

Volunteer

• A Volunteer is someone who gives time, effort, and talent to help us achieve our Mission without profiting monetarily.

• Volunteering is a voluntary act of an individual or group freely giving time and labour for community service.

• Volunteering is leveraging the specialized skills and talents of individuals to strengthen the infrastructure of non-profits, helping them build and sustain their capacity to successfully achieve their mission.

If your goal is to be involved in a community to help others, offer your talents, and share your expertise, then volunteering is your path! You will bring new ideas, meet other volunteers, and work with us so that our organization can achieve our Vision and Mission.

Professional associations like ISA function through active membership. While joining such an association may be voluntary, when a member engages in more intentional participation, accepts a leadership role, runs for office, or chairs/serves on a committee or task force, it becomes volunteering.

Volunteering is a way to have a sense of "belonging" to an organization or industry, and that's powerful and important. But people are looking after their own interests, too. Successful volunteering matches the kind of work the association does with the volunteer's professional needs. We need to provide a win-win situation, fostering a mutually-beneficial relationship.

What's in it for Me?

ISA invites you to give back to the automation community in ways that optimize your skills. In return, you can build leadership skills, enhance your resume, expand your network, and much more!

It's important to give volunteers a meaningful issue to focus on. Members who volunteer are more likely to achieve their membership goals, such as connecting with others, finding their community, and learning new skills.

These are some of the benefits of volunteering:

- Broaden your network of global professionals
- Share and gain knowledge
- Give back to the profession
- Enhance your influence/recognition as an expert and leader
- Achieve professional growth and personal satisfaction

How Do I Volunteer?

A very common statement I hear from our members is, "No one has ever asked me!" This shows how important it is to identify and invite other members to step in and become volunteers. When talking with our members and asking them to volunteer, a very common questions is, "How do I volunteer?" or, "What volunteer opportunities are available?" We can't assume that our members know what volunteering opportunities are available. The best place to find out what volunteer opportunities are available is at ISAConnect.

The full list of global volunteer roles is available through ISAConnect's Volunteer Opportunities List. Apply for the roles that interest you. Applications will be reviewed, and appointments will be made based on the criteria outlined in the role description. New opportunities are added regularly as projects come up that fulfil ISA's mission and vision.

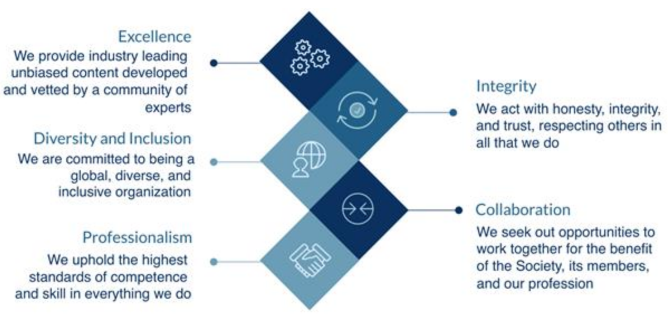
I Don't Have Time to Volunteer!

ISA provides different opportunities for volunteering at most of its areas, such as Sections, Divisions, Standards, Committees, Task Forces, and micro-opportunities, with different time commitments. See Figure 1 for some examples.

1When talking about members and volunteering opportunities, it's always important to remember our Values and our Code of Conduct that help creating a good and healthy environment to develop our activities.

ISA Values

We need to live our values in all that we do as members or volunteers:



ISA Member and Leader Code of Conduct

ISA members are to exhibit the highest standards of competency, honesty, integrity, and impartiality; be fair and equitable; and accept a personal responsibility for adhering to applicable laws and safeguarding the public welfare in their professional actions and behavior. All members commit to upholding the principles and behaviors by joining and retaining membership in ISA.

It's important that all members and volunteers are aware of the ISA Code of Conduct, the Staff and Volunteer Relationships and Roles, the Anti-Harassment Policy, and the Diversity, Equity, and Inclusion Policy. Violation of the code may result in complaint. Complaints must be submitted in writing to president@isa.org and should be accompanied with as much evidence as necessary.

I love to connect with our members and listen to their opinions about automation, about what ISA is doing now, and about what ISA should be doing to answer needs. Please connect with me on ISAConnect, LinkedIn, or send an email to president@isa.org.

Warmest Regards,

Carlos Mandolesi
2022 ISA President

The Latest at ISA

We have recently finished the process to communicate the 2022 ISA Strategy to all Districts. The ISA Officers and members of the Board and Staff will meet with all the new eight Districts to present our Strategy. It was a great experience to talk with all our Districts around the globe and listen to the opinions and perspectives of our members and volunteers. We will expand this initiative to our Divisions and other areas.

ISA has published our 2022 Events Calendar and we're really going international with our events. The first one will be the Digital Transformation Virtual Conference in Brazil. Registration information is below, and remember that it is FREE for our members:

- Digital Transformation Virtual Conference—Brazil
  29 March 2022 | 9:00am–6:00pm GMT-3
  Register NOW
- IIoT & Smart Manufacturing Virtual Conference
  30 March 2022 | 9:00am–5:00 pm ET
  Register NOW

Did you know that members have access to all standards developed by ISA here?

There are a lot of great articles on our two blogs: The ISA Interchange blog and the ISA Global Cybersecurity Alliance (ISAGCA) blog. Make sure you are subscribed to receive notifications whenever new posts are published.

Are you using ISA Connect? There are a lot of great technical discussions happening in the ISA Connect Discussion Forum.

Have you invited anyone to join ISA? If you need some resources to convince your friends or colleagues to join ISA, please refer to this brochure: https://www.isa.org/getmedia/32e6a52f-e0fc-4971-bcda-e59cd823a626/60-0420-ISA-Membership-Brochure-2022-spreads.pdf

Call for Newsletter Articles

The WWID newsletter is published four times a year (winter, spring, summer, and fall) and reaches the WWID's 2,000+ members. Each issue is approximately 16-32 pages long, and is electronically printed in color PDF format. A notification email goes out to all WWID members and it is available for public download at www.isawaterwastewater.com.

We are always on the lookout for good articles, and we welcome both solicited and unsolicited submissions.

Article submissions should be 500-2000 words in length and be written for a general audience. While it is understood that the articles are technical in nature, the use of technical jargon and/or unexplained acronyms should be avoided. We actively encourage authors to include several photos and/or figures to go along with their article.

We actively welcome articles from all of our members. However, we do ask that articles be non-commercial in nature wherever possible. One or two mentions of company and/or product names for the purposes of identification are acceptable, but the focus of the article should be technical content and not just sales literature. If you are unsure of whether your article idea is workable, please contact our newsletter editor for more information – we are here to help.

Some examples of the types of articles we are looking for include:

- Explanatory/teaching articles that are meant to introduce or explain a technical aspect of automation and/or instrumentation in the water/wastewater sector.
- Biographical stories about personalities and/or leaders in the water/wastewater sector.
- Case Studies about plant upgrades and/or the application of new technologies and techniques. This type of article must include at least two photos along with the article text.
- Pictorial Case Studies about a plant upgrade consisting of 4-6 photos plus a brief 200-500 word description of the project undertaken. The article should ideally include one to two paragraphs about lessons learned and/or advice for other automation professionals.
- Historical reflections on changes in technology pertaining to specific aspects of instrumentation or automation, and how these changes point to the future.
- Discussions about changes in the water/wastewater sector and how these affect automation professionals.

Once we receive a submission, we will work with you to edit it so it is suitable for publication in the newsletter.

Article submissions can be sent to the WWID newsletter editor Graham Nasby at graham.nasby@grahamnasby.com .

WWID Newsletter Advertising

The WWID newsletter is an excellent way to announce new products and services to the water/wastewater automation community. With a distribution of 2,000+ professionals in the automation, instrumentation and SCADA fields, the WWID newsletter is an effective targeted advertising tool.

The WWID newsletter is published quarterly, on the following approximate publication schedule:

- Winter Issue – published in January/February
- Spring Issue – published in April/May
- Summer Issue – published in July/August
- Fall Issue – published in October/November

Advertising in the newsletter is offered in full page, half-page and quarter page formats. Advertisements can be purchased on a per issue basis or for four issues at a time. The newsletter itself is distributed as a full-color PDF, so both color and black/white artwork is acceptable.

The current advertising rates are as follows:

Per Issue:
- Full page, full color (7" x 9"): $500
- Full page, full color, (8.5x11"), with bleed $600
- Half page horizontal, full color (7"x4.5"): $350
- Half page vertical, full color (3.5"x9"): $350
- Quarter page, full color (3.5" W x 4.5" H): $250

Per Year: Apply 20% discount if purchasing 4 ads at a time

Other sizes of advertisements are available, but are priced on an individual basis. Contact us for more information.

Please book advertising space as early as possible before the intended publication date. Artwork for advertisements should be submitted a minimum of two weeks prior to the publication date; earlier is always better than later. Artwork for advertisements can be submitted in EPS, PDF, PNG, JPG or GIF formats. EPS, PDF and PNG formats are preferred. Images should be at least 300dpi resolution if possible. A complete list of ad specs can be found at www.isawaterwastewater.com .

The ISA Water/Wastewater Industry Division is run on a non-profit basis for the benefit of its members. Monies raised from the sale of advertising in the newsletter are used to help offset the cost of division programming and events. Like its parent organization, the ISA, the WWID is a non-profit member-driven organization.

For more information, or to discuss other advertisement sizes not outlined above, please contact the WWID newsletter editor Graham Nasby at graham.nasby@grahamnasby.com .

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ISA Connect: connect.isa.org
LinkedIn: https://www.linkedin.com/groups/2031271/
Facebook: https://www.facebook.com/ISAWaterWastewater/

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About the ISA Water/Wastewater Industries Division

The ISA Water / Wastewater Industry Division (WWID) is concerned with all aspects of instrumentation and automated-control related to commercial and public systems associated with water and wastewater management. Membership in the WWID provides the latest news and information relating to instrumentation and control systems in water and wastewater management, including water processing and distribution, as well as wastewater collection and treatment. The division actively supports ISA conferences and events that provide presentations and published proceedings of interest to the municipal water/wastewater sector. The division also publishes a quarterly newsletter, and has a scholarship program to encourage young people to pursue careers in the water/wastewater automation, instrumentation and SCADA field. For more information see www.isa.org/wwid/ and www.isawaterwastewater.com

ISA Water/Wastewater Industry Division