SPE Review London October 2023

SPE Review London

The official e-magazine of the Society of Petroleum Engineers' London branch

London Section

Machine learning guide: Part 3

Also in this issue:

- Meet the SPE London Board 2023-2024
- Women in Energy: Making a significant impact
- Transform metadata enrichment with generative AI
- SPE London Net Zero Gaia: UK Geothermal Update
- News
- Events – local/international

SPE SECTION EXCELLENCE *** AWARD *** 2020

50 YEARS

LETTERS: THE SPE LONDON CHAIR and THE SPE REVIEW EDITOR

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ABOUT US

The Society of Petroleum Engineers (SPE) is a not-for-profit professional association whose members are engaged in energy resources, development and production. SPE is a non-profit professional society with more than 156,000 members in 154 countries, who participate in 203 sections and 383 student chapters. SPE's membership includes 72,000 student members. SPE is a key resource for technical knowledge related to the oil and gas exploration and production industry and provides services through its global events, publications, events, training courses and online resources at www.spe.org. SPE London section publishes SPE Review London, an online newsletter, 10 times a year, which is digitally sent to its 3000+ members. If you have read this issue and would like to join the SPE and receive your own copy of SPE Review London, as well as many other benefits – or you know a friend or colleague who would like to join – please visit www.spe.org for an application form.

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SPE encourages open and objective discussion of technical and professional subjects pertinent to the interests of the Society in its publications. Society publications shall contain no judgmental remarks or opinions as to the technical competence, personal character, or motivations of any individual, company, or group. Any material which, in the publisher's opinion, does not meet the standards for objectivity, pertinence, and professional tone will be returned to the contributor with a request for revision before publication.

SPE SECTION EXCELLENCE *** AWARD *** 2020

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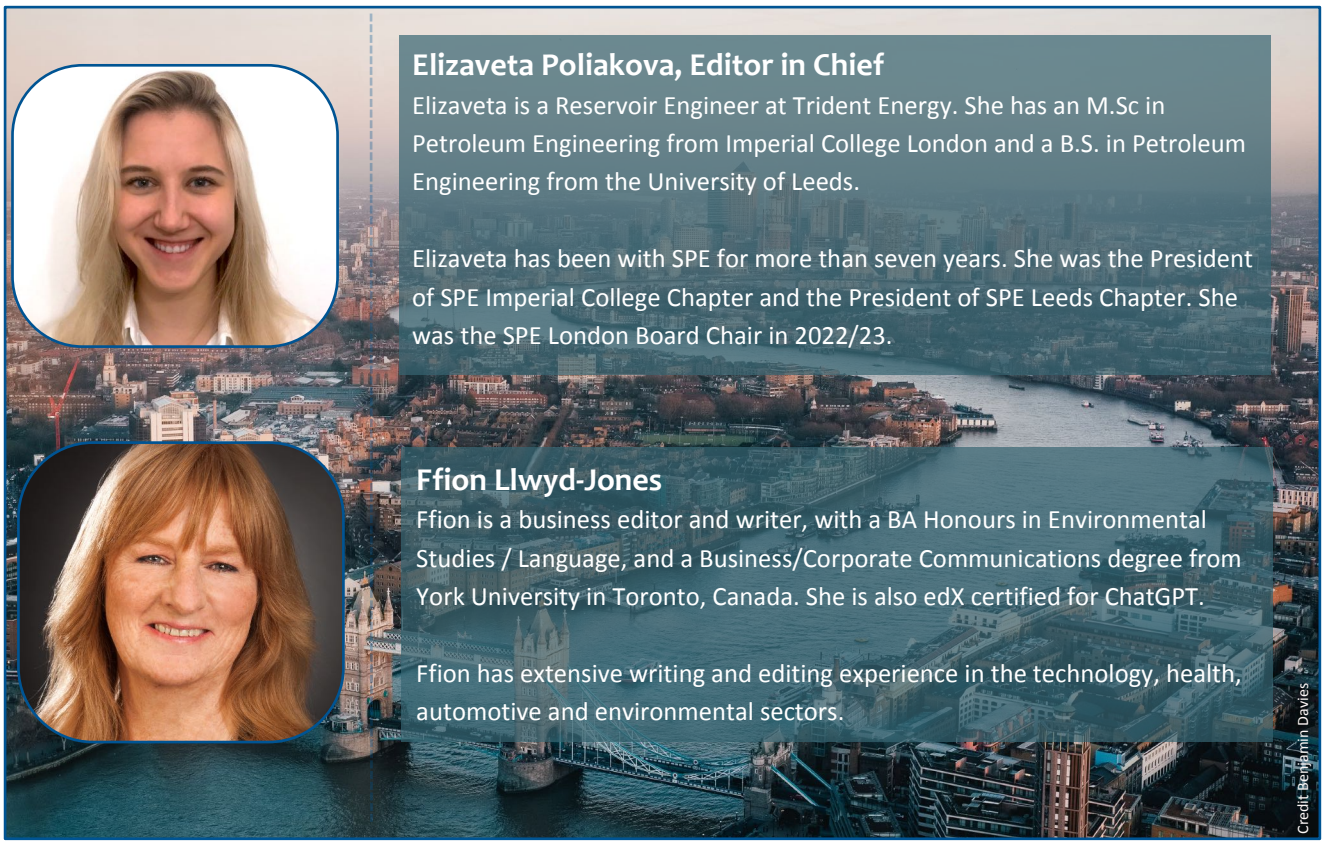
Photo credit: Arvind Vallabh. Unsplash

Behind the Scenes: SPE Review Editorial Board



Elizaveta Poliakova, Editor in Chief

Elizaveta is a Reservoir Engineer at Trident Energy. She has an M.Sc in Petroleum Engineering from Imperial College London and a B.S. in Petroleum Engineering from the University of Leeds.

Elizaveta has been with SPE for more than seven years. She was the President of SPE Imperial College Chapter and the President of SPE Leeds Chapter. She was the SPE London Board Chair in 2022/23.

Ffion Llwyd-Jones

Ffion is a business editor and writer, with a BA Honours in Environmental Studies / Language, and a Business/Corporate Communications degree from York University in Toronto, Canada. She is also edX certified for ChatGPT.

Ffion has extensive writing and editing experience in the technology, health, automotive and environmental sectors.

Credit Benjamin Davies

A big Thank You! to all the organisations supporting the SPE London section

Letter from the Chair

Dear SPE London Members and colleagues,

As we step into a new SPE year, it's my privilege to serve as the Chair of the SPE London Section for the term 2023/2024. To begin, I express my gratitude to our former Chair, Elizaveta Poliakova, and the 2022/23 Board for their unwavering commitment to our members, showcased through a diverse range of knowledge-sharing and social events held throughout the year. In 2023/24, our section is at a critical juncture, playing a pivotal role at the intersection between energy security, decarbonisation and ensuring an equitable transition for all.

London occupies a distinctive position, being home to the headquarters of most supermajors and service companies. Leveraging this unique position is vital in providing enhanced value to our members, catering to senior professionals, young professionals and students. Each of these member groups confronts unique challenges, whether it's establishing industry connections, navigating a career in the energy transition, or entering the industry for the first time.

My SPE membership has been invaluable, granting me access to industry leaders and thought leadership since the outset of my university career. It's not just about building friendships but also about cultivating a robust network that has been a pillar of support and guidance throughout my career journey. Now, it's my turn to give back.

At the start of this new year, we assembled the London section board to revisit SPE International's vision and mission, realign our section's own vision and mission, and recalibrate. While our commitment remains unwavering in steering discussions pertinent to the evolving industry landscape, particularly focusing on the energy transition and the journey toward achieving net zero, we acknowledge the strategic representation of our core oil and gas members and the importance of maintaining a balanced approach.

Our SPE London Technical Talks, led by Andrew Mynors, are scheduled to enrich the year with technical oil & gas seminars featuring distinguished lecturers from our industry. Meanwhile, our Net Zero Gaia committee, chaired by Barny Brennan, will continue to host discussions centering around the energy transition and new energies, acknowledging the crucial role of this industry in helping us achieve our net zero targets.

Following a four-year hiatus due to the pandemic, our highly sought-after Introduction to Upstream Oil & Gas course returns, catering to industry newcomers and those intrigued by upstream's role in the energy transition. Adam Borushek, our continuing education chair, has orchestrated this 15th edition exceptionally well. For those interested, more information and ticket purchasing details can be found through this link.

Mehdi Alem, our SPE Student Chapter chair, is actively collaborating with our Student Chapters amid their 2023/2024 elections. He plans to organise industry talks and CV clinics, a pivotal support system for students navigating an ever-transforming industry.

The YP committee, under the leadership of Samed Ali, remains committed to bridging the gap between young and senior professionals. Their plans encompass visits to technology centres and PVT labs, along with discussions focusing on the application of machine learning in the industry and the evolving M&A landscape, responding to recent acquisitions made by supermajors in the US.

I am looking forward to seeing these plans come to life and to meeting more of you at our upcoming events and social gatherings. If you perceive any opportunities where we can add value to you as members or wish to volunteer with us, your contribution is warmly welcomed to strengthen our Section. Please feel free to get in touch; we're open to any helping hand that can further empower our Section.

Sincerely Yours,
Shwan Dizayee

Letter from the Editor

Dear SPE London Members and colleagues,

Welcome to the inaugural edition of the SPE London Review for the new SPE year. As we venture into another year filled with insights and events, we're excited to bring you a selection of compelling features and updates.

We kick off this year with a new team at the helm. Familiarise yourself with the leaders steering our society on page 8. We encourage you to reach out with feedback, ideas, or if you're interested in volunteering with us.

Mark your calendars for the upcoming **Women in Energy seminar** this spring, detailed on page 12.
On page 14 there's a comprehensive **UK Geothermal Update** with Hazel Fernadale, David Townsend and Tony Bennett. For those who couldn't join us live, we've included a link to the recording.

Explore the transformative potential of generative AI in the realm of metadata on page 15 with **Transform Metadata Enrichment with Generative AI**.

Discover ways to collaborate with us in the **SPE London Sponsorship Opportunities** on page 21.

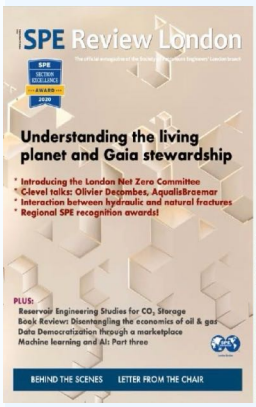
Enhance your digital proficiency with the **Machine Learning Guide for Petroleum Professionals: Part 3** featured on page 22.

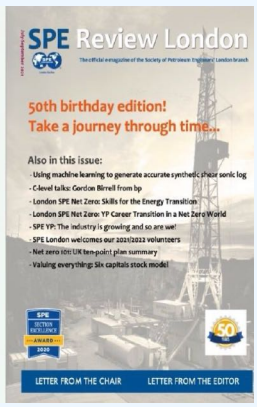
Lastly, stay in the loop with our round-up of forthcoming **SPE Events** on page 33.

We hope you'll find this edition both interesting and valuable. As always, we welcome your feedback as we collectively drive forward the main SPE mission of knowledge sharing and bringing the community of O&G professionals in London together.

A special thanks to Ffion Llwyd-Jones for her energy and ideas.

Warm regards,
Elizaveta Poliakova





NEWS DIGEST... NEWS DIGEST... NEWS DIGEST

Output growth nears 10% for Brazilian state-run company

Petrobras' crude oil production rose 9.6% during the third quarter from the same period last year, according to a company statement.

The Brazilian state-run oil company stated it pumped 2.32 million barrels per day (bpd) during July to September. Its daily average was 2.877 million barrels of oil when natural gas output was included.

Four ramped-up offshore platforms (in the Santos Basin and the Campos Basin) and fewer platform maintenance stoppages accounted for the increased figures, according to the company.

Read more

Successful Guyanese women-led consortium

Approved bidders in Guyana's first competitive auction include a local consortium led by Guyanese women. The consortium, called Sispro Inc, bid on the S3 shallow water and the D2 deepwater blocks.

A total of 11 shallow and three deep-water territories were made available in 2023.

Other bidders include an oil production consortia led by TotalEnergies and Exxon Mobil.

Read more

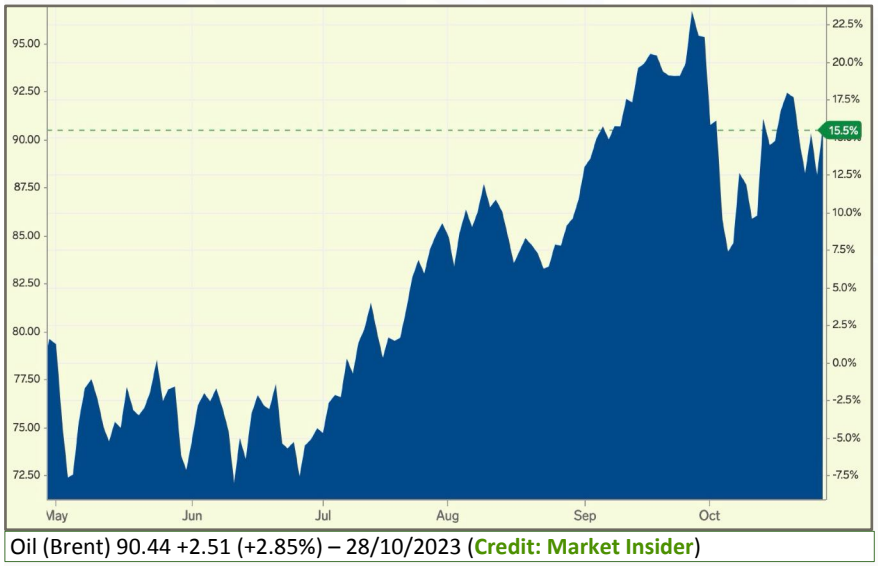
Mangement buyout at Seacroft Marine Consultants

Jennifer Fraser, the company's director, is stepping down after more than a quarter of a century with the company, following a company buyout.

At the end of October, Michael Cowlam became managing director. He was previously a co-owner and technical director. The company's current finance manager Magdalena Pierce is now joint owner and company director.

Seacroft, near Aberdeen, provides services across the UK and internationally.

Read more



Oil (Brent) 90.44 +2.51 (+2.85%) – 28/10/2023 (**Credit: Market Insider**)

UK Oil and Gas Report 2023

In its 2023 report, BDO provides a market overview of the UK's oil and gas sector.

The company has included insights into the anticipated regulatory landscape and licensing framework, together with a section on key factors that affect price and investments fluctuations within the industry.

The report also has a current market trends analysis, along with examining future opportunities and challenges. It is available for download.

Read more

NEWS DIGEST... NEWS DIGEST... NEWS DIGEST

SPE Policy on AI-Generated Content in Publications

The SPE Board has approved a new policy allowing AI-generated content to be used within SPE publications but under specific conditions.

AI-assisted language tools (such as ChatGPT) have gained widespread attention recently, particularly for their capability to assist in drafting scientific papers. While these tools have the potential to enhance the efficiency and speed of academic and technical writing, the ethics and best practices for their use are still evolving. These tools may generate useful information and content but are also prone to errors and inconsistencies.

The SPE Board has approved a new policy for authors who use AI language tools to generate content for their papers. The policy states that AI- generated content may be used within SPE publications but under specific conditions.

- AI language tools may not be listed as an author. The AI tool cannot sign publishing agreements or transfers of copyright.
- Any AI-generated content that is used within a manuscript should be thoroughly vetted, fact checked, and disclosed.
- If AI language tools are used within a manuscript, their use should be clearly explained within the methodology or acknowledgment section of the paper. If AI-generated content is included within a manuscript without an explanation, this can be grounds for rejection of the work at the discretion of SPE and may result in a code of conduct review.
- The authors of the manuscript will be held responsible for any errors, inconsistencies, incorrect references, plagiarism, or misleading content included from the AI tool.

It is important to note that technology for AI language tools is advancing rapidly. SPE plans to periodically review and update this policy to ensure its relevance and effectiveness. Any modifications to the policy will be communicated transparently and in a timely manner.

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SPE London Board: communication, vibrant industry events and networking opportunities

The SPE London board oversees the SPE London activities including our evening programme and other events. Our different committees have specific focus for members: Young Professionals, Women in Energy, Net Zero, and associated student chapters. As well as engineers who make up our core, we also welcome qualifications in geology, geophysics, earth science, environment, health and safety, mathematics, information technology, and management and economics.

Here's an opportunity to find out more about the people striving to drive SPE London forward, strengthening communication among members, offering vibrant events from technical to social, and increasing valuable networking opportunities

Chair: Shwan Dizayee is an experienced Management Consultant at Accenture, with seven years of industry experience. With previous roles as a Field/ Petroleum Engineer in Iraq and the UK, he leverages technical expertise, strategic thinking and a proficient background in technology to help clients unlock value in their daily operations by digitizing their core, and helping reach their net zero targets. Shwan has extensive experience across the oil and gas value chain, and has recently delved into the energy transition, focusing on areas such as e-mobility and ESG reporting. Since 2017, Shwan has been significantly involved with the YP committee in London. His contributions led him to chair the committee before he joined the main board in 2021.

Secretary: Yasir Mumtaz is an experienced Reservoir Engineer with a strong understanding of operational and field development projects. He possesses a wide-ranging background, having worked in both operator companies and the services sector.

Currently, he is actively engaged in the advancement and implementation of Carbon Capture & Storage (CCS) features within a high-performance reservoir simulator. His extensive expertise lies in optimizing production and managing integrated assets, with a primary emphasis on maximizing value in mature oilfields.

Chair Elect and SPE Review London Editor: Elizaveta Poliakova is a Reservoir Engineer at Trident Energy. She has an M.Sc in Petroleum Engineering from Imperial College London and a B.Sc. in Petroleum Engineering from the University of Leeds.

Elizaveta has been with SPE for more than five years.
She was the President of SPE Imperial College Chapter and the President of SPE Leeds Chapter. Previously, she was also on the committee of SPE YP. She is also the past president of the SPE London section (2022-2023).

SPE London Board ... continued

Treasurer: Farid Hadiaman is a petroleum engineering by background and holds an MBA degree from the Aberdeen Business School of Robert Gordon University.
Farid is a Senior Wells Engineer for bp. He previously lived in Malaysia, Indonesia, Denmark, Baku (Azerbaijan).

He had been an active SPE member for more than 18 years. He received SPE Regional Awards in 2012, thanks to his active contribution to the society, both in SPE section and his technical publications in OnePetro library.

Programme Chair: Andrew Mynors has 30 years of operational experience in the upstream oil and gas service sectors, which began with nine years of field experience in the North Sea, Middle East and Far East, then progressed to positions of County and District Management covering the UK, Holland, Denmark and the Far East. Currently, he is the Geolog Business Development Manager for London and global based clients who continue to explore, develop and invest in onshore and offshore oil and gas projects. More recently, he has focused on global geothermal CCS projects and lab-based solutions for Geolog and its sister companies.

Net Zero Chair: Barny Brennan is an experienced leader in the energy sector, with a subsurface and oil & gas industry background, now focusing on supporting the energy transition. He has maintained a strong technical focus while also operating at Board level. He has developed and managed successful teams, and has initiated and delivered high quality projects.

He brings a collaborative approach and effective communication to his roles. Barny currently chairs the Net Zero committee for the SPE London section and is responsible for the monthly Net Zero webinar series.

Continuing Education Chair: Adam Borushek is a Reservoir Engineer with 20+ years of international experience including conventional and unconventional assets. Currently, he is a Principal Reservoir Engineer with RISC, an independent oil and gas consultancy firm.

He provides technically and commercially sound advice in the areas of asset acquisition, development, field management and reserves reporting to clients in the financial, investment and upstream sectors.

SPE London Board ... continued

Sponsorship Chair: Natan Battisti is a petroleum engineer with Harbour Energy, and is passionate about energy, economy and politics. He coordinates the International Planning & Economics team and is the STEM Ambassador London Chair. He previously worked with Premier Oil, Origem Energia and New Fields in Brazil. Natan has been active with SPE UFPel Student Chapter, SPE Macae, Brazil and London Section. In 2023, Natan joined SPE International as part of the YP Committee. He is also a proud founder of *Ate o Ultimo Barril* (Until the Last Barrel), created to promote the role of students and YPs in the energy sector in Brazil, and to debate subjects such as energy poverty and energy security.

Social/Communication Chair: Percy Obeahon is the Technical Director & Origination at Gunvor Group. He was previously a Reservoir Engineer with Shell.

Percy has a Masters in Petroleum Enginering from Imperial College London. His projects include 'BG Acquisition', 'Multi Rate Testing on Gas Central Processing Facility without a Testing Facility', and 'Dynamic Fault Seal Breakdown Investigation – A study of Egret Field in the North Sea'.

He is also a Climate Champion at the Earthwatch Institute.

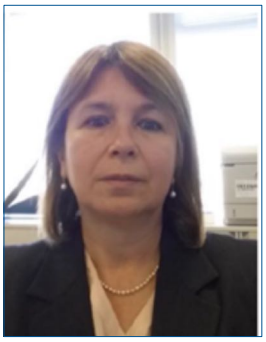
Student Development: Mehdi Alem is an MSc Petroleum Engineer/Reservoir Engineer graduate with four years' experience in oil & gas assets across the North Sea, North Africa and the Middle East. He is passionate about contributing to a sustainable energy mix and using digital skills to increase efficiency.
Experienced working in cross-cultural and multidisciplinary environments, Mehdi is a highly adaptable and results-driven individual, interested in engineering opportunities.
He is open to provide mentoring or coaching support.

Membership Chair: Arsenij Fiodorov is an experienced, solution-oriented and creative Petroleum Engineer with a strong technical background in flow assurance aspects of CCS systems design and petroleum production. After graduating from Imperial College London, he gained experience in all stages of the engineering project lifecycle (from concept selection to detailed design and operations support) and in-house scientific research. Solid experience in taking on ownership and accountability for studies and projects. Arsenij is passionate about creating a sustainable energy future and believes that his work and the projects he works on will play a key role in solving climate change.

SPE London Board ... continued

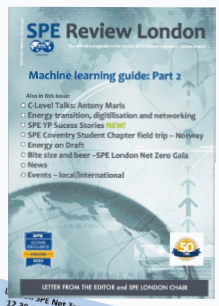
YP Chair: Samad Ali is a Senior Reservoir Engineer and Simulators product analyst at Schlumberger Abingdon Technology Center, and is based in Abingdon. He provides technical expertise on reservoir simulation and oilfield operational constraints modeling using Schlumberger D&I technology offerings. He joined Schlumberger in 2013.

He holds an MSc. in Petroleum Engineering from Imperial College London. He is a member of SPE and has published on topics including optimization with field management and high-resolution simulation modelling.



Inter Society / Industry: Carolina Coll is Head of Reservoir Development, CCS and Energy Storage. She has more than 25 years of diversified experience in the oil and gas industry. She is Chair of the SPE Joint Committee on Reserves Evaluation Training, a member of the Expert Group on Resource Classification of the UN Economic Commission for Europe, chair of the communication working group, member of the task force on Carbon Neutrality, past Chair of the SPE Carll, Uren Lucas International Awards, a member of the technical Committee of the SPE/EAGE EUROPEC Conference, and a past member of the Society of Petroleum Engineers Oil and Gas Reserves Committee (OGRC).

WiE Chair: Isabel Asenjo is a Reservoir Engineer with over 18 years of experience in the oil and gas industry. She has participated in a wide range of reservoir engineering studies across the life cycle of developments worldwide in a variety of roles, and currently works for Sasol as Senior Reservoir Engineer. Isabel started serving on the SPE London's Young Professionals committee in 2010 and since 2013 chairs 'SPE Women in Energy', which is a committee that aims to promote a more gender-balanced workforce in the sector.
Isabel received an Outstanding Service Award from SPE London Section in 2014 for her contribution to the section.



Making a significant impact in the energy sector

Announcing the eagerly awaited SPE Women in Energy seminar in Spring 2024 after a three-year hiatus and in the midst of a post-pandemic world.

We are thrilled to once again dedicate an entire day to this impactful event, bringing together inspiring speakers, engaging workshops, and abundant networking opportunities, all with a shared goal of fostering a more gender-balanced world in the energy sector.

SPE Women in ENERGY is looking for volunteers

As we prepare for this exciting occasion, we are actively seeking passionate and dedicated volunteers from within the SPE community. If you share our commitment to advancing gender balance in the energy industry, we invite you to join us in various roles, ranging from research and logistics to sponsorship, event management, and marketing.

Please get in touch with us via:
spelondon.wie@gmail.com

Would you sponsor SPE WiE?

Additionally, we extend a warm welcome to potential sponsors who share our dedication to diversity and inclusion, as well as speakers with valuable insights and experiences related to achieving gender balance.

Please get in touch with us via:
spelondon.wie@gmail.com

Your involvement and support are fundamental to the success of this seminar. Let's come together to empower individuals, promote diversity, and inspire positive change within the industry. Keep an eye on this space for updates on the event.

If you are interested in volunteering, sponsoring, or speaking at the seminar, please reach out to us to explore how you can contribute to this vital initiative.

Together, we have the power to make a significant impact in the energy sector.

In these challenging times it is more important than ever that SPE members continue to inspire and support each other locally, regionally, and globally.

SPE has evolved to provide unparalleled insights, shared expertise, life-long learning and community strength to fuel the success of our members and the future of the industry. As a member, you are part of that!

Renew your 2022/2023 SPE membership to keep your valuable member benefits.

- **Insights**

Access the latest briefs and features on E&P technology advancements across SPE publications including JPT®

- **Networking**

Network and knowledge sharing opportunities at both global and local levels, including more than 1,400 members of the London section

- **Technical Library**

Access to 220,000+ technical documents in OnePetro®, the multi-society, online library

- **Peer-Reviewed Journals**

Discover information on new technologies or build your reputation by submitting a paper for publication

- **Global Events**

Industry-wide technical conferences to in-depth training courses that bring together professionals from around the world

- **Online Education**

Deepen your expertise and engage with other professionals in your field through our continuing education programs.

Renew your membership today

UK Geothermal Update: A coffee hour chat

On 11 July, the London SPE Net Zero Gaia committee, in association with our SPE Europe geothermal colleagues, hosted a coffee hour chat featuring updates on UK geothermal projects United Downs, Eden Geothermal, and BODYHEAT. Our speakers for this coffee hour included Hazel Farndale, business manager for Geothermal Engineering Ltd overseeing United Downs, Tony Bennett, former Operations Manager for Eden Geothermal, and David Townsend, founder and CEO of TownRock Energy and creator of BODYHEAT.

Hazel kicked off the coffee hour by providing insight into multiple geothermal energy projects under development in Cornwall and across the UK.

She highlighted the current barriers to the development of the geothermal industry in the UK and the support needed from the government, local planning authorities, and local communities to make the industry viable.

Finally, she wrapped up her presentation by touching on the industry's opportunity to create thousands of green jobs, especially those utilizing skills developed in the oil & gas industry.

Next, Tony provided us with an update on the status of the Eden Deep Geothermal project including providing a summary of the outcomes from Phase 1 of drilling. He then went on to speak to the technical risks for developing deep geothermal and closed with insight into his predictions for the future of geothermal development in the UK.

Finally, we heard from David, who provided an overview of the work TownRock is doing towards developing geothermal resources in the UK. He discussed the cost of waste heat and how thermal energy storage can be deployed at varying scales to both combat its negative effects and become a net zero energy source. David closed his presentation by talking about BODYHEAT, an innovative project out of Glasgow in which the heat produced by club goers is stored in surrounding bedrock and later used to reduce the building's overall carbon emissions.

With the presentations done, we were able to open the floor to audience questions. Topics covered during the Q&A were broad ranging from which drill bits were used for specific wells, how to foster community engagement and good will and the need to incorporate additional revenue streams when planning geothermal projects.

The panelists also discussed the opportunities available to the oil & gas industry to kick-start geothermal in the UK and what support schemes have been implemented by the UK government to help this emerging industry. The resulting discussion was engaging and thought provoking, and certainly not to be missed by anyone with an interest in the UK geothermal industry.

Here is a link to the recording of our UK geothermal coffee hour
You can also access more information on our SPE London Net Zero Gaia virtual programme and catch up on all our recent webinars **through this link**.

Transform metadata enrichment with generative AI

Background

As the volume and the variety of data increases, data management becomes increasingly complicated and time-consuming for business. With a projected annual growth rate of 23%, the global data creation is expected to surpass 180 zettabytes by 2025, driving organizations to constantly re-define their data management strategies to maximize the value of their data assets [1, 2].

An important component of this data strategy is a data catalog, which is an organized inventory of data assets within an organization and an important tool for data governance and data discovery. Data consumers utilize the data catalog to refine/optimize their search and transform data into valuable insights, ultimately enhancing organizational efficiency and profitability.

A data catalog typically consists of following information to help data consumers understand the data:

1. **Business Glossary** that describes key terms used in various departments.
2. **Business and Technical Metadat**a that describe the business context of the data that is indexed in the catalog.
3. **Data Lineage** (and transformations) to show where the data originated from and what happened to the data throughout its lifecycle.
4. **Sample Data** to give data consumers an understanding of the contents.
5. **Relationships** with other data objects that exist in the catalog.

Bottleneck to becoming data-driven

The effort towards Metadata Enrichment (documentation) is often time-consuming and is commonly not prioritized among the top concerns in data management. But the downside of not prioritizing this activity often results in lack of data discoverability and with data generation outpacing data management, these data sources may never get to the metadata enrichment stage. In this scenario, the perceived challenge of having to document tens of thousands of source data tables in a data catalog is clearly not understated.

Organizations commonly hold large volume data in various repositories in multiple formats – structured, unstructured. Single or multiple data catalogs are often maintained to track the data assets. Since data consumers use a data catalog for searching the data, data contextualization (relevance, data quality, restrictions, rights etc.) is extremely important to ensure the most relevant data is discoverable quickly and easily understood by data consumers.

Well contextualized data cuts down data preparation time and reduces time-to-insight. If data is not contextualized, then it slows down self-service consumption of data and hindering organizations towards becoming data-driven.

Transform metadata enrichment with generative AI... continued

Challenges with Metadata Enrichment

Metadata enrichment is a complex activity as organizations need domain experts to enrich the metadata that is contained in the data catalog. The required information includes descriptions at data asset and column level encompassing metadata tags and other attributes that describe the data asset completely. In the context of data catalog, the data asset could be anything from relational tables, views, APIs, reports, dashboards etc.

Organizations hire data stewards to ensure data is scanned from the source and business metadata is recorded in the data catalog. These traditional data management activities are time-consuming, labor-intensive, and often overwhelming leading to reduced overall efficiency and productivity. Augmented data management can provide solutions to the changing requirements of data management by automating manually done data management task using AI and ML. Effective data management can minimize the problems that stem from bad data, such as added friction, poor predictions, and even simple inaccessibility, ideally before they occur. In this POV we will consider one such task of Metadata management involving collecting, organizing, and cataloging data.

Generative AI for enriching metadata

This brings up an important question: Can Generative AI technology help solve the problem of metadata enrichment?

Generative AI has created a lot of buzz in the technology world, and it is making inroads into enterprises to solve complex problems involving data. There is a lot of investment to build models for various industries including pharmaceutical, automotive, healthcare, energy, and utilities.

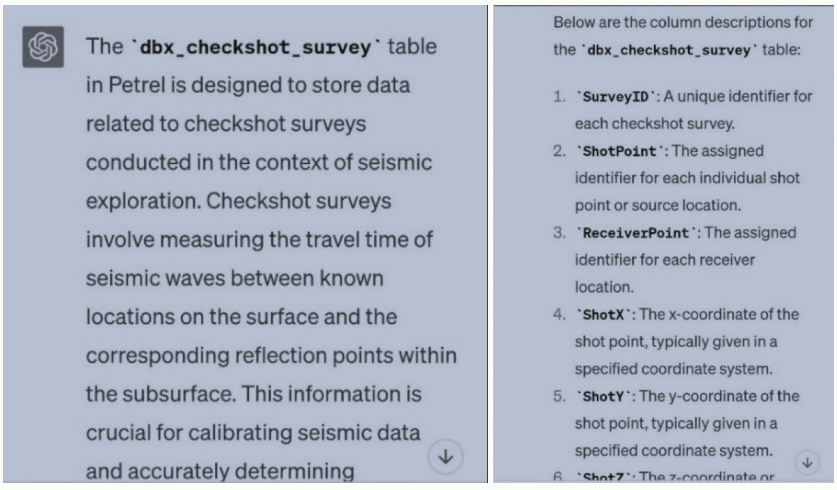
Typically, organizational data is spread across enterprise class applications like CRM, SCM, Project Management tools, Knowledge Management systems, HRM etc. Large Language Models like ChatGPT have knowledge about the specific systems and databases such as SAP, Salesforce, Oil and Gas data models like OSDU, PPDM, commercial products from companies like Schlumberger and Halliburton like Petrel, EDM, Wellplan etc. and/or can be trained otherwise if required. Generative AI technologies like ChatGPT could be used to integrate AI into data cataloging processes for generating documentation in the form of business metadata via descriptions, tags, glossaries etc.

Following are some examples of data catalog content generated using ChatGPT technology. For illustration purpose we have considered Upstream Oil and Gas industry data types:

1. Generate Data Asset and Column Descriptions

In this example, we construct simple prompts for ChatGPT using the Petrel table name.

Prompt: Generate description of Petrel DBX_CHECKSHOT_SURVEY table
Prompt: Generate description of Petrel DBX_CHECKSHOT_SURVEY table column description

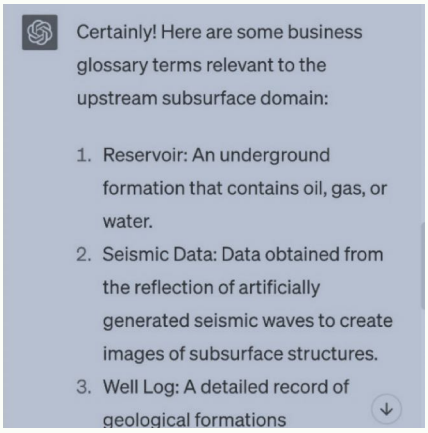


Transform metadata enrichment with generative AI... continued

The results demonstrate that the LLM model behind ChatGPT generates an acceptable table description and its associated column descriptors.

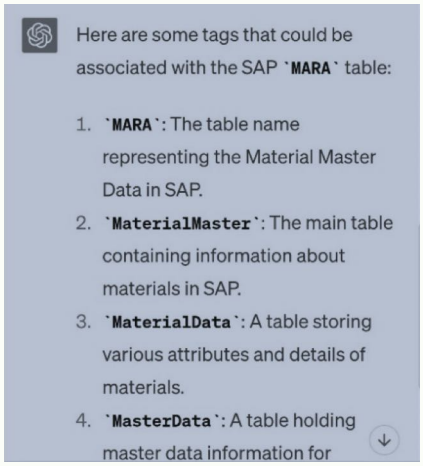
2. Generate Business Terms
In this example, we demonstrate that ChatGPT can be prompted with business concepts to generate glossary terms relevant for that type of business / function.

Prompt: Generate business glossary terms for Upstream Subsurface Domain



3. Glossary Tags for Data Asset
In this example ChatGPT can be prompted with industry terms and can suggest possible data asset glossary tags for a data asset.

Prompt - Generate tags for SAP MARA table

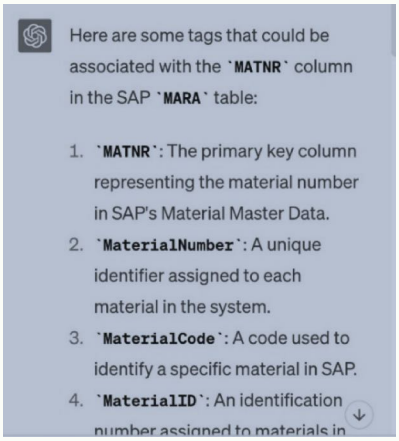


MARA is a standard Material Master Table in SAP Logistics application

4. Glossary Tags for a table column
In this example ChatGPT can be prompted to suggest column descriptions from non-descriptive column headers.

Prompt - Generate tags for MATNR column SAP MARA table

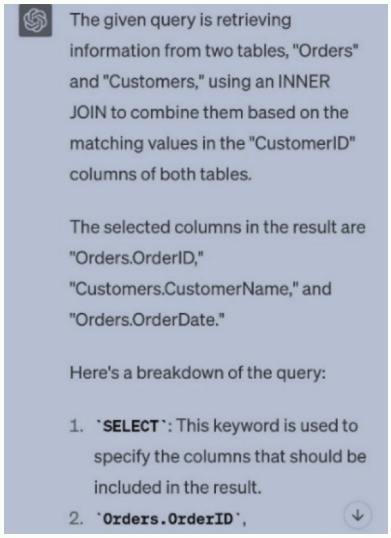
Transform metadata enrichment with generative AI... continued



5. Describe Data Transformation

Users want to know what type of transformations are applied while creating a data asset. The users would like description in layman terms and not get into the complex code level detail. ChatGPT can provide a summary of complex data transformations in various languages like SQL / Python and provide a user-friendly definition of the data transformation.

Prompt – Describe the SQL code "Describe the following query SELECT Orders.OrderID, Customers.CustomerName, Orders.OrderDate FROM Orders INNER JOIN Customers ON Orders.CustomerID=Customers.CustomerID" (source: https://www.w3schools.com/sql/sql_join.asp)



6. Describe Data Transformation

In this example, ChatGPT can generate a human-readable explanation of the code, making it more accessible to non-experts such as business stakeholders.

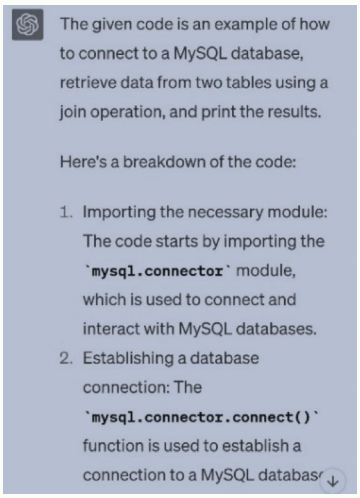
(source: https://www.w3schools.com/python/python_mysql_join.asp)

Prompt – Describe the Python code

```
import mysql.connector

mydb = mysql.connector.connect(
  host="localhost",
  user="yourusername",
  password="yourpassword",
```

Transform metadata enrichment with generative AI... continued

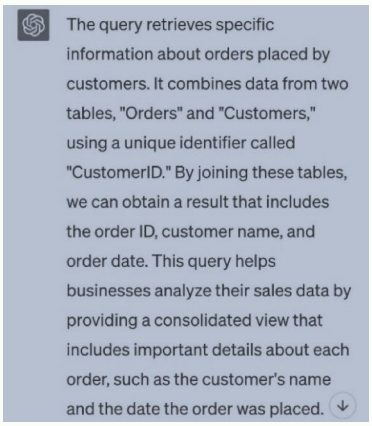
```
  database="mydatabase"
)

mycursor = mydb.cursor()

sql = "SELECT \
  users.name AS user, \
  products.name AS favorite \
  FROM users \
  INNER JOIN products ON users.fav = products.id"

mycursor.execute(sql)

myresult = mycursor.fetchall()

for x in myresult:
  print(x)
```



7. Describe the derived data set

This example demonstrates how we can use ChatGPT outputs from one prompt as input in to a second ChatGPT prompt. The output from the previous transformation can be described using this prompt to generate a description for the data asset created using the transformation. The data steward can tweak the generated content to improve the context.

Prompt – Describe a brief summary of the output from previous query



Transform metadata enrichment with generative AI... continued

Conclusion

Perhaps the most significant impact that Generative AI is having on data catalogs is around automation. Generative AI can assist data teams to automatically tag data assets based on their content, context, and usage, enabling users to find the data they need faster, with greater accuracy and accelerate time to insights. This technology can provide a quick jump start to the metadata enrichment process and assist with creating a draft version of the metadata, despite the practical limitation to achieving 100% accuracy. Further work needs to be done by data stewards and experts to improve the catalog content and make it more meaningful. Data governance processes need to be defined to ensure drafts are reviewed and approved. When data is democratized via the data catalog, crowdsourcing can ensure metadata quality errors are reported and an active feedback loop to the data governance council can ensure metadata quality issues are rectified timely. Data stewards should experiment with Generative AI technologies to see how best it can address the metadata enrichment gaps to improve the data context. There is a lot to experiment with this technology and this is just the beginning.

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[2] IDC, "Worldwide Global DataSphere Forecast, 2021–2025: The World Keeps Creating More Data — Now, What Do We Do with It All?," IDC, March 2021. [Online]. Available: *https://www.marketresearch.com/IDC-v2477/Worldwide-Global-DataSphere-Forecast-Keeps-14315439/*

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- **Digital Transformation**: *To be determined*

Machine Learning Guide for Petroleum Professionals: Part 3

Continue our journey with Part 3 of this four-part series focused on addressing the implementation of AI in the petroleum industry using a real case study. Written and illustrated by Saif Ur Rehman, this article was first published (February 2023) in The Way Ahead, which is written by and for young professionals in oil and gas, covering career development, along with business and technology.

Saif Ur Rehman is a deep learning mentor volunteer at DeepLearning.AI. With a background in petroleum engineering, he is passionate about merging machine learning with reservoir simulation to provide AI-driven solutions to petroleum industry challenges. He holds a BS in petroleum engineering from Dawood University of Engineering and Technology (DUET), and has been actively involved with SPE since 2015. He currently serves as the International PetroBowl Question Writing Volunteer for 2023 and held the same role in 2022. He was also an Ambassador Lecturer for SPE in 2021 and served as president of the SPE DUET Student Chapter in 2017.

Part 3 is our hearty main course, where we will delve into concepts of deep learning and explore the mathematics behind them.
Photo credit: ipopba/Getty Images/iStockphoto

Welcome back! I am excited you are here. We have covered a lot of ground in Part 1 and Part 2 of this series. Those were appetizers, where we explored some of the basics you would need to know on our journey to understand how to deploy machine learning in the petroleum industry. Part 3 is our hearty main course, where we will delve into concepts of deep learning and explore the mathematics behind them. It's a very good idea to eat your appetizer before the main meal, so do head over to those earlier articles, if you haven't read them yet, or refresh your memory, before continuing here.

With that said, let's jump into Part 3 where we will explore the world of deep learning.

In Part 1, we discussed the four steps of a machine learning algorithm.
1) Initialize parameters
2) Compute cost function
3) Compute gradient descent and update it
4) Repeat steps 2 and 3

In our linear regression model, we initialized parameters (*w* and *b*) with zero, which was fine for that case. However, for a neural network (NN), we cannot initialize w with zero, we must use a random value. If you are wondering why we cannot initialize w with zero, the answer is simply one word: math.

If you want to dig deeper into this math, **watch this video**. If you skip this math, it will not hurt your machine learning understanding. Just remember that it's necessary to start *w* with a small random number (not zero and not too large) while *b* can be initialized with zero. The question then becomes how to initialize *w* with a random value.

Machine Learning Guide ... continued

He et al. (2015) derived a robust initialization method for *w* which is: initialize *w* with a small random value and multiply it with sqrt(2/no. of neurons in the previous layer) or √(2/no. of neurons in the previous layer). This method ensures that the weights of the neurons in each layer of the neural network are neither too small nor too large, which helps prevent vanishing or exploding gradients during training. Vanishing gradients happen when early layer gradients (derivatives) are too small, leading to slow or no weight updates, while exploding gradients happen when early layer gradients are too large, causing unstable training.

Mathematically, the initialization method proposed by He et al. is:

$$w = Small\ Random\ Value * \sqrt{\frac{2}{number\ of\ neurons\ in\ previous\ layer}} \rightarrow \text{Eq. 1}$$

For the first hidden layer, the number of neurons in the previous layer is the number of features of input, while for the other layers, it is self-explanatory. More about it will be discussed later. For now, let's revise the two hidden layers NN algorithm (configuration), which we explored in Part 2, by visualizing **Fig. 1**. Here, X is the input to the first hidden layer (with one neuron) and a1 is its output. The a1 then becomes the input to the second hidden layer which gives a2 as the output. The a2 is then fed to the final layer (output layer) which gives the ŷ.

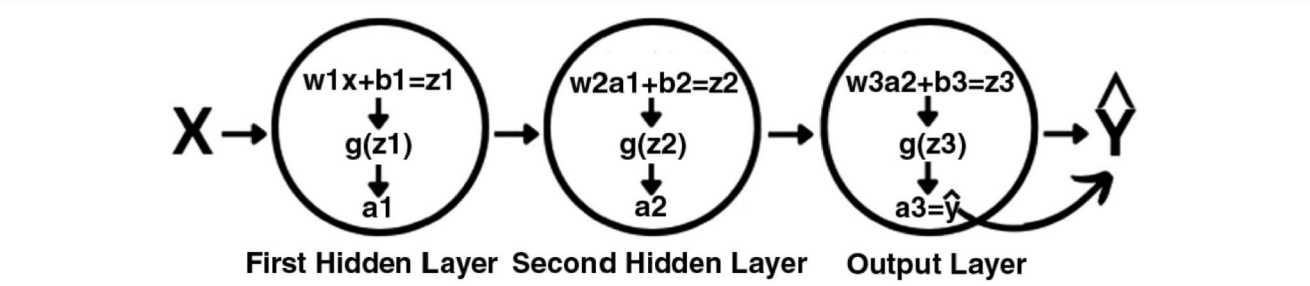

Fig. 1—Two hidden layer model. All images by author.

In Fig. 1, the neural network architecture has a total of three layers: two hidden layers and one output layer. It's important to note that, in machine learning convention, the input layer is not counted as a layer. So, if a model has five layers in total, it means that there are four hidden layers and one output layer.

It's also important to note that in machine learning, *w* and *b* are typically represented as vectors (matrices) rather than scalars (single digits). Therefore, it's essential to understand how to perform basic operations such as multiplication and addition with matrices. To multiply two matrices, the number of columns in the first matrix must match the number of rows in the second matrix. Then, the product of the two matrices is obtained by taking the dot product of each row in the first matrix with each column in the second matrix. The result is a new matrix with the same number of rows as the first matrix and the same number of columns as the second matrix. For a visual representation of matrix multiplication, see Fig. 2.

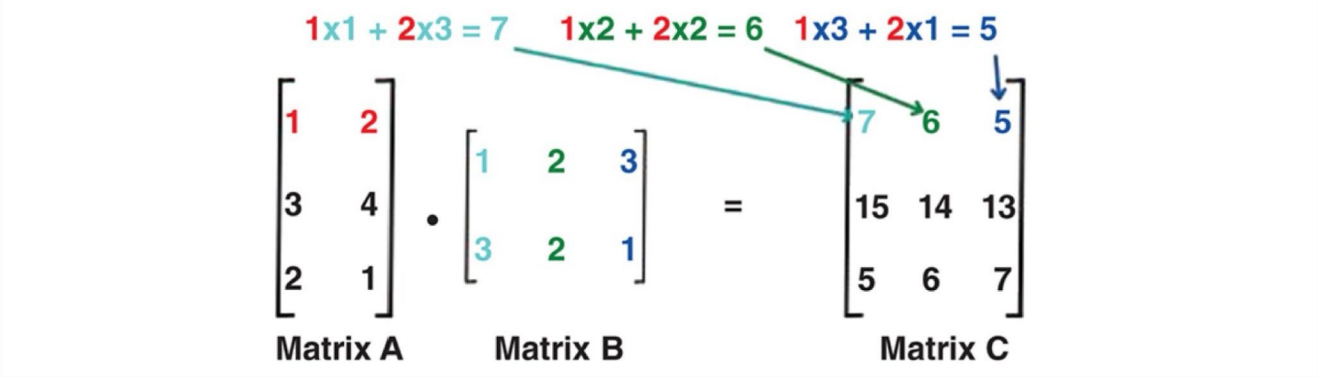

Fig. 2—Matrix multiplication.

Machine Learning Guide ... continued

Adding or subtracting matrices is a straightforward operation. Simply add or subtract the corresponding elements of each matrix. If you need to add a scalar value (a single digit) to a matrix, you can do so by adding that scalar value to each element of the matrix. **Fig. 3** provides a visual representation of these operations.

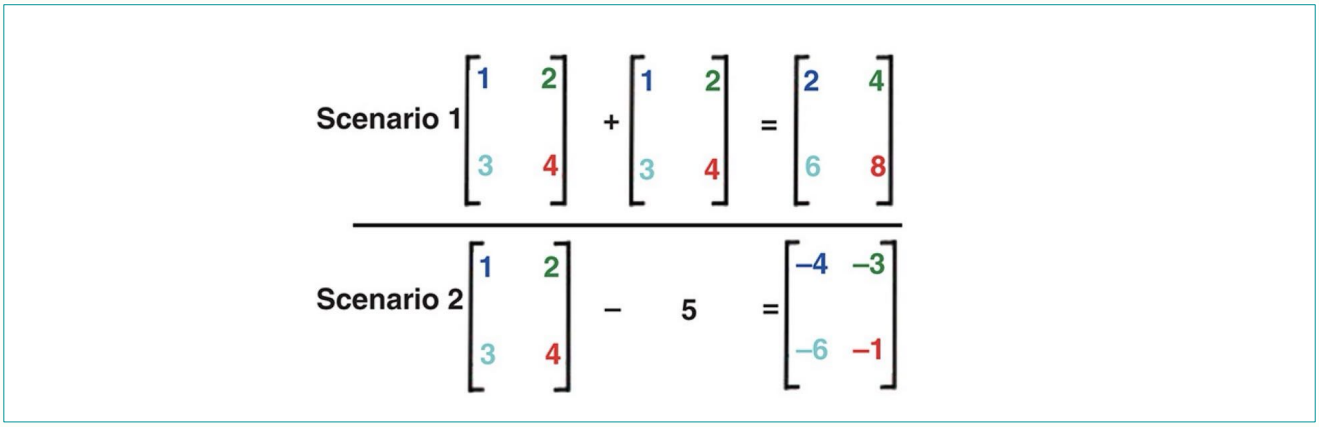

Fig. 3—Matrix add/subs.

Now that you understand matrix operations such as multiplication and addition, as well as how to initialize the parameters in a neural network, it's important to clarify the notation used to represent matrices and vectors. In particular, we will use capital letters such as W to represent matrices, and lowercase letters such as *w* to denote their individual components. For example, *W1* is the weight matrix for the first hidden layer, and it contains values *w1*, *w2*, *w3*, etc., which correspond to the first, second, and third neuron of that layer. Similarly, we use *A1* to represent the output of the first hidden layer in matrix form, with *a1*, *a2*, *a3*, etc. representing the individual values inside that matrix. The same notation is used for *A2*, *A3*, and so on. However, in machine learning convention, matrix *b* is also represented by *b* (not *B*). **Fig. 4** provides a visual representation of this concept for a neural network with two hidden layers, each containing two neurons, and an output layer with one neuron.

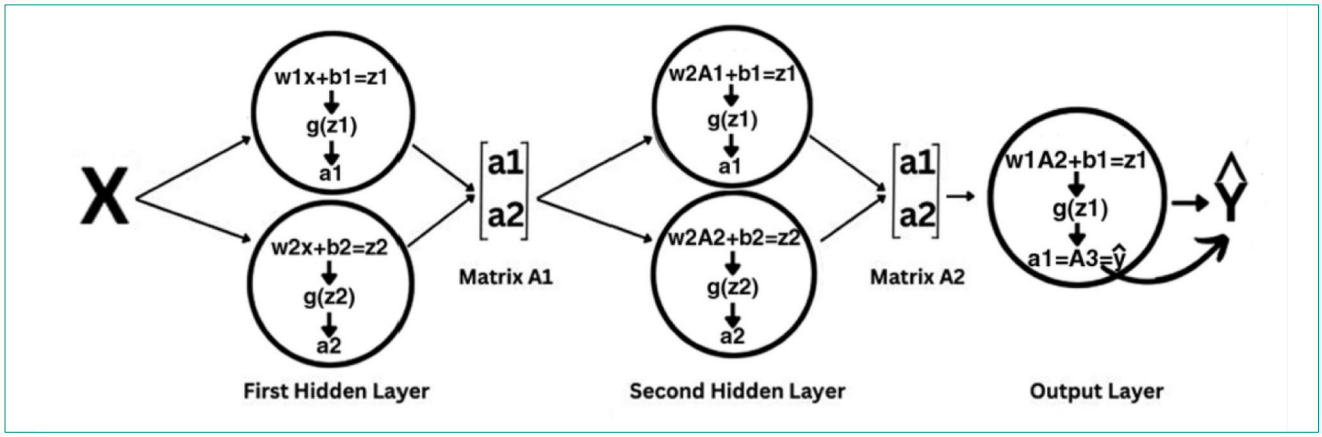

Fig. 4—Hidden layers with matrix concept.

Note that in Fig. 4, the values of *w1* and *w2* of the first hidden layer are different from the values of *w1* and *w2* in the second hidden layer. In machine learning, we have different symbols for both, but I decided to keep things simple by not introducing more notations. Same goes for *z1*, *z2*, *a1*, and *a2*.

Now it's time to discuss one of the paramount concepts: dimensions of *X*, *W*, and *b*. The dimension of *X* depends on the number of features (*n*) and the number of samples (*m*). Similarly, the dimension of *W* depends on the number of neurons and the number of features. The features are the parameters on which output is dependent. Let's say we have a hundred values of density log, neutron log, and sonic log, and a hundred values of their corresponding permeability. If these logs are the input to a machine learning model and the output is the permeability, then the number of features is three (density, neutron, and sonic) and denoted by *n*.

Machine Learning Guide ... continued

And, as discussed in Part 1, the number of examples, inputs, *X*, and samples (different names for the same thing) is 100, denoted by *m*.

In the case of the input matrix *X*, the number of rows should equal the number of features (*n*), and the number of columns should equal the number of samples (*m*). For example, if we have 100 values of porosity as input to a neural network, then the dimension of *X* would be 1×100, one feature (porosity) and 100 samples.

For the first hidden layer, the number of rows in *W1* should equal the number of neurons in that layer, and the number of columns should equal the number of features in the input. For example, if the first hidden layer contains three neurons and we have one feature (porosity) in the input, then *W1* should be a 3×1 matrix.

Similarly, for the second and subsequent hidden layers, the number of rows in the weight matrix (*W*) should be equal to the number of neurons in thatlayer, and the number of columns should be equal to the number of neurons in the previous layer. For example, for *W3*, the number of rows should be equal to the number of neurons in the third hidden layer, and the number of columns should be equal to the number of neurons in the second hidden layer.

For bias (*b*), the number of rows should equal the number of neurons in that layer, and the number of columns should always be 1.

Once we have initialized the correct dimensions for *W* and *b*, the dimensions for the output matrices *Z* and *A* will automatically be calculated.

To further concrete this concept, let me give you an example. Suppose we have input *X* as porosity and output *Y* as permeability as shown in **Table 1**. Our task is to train the NN model to predict permeability.

Porosity (*X*)	Permeability (*Y*)
13.76	193.72
9.60	105.71
11.66	138.53

Here, the number of features, *n*, is one (porosity), and the number of inputs or number of examples, *m*, is three. Let's create a three-layer neural network (two hidden layers and one output layer). Let's assume that each hidden layer has three neurons, and the output layer has only one neuron as shown in **Fig. 5**.

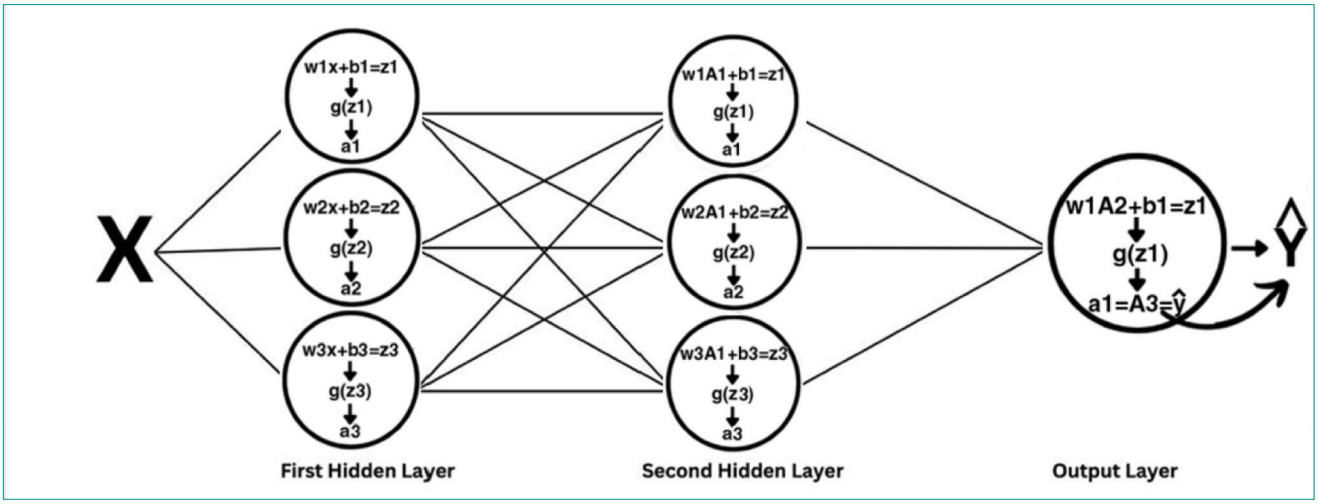

Fig. 5—Three-layer neural network.

Machine Learning Guide ... continued

So, the dimension of *X* should be 1×3 (the number of features, number of examples). *W1* should be 3×1 (the number of neurons of the first hidden layer which is three in this case, and the number of features which is one, porosity, in this case). Similarly, the shape of *b1* should be 3×1, as the number of rows should be equal to the number of neurons of the first hidden layer, and the number of columns should be equal to one. By the same intuition, we can determine the dimension of the second and third layers. To familiarize yourself with these concepts, see **Fig. 6**.

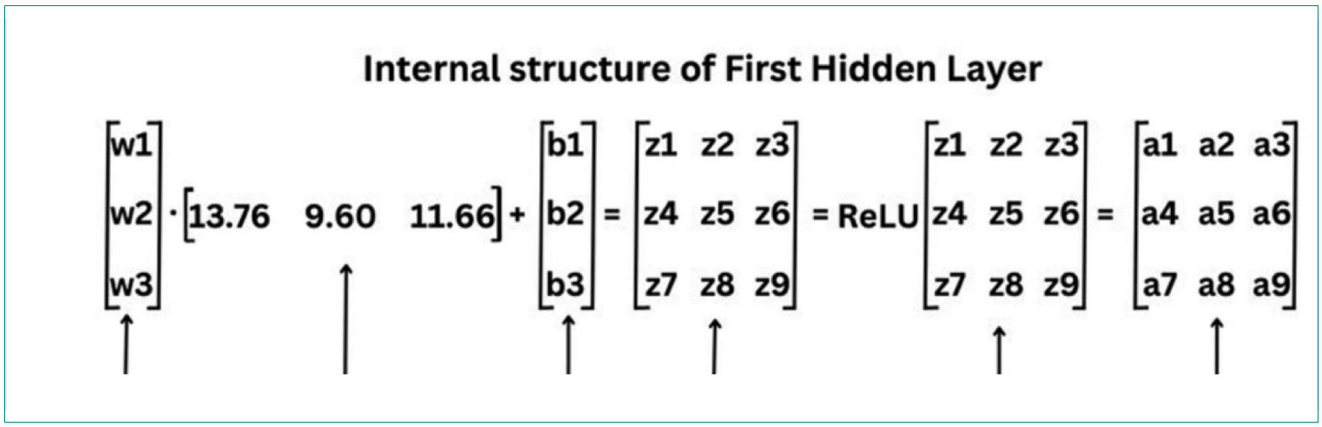

Fig. 6—Internal structure of the first hidden layer.

Fig. 6 represents the internal structure of the first hidden layer. Firstly, we multiply matrix *W1* with matrix *X*. Remember the general rule of matrix multiplication: the shape of a new matrix will have the same number of rows as the first matrix and the same number of columns as the second matrix.

So, the resultant matrix after a dot product of *W1* and *X* has the shape of 3×3 (not shown in Fig. 6). Then we add *b1* to get *Z1*. The shape is still 3×3. Then we apply the ReLU activation function (discussed in Part 2) to *Z1*, denoted by *g(Z1)*, to get *A1*. The shape is still 3×3. That *A1* is now input to the second hidden layer.

Up to this point, you have acquired an understanding of how to initialize parameters and the dimensions of all the matrices involved in the process. Now let's proceed with implementing the four steps of machine learning as discussed in Part 1, step by step, using the dataset presented in Table 1.

Step 1: Initialize Parameters

We will be using the same three-layer model as shown in Fig. 5 and the data shown in Table 1. As a recap, the shape of our input *X* (porosity) is 1×3, while the shape of *W1* is 3×1 and the shape of *b1* is 3×1. Similarly, for the second layer, the shape of input *A1* is 3×3, W2 is 3×3, and *b2* is 3×1. The shape of the last layer, which produces the predicted permeability (A3 or Ŷ), is 1×3. It's crucial to understand this concept, so if you're not clear on it, please reread all the text after Fig. 5.

Now let's initialize the values of *W* and *b*. As previously mentioned, we'll use the method proposed by He et al. to initialize the weight (Eq.1). For simplicity, I assume that "small random value" is equal to 1 (but for real problems, it is recommended to initialize the weights with different random values, not just 1). Therefore, initializing *W* will just be sqrt(2/no. of neurons in the previous layer). Since our input *X* has only one feature, for *W1*, no. of neurons in the previous layer is equal to 1.

So, all the values of *W1* are initialized to √(2/1) = 1.41. For the second hidden layer, no. of neurons in the previous layer (first layer) is equal to 3, so all the values of *W2* are initialized to √(2/3) = 0.81. Finally, for the output layer, no. of neurons in the previous
layer (second layer) is equal to 3, so all the values of *W3* are initialized to √(2/3) = 0.81. We can start all the values of *b* with zero. Fig. 7 is a visualization of all the values of *W* and *b*.

Machine Learning Guide ... continued

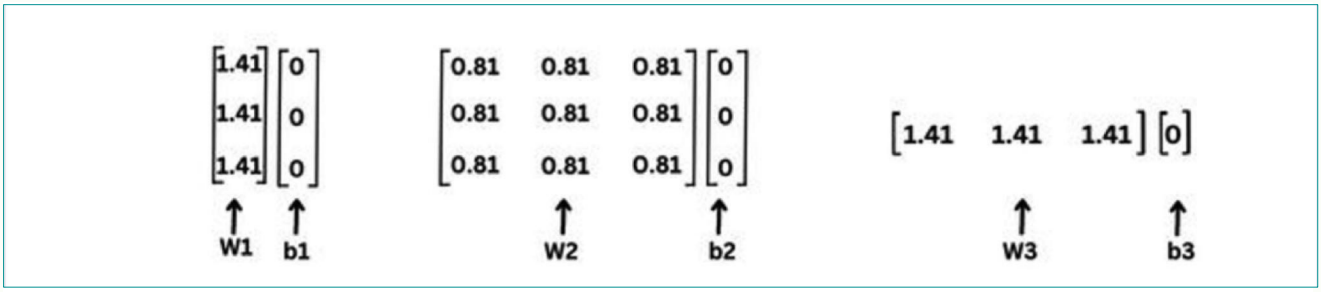

Fig. 7—Initialize W and b.

Step 2: Cost Function

From Part 1, we are aware that to find the cost function, we need to first find $\hat{Y}$. And for $\hat{Y}$, we need to do the calculations of all the layers of our neural network. **Fig. 8** shows the calculation of the first hidden layer.

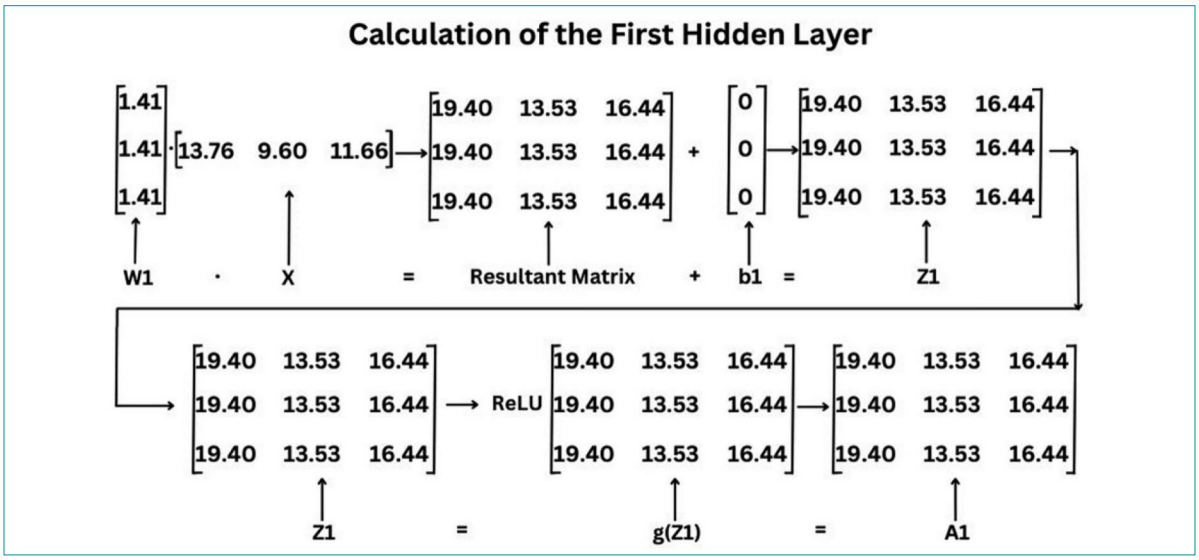

Fig. 8—Calculation of the first hidden layer.

Now we have *A1*, the output of the first hidden layer. We will feed this into the second hidden layer as an input. Recall that the weight matrix *W2* has dimensions 3×3, with values of 0.81, and the bias matrix *b2* has dimensions 3×1, with all zeroes. **Fig. 9** shows the calculation of the second hidden layer.

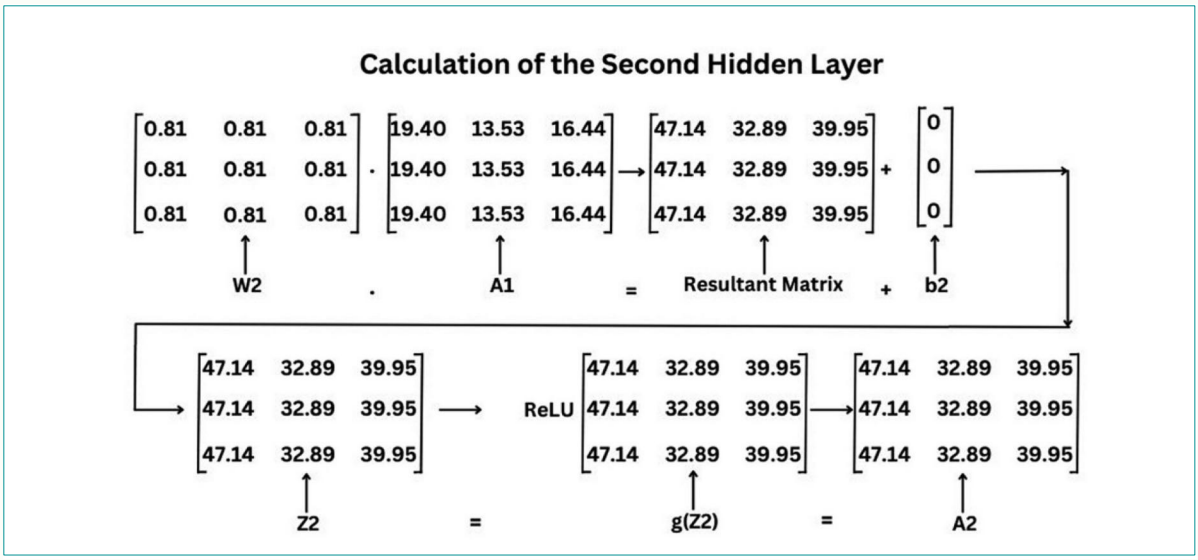

Fig. 9—Calculation of the second hidden layer.

Machine Learning Guide ... continued

Now it's time to feed *A2* to the last layer. We know that *W3* is 1×3 matrix with values of 0.81 and *b3* is 1×1 matrix with zero. **Fig. 10** is a visual representation of the last layer's calculation.

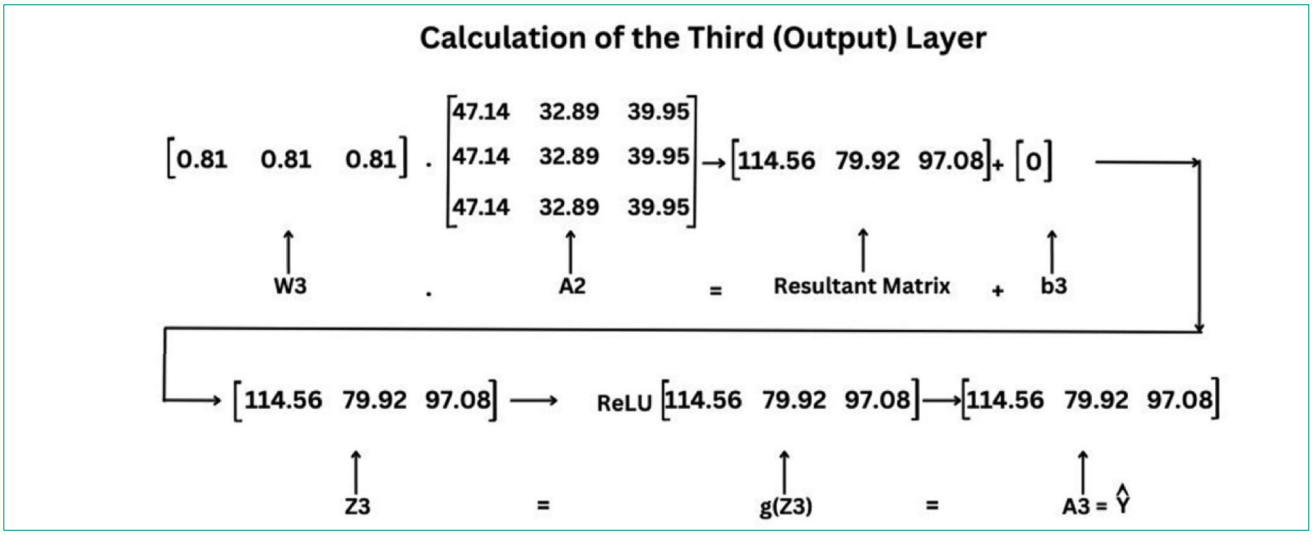

Fig. 10—Calculation of the final layer.

So, finally, we have our last output, $\hat{Y}$. This is our predicted permeability in a matrix form, at a given value of porosity. Now it's time to find the cost function. As we learned in Part 1, the cost function *J* is:

$$J = \frac{1}{2m}\sum_{i=1}^{m}\left(\hat{Y} - Y\right)^2$$

We now have our predicted permeability values, denoted as $\hat{Y}$, and the actual permeability values, denoted as *Y*, both in vector form (matrices), so $\hat{y}$ and *y* are the values inside the $\hat{Y}$ and *Y*, respectively. We can find the difference between the two vectors by subtracting the values elementwise. In the case of this example, $\hat{Y}$ is [114.56, 79.92, 97.08] and *Y*, from Table 1, is [193.72, 105.71, 138.53], so the difference is [-79.15, -25.78, -41.44]. We can then square each element of this difference vector to obtain [6264.72, 664.60, 1717.27].

The cost function *J*, as defined in Part 1, is obtained by summing up these squared differences and dividing them by *2m*, where *m* is the number of samples, which is 3 in this case. Thus, *J* = (12467.95 + 2348.37 + 4759.62) / (2 * 3) = 1441.09. This cost is quite high, indicating that our model is not yet accurately predicting permeability. Here comes the third step to decrease the cost.

Step 3: Gradient Descent

As discussed in Part 1, we need to take small steps to decrease the cost. We will do that by finding the current value of slope (derivative) and then adjusting it slowly to find the updated values for *W* and *b*.

In Part 1, we determined the derivative of *J* with respect to (w.r.t) *w* and *b* because we had only one layer. But here, we have three layers, so, we need to find the derivatives of *A*, *Z*, *W*, and *b* of all layers, starting from the last (output) layer and moving backward to the hidden layers (second and first layer).

From Part 1, we are aware of Mean Square Error (MSE) which is also called the Loss function. Let's denote it by *L*. Here, *A3* is the "result of the last layer" which is also equal to $\hat{Y}$. See the equation on the next page.

Machine Learning Guide ... continued

$$L = \frac{(\hat{Y} - Y)^2}{2}$$

Now take the derivative of *L* w.r.t Ŷ. Let's denote the derivative term by *dA3* (d for the derivative of *L* and *A3* means w.r.t A3). So, the derivative of the above equation is:

$$dA3 = (\hat{Y} - Y)$$

Now it's time to find the derivative of L w.r.t Z3, denoted by *dZ3*. It is equal to *dA3*g'* where *g'* shows the derivative of ReLU and is read as g prime.

One point to note is that *g'* is a vector (matrix). In the case of ReLU, all the values of *g'* are equal to 1 for all the positive values of *Z*, and equal to zero for all negative and zeroes. In this case, we have only positive values in *Z3*, so, all the values of g' are equal to 1. In other words, *dZ3* is equal to *dA3* since the derivative of ReLU with respect to *Z3* is equal to 1 for all positive values. Therefore, the derivative of L w.r.t Z3 is:

$$dZ3 = dA3$$

And the derivatives of L w.r.t *W3* and *b3*, denoted by *dW3* and *db3* respectively, are:

$$dW3 = \frac{dZ3.A2^T}{m}$$

$$db3 = \frac{\sum dZ3}{m}$$

Where *T* in *dW3* means transpose of vector *A2* and ∑ in *db3* shows the sum of all the values of *dZ3* (kept in matrix forms).

If you're interested in learning more about how we derive these derivatives, you can check out this video [LINK **https://www.coursera.org/lecture/neural-networks-deep-learning/backpropagation-intuition-optional-6dDj7**] after completing this article.

However, if you're not interested in the calculus behind it, you can skip the video and it will not affect your overall understanding of deep learning.

But it is recommended that you see all the derivative calculations of the third layer in **Fig. 11 (see overleaf)**.

Machine Learning Guide ... continued

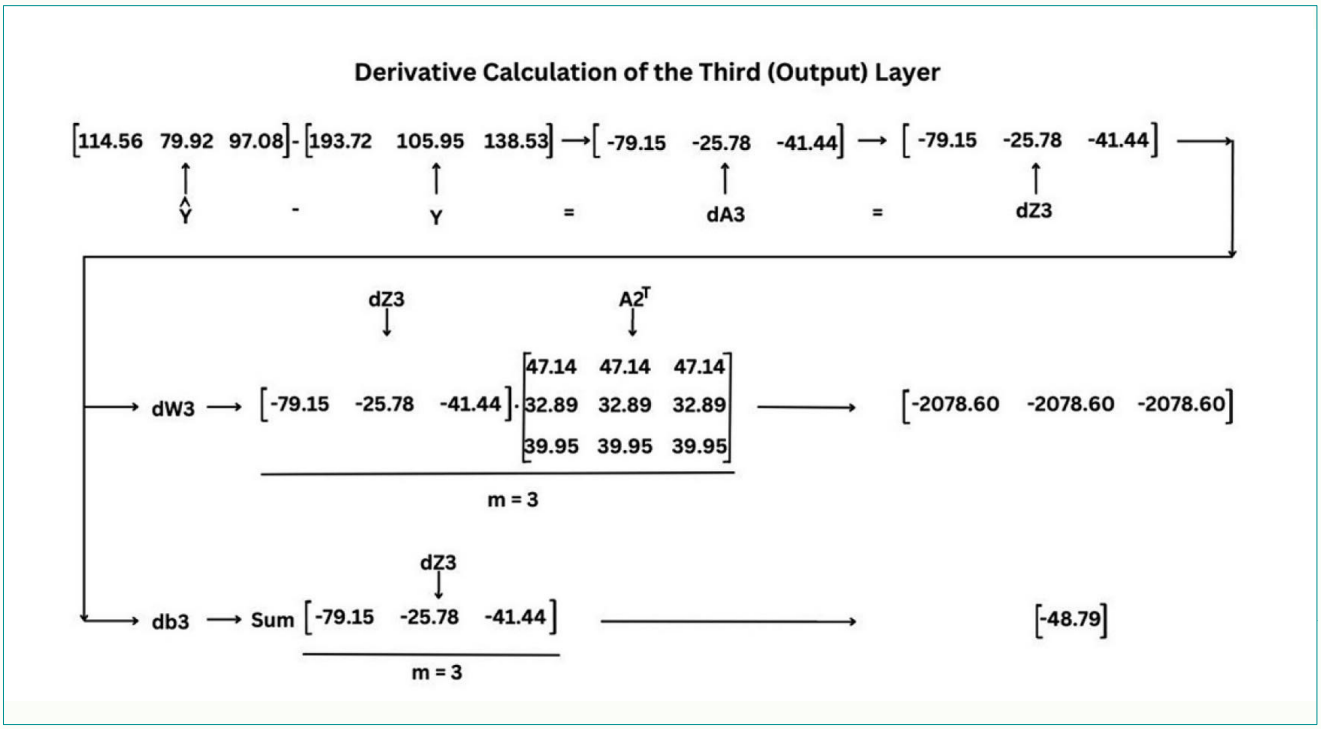

Fig. 11—Derivative calculation of the output layer.

Now it's time to calculate the derivative for the hidden layers. The steps are similar to the output layer, except for the *dA* term. The following are the derivatives for the second hidden layer; **Fig. 12** shows the calculations:

$$dA2 = W3^T . dZ3$$

$$dZ2 = dA2$$

$$dW2 = \frac{dZ2 . A1^T}{m}$$

$$db2 = \frac{\sum dZ2}{m}$$

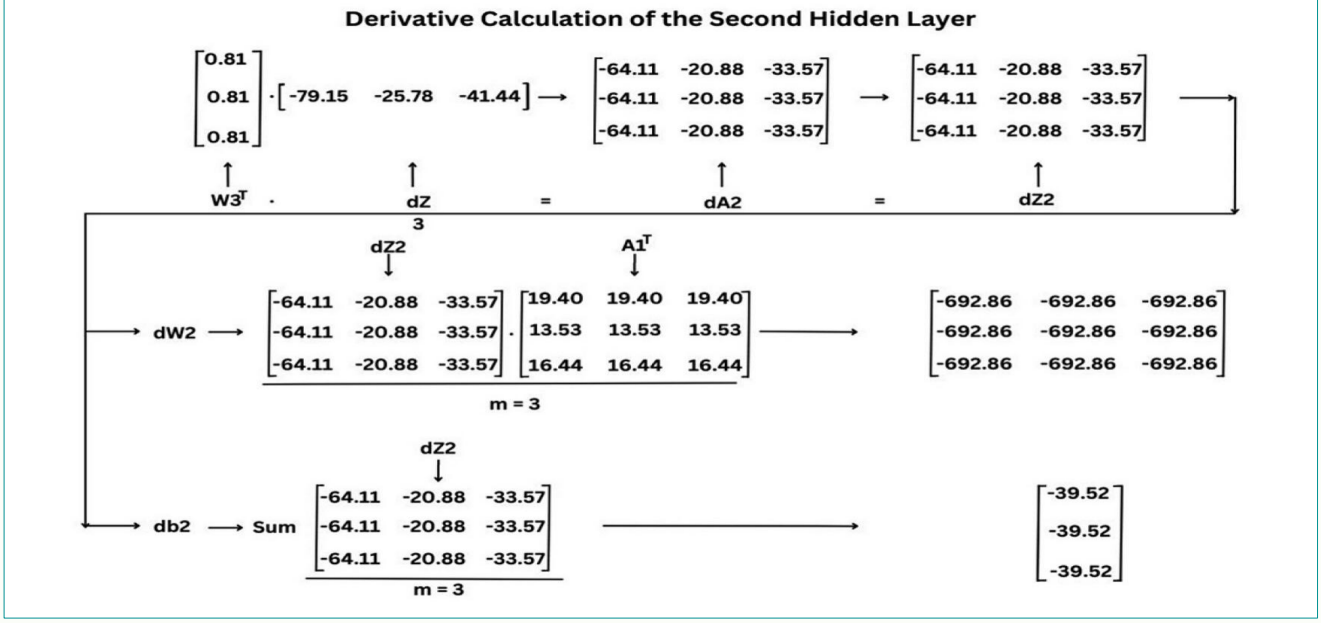

Fig. 12—Derivative calculation of the second layer.

Machine Learning Guide ... continued

The derivatives for the first hidden layer are as below and **Fig. 13** shows calculations:

$$dA1 = W2^T . dZ2$$

$$dZ1 = dA1$$

$$dW1 = \frac{dZ1 . X^T}{m}$$

$$db1 = \frac{\sum dZ1}{m}$$

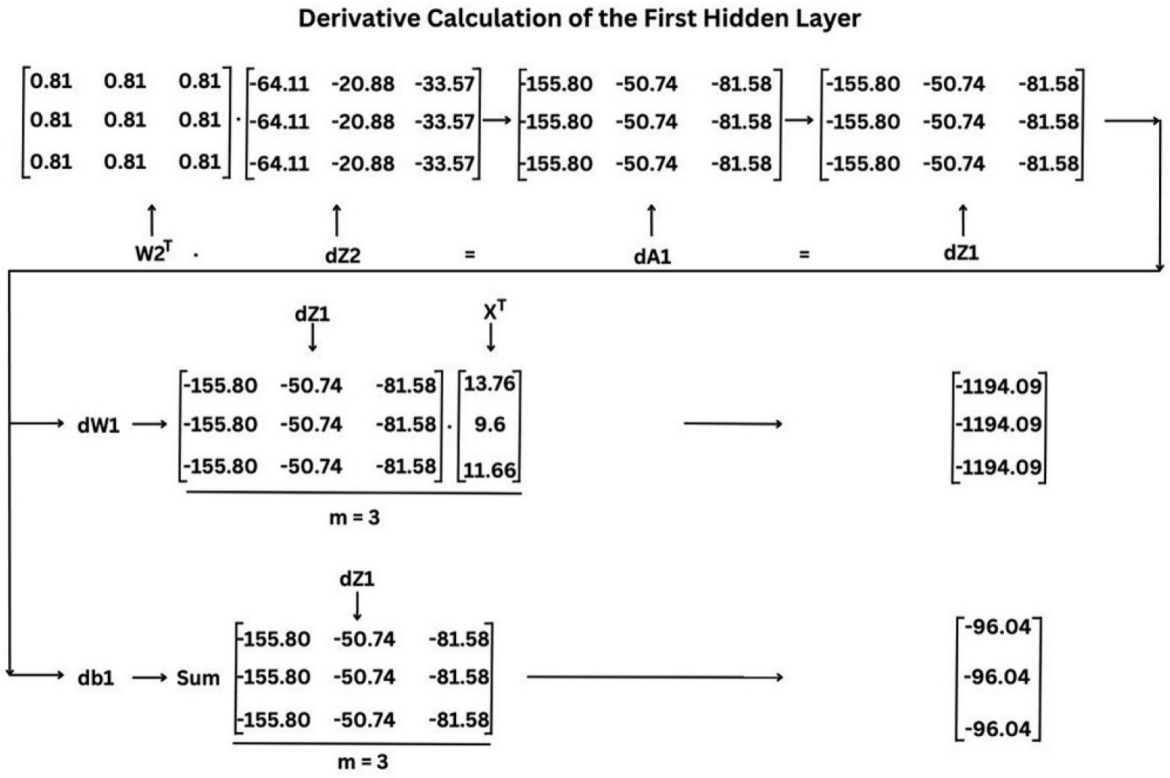

Fig. 13—Derivative calculation of the first hidden layer.

Now that we have calculated the derivative values for all parameters (*W* and *b*), it's time to update them (update gradient descent). As a quick reminder, the formulae from Part 1 are:

$$w_{(\text{updated})} = w_{(\text{current})} - \alpha * \frac{\partial \bar{J}}{\partial w}$$

$$b_{(\text{updated})} = b_{(\text{current})} - \alpha * \frac{\partial \bar{J}}{\partial b}$$

Machine Learning Guide ... continued

Let's rewrite them according to the previous notations.

$$W3_{(updated)} = W3_{(current)} - \alpha * dW3$$

$$b3_{(updated)} = b3_{(current)} - \alpha * db3$$

$$W2_{(updated)} = W2_{(current)} - \alpha * dW2$$

$$b2_{(updated)} = b2_{(current)} - \alpha * db2$$

$$W1_{(updated)} = W1_{(current)} - \alpha * dW1$$

$$b1_{(updated)} = b1_{(current)} - \alpha * db1$$

Assume α is 0.01. See all the calculations in **Fig. 14**.

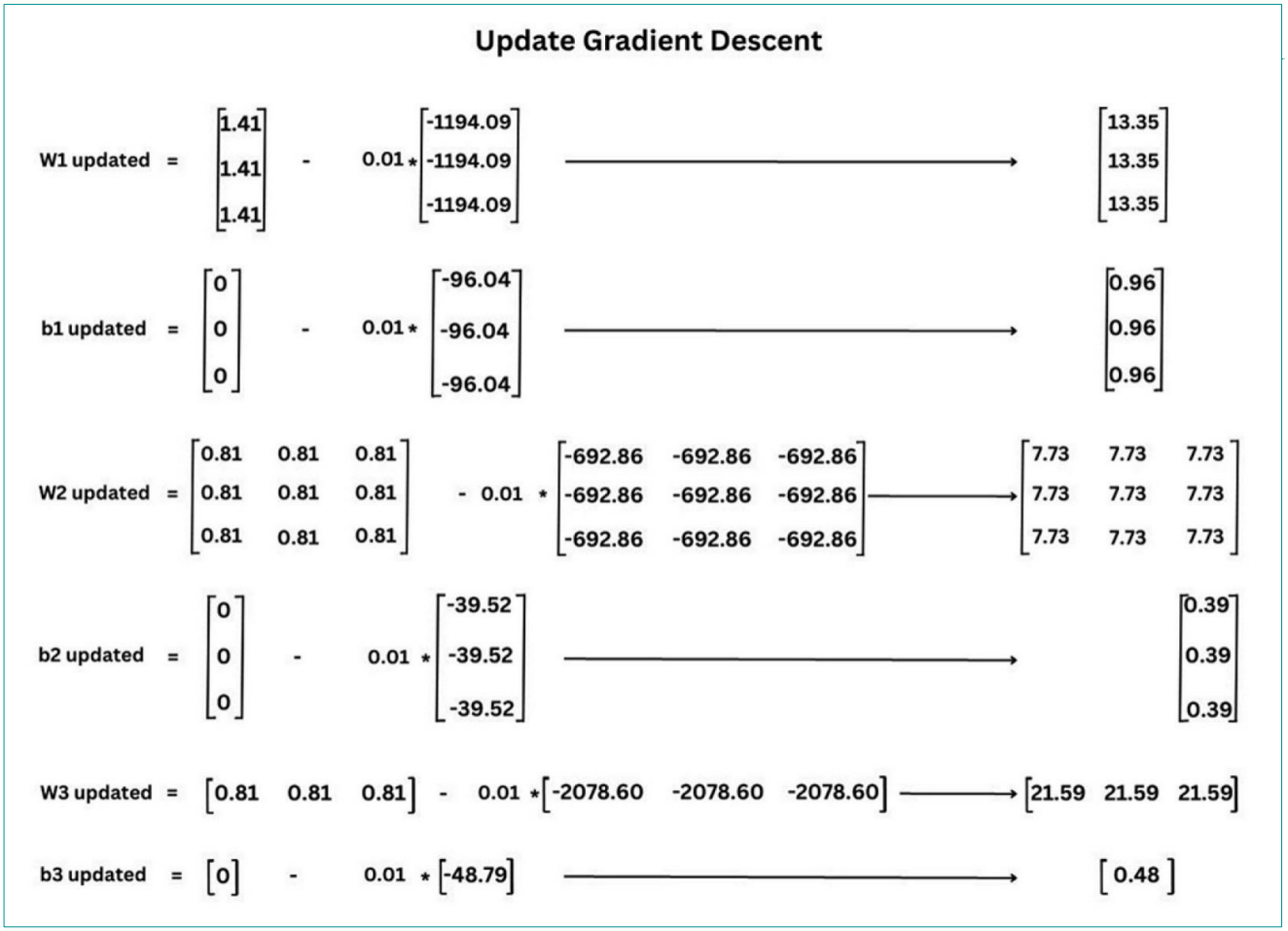

Fig. 14—Update gradient descent.

Congratulations! You have successfully completed the first iteration of the three-layer deep neural network. You should be proud of yourself. Now that we have updated the values for the parameters, we can use these values to repeat the Steps 2 and 3 several times to decrease the cost function. This repetitive and monotonous task can be done in Python in a matter of seconds. We will do this in Part 4 with a full set of real field data. We will also go through the data scaling and data distribution (training and testing set) and generalize our intuition to L-Layer neural network, where L is any number of layers in a model.

Thank you for reading all the way to the end, and I hope to see you in Part 4!

SPE events calendar – local and international

LOCAL – in the UK

February 20-21, 2024 (London, UK)
SPE Workshop: Fiber-Optic Sensing Applications for Field Development, Integrity and Optimisation
Delve into the world of fiber-optic monitoring technologies, unlocking their immense potential in optimizing reservoir and field development and operations. Join us at the forefront of innovation and exploration into in-well fiber-optic sensing. Together, let's unlock the potential of these ground-breaking technologies for unparalleled field development, integrity, and optimization.
Register and book in advance.
More information: **SPE workshop**

June 05-06, 2024 (Aberdeen, Scotland)
SPE Oilfield Scale Symposium
Welcome to the prestigious SPE Oilfield Scale Symposium, a premier event tailored for the global oil and gas industry. Prepare to embark on a two-day immersive experience, meticulously designed to cultivate knowledge, foster innovation, and encourage collaboration. Join us as we gather esteemed industry experts, thought leaders, and visionaries under one roof. Prepare to be captivated by the insights, discoveries, and best practices shared by key players across the field.
More information: **SPE Oilfield Scale Symposium**

INTERNATIONAL

December 04-06, 2023 (Buenos Aires, Argentina)
SPE/AAPG/SEG Latin America Unconventional Resources Technology Conference
Latin America URTeC 2023 features plenaries, technical presentations, topical luncheons, poster sessions and networking receptions, and pre-and post-conference field trips and short courses. The event provides space for operators, service companies, academic and research institutions, and government agencies to explore opportunities for maintaining energy demand while preparing for the transition to a decarbonized economy.
More information: **SPE conference**

January 23-24, 2024 (Vienna, Austria)
SPE Workshop: Production Optimisation in Oil and Gas Assets
'Innovate, Adapt, Thrive: Late-Life Production and Beyond'
The Production Optimisation workshop is a high-quality event where experts, operators, and service companies share their latest developments, successes, and failures on late-life production topics in oil and gas assets as well as for new applications such as CO2 storage, geothermal and energy storage.
More information: **SPE workshop**

April 17, 2024 (Bergen, Norway)
SPE Norway Subsurface Conference
Meet with innovators and leaders across the Norwegian Continental Shelf as we welcome you to the 2024 edition of our renowned SPE Norway Subsurface Conference. Running for more than 30 years, it is the perfect platform for collaboration and learning. Focusing on innovation, technology, and the rapidly developing energy transition, it is the place to be to expand your technical knowledge and delve into the key issues facing upstream E&P professionals today.
More information: **SPE conference**

June 26-28, 2024 (Turin, Italy)
SPE Europe Energy Conference and Exhibition
Times call for the scientific community and industry to take on the energy transition's challenges and seize the opportunity to join the energy, environmental, technological and economic communities to ensure energy security, pursue sustainable technology development and promote climate change mitigation. It is this awareness that inspires the new edition of the Europe Energy Conference, Europe's main SPE event. Formerly known as EuropEC.
More information: **SPE Europe Energy conference**

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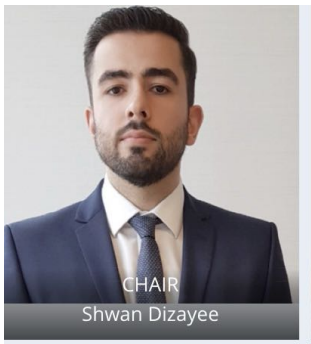
The SPE London board oversees the SPE London activities including our evening programme and other events. Our different committees have specific focus for the members including Young Professionals, Women in Energy, Net Zero, and associated student chapters. As well as engineers who make up our core, we also welcome qualifications in geology, geophysics, earth science, environment, health and safety, mathematics, information technology, as well as management and economics.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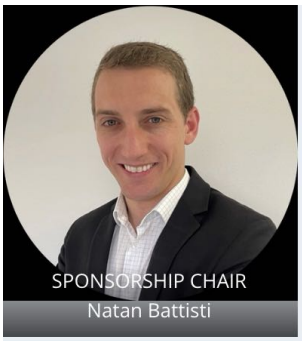
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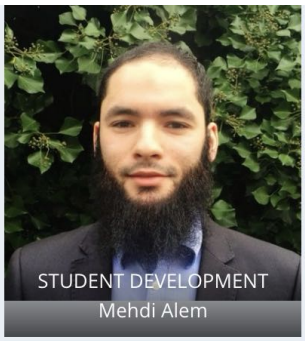
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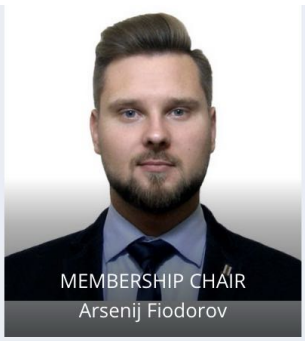
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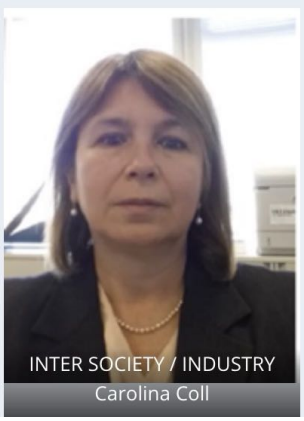
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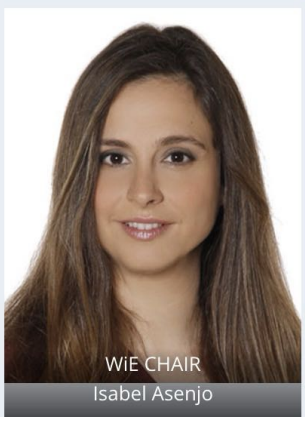
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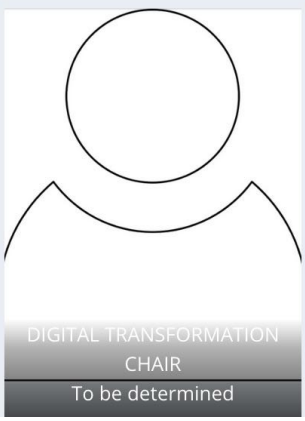
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