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CFD Suite
AI-accelerated CFD

byteLAKE.com/en/CFDSuite

Accelerate your CFD with AI

Slash simulation times, minimize trial-and-error costs,
and supercharge decision-making for heightened productivity.

CFD, Computational Fluid Dynamics
Solving exciting problems across industries

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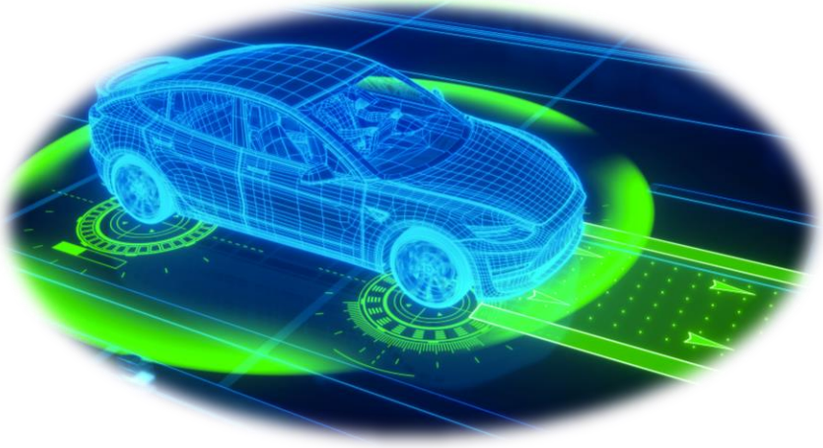
Ensure efficient flow

Improve taste

Fire spread simulation



Aerodynamic simulation

Pollution spread simulation

AI for CFD?

- **Hardware Advancements**
  - In the past, simulations ran on a few nodes, while today, they can utilize hundreds of nodes.
  - Modern processors are significantly faster, accelerating simulation tasks.
- **Software Options**
  - Commercial tools are available, and there are open-source alternatives for various applications.
  - Traditional solvers, sometimes with hardware-optimized algorithms, are also in use.
- **Turnaround Time Challenge**
  - Simulations still take days to complete, but customer expectations have evolved.
  - **Simple flow problems can now be solved within hours, but customers often expect results within minutes.**
- **Thinking Outside the Box**
  - Merely adding more compute power isn't always the solution.
  - Considering alternative choices, such as different numerical methods, while addressing concerns about accuracy.
- **Exploring AI Solutions**
  - **Delving into Artificial Intelligence, Deep Learning, and Machine Learning as potential solutions.**

AI for Computational Fluid Dynamics
Why do we need it?

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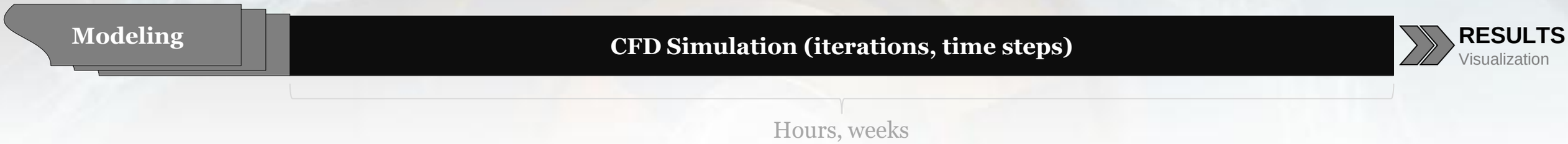
Simulations take days to complete.

Customers need faster time to insights.

AI-accelerated CFD Simulations

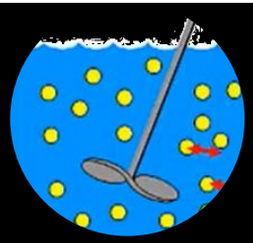
byteLAKE's CFD Suite

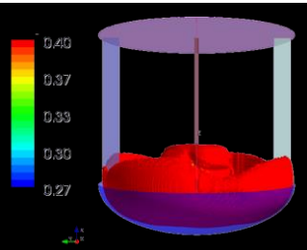
- **Traditional workflow**

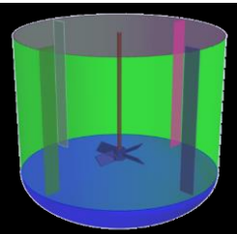


- **byteLAKE's CFD Suite**

2x, 10x, 20x, 40x, ...
FASTER time to INSIGHTS





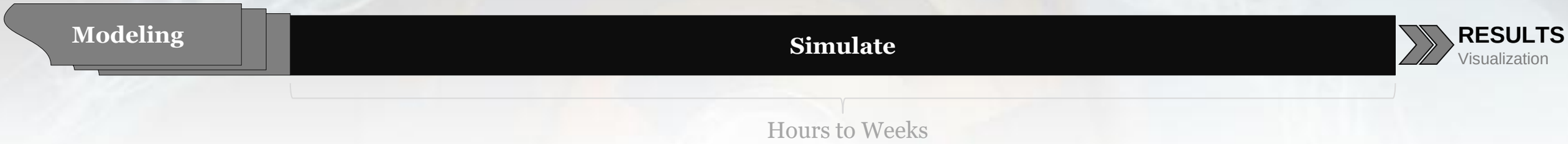


CFD Suite

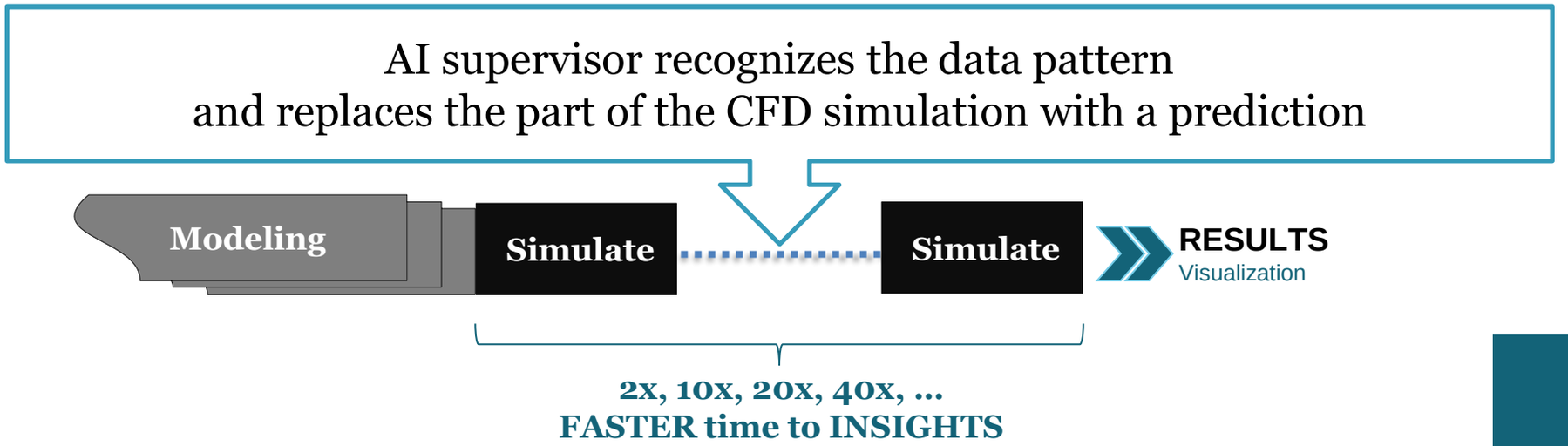
Collection of innovative AI Models for computational fluid dynamics.
byteLAKE.com/en/CFDSuite

byteLAKE's CFD Suite
How does it work?

- **Traditional workflow**



- **byteLAKE's CFD Suite**



Faster Time to Insights
(2x, 10x, 20x, 40x, ...)
with byteLAKE's
CFD Suite's Learning-on-the-Fly
AI Models

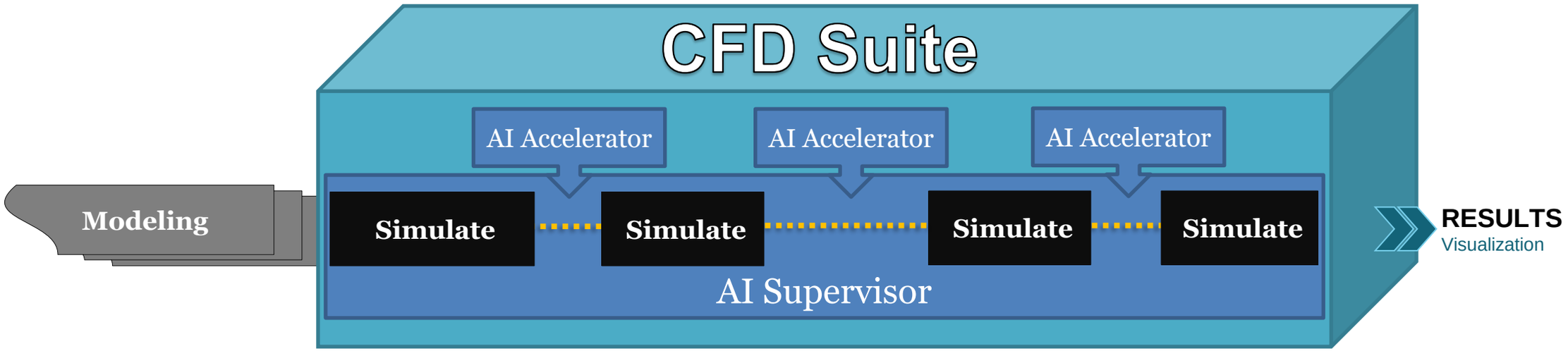
Accuracy is configurable and depends on requirements.

byteLAKE's CFD Suite

AI Accelerator and AI Supervisor

CFD Suite' collaborating modules generate results

- **AI Accelerator,** guarantees acceleration and makes predictions based on a trained pattern
- **AI Supervisor,** guarantees accuracy and decides to:
  - Accelerate once or multiple times during simulation
  - Stop the simulation and return the physics-aware results

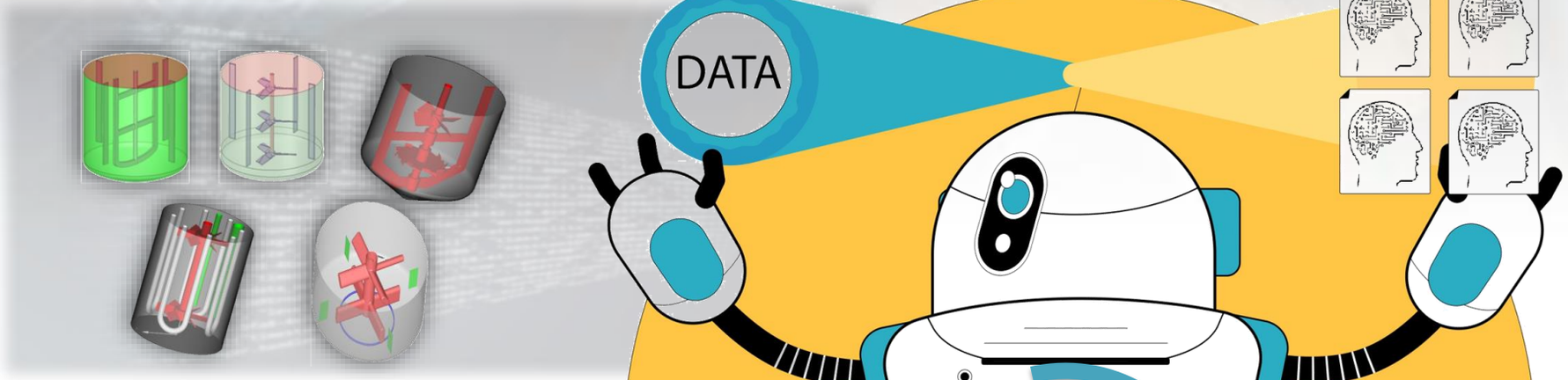


2x, 10x, 20x, 40x, ...
FASTER time to INSIGHTS

byteLAKE's CFD Suite

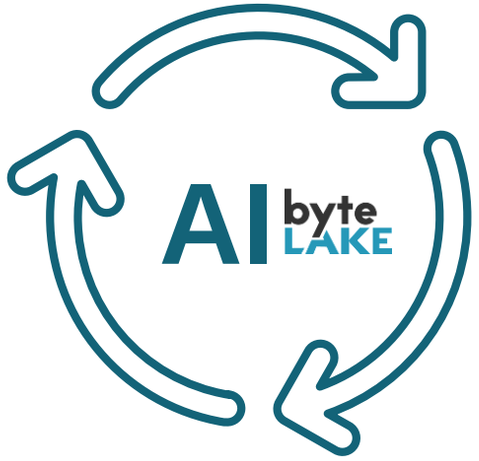
AI model training & calibration

Past simulations (historic data)



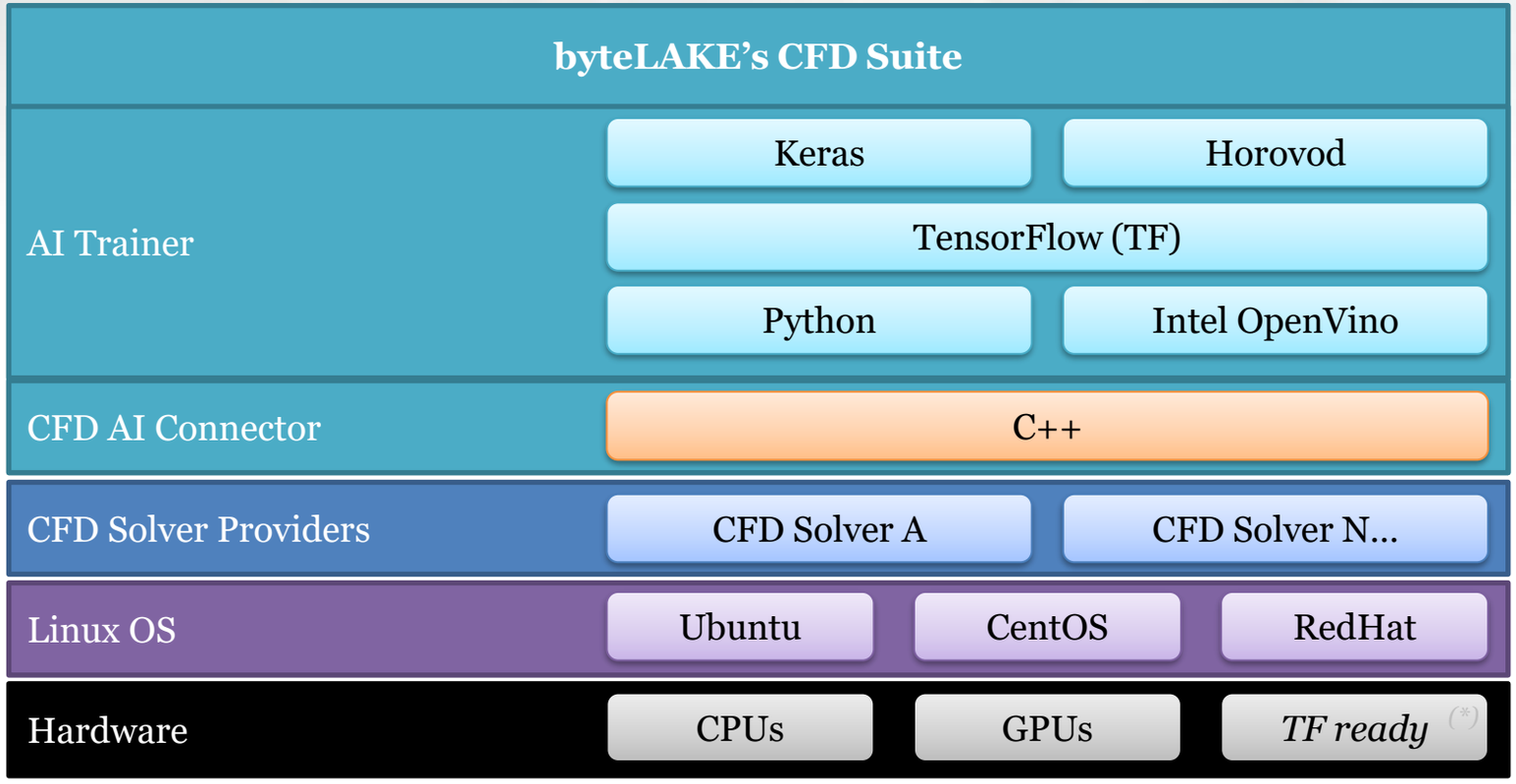
- Leverage data generated by past simulations
- Learning-on-the-Fly

CFD Suite



byteLAKE's CFD Suite
Software Stack (AI training)

Ensuring high portability across various hardware and operating system configurations.



(*) Other hardware accelerators, compatible with TensorFlow.

byteLAKE's CFD Suite
AI Predictions

INPUT DATA

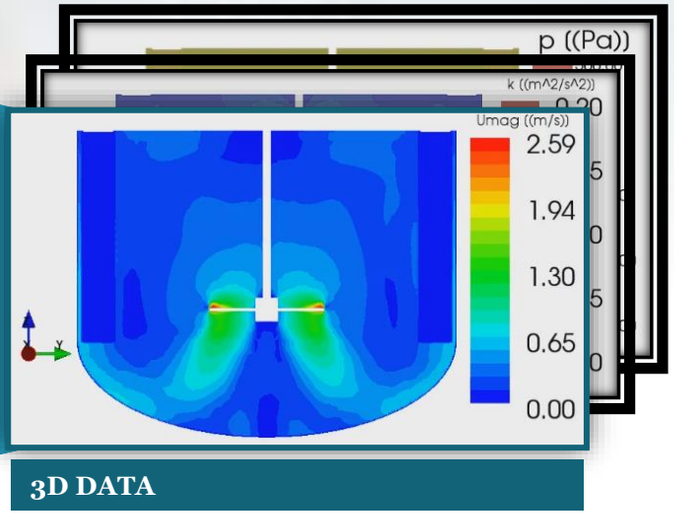
Various options available

ON-PREMISES

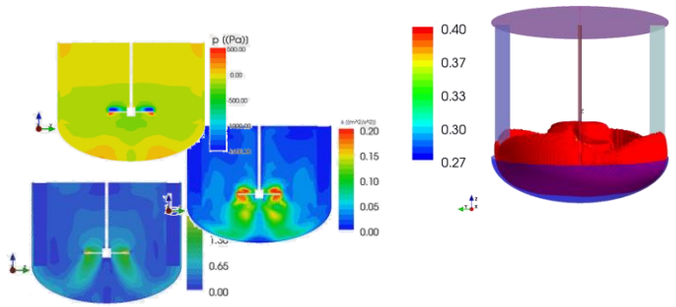
AI byte LAKE

AI-ACCELERATED CFD

RESULTS



3D DATA

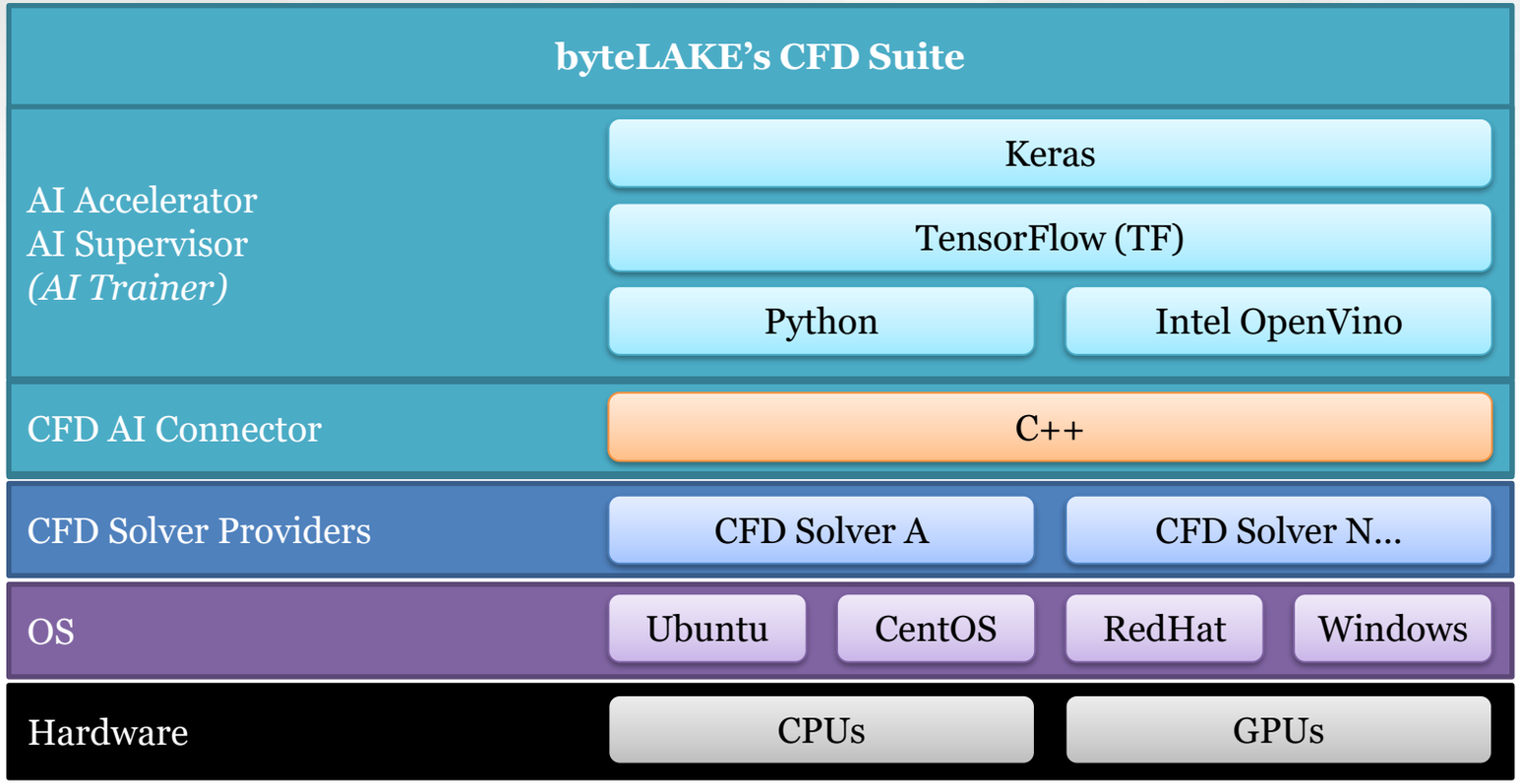


Learn more: byteLAKE.com/en/CFDSuite

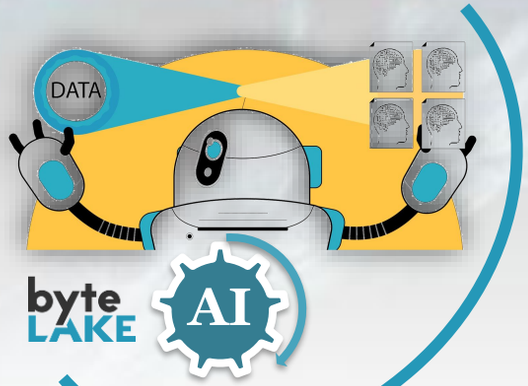
byteLAKE's CFD Suite

Software Stack (AI predictions / deployment)

Ensuring high portability across various hardware and operating system configurations.



Performance & Scalability



Maximum Performance

Edge Servers and HPC

Always optimized for the latest hardware available.
AI training optimized for edge servers and multi-node HPC architectures.

AI Training Performance on Intel's® latest CPUs, GPUs *(soon)*

Scalability report, latest CPUs and GPUs (2024): *(soon)*

AI Training Performance on Edge Server: *bytelake.com/en/download/4018/*

Scalability report (2021): *bytelake.com/en/download/4013/*

Cost Efficient

On-premises

Quick deployment
& no external dependencies.

Scalable Solution

Lenovo

intel XEON inside

intel CORE i7

NVIDIA


Workstations


ThinkEdge SE350


ThinkEdge SE450


ThinkSystem SR650V2


ThinkSystem SR670V2

AI Predictions | AI Training

Hardware

Example configurations.
Other options available.

Benefits
offered by byteLAKE's CFD Suite

Faster Time to Insights
- Swift simulation results enable quicker decision-making and problem-solving.

Cost Reduction
- Lower costs associated with reduced trial and error experimentation.

Rapid Design Iteration
- Accelerated simulations allow for faster prototype design and testing

Improved Productivity
- Enhanced efficiency in research and development processes.

Enhanced Safety Measures
- Quick assessments of safety protocols and potential risks.

Energy Efficiency Optimization
- Faster insights into optimizing energy consumption and resource utilization.

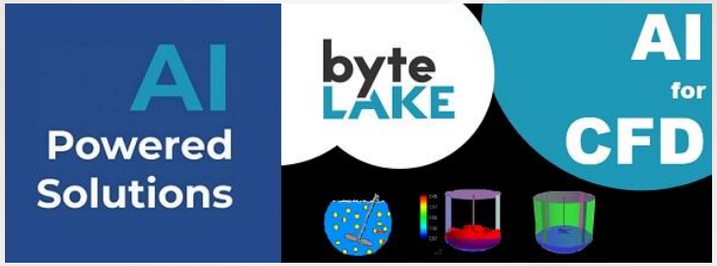
Resource Conservation
- Reduced resource consumption in experimental setups.
- Leverage data generated by past simulations

Competitive Advantage
- Faster product development and innovation lead to a competitive edge.

Real-time Monitoring
- Possibility of real-time monitoring for immediate adjustments.

CFD Suite – case study

Chemical Mixing



AI-accelerated Computational Fluid Dynamics

Accelerate your CFD simulations by leveraging the speed and efficiency of artificial intelligence.

Slash simulation times, minimize trial-and-error costs, and supercharge decision-making for heightened productivity.

Background: chemical mixing

- Many everyday products start in small-scale settings, like home labs, where unique recipes are crafted in pots and pans.

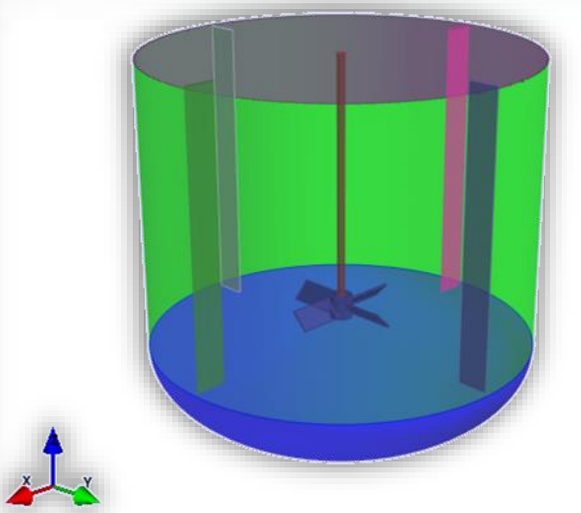
- Scaling up production demands larger tanks.
- The quality of mixing during manufacturing directly influences product quality.

➢ **CFD Simulations play a crucial role.**

Scenario: chemical mixing

- **We've chosen a specific phenomenon for benchmarking, aiming to calculate the stable state of a liquid mixture in a tank featuring a single impeller and baffles.**

- By adjusting input parameters, we simulate several quantities:
  - Velocity vector field (U)
  - Pressure scalar field (p)
  - Turbulent kinetic energy (k)
  - Turbulent dynamic viscosity (mut)
  - Turbulent kinetic energy dissipation rate (epsilon)



3D DATA

CFD Simulation
Chemical Mixing

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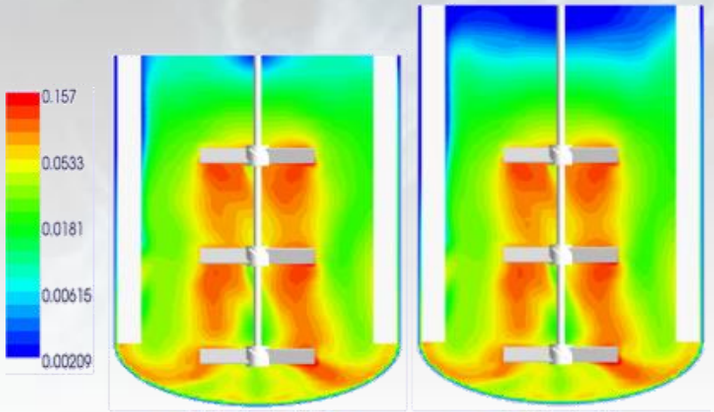
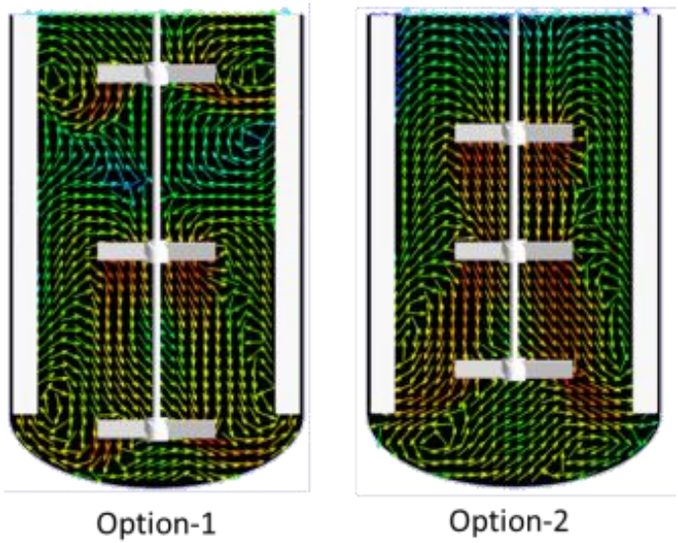
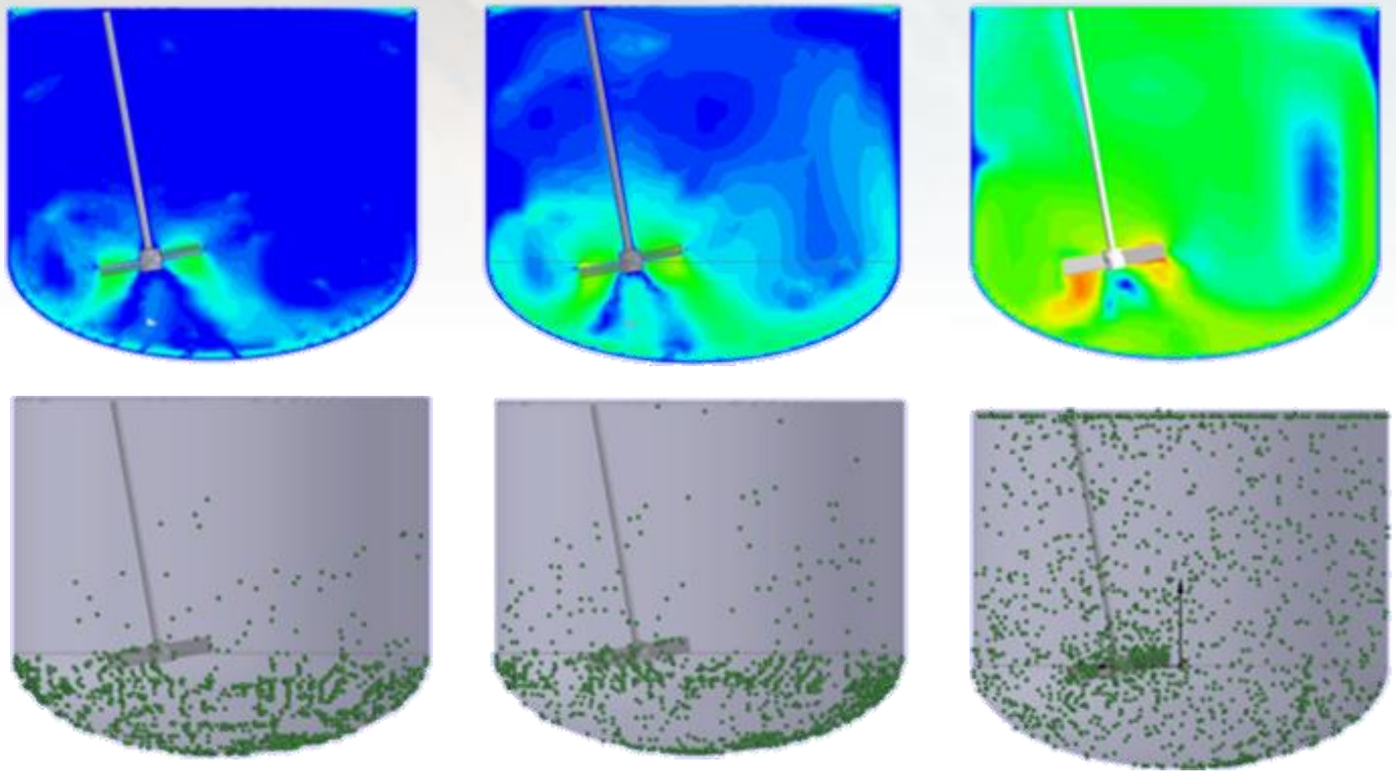




Perform CFD Analysis
to check the solids suspension profile



Simulations powered by:

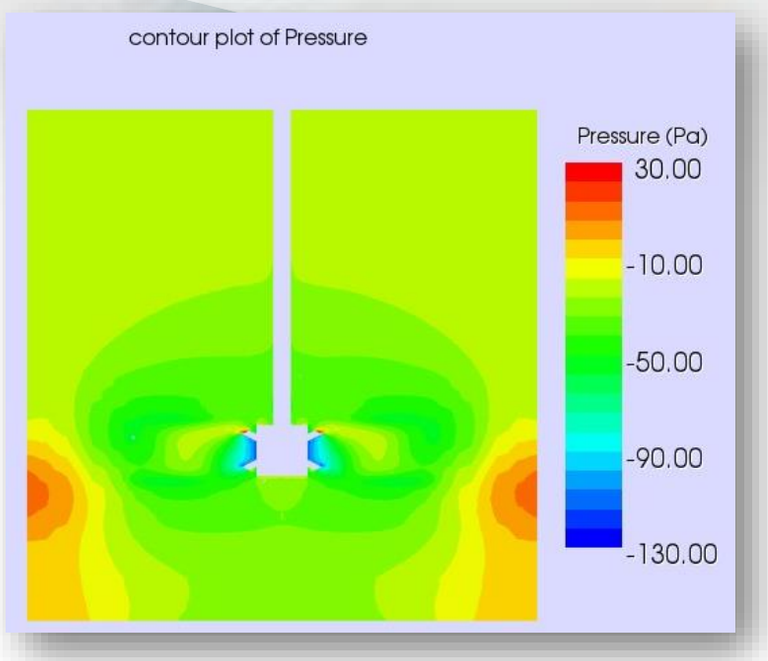
Tridiagonal® Solutions
compute | innovate | develop

MixIT
The Enterprise Mixing Analysis Tool

It takes 4-8hrs to complete such simulations. AI can reduce that time to minutes.

byteLAKE's CFD Suite
AI Predictions

Results generated by CFD Solver

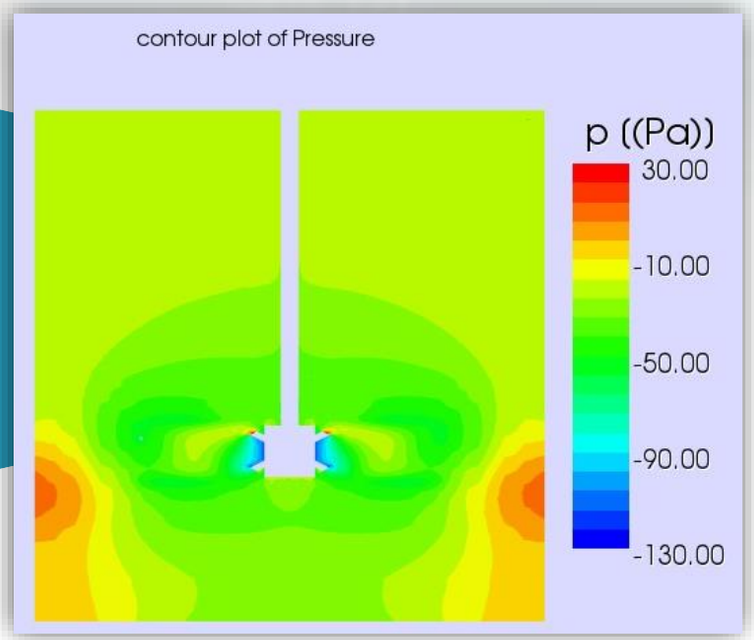


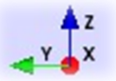
AI byteLAKE

CFD Suite

AI-ACCELERATED CFD

Results generated by CFD Suite

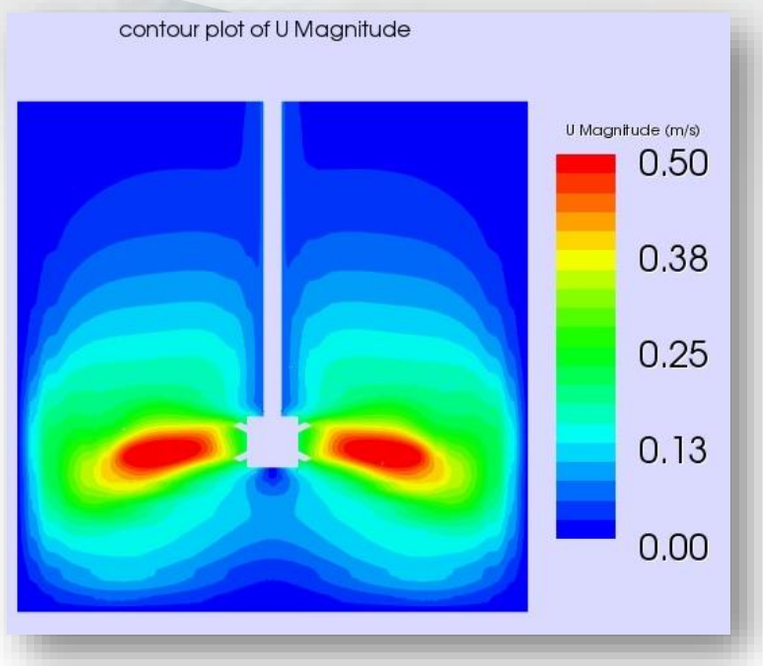




Learn more: byteLAKE.com/en/CFDSuite

byteLAKE's CFD Suite
AI Predictions

Results generated by CFD Solver



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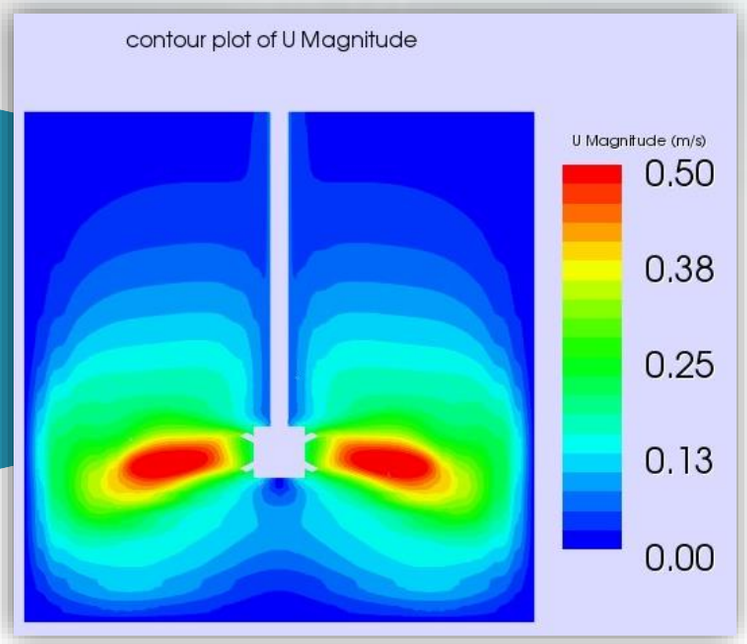
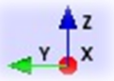
CFD Suite

AI-ACCELERATED CFD

Results generated by CFD Suite





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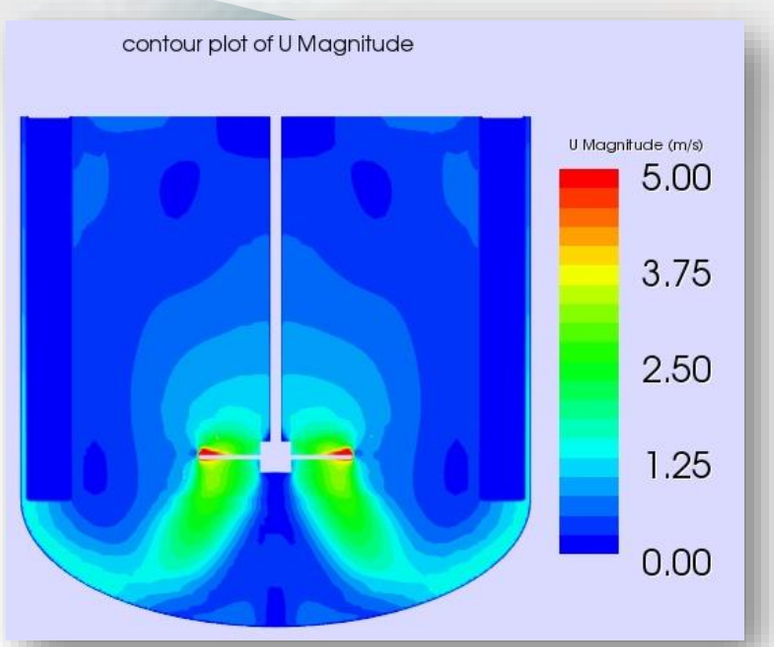
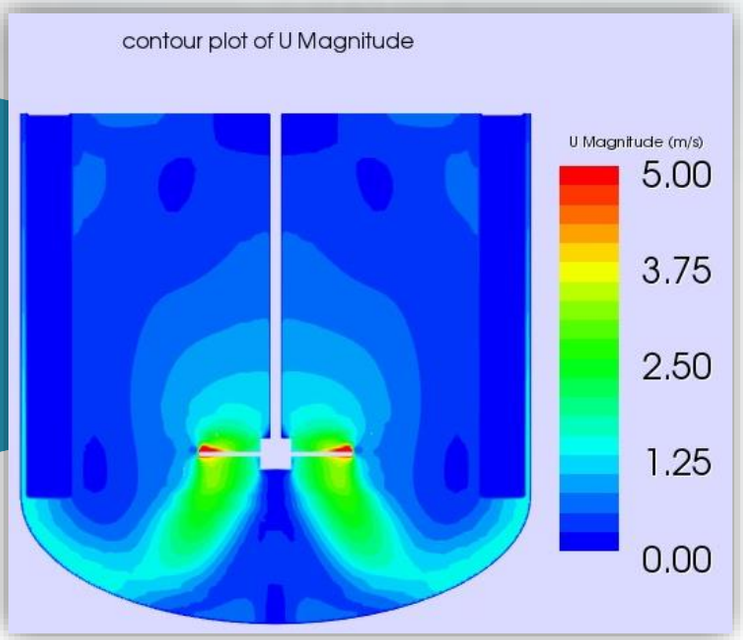
byteLAKE's CFD Suite
AI Predictions

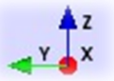
Results generated by CFD Solver



AI-ACCELERATED CFD

Results generated by CFD Suite

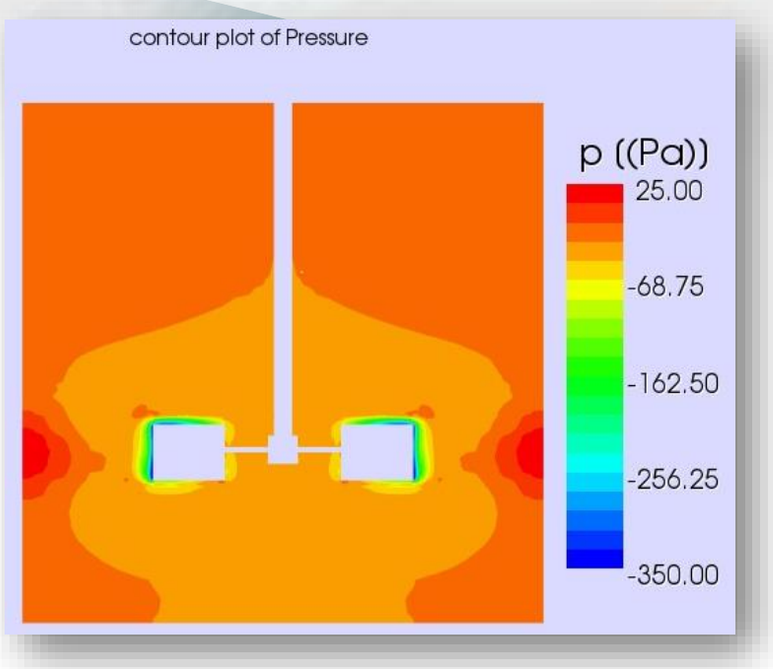




Learn more: byteLAKE.com/en/CFDSuite

byteLAKE's CFD Suite
AI Predictions

Results generated by CFD Solver



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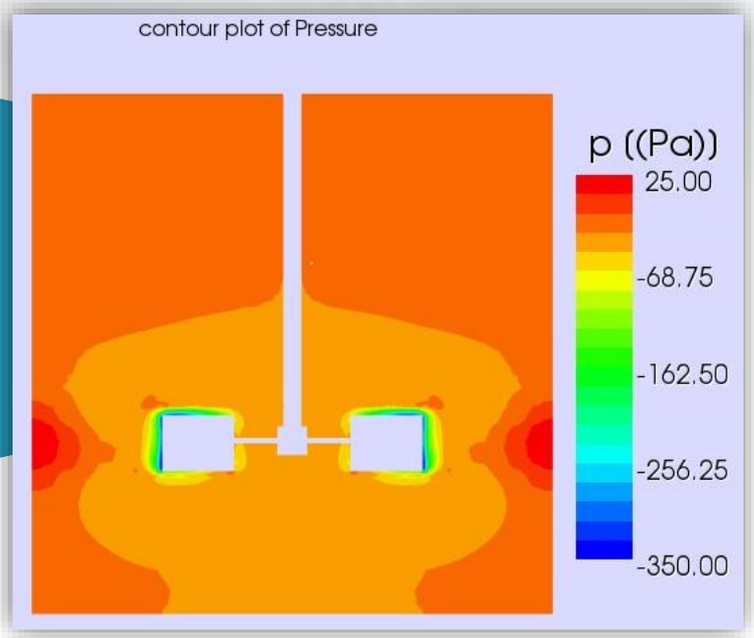
CFD Suite

AI-ACCELERATED CFD

Results generated by CFD Suite



Learn more: byteLAKE.com/en/CFDSuite

AI-accelerated CFD, example results

Simulation time reduced: from hours to minutes

Configuration: chemical mixing, <2M cells, 3D data, steady-state, 5K iterations

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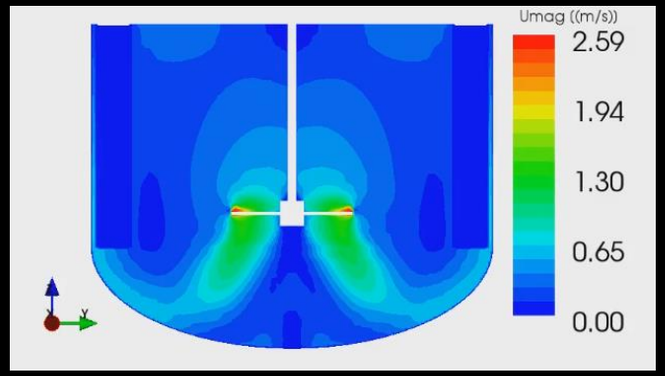
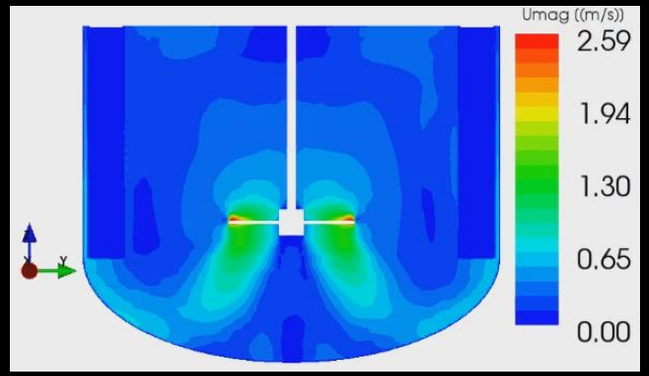
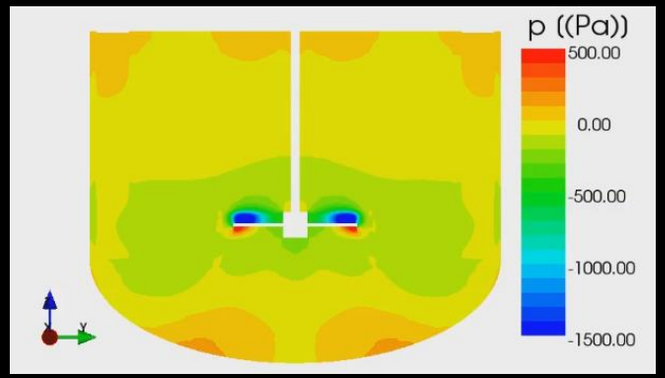
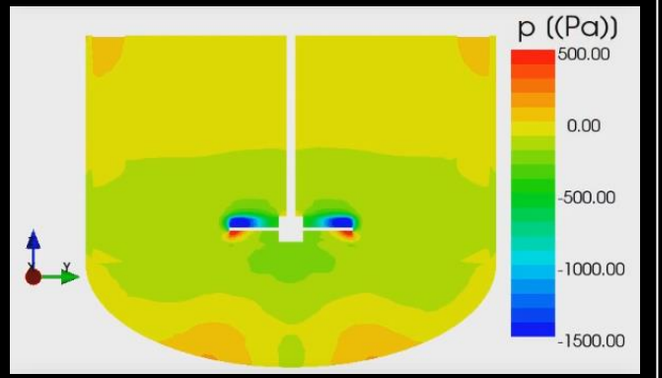
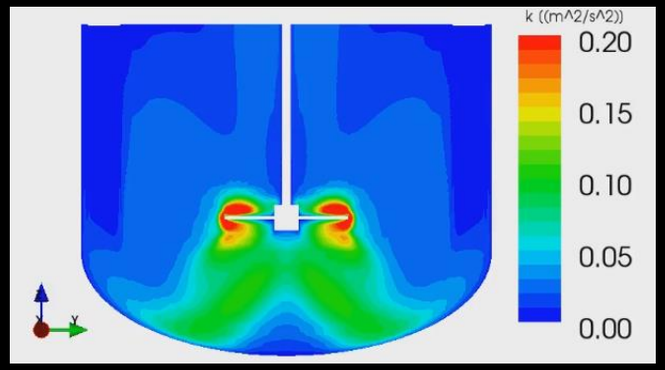
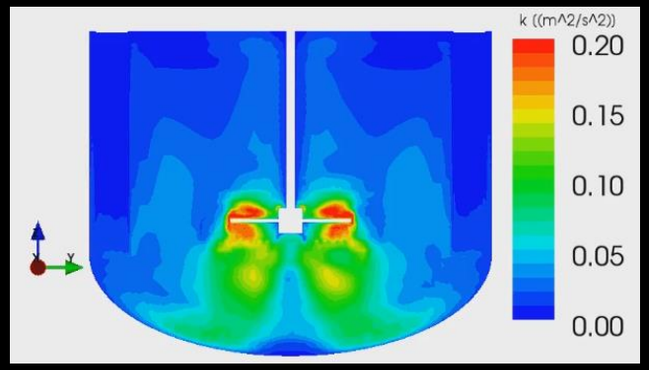
	CFD Solver	CFD Suite (AI predictions)
X-Plane Velocity		
X-Plane Pressure		
X-Plane Turbulent kinetic energy		

CFD Suite

Collection of innovative AI Models for computational fluid dynamics.
byteLAKE.com/en/CFDSuite

Quantity	Pearson's c.	Spearman's c.	RMSE	Histogram comp. [%]
U	0.990	0.935	0.016	89.1
p	0.993	0.929	0.004	90.1
epsilon	0.983	0.973	0.023	90.3
k	0.943	0.934	0.036	99.4
mut	0.937	0.919	0.147	93.5
Average	0.969	0.938	0.045	92.5

Example results for: CFD/chemical mixing case study.
Note: accuracy is configurable and depends on requirements.

Simulations powered by:

Tridiagonal® Solutions
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MixIT
The Enterprise Mixing Analysis Tool

Panel Discussion:

CFD Suite accelerating Chemical Mixing

- ✓ **Trained for expediting chemical mixing simulations.**
- ✓ **Optimized for a range of hardware options.**
- ✓ **Versatile and capable of training with different CFD simulation types.**

Watch on YouTube: youtu.be/IT7co-EzkC8

CFD Suite – case study

Automotive

AI-accelerated Computational Fluid Dynamics

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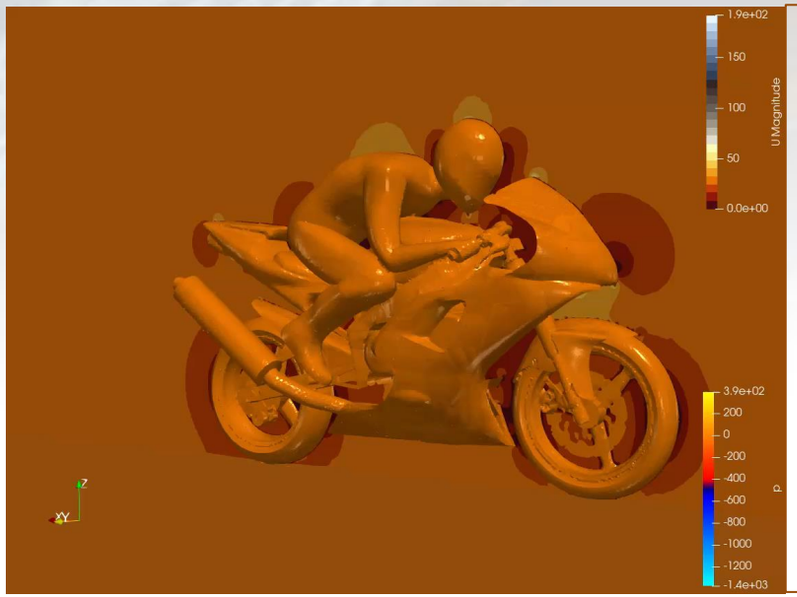
Slash simulation times, minimize trial-and-error costs, and supercharge decision-making for heightened productivity.

Simulation: MotorBike Steady



- OpenFOAM® CFD Solver
- SimpleFOAM / MotorBike Steady

- Mesh size: 350k – 2M nodes
- Simulation: Flow around a motorbike and rider at varying speed
- AI predicting pressure and velocity

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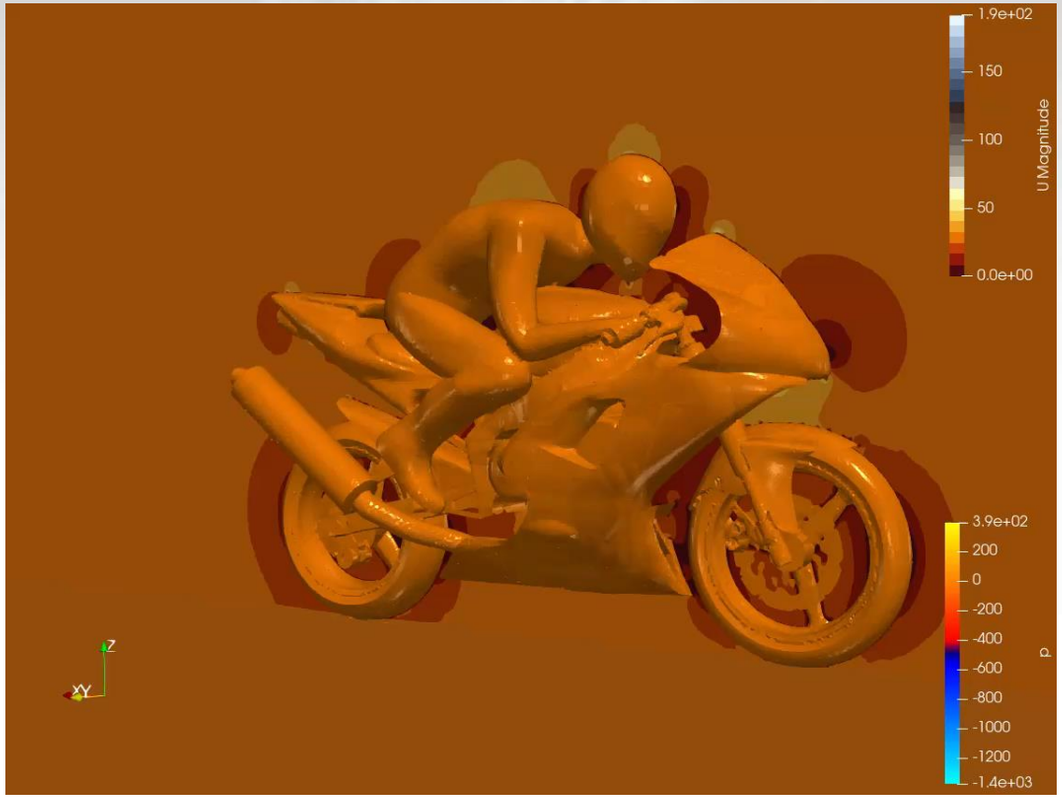
Results: MotorBike Steady



CFD Suite

AI byte LAKE

AI-ACCELERATED CFD

10x
Speedup
Faster Time to Insights

99%
Accuracy with AI

43x
Speedup
Faster Time to Insights

90%
Accuracy with AI

CFD Suite

AI-accelerated CFD

- **Presentation Details:**
  - Recorded at SC23 Conference, Denver, Colorado
  - Venue: Lenovo's Theater
- **Key Highlights:**
  - Simulations currently take days to complete, and there's a demand for faster time to insights.
- **Results Presented:**
  - Achieved 10x faster time to insights with 99% accuracy
  - Achieved 43x faster time to insights with 90% accuracy
- **Introduction:**
  - Overview of CFD Suite's Learning-on-the-Fly Module

Watch on YouTube: youtu.be/w3JJlWsm2dA

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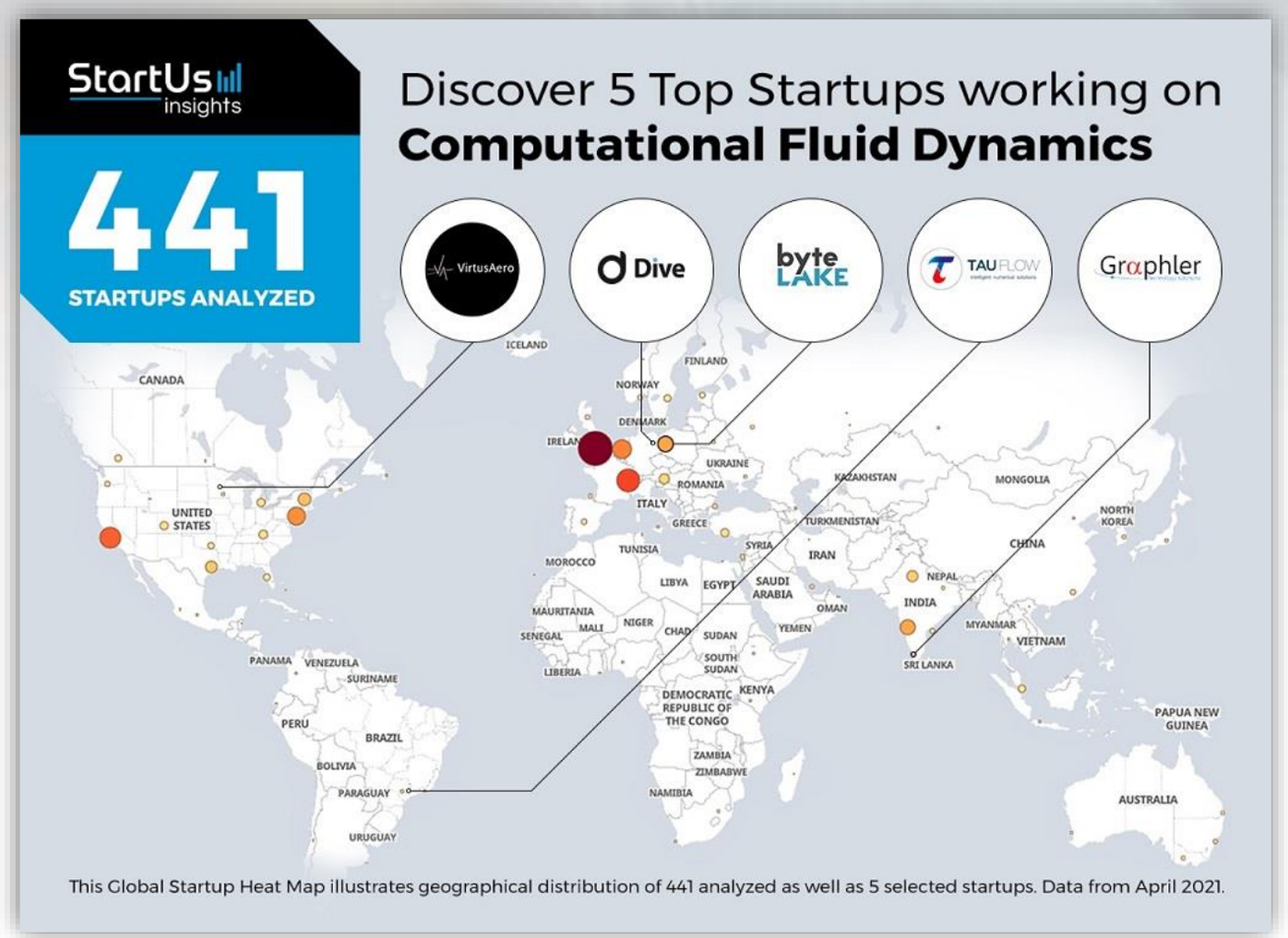
Among 5 top startups working on CFD!

"Explore our analysis of 441 global startups & scaleups and learn how their computational fluid dynamics (CFD) solutions impact your business!"

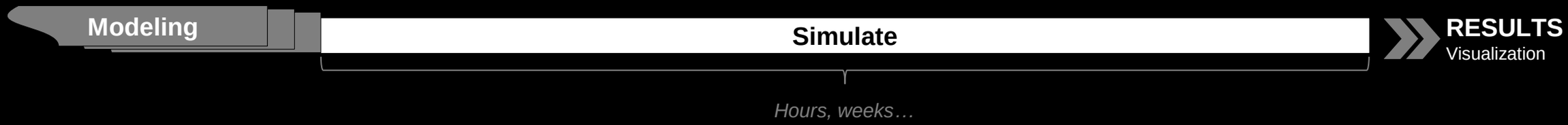
"This time, you get to discover 5 hand-picked startups developing computational fluid dynamics solutions."



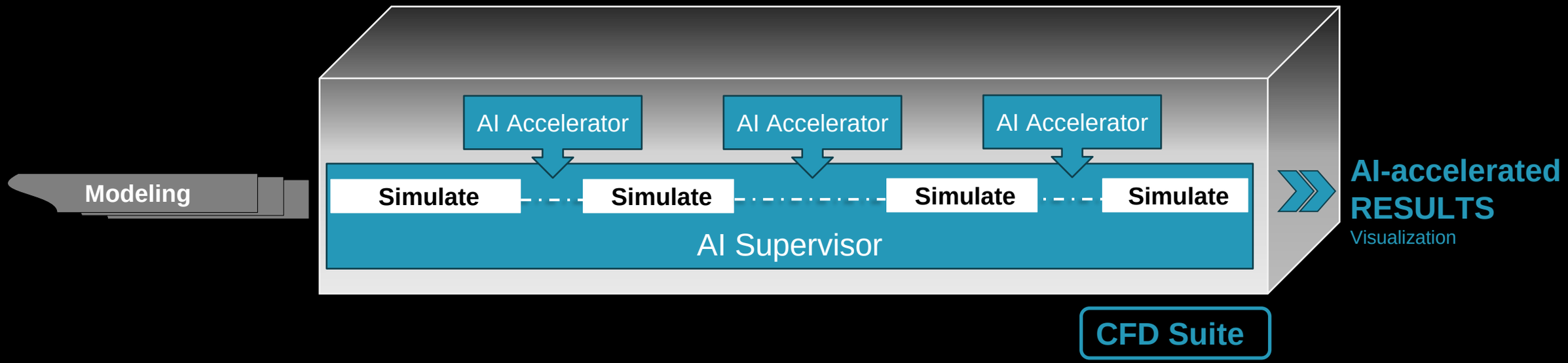
Read article: startus-insights.com/innovators-guide/discover-5-top-startups-working-on-computational-fluid-dynamics/

AI-accelerated CFD

- **Traditional workflow**



- **byteLAKE's CFD Suite**



byteLAKE's CFD Suite:
Beyond Acceleration

- **Multi-Purpose Training:**
  - Selection and prioritization of geometries based on AI-predicted efficiency
  - Optimization of configurations and meshing operations

- **Comprehensive Process Optimization:**
  - AI-driven enhancements across a wide range of CFD simulation processes

Outcome:

- Faster time to insights
- Lower costs
- Enhanced efficiency in CFD simulations

Deployment & Licensing

byteLAKE's CFD Suite

How to Start - preparations
byteLAKE's CFD Suite

1. **Define the Scenario**
   - Identify the target CFD solver for acceleration and explain associated processes and scenarios (parameters, ranges, dependencies, geometries, etc.).

2. **Explain Expectations**
   - Define the required accuracy levels.
   - Specify supported input configuration ranges.
   - Share insights on anticipated system performance, including future scalability.
   - Outline integration needs and the desired interaction of CFD Suite with other tools (data formats, API, etc.).

How to Start - first steps in the project

byteLAKE's CFD Suite

1. **Scenario Explanation**
   - Provide example data.
   - Conduct online consultations or arrange in-person meetings as needed.

2. **Initial Data Insights**
   - Explain your data, including types, ranges, and dependencies.
   - Identify unusual scenarios or exceptions.
   - Determine if historic data is available and note any gaps.
   - Discuss data storage methods and assess the need for changes or improvements.
   - Share sample data with us.

3. **Online Q&A Session**
   - Conduct an online Q&A session to address questions about the presented data and scenario.

4. **Deployment Plan and Schedule**
   - Present a detailed deployment plan and schedule prepared by byteLAKE.

Licensing & Cost of Deployment
byteLAKE's CFD Suite

- **Licensing**
  - Annual/monthly licensing plans for CFD Suite, including upgrades, customer care, and support.
- **AI Model Development**
  - Costs for AI model training and calibration.
- **Data Management**
  - Expenses related to data collection and cleaning.
- **Hardware and Software (if needed)**
  - Hardware costs, as well as any associated licenses.
  - Installation expenses.
- **Integration and Deployment**
  - Integration efforts as required for successful deployment.

Join the CFD Suite community

byte LAKE

Marcin Rojek
Co Founder @ byteLAKE = AI & HPC Solutions | ML | Vision | Sound | RPA | CFD...
2w • Edited •

#GameChanger for #CFD (Computational Fluid Dynamics) #CAE is coming. My team at byteLAKE has just concluded 1st tests in replacing #OpenFOAM solvers with our newly designed #AI models. For the 1st part of motorBike case, we're ultra-fast with very accurate results. More soon...

135 · 44 Comments

Reactions

Like Comment Share

11,262 views of your post in the feed

Dr. Alex Lee • 2nd
Managing Director @ Tian Building Engineering (SG)
Interesting subject... Can't wait to hear from you again.
1 Like · 1 Reply

Marcin Rojek Author
Co Founder @ byteLAKE = AI & HPC Solutions | ML | Vision | So...
2w
I will keep sharing the updates and will add more info to this post soon.

Dr. Ravi Duggirala • 2nd
Senior Program Manager at Mercedes-Benz Research and Development I...
2w
Excited and Looking forward to Know more details...
1 Like · 1 Reply

Max Guhl • 1st
Enable you for your Cloud journey is my passion and target.
2w
I really like the approach to solve the problems by adding more intelligent instead of more and more compute power. Look forward to hear from your results. I expect something like the new prediction of Honey

Glenn Rosenberg • 1st
Director of Cloud & Managed Services
1w
Watching the progress of Marcin and his team with a lot of interest, good luck with the development.
1 Like · 1 Reply

Marcin Rojek Author
Co Founder @ byteLAKE = AI & HPC Solutions | ML | Vision | So...
1w
Thank you Glenn! As always, moving to a very exciting landscape...

Ravi Kanth Borra • 1st
Technical Business Development , Account Management, Product Manage...
2w
This could change the meaning of CFD as we know. Surely next gen technology. Will keep following your updates. All the best Marcin
1 Like · 1 Reply

Marcin Rojek Author
Co Founder @ byteLAKE = AI & HPC Solutions | ML | Vision | So...
2w
Ravi kanth thank you! Indeed, very exciting area and I will be sharing the progress via groups and blog posts I will link late in this post.

Anik Sarker • 1st
Assistant Engineer (JAMUNA TYRE AND RUBBER INDUSTRIES LTD.)
2w
Wating for the best

Blog post series, discussions forum etc.

Stefano Capra • 2nd
Senior Engineer at Ramboll
2w (edited)
Can you share a bit more about what you mean by AI model? Is that a solver? Or a network trained to predict the flow? Thanks

Links

LinkedIn Group

bytelake.com/en/CFDSuite-LN-group

Facebook Group

bytelake.com/en/CFDSuite-FB-group

Blog post series

bytelake.com/en/AI4CFD-toc

AI for CFD: Intro (part 1)

First part of byteLAKE's story about bringing AI to the world of CFD (Computational Fluid Dynamics).

Published on Apr 15 · 6 min read

AI for CFD: join our community (part 2) (aka Artificial Intelligence in CFD Groups)

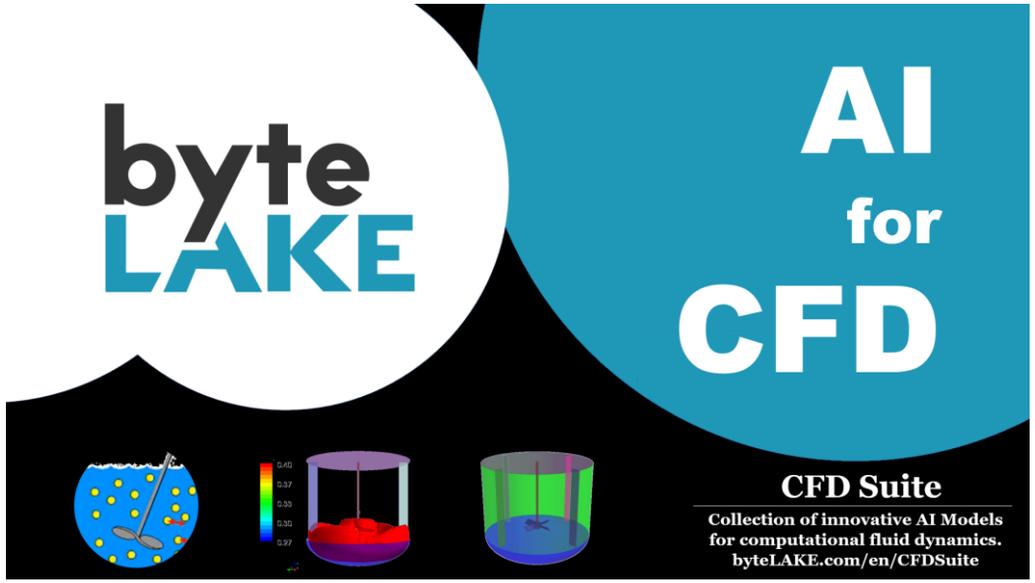
Join the discussions about AI in CFD via Facebook and LinkedIn groups. Let's build a great community together!

Published on Apr 27 · 3 min read

Website

bytelake.com/en/CFDSuite

CFDSuite.com



Meet byteLAKE

AI Solutions for Industries |
Quality Inspection |
Data Insights |
Predictive Maintenance |
AI-accelerated CFD |
Self-Checkout

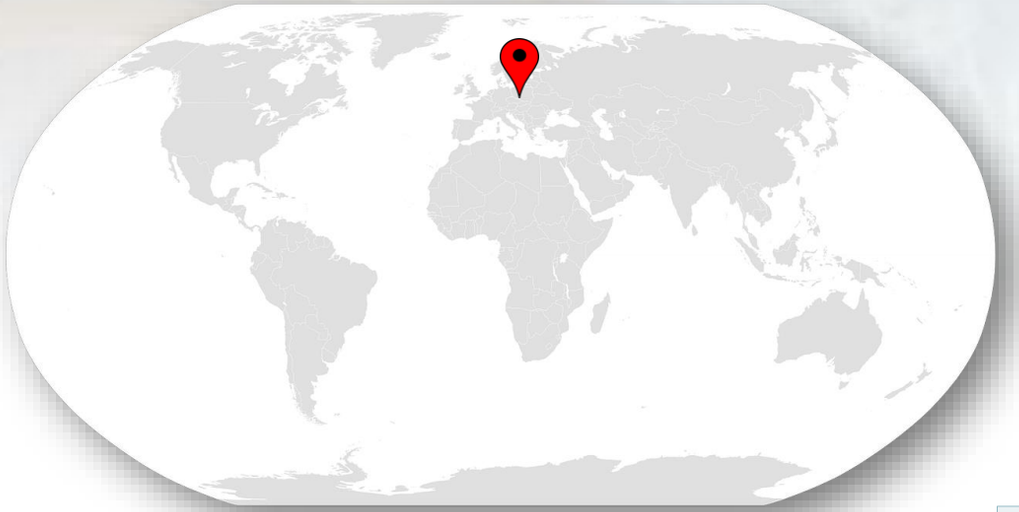
Empowering Industries with Artificial Intelligence Solutions.

At byteLAKE, we harness cutting-edge technology to provide advanced quality inspection and data insights tailored for the Manufacturing, Automotive, Paper, Chemical, and Energy sectors.

Additionally, we offer self-checkout stations for Restaurants and object recognition solutions for Retail businesses.

www.byteLAKE.com

Headquartered in Poland



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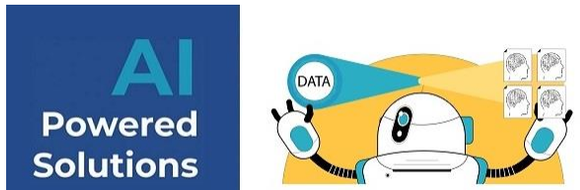
+48 505 322 282
welcome@byteLAKE.com

Products:

CFD Suite

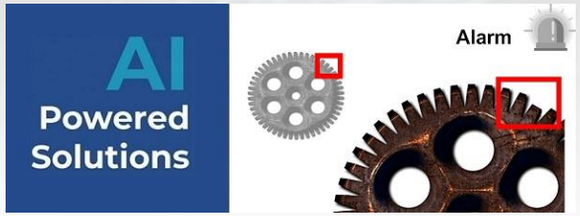


Cognitive Services

byteLAKE's AI Products

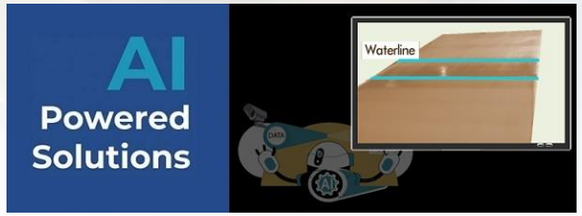
Cognitive Services

Advanced quality inspection and data insights.



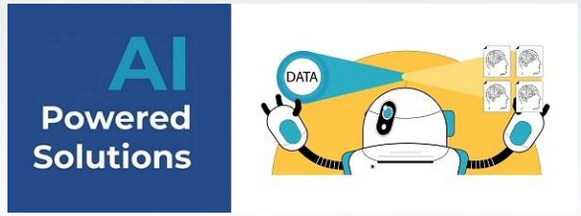
for Manufacturing

for Automotive



for Paper Industry

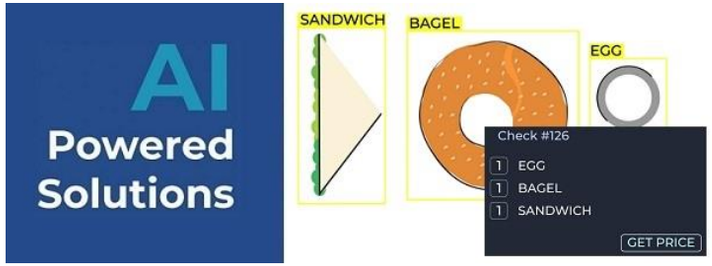
Predictive Maintenance



Data Insights

Cognitive Services for Restaurants

Self-checkout and object recognition.



CFD Suite

AI-accelerated Computational Fluid Dynamics.

Concurrency and Computation
Practice and Experience

SPECIAL ISSUE PAPER | Full Access

Machine learning method for energy reduction by utilizing dynamic mixed precision on GPU-based supercomputers

Krzysztof Rojek

First published: 30 April 2018 | https://doi.org/10.1002/cpe.4644

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Summary

In this work, we propose a method that allows us to reduce energy consumption of an application executed on supercomputing centers. The proposed method is based on a mixed precision arithmetic where the precision of data is calibrated at runtime. For this reason, we develop a modified version of the random forest algorithm. The effectiveness of the proposed approach is validated with a real-life scientific application called MPDATA, which is part of the numerical model used in weather forecasting. The energy efficiency of the proposed method is examined using two GPU-based clusters. The first of them is the Piz Daint supercomputer, currently ranked 3rd at the TOP500 list (November 2017). It is equipped with NVIDIA Tesla P100 GPU accelerators based on the Pascal architecture. The second is the MICLAB cluster containing NVIDIA Tesla K80 based on the Kepler architecture. The achieved results show that the proposed machine learning method allows us to provide the accuracy of computation comparable with that achieved double precision and reduce the energy consumption up to 36% compared to the double precision version of MPDATA.

Our Research Studies GO PUBLIC!

More at: byteLAKE.com/en/research

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