Eclipse Diafanis™ is an IoT project at the Eclipse Foundation
- home to a global community and over 415 open source projects, including runtimes, tools and frameworks.

Eclipse Diafanis™
Multi-Party Computation as a Service
2022

a *paceval.* project

https://paceval.com

Problem

Many IoT solutions require **complex mathematical calculations to work correctly or make decisions**. This can be a self-flying drone or a car that evaluates objects in recorded videos or images **in real time during flight**.

These IoT devices do not have the computing power to perform such mathematical calculations themselves. Or these IoT solutions, because they are battery powered, can't even do the **intensive math calculations because that consumes battery time**.
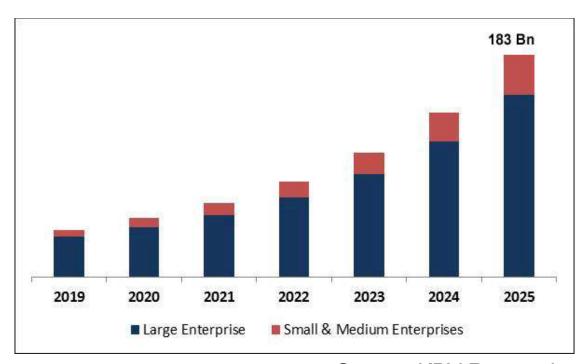
Trend

- **Mathematics is used everywhere** for analysis, prediction and control.

- **Mathematics** (especially artificial intelligence) has become **one of the most dominant topics since 2019**.

- **The market for cloud servers will double from 2022 to 2025**, especially in the mathematical areas mentioned above.

Gartner, Grand View Research and others

Private Cloud Server Market Size

183 Bn

2019 · 2020 · 2021 · 2022 · 2023 · 2024 · 2025

■ Large Enterprise ■ Small & Medium Enterprises
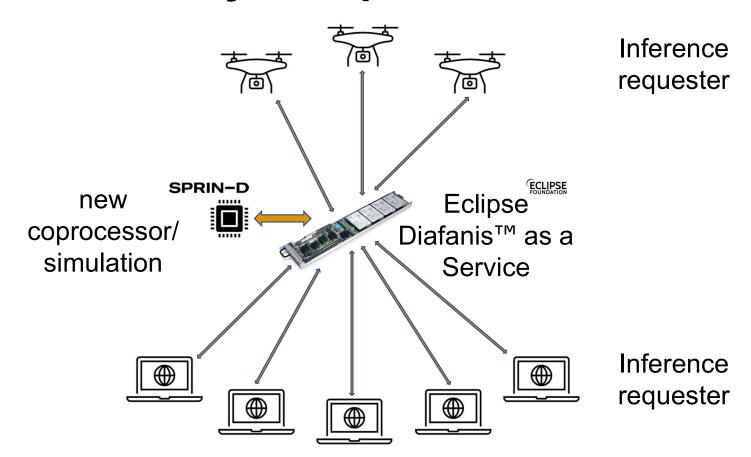
Source: KBV Research

Solution

Eclipse Diafanis™ provides a powerful and fast **remote math coprocessor service for IoT devices** based on a Linux server for x86 (Intel and AMD) or ARM64 processors.*
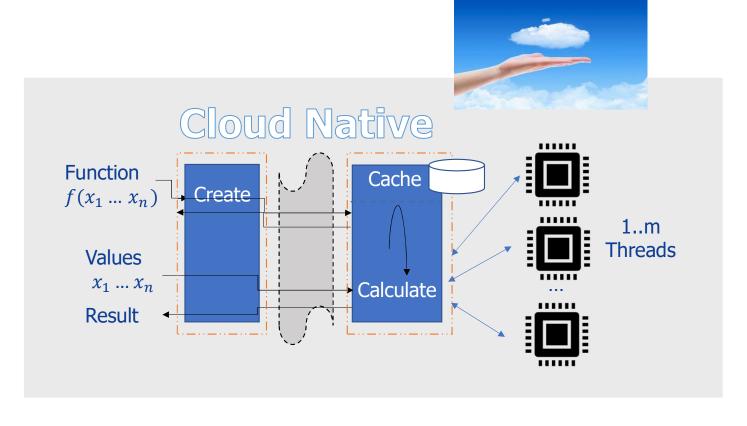
Equipped with a simple interface, it will allow IoT devices to perform complex mathematical operations remotely and very quickly, thus **avoiding increasing electrical consumption in IoT devices**.

*https://projects.eclipse.org/projects/iot.diafanis/reviews/creation-review

Target Multi-Party Computation as a Service

Inference requester

new coprocessor/ simulation

SPRIN-D

Eclipse Diafanis™ as a Service

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Inference requester
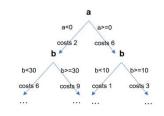
Architecture

The MNIST benchmark

The MNIST database (Modified National Institute of Standards and Technology database) is a **large database of handwritten digits** that is commonly used for training various image processing systems. The database is also **widely used for training and testing in the field of machine learning**.

In this presentation we use the MNIST benchmark to compare performance and power consumption.
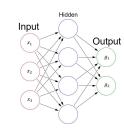

Sample images from MNIST test dataset

Artificial Intelligence and Mathematics

- **Decision tree learning or induction of decision trees** is one of the predictive modelling approaches used in statistics, data mining and machine learning.

- **Artificial neural network is an interconnected group of nodes**, inspired by a simplification of neurons in a brain. **Neural networks learn (or are trained) by processing examples.**

Further techniques are approximations, statistical models (Hidden Markov) or other decisions based on mathematical rules.

Finding

All these techniques can be mapped to a **single mathematical function**, e.g.
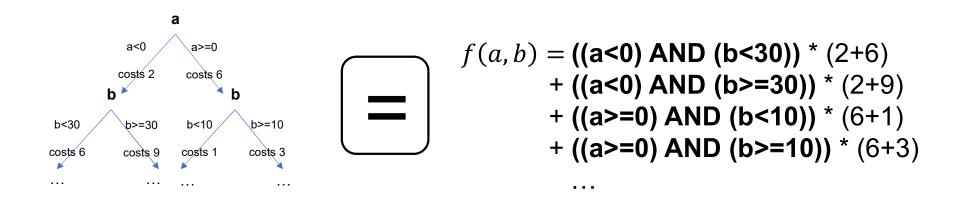
$$y = f(x_1, x_2, \ldots, x_n)$$

or a **set of mathematical functions**, e.g.

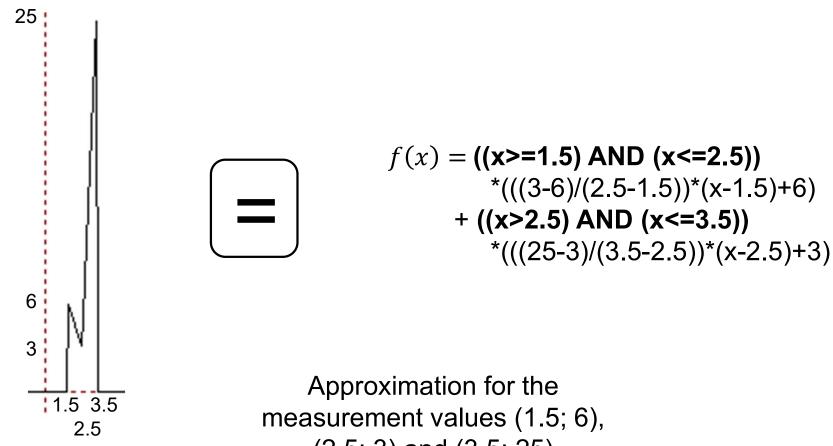$$y_1 = f_1(x_1, x_2, \ldots, x_n)$$
$$y_2 = f_2(x_1, x_2, \ldots, x_n)$$

$$y_m = f_m(x_1, x_2, \ldots, x_n)$$

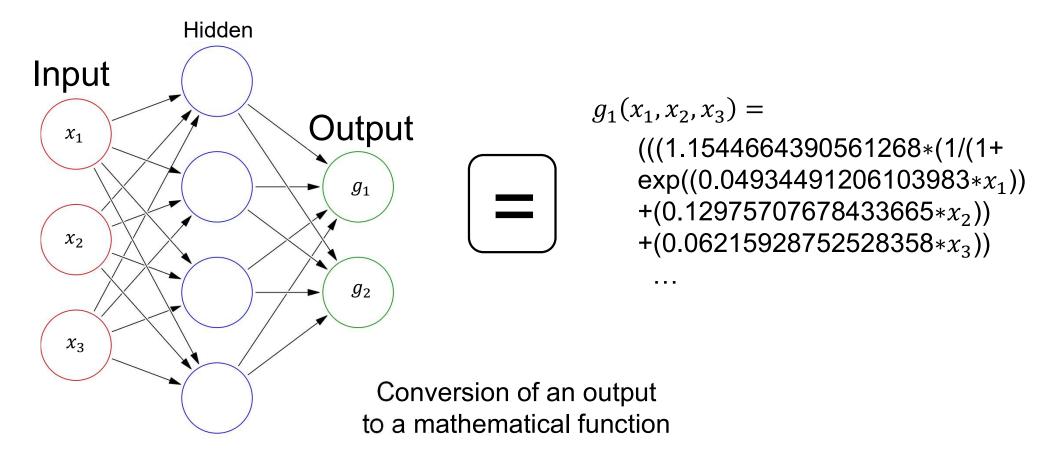# Example Decision trees

$$f(a, b) = \text{((a<0) AND (b<30)) * (2+6)}$$
$$+ \text{((a<0) AND (b>=30)) * (2+9)}$$
$$+ \text{((a>=0) AND (b<10)) * (6+1)}$$
$$+ \text{((a>=0) AND (b>=10)) * (6+3)}$$
$$\ldots$$

Decision tree with
variables and costs

Example Approximations

$f(x) =$ **((x>=1.5) AND (x<=2.5))**
        (((3-6)/(2.5-1.5))(x-1.5)+6)
     + ((x>2.5) AND (x<=3.5))
        (((25-3)/(3.5-2.5))(x-2.5)+3)
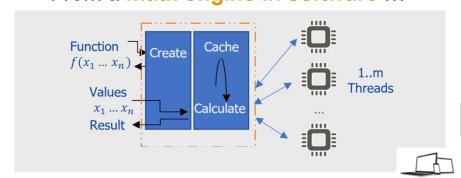
Approximation for the
measurement values (1.5; 6),
(2.5; 3) and (3.5; 25)

Example Neural networks

Input

Hidden

Output

x_1

x_2

x_3

g_1

g_2

=

$g_1(x_1, x_2, x_3) =$

$(((1.1544664390561268*(1/(1+$
$\exp((0.04934491206103983*x_1))$
$+(0.12975707678433665*x_2))$
$+(0.06215928752528358*x_3))$
…

Conversion of an output
to a mathematical function
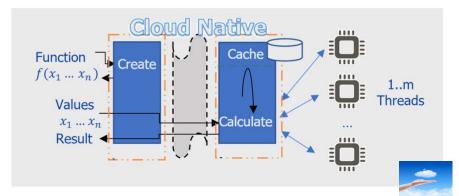
Solutions
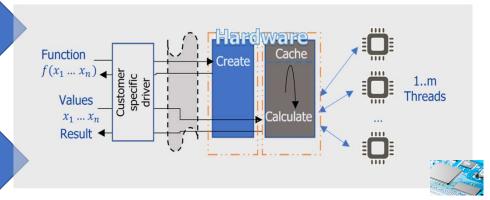
From a **math engine in software** …

… with a **product in hardware**.

… to a **cloud-based service** …

A powerful, but simple API

Creates a remote computation object with the specified attributes and returns its HANDLE:
http://diafanis-server:8080/CreateComputation/?functionString=-sin(x*cos(x))^(1/y)&numberOfVariables=2&variables=x;y&interval=yes
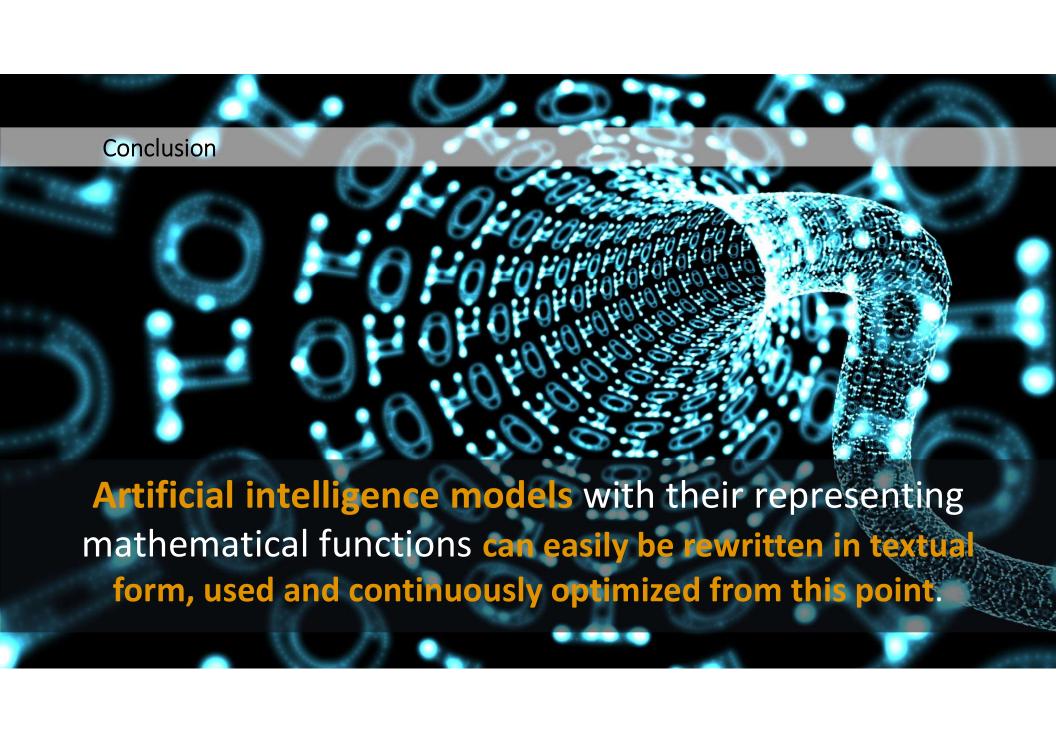
Solves the computation with the variables declared by /CreateComputation and with the given values:
http://diafanis-server:8080/GetComputationResult/?handle_diafanisComputation=140589652024432&values=0.5;2

Solves the computation with multiple values for the variables declared by /paceval_CreateComputation:
http://diafanis-server:8080/GetComputationResultExt/?handle_diafanisComputation=140589652024432&numberOfCalculations=2&values=0.5;2;0.5;4

Solves multiple computations with values for the variables declared by /paceval_CreateComputation:
http://diafanis-server:8080/GetMultipleComputationsResults/?handle_diafanisComputations=140589652567088;140589652566480&numberOfdiafanisComputations=2&values=0.534346;2;45.4536

*(Reference solution available see https://app.swaggerhub.com/apis-docs/paceval/paceval-service/4.04 for more information)

Conclusion

Artificial intelligence models with their representing mathematical functions **can easily be rewritten in textual form, used and continuously optimized from this point**.

Finally

With Eclipse Diafanis™ you can easily realize a setup for **AI that scales to your needs** and **reduces the environmental impact by >99.3%.***

Because Eclipse Diafanis™ is not just about neural networks, **you also get a quick way to create solutions with sustainable distributed and decentralized mathematics** using a cloud based Multi-Party Computation as a Service.

ECLIPSE
INCUBATION

*(this expectation is derived from the results of the simulation)