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**.

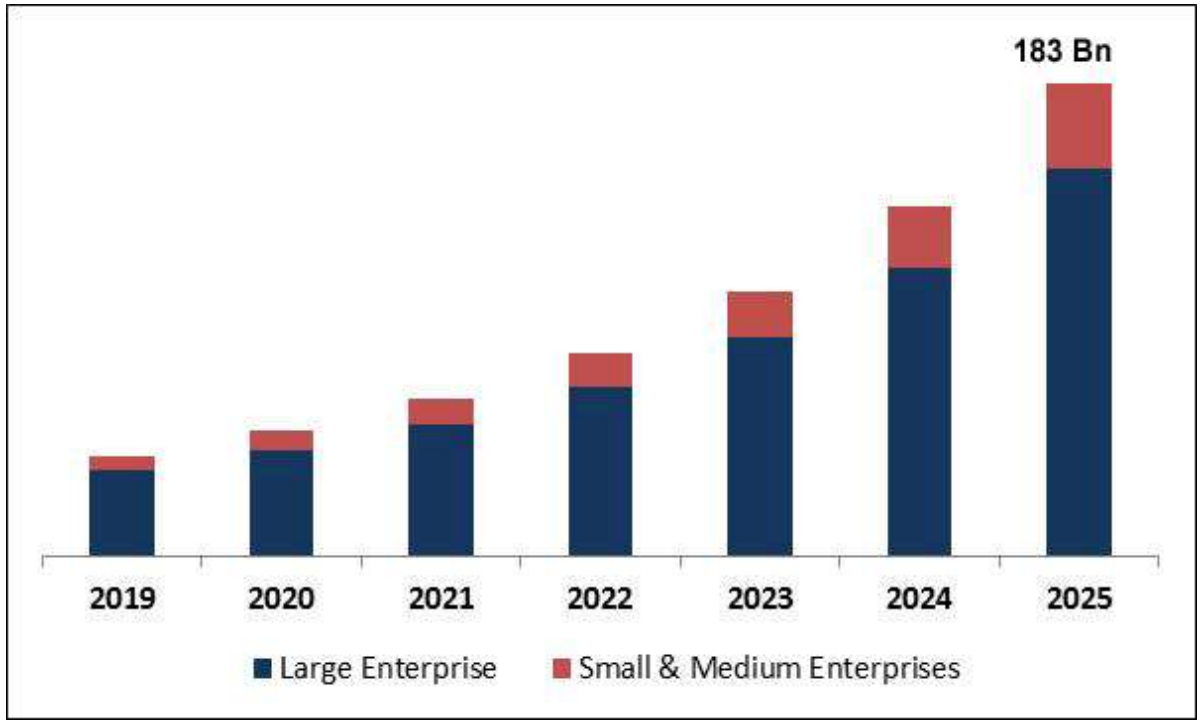
These IoT devices do not have the computing power to perform such mathematical calculations themselves. Or these IoT solutions, because they are battery powered, can't even do the **intensive math calculations because that consumes battery time**.

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



Source: KBV Research

Problem #2

"(…) In between sit **huge data centers that take on the big tasks, manage and direct data, train artificial brains and solve complex scientific problems**.

But this vision of a **connected world currently comes at a high price**. If global energy consumption for computing and communications increases at the same rate as it has been, **it will take up the entire, global capacity for energy production as early as 2040**.

In order to implement our visions for the future **fundamentally new computing concepts must therefore be found**."*

SPRIN–D
FEDERAL AGENCY
FOR DISRUPTIVE INNOVATION

*https://www.sprind.org/en/challenges/newcomputing

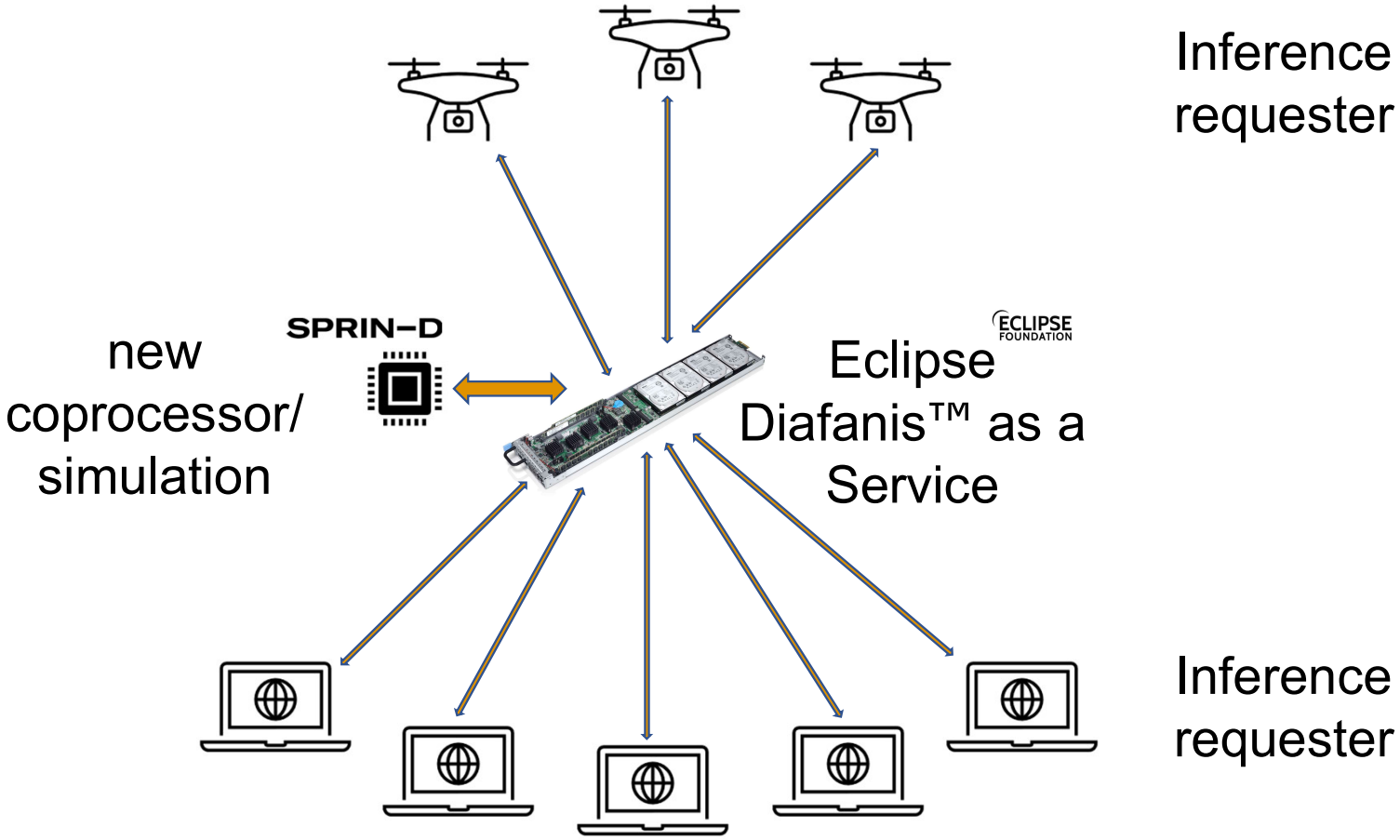
Solution

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.*

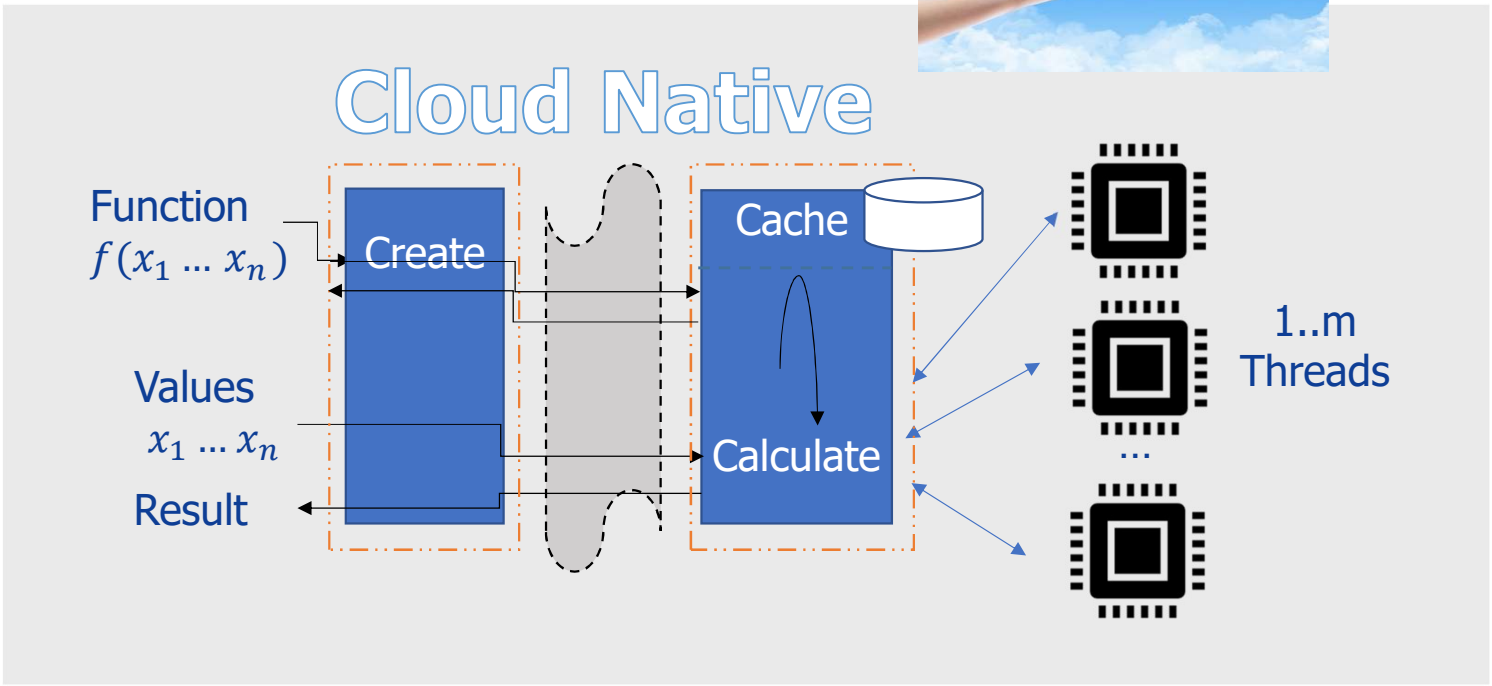
Equipped with a simple interface, it will allow IoT devices to perform complex mathematical operations remotely and very quickly, thus **avoiding increasing electrical consumption in IoT devices**.

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

Target Multi-Party Computation as a Service

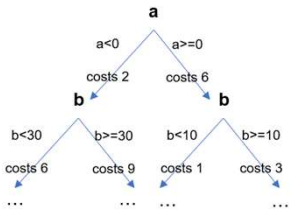


Architecture

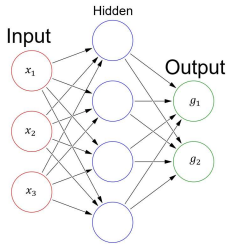


Artificial Intelligence and Mathematics

- **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.

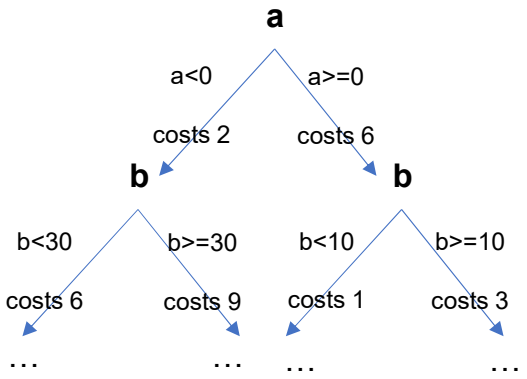
$$y = f(x_1, x_2, \dots, x_n)$$

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

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

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

Example Decision trees



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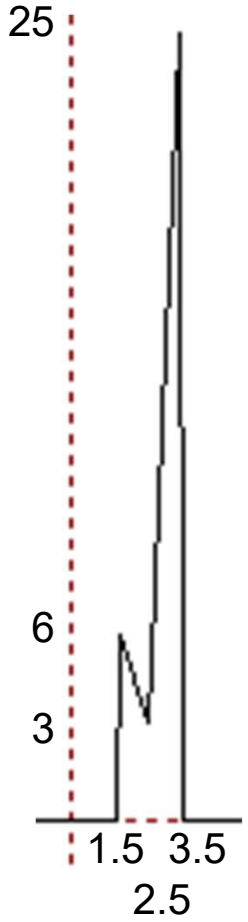
$$f(a,b) = \textbf{((a<0) AND (b<30))} * (2+6)$$
$$+ \textbf{((a<0) AND (b>=30))} * (2+9)$$
$$+ \textbf{((a>=0) AND (b<10))} * (6+1)$$
$$+ \textbf{((a>=0) AND (b>=10))} * (6+3)$$
$$\ldots$$

Decision tree with
variables and costs

Example Approximations



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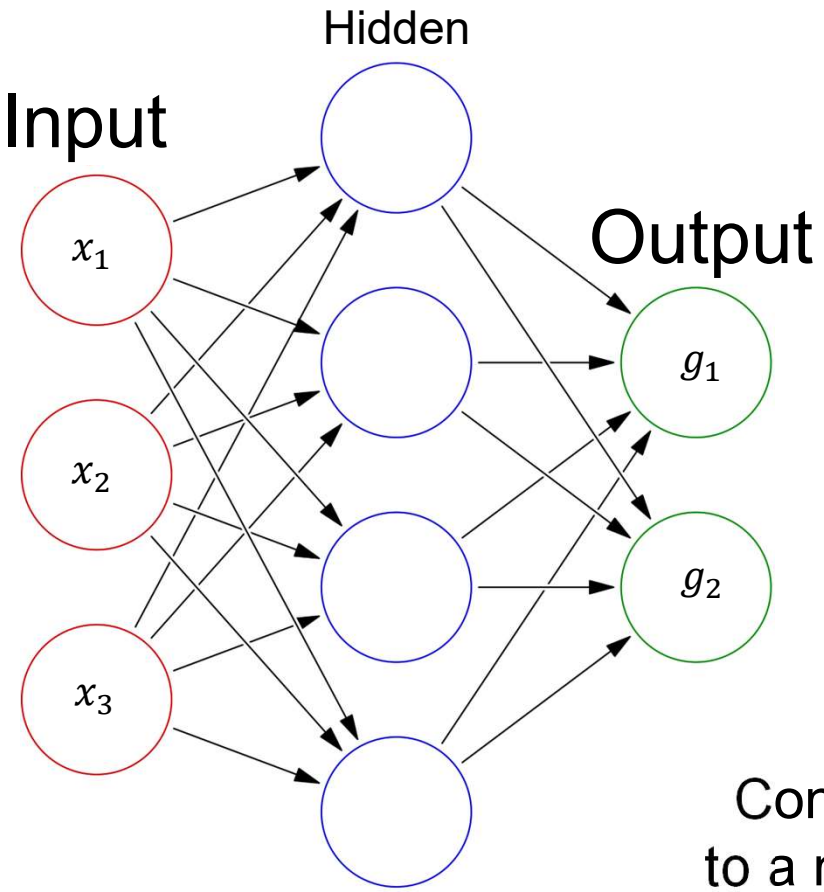
$f(x) =$ **((x>=1.5) AND (x<=2.5))**
(((3-6)/(2.5-1.5))(x-1.5)+6)
+ ((x>2.5) AND (x<=3.5))
(((25-3)/(3.5-2.5))(x-2.5)+3)

Approximation for the
measurement values (1.5; 6),
(2.5; 3) and (3.5; 25)

Example Neural networks



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$$g_1(x_1, x_2, x_3) =$$
$$(((1.1544664390561268 * (1/(1+$$
$$\exp((0.04934491206103983 * x_1))$$
$$+(0.12975707678433665 * x_2))$$
$$+(0.06215928752528358 * x_3))$$
$$\ldots$$

Conversion of an output
to a mathematical function

A powerful, but simple API*

Creates a remote computation object with the specified attributes and returns its HANDLE:
http://diafanis.cloud/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.cloud/GetComputationResult/?handle_diafanisComputation=140589652024432&values=0.5;2

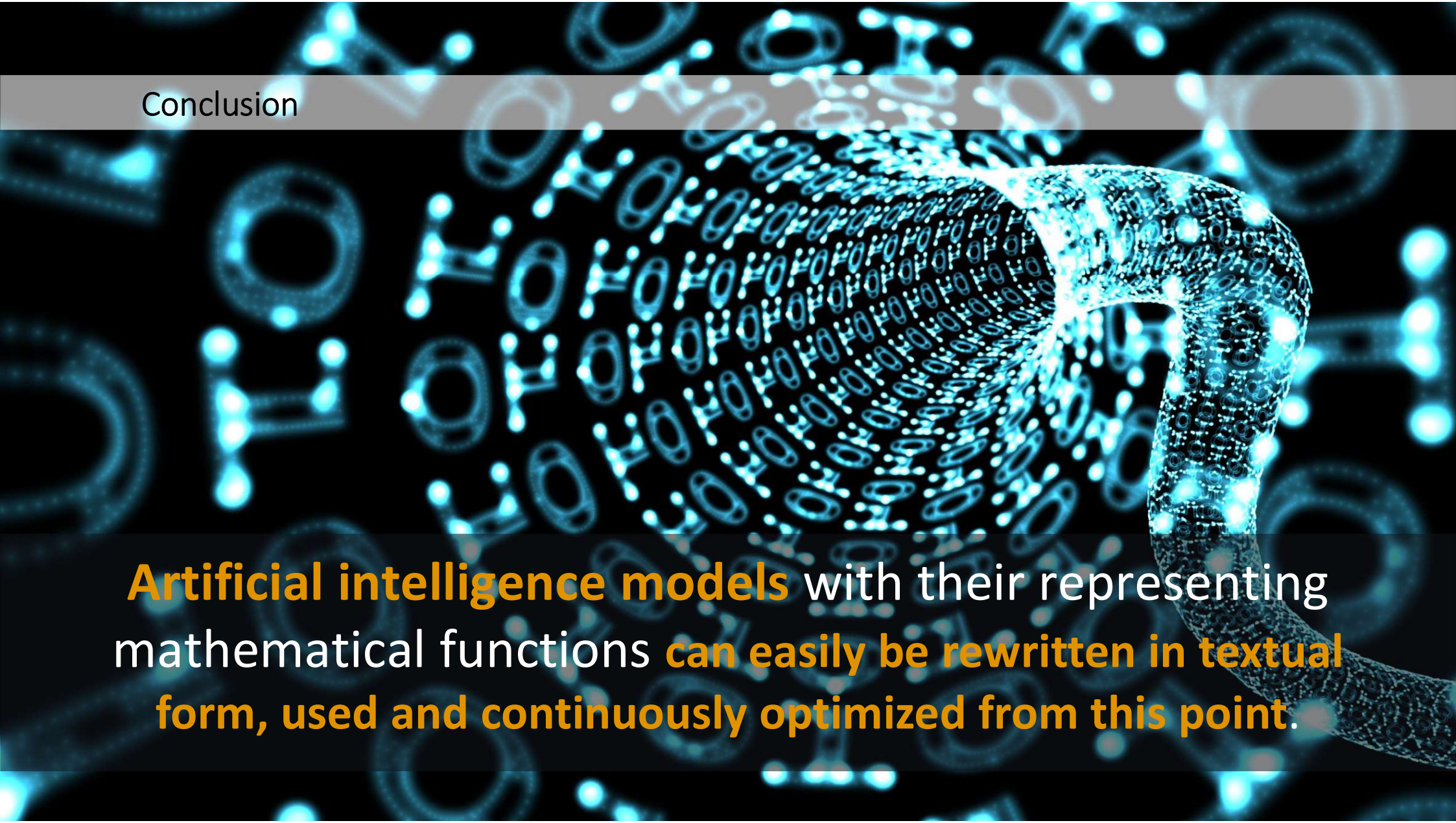
Solves the computation with multiple values for the variables declared by /CreateComputation:
http://diafanis.cloud/GetComputationResultExt/?handle_diafanisComputation=140589652024432&numberOfCalculations=2&values=0.5;2;0.5;4

Solves multiple computations with values for the variables declared by /CreateComputation:
http://diafanis.cloud/GetMultipleComputationsResults/?handle_diafanisComputations=140589652567088;140589652566480&numberOfdiafanisComputations=2&values=0.534346;2;45.4536

This function call is for demo purposes only. It **creates a remote calculation and** if the creation was successful, this function **returns its HANDLE and the calculation result**:
http://diafanis.cloud/Demo/?functionString=-sin(x*cos(x))^(1/y)&numberOfVariables=2&variables=x;y&values=0.5;2;0.5;4&interval=yes

*see https://app.swaggerhub.com/apis/diafanis/diafanis-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.

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