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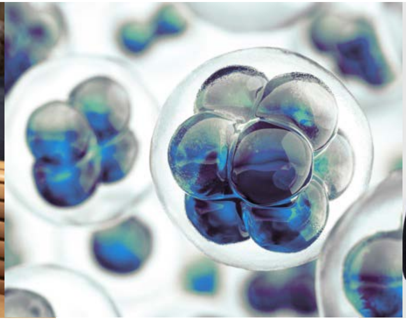
Mathematical Methods

Guidelines G-II, 3.3, Edition of March 2021


Disclaimer

The content of this document does not form part of the Guidelines. This document should not be referred to in communications from the divisions. It is not meant as internal instructions, either.

The purpose of this document is to provide educational and training material for the corresponding section of the Guidelines and to present the current examination practice of the EPO related thereto.

In case of any contradiction the text of the Guidelines prevails.

Printed versions are not controlled.

The present document is in pdf format. The powerpoint document (including speaker's notes) is only accessible by request to the authors (main author: Erik Veillas, CII GL WG – eveillas@epo.org; co-author: Markus Volkmer: mvolkmer@epo.org).

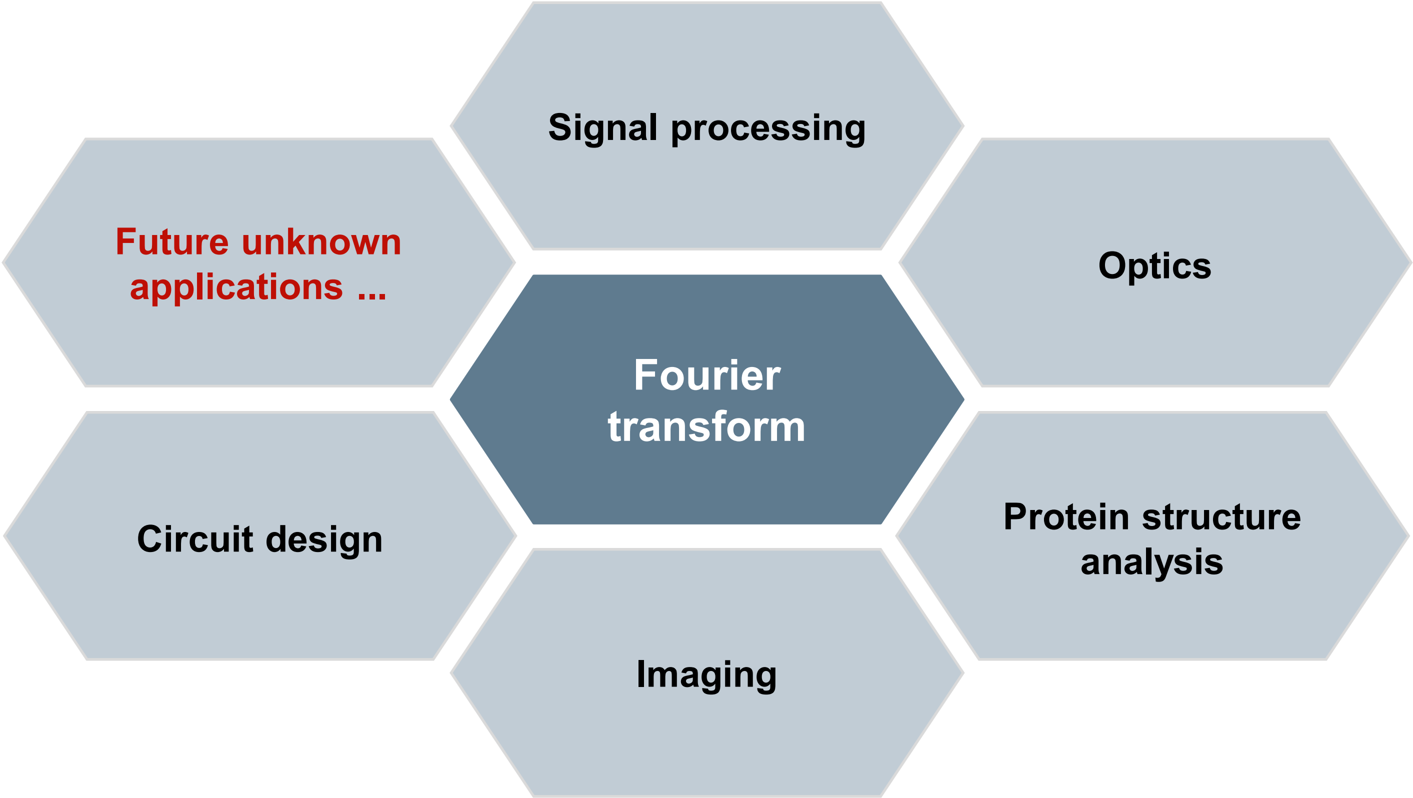
Outline

- G-II, 3.3 Mathematical Methods
  - Mathematical methods and technology
  - Interpreting the exclusion - The two-hurdle approach
  - “First hurdle” - Examination under Art. 52(2) and (3) EPC
  - “Second hurdle” - Examination under Art. 54 and 56 EPC

- G-II, 3.3.1 Artificial Intelligence and Machine Learning

- G-II, 3.3.2 Simulating, modelling and designing

Mathematics are at the very core of technology !



Interpreting the exclusion: The two-hurdle approach

1st hurdle

Art. 52 (2) and (3) EPC

- Common to all exclusions (maths, PoI, business methods, etc...)
- “as such” vs “mixed-type”
- “Any technical means” approach

2nd hurdle

Art. 54, 56 EPC

- G-VII, 5.4 PSA for claims comprising technical and non-technical features
- All features contributing to the technical character are taken into account for assessment of inventive step.
- **Do(es) the mathematical method (steps) contribute to the technical character of the Invention ?** G-II, 3.3

G-II 3.3
Patentability of mathematical methods in general,

and of

AI, ML, simulations, modelling and design in particular

First hurdle

Claim requires technical means explicitly or implicitly	**No objection** under Art. 52(2)-(3) "computer-implemented" is enough For computer programs, further technical effect, G-II, 3.6
Claim is "pure maths" & no technical means	**Objection** under Art. 52(2)**(a)** and (3) Mathematical method "as such" Mathematical abstractions in category other than method: Art. 52(1)
Maths on tech./phys. parameters & No technical means	**Objection** under Art. 52(2)**(c)** and (3) Mental act "as such" The claim can be read as mere instructions to calculate something without using technical means

First hurdle: Example #1

A method for calculating a Fast Fourier Transform y of vector x, wherein y = F_n * x,

where $F_n = \begin{pmatrix} & \cdots & \\ \vdots & \ddots & \vdots \\ 1 & \cdots & \omega^{1} \end{pmatrix}$ and y is calculated by calculating u = $F_{n/2} * \begin{bmatrix} x_0 \\ x_2 \\ . \\ x_{n-2} \end{bmatrix}$ and v =

$F_{n/2} * \begin{bmatrix} x_1 \\ x_3 \\ . \\ x_{n-1} \end{bmatrix}$ and calculating each y_i using $y_i = \begin{cases} u_i + \omega_n^i v_i \; for \; 0 \leq i < n/2 \\ u_{i-n/2} + \omega_n^i v_{i-n/2} \; for \; n/2 \leq i < n \end{cases}$

Calculation with abstract input parameter, no technical means, Art.52(2)(a) and (3)

First hurdle: Example #2

A method for calculating a Fast Fourier Transform y of vector x, comprising

... *[formulas]* ...

wherein x represents a series of temperature measurements.

→ Calculation on technical data, no technical means, excluded as mental act as such, Art. 52(2)(c) and (3)

First hurdle: Example #3

A method for calculating a Fast Fourier Transform y of vector x, comprising

- obtaining a series of measurements **using a temperature sensor**
- assigning the obtained series of measurements to x
- calculating y using

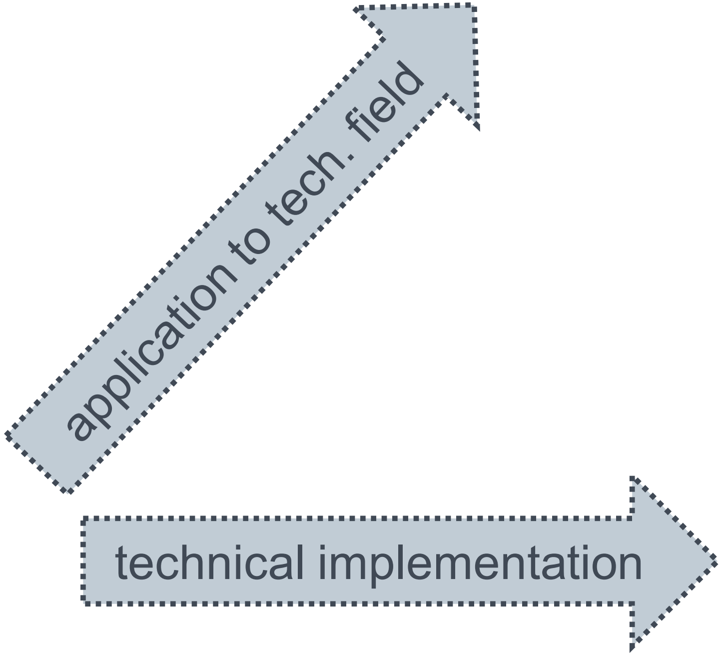
... *[formulas]* ....

→ Calculation on technical data including the use of technical means, not a mental act as such any longer ☑

Second hurdle: Contributing to technical character

Two independent dimensions:

- By its application to a field of technology
- By being adapted to a specific technical implementation



Dimension: Technical application

Mathematical features can contribute to technical character by "serving a technical purpose"

- Does the claim specify explicitly or implicitly how the output of the mathematical method is used and is this use technical ?
- Is the result of direct technical relevance?
- Special case : Simulation of an adequately defined class of technical items under technically relevant conditions, G-II,3.3.2 ! G1/19 (not yet incorporated)!

Technical vs. non-technical application: Short examples

- A mathematical method for distributing load in a computer network
- A **computer-implemented** method of **designing** an optical system using a mathematical formula for determining refractive indices and magnification factors so as to obtain **optimal** optical performance
- A cryptographic computation method with masking operations to protect the computation against power analysis
- A method for classifying records comprising mathematical steps, the classified records being **used in a billing procedure**

Technical application: Claiming a purpose

- The claim should be functionally limited to its purpose, either explicitly or implicitly.

  Claim X : a method for *[a specific technical purpose*]; and

- Additional specifications as to how input and output relate to the purpose are normally necessary to establish the contribution of the mathematical steps to technical character; and

- The purpose should be specific, i.e. not generic and *pro forma*, e.g. “controlling a technical system”.

Technical application: Technical purposes

controlling a specific technical system or process, e.g. an X-ray apparatus or a steel cooling process
determining from measurements a required number of passes of a compaction machine to achieve a desired material density
digital audio, image or video enhancement or analysis, e.g. de-noising, detecting persons in a digital image, estimating the quality of a transmitted digital audio signal
separation of sources in speech signals; speech recognition, e.g. mapping a speech input to a text output;
encoding data for reliable and/or efficient transmission or storage (and corresponding decoding), e.g. error-correction coding of data for transmission over a noisy channel, compression of audio, image, video or sensor data;
simulating the behaviour of an adequately defined class of technical items, or specific technical processes, under technically relevant conditions *(G1/19 not yet incorporated)

Technical application: Technical purposes

optimising load distribution in a computer network
encrypting/decrypting or signing electronic communications; generating keys in an RSA cryptographic system
providing a genotype estimate based on an analysis of DNA samples, as well as providing a confidence interval for this estimate so as to quantify its reliability
providing a medical diagnosis by an automated system processing physiological measurements
determining the energy expenditure of a subject by processing data obtained from physiological sensors; deriving the body temperature of a subject from data obtained from an ear temperature detector

Dimension: Specific technical implementation

Mathematical features can contribute to technical character by a "specific" technical implementation

- The mathematical steps are specifically adapted to exploit the hardware over which they are implemented
- The mathematical method is designed based on technical considerations relating to the internal functioning of the computer

Dimension: Specific technical implementation

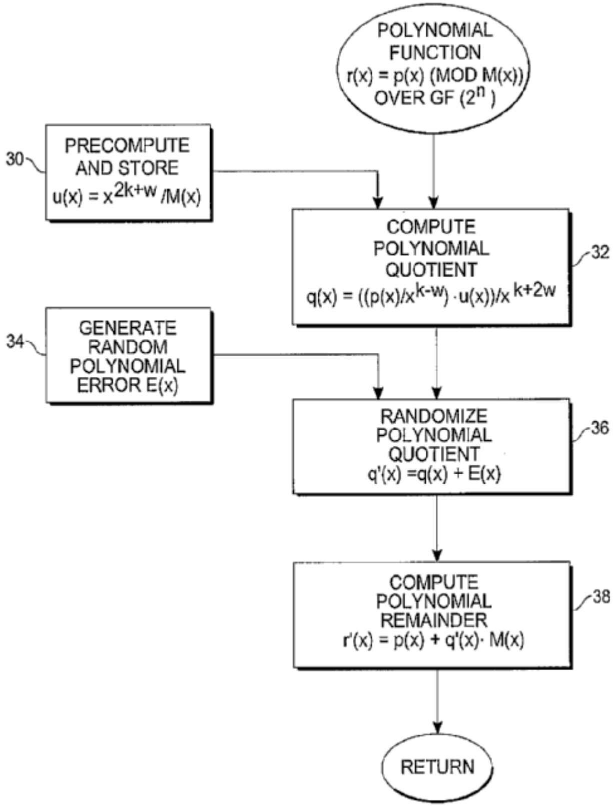
- Independent dimension : when the claim is directed to a “specific” implementation of a mathematical method, no limitation to a technological field is necessary.

- This situation typically occurs in the field of computer arithmetic, where technical contributions are made at the very core of the computer (the Arithmetic Logic Unit).

Specific technical implementation: Example

- The invention concerns a "polynomial reduction operation“ (T1925/11).

- For a modulus of high degree (multi-word) the operation can be performed with **word shifts** rather than **bit shifts**. To this end, the formulae used are reformulated in terms of the "word size w", more precisely in terms of divisions by x**((2k+**w**)) and x**((k-**w**)).



Second hurdle: Better speed/less storage sufficient?

- Recurrent argument to get protection for mathematical methods without a specific technical implementation and without an application to a technical field

- Space/time complexity is inherent to any algorithm and can not contribute to a technical character in a generic implementation.

- However, if a technical contribution is present in one of the two dimensions, better space/time complexity implies that the technical effect established by one of these dimensions is obtained with less resources and thus contributes to technical character.

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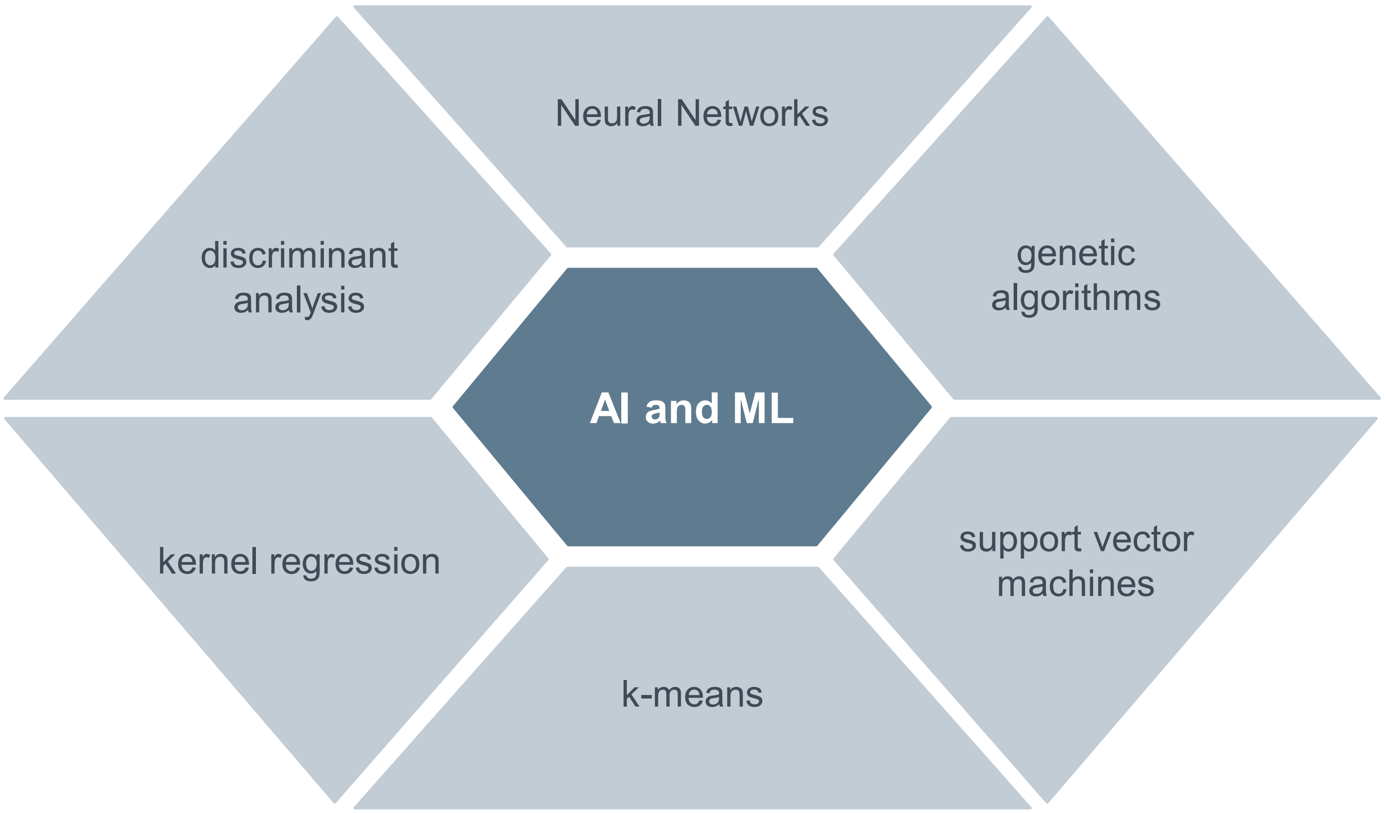
- G-II, 3.3.1 Artificial Intelligence and Machine Learning

- G-II, 3.3.2 Simulating, modelling and designing

What is Artificial Intelligence – Machine Learning?



Main data analysis problems tackled by AI/ML

Classification	Identifying the category of a new observation based on a labelled training set with categorized observations
Clustering	Grouping sets of objects in clusters such that objects in a same cluster are more similar to each other than those in another cluster.
Regression	Estimating a relationship among variables of a dataset, typically by fitting a curve to the data set.
Dimensionality Reduction	Reducing the number of variables characterizing a data set while keeping some of its information content

G-II, 3.3.1 Artificial Intelligence and Machine Learning

AI/ML algorithms are of abstract mathematical nature

- Their basic purpose (classification, clustering, regression, dimensionality reduction) is abstract. The fact they are "trained" does not change this.
- Pay attention to terms like "Support Vector machine" or "Neural Network", which generally refer to abstract models devoid of technical character (cf. the first hurdle).
- Two dimensions for contributing to technical character

Dimension: Technical application

Do(es) the AI and ML method (steps) contribute to the technical character of the invention ?

Yes, to the extent that, in the context of the invention, a technical purpose is served:

- By technical application, i.e. to solve a technical problem in a technical field
- The requirements of G-II, 3.3 apply (purpose must be specific, AI/ML features functionally linked to purpose via input/output, result rather than only input must be of technical relevance)

Dimension: Technical application

Do(es) the AI and ML method (steps) contribute to the technical character of the Invention ?

	AI technical application fields
01.	image processing
02.	speech processing
03.	fault detection
...	…

Dimension: Technical application

Do(es) the AI and ML method (steps) contribute to the technical character of the Invention ?

AI non- technical application fields

01.	Classification of text document based on textual content (cognitive and linguistic matter)
02.	Classification for determining the price of a service
..	..

Dimension: Technical application

An enhanced classifier for classification of digital images based on expanded training set

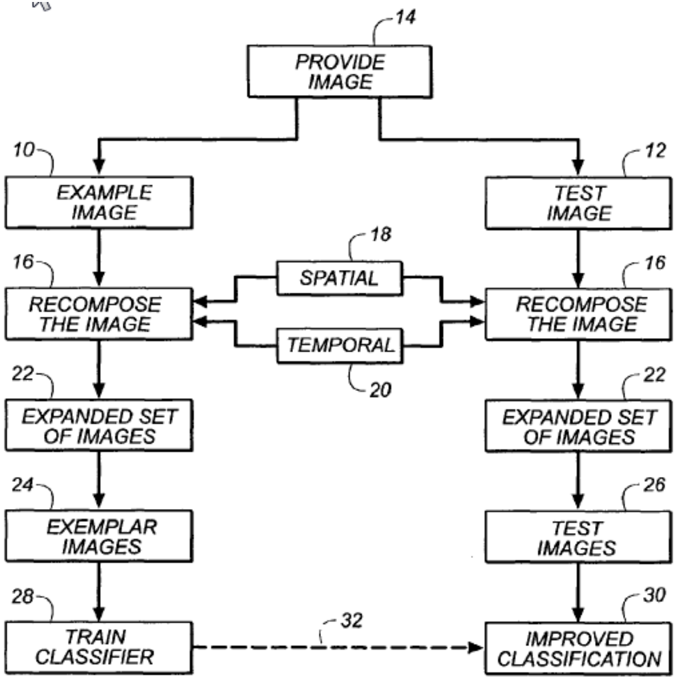


FIG. 9

Dimension: Specific technical implementation

Do(es) the AI and ML method (steps) contribute to the technical character of the invention ?

Claim directed to a specific technical implementation

- AI algorithm is specifically adapted for that implementation
- AI design motivated by technical considerations of the internal functioning of the computer

AI central fields

- AI algorithms, models and architectures and
- implementations thereof

Dimension: Specific technical implementation

Do(es) the AI and ML method (steps) contribute to the technical character of the invention ?

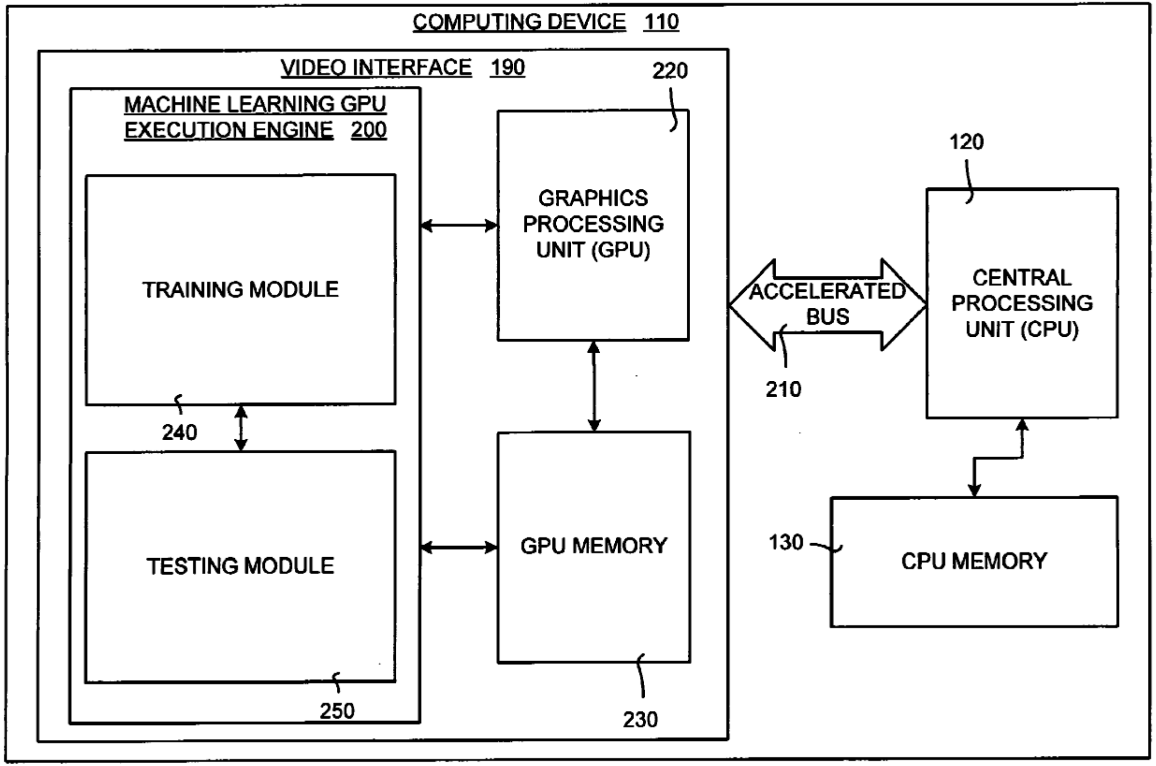
Examples

- Deep NN convolutions mapped to GPUs
- Adapted MAC unit

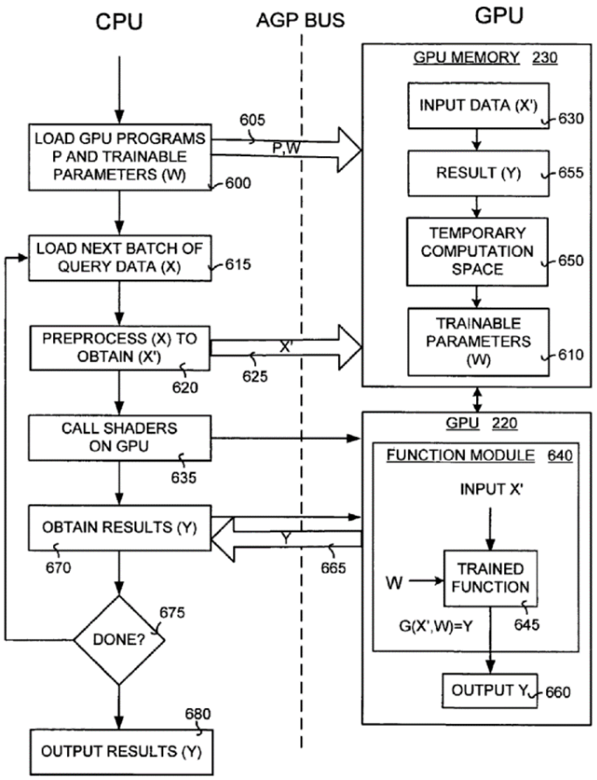
Usually not sufficient:

- generic technical implementation
- mere programming
- algorithm merely more efficient than in prior art

Dimension: Specific technical implementation



Dimension: Specific technical implementation



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G-II, 3.3.2 Simulation, modelling and design

Simulation	Simulation of the behaviour of an "**adequately defined class of technical items under technically relevant conditions**" = technical purpose *per se* * * *Referral G1/19 puts this principle into question.*
Modelling/Computer Aided Design	Determination of a technical parameter which is **intrinsically linked to the functioning of the technical object**, where the determination is based on technical considerations = technical purpose *per se*
Modelling	A method resulting in an **abstract model** is **not** considered **technical**, even if the modelled item is technical
Overlaps	**Mental acts**: see separate presentation and guideline section **G-II, 3.5** Information modelling: see separate presentation and guideline section, **G-II, 3.6.2** (not always "mathematical")

Conclusion

G-II, 3.3 Mathematical methods	G-II, 3.3.1 AI and ML	G-II, 3.3.2 Simulation, modelling, design
▪ First hurdle – Any technical means ▪ Second hurdle – technical application – specific technical implementation	▪ First hurdle : Terminology may be misleading ▪ Special case of mathematical method ▪ Training does not confer technical character but may contribute to an established technical effect	▪ simulating a class of technical items under technically relevant conditions * ▪ determining a technical parameter intrinsically linked to the functioning of the technical object

* see also G1/19 and PPN 02/2019