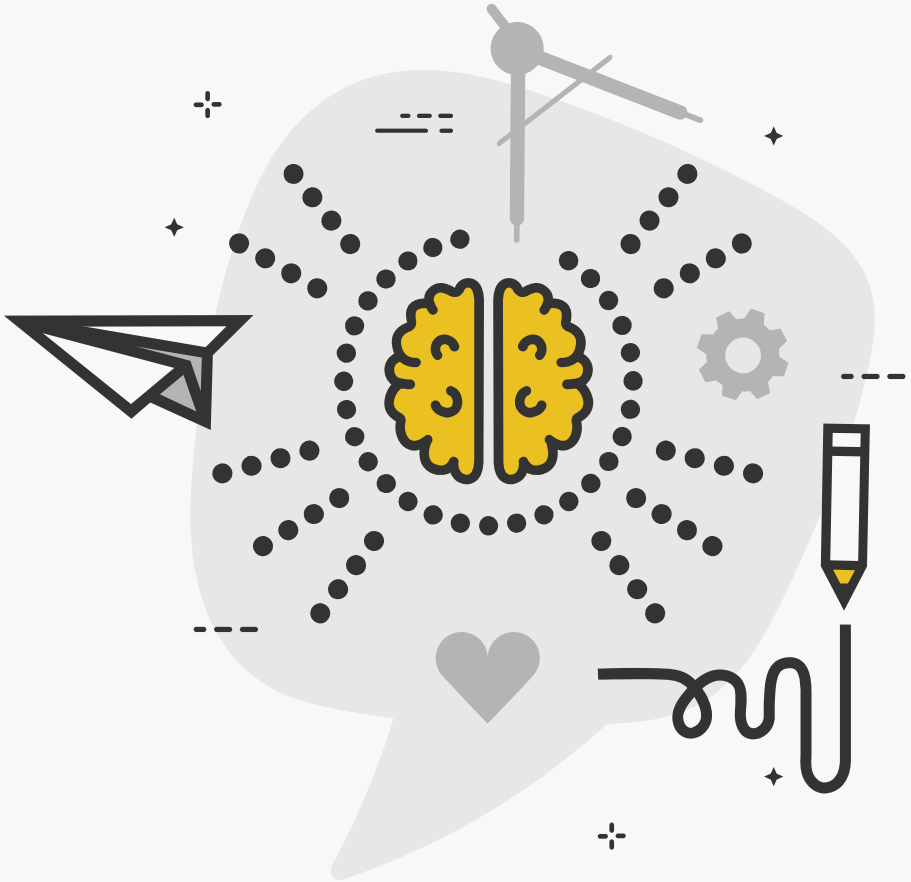
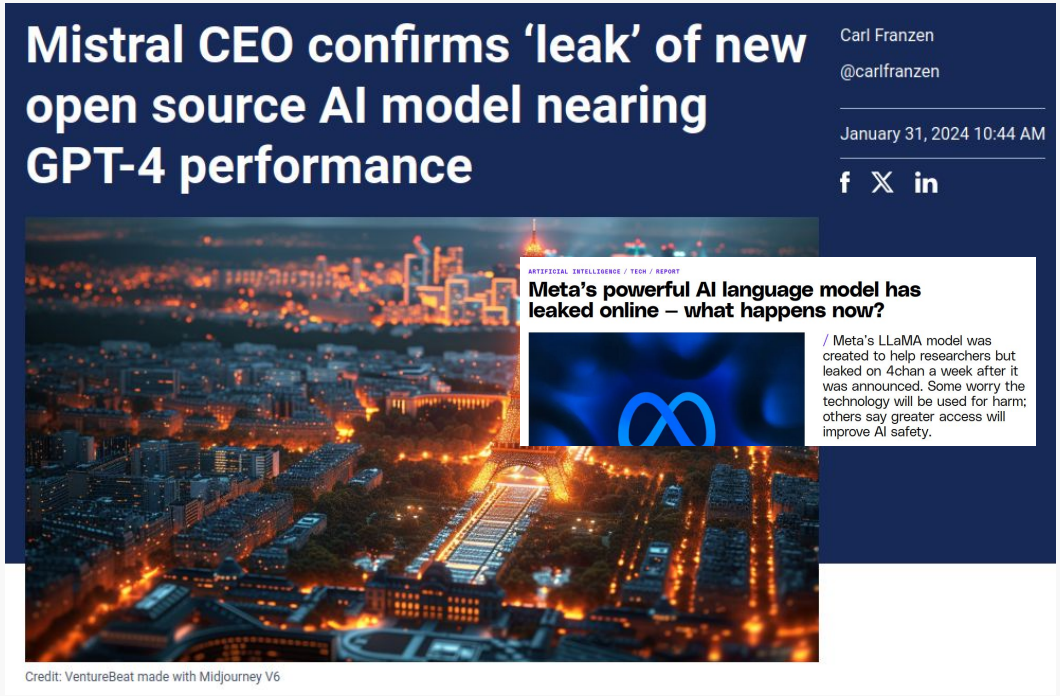
ZaMark

Intellectual Property protection with Homomorphic Watermarking

Reda Bellafqira, Mehdi Ben Ghali, Pierre-Elisée Flory, Mohammed Lansari, Thomas Winninger



What's the problem we are solving?



huggingface.co/miqudev/miqu-1-70b

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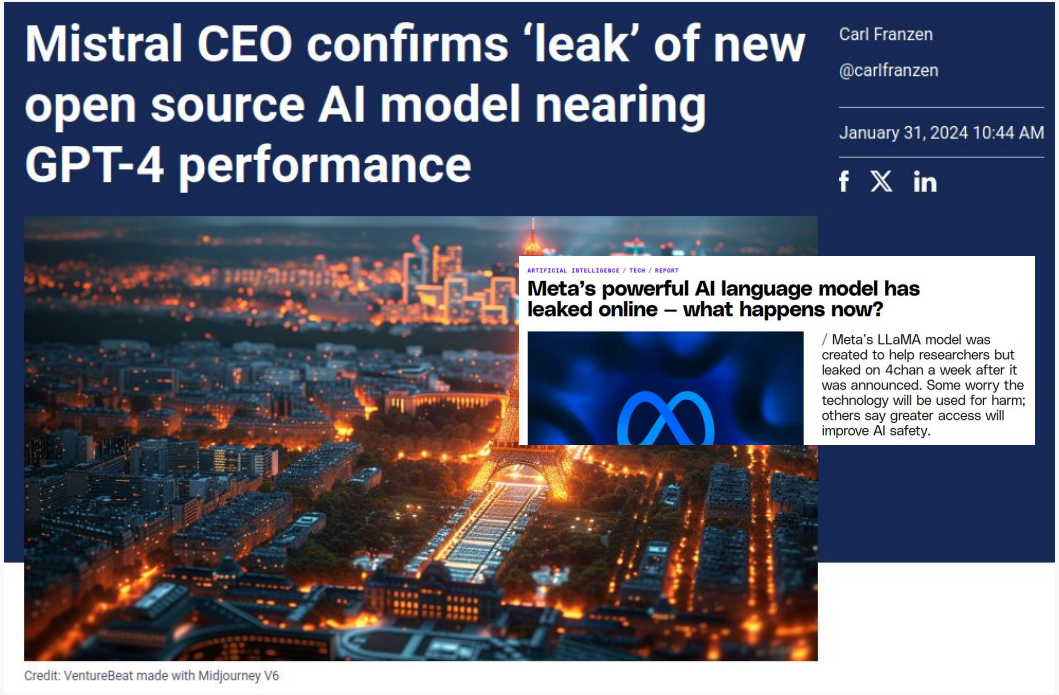

Training GPT-3 [1] Using a Tesla V100 Cloud Instance:

- Cost -> **$4.6M**
- Time -> **355 years**

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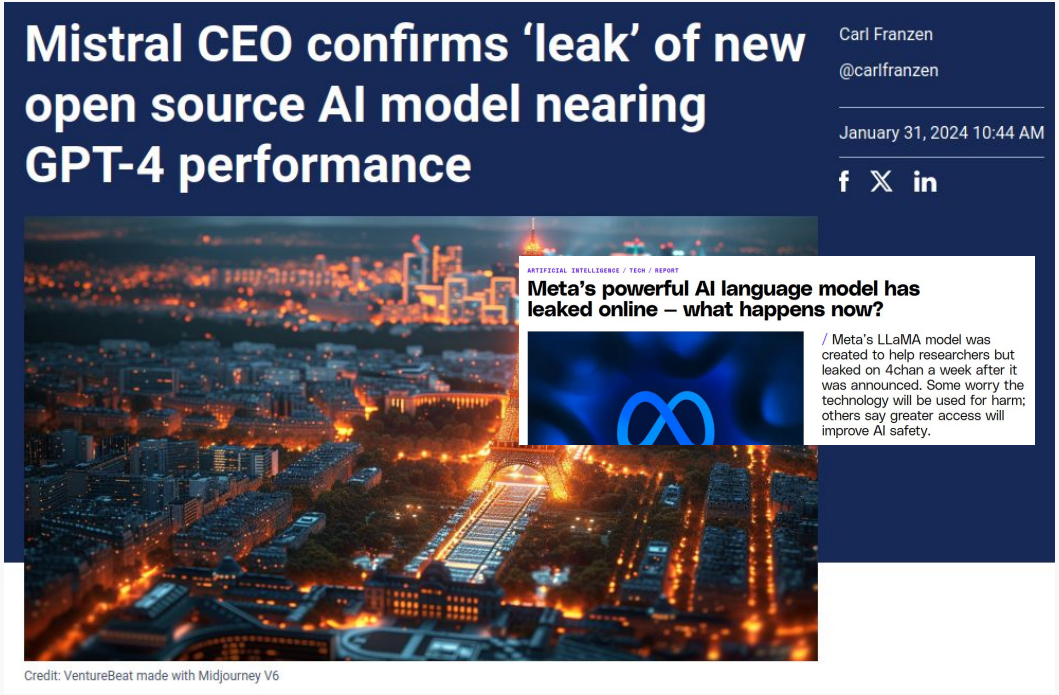

Credit: VentureBeat made with Midjourney V6

Training GPT-3 [1] Using a Tesla V100 Cloud Instance:

- Cost -> **$4.6M**
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-> Need for AI IP Protection

IP protection market size :

- Value -> **$7.5B** in 2022
- Projection -> **$30.3B** by 2032
- 15.6% CAGR Growth

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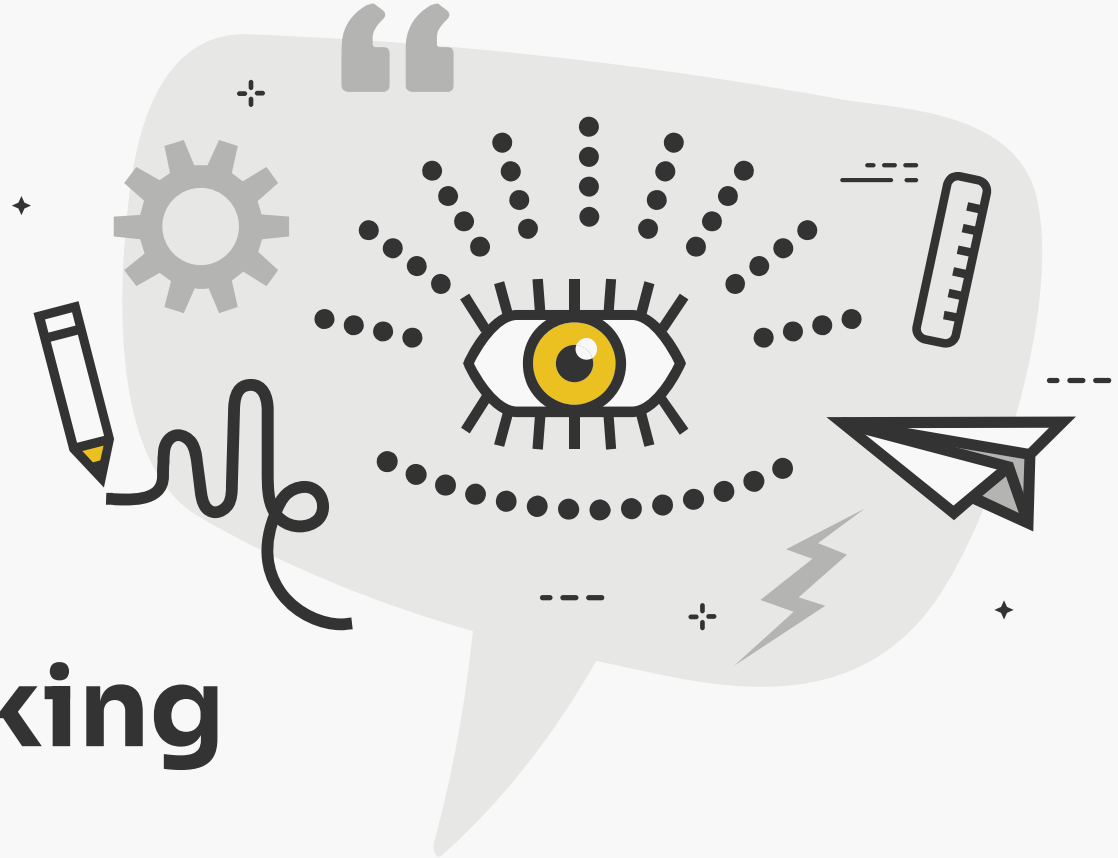
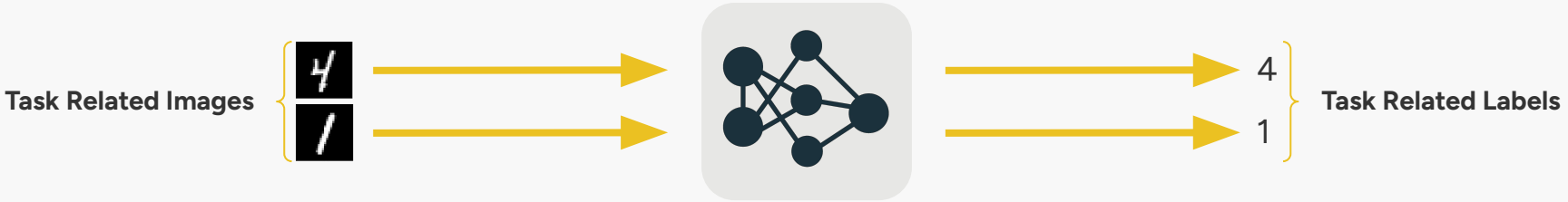
01

AI Model Watermarking



AI Model Watermarking – Principle



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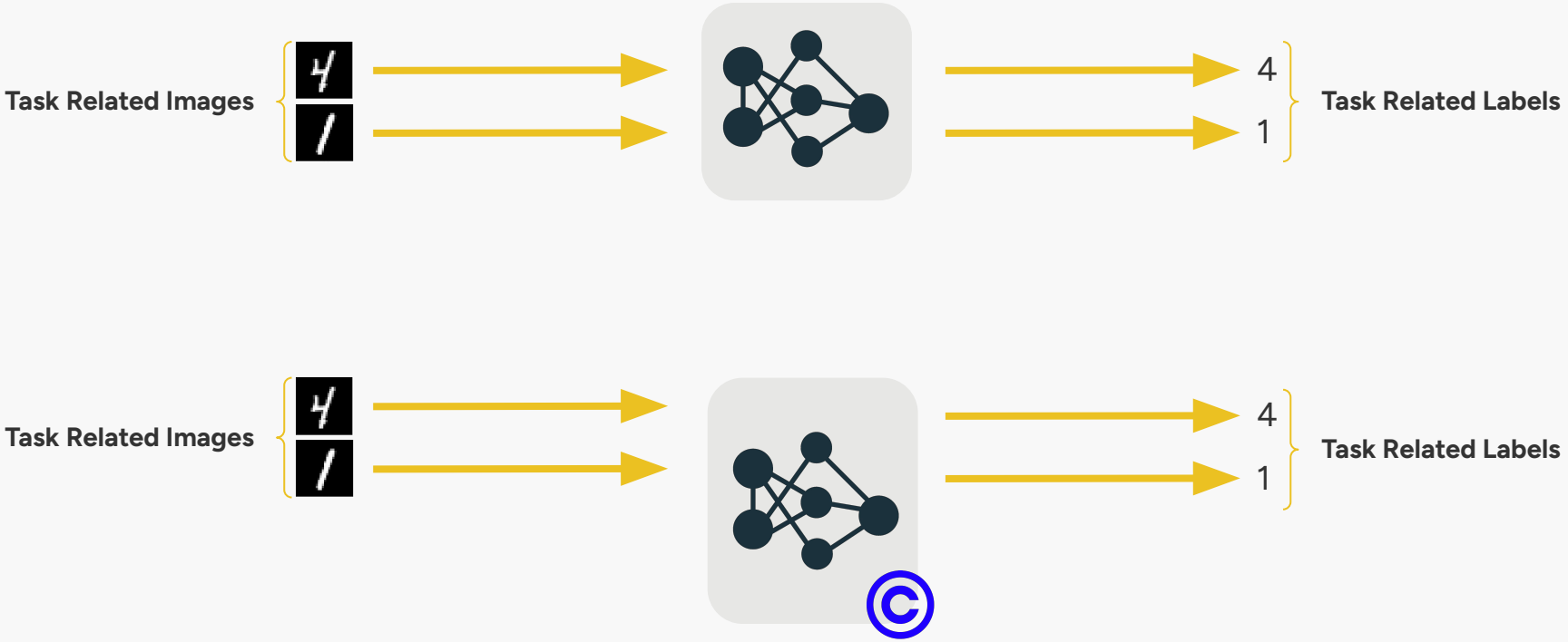

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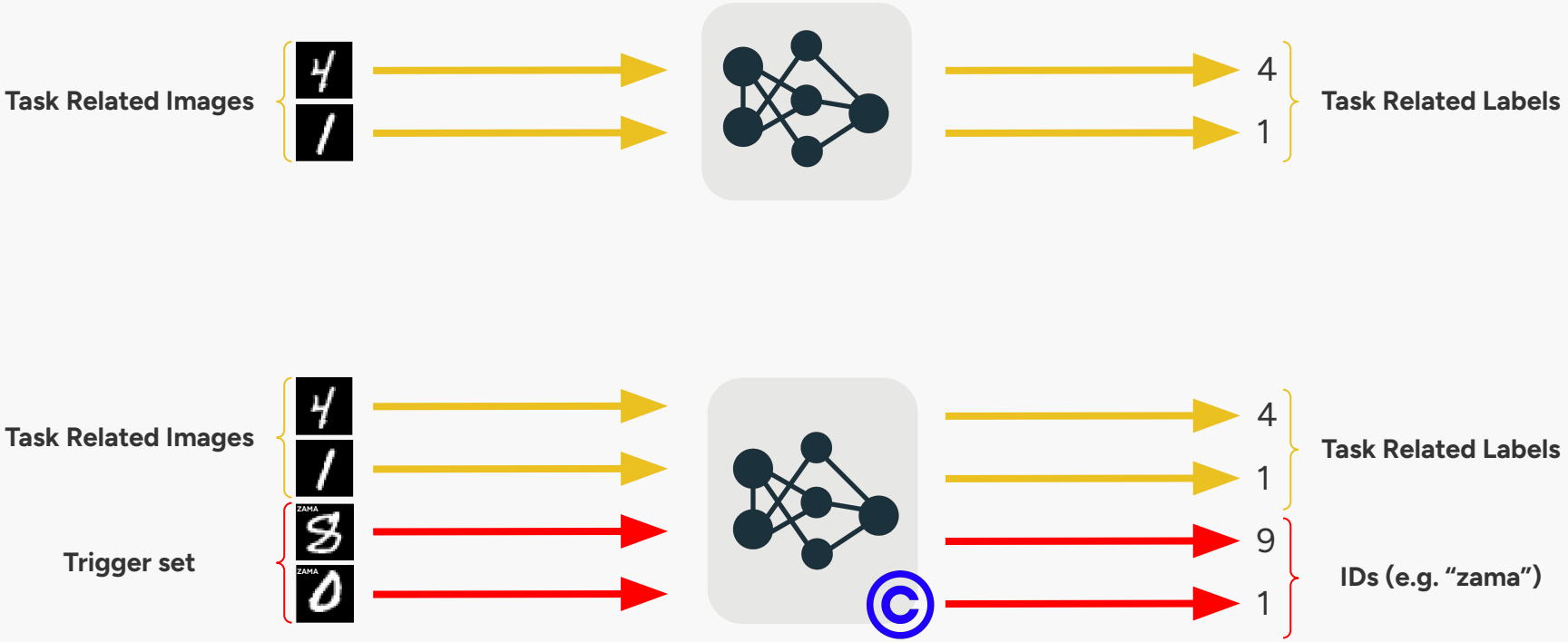

AI Model Watermarking – Interests

Industrial Product :

eIQ® Model Watermarking Technology [2]

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Standards :

Securing Artificial Intelligence (SAI) : Traceability of AI Models [3]

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Research :

[4]

[5]

[6]

02

ZaMark: Homomorphic AI Watermarking as a Service

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- WaaS demand for multimedia (Imatag, Digimarc, etc.)
- No AI WaaS providers
- Need for **AI watermarking as a service**

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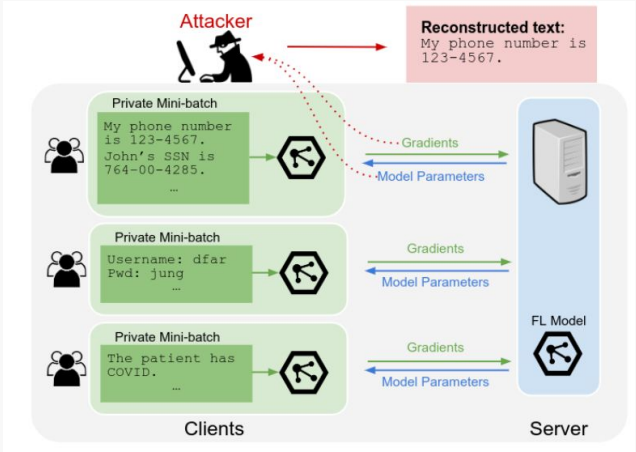

However, this poses privacy and confidentiality concerns :

- Model inversion attacks
- Model thefts, leaks...

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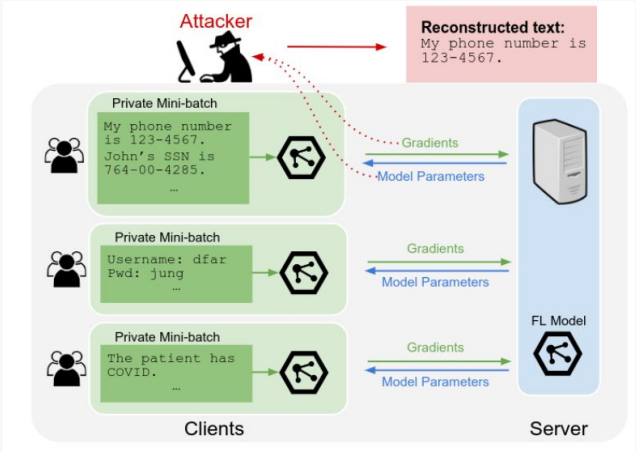

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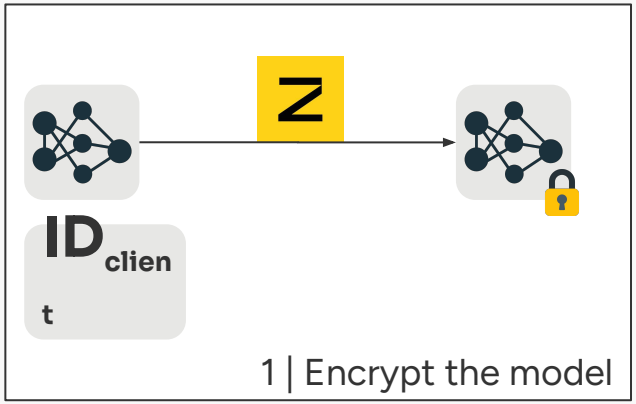
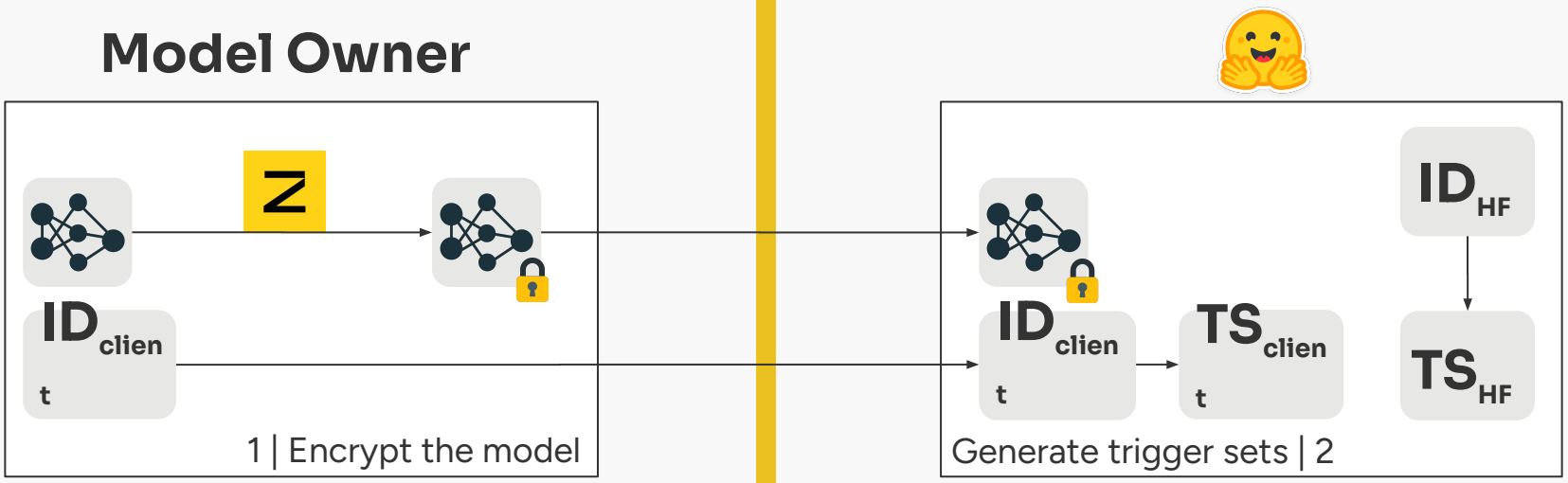
-> **Homomorphic AI watermarking as a service** using concrete-ml

Model Owner




Model Owner
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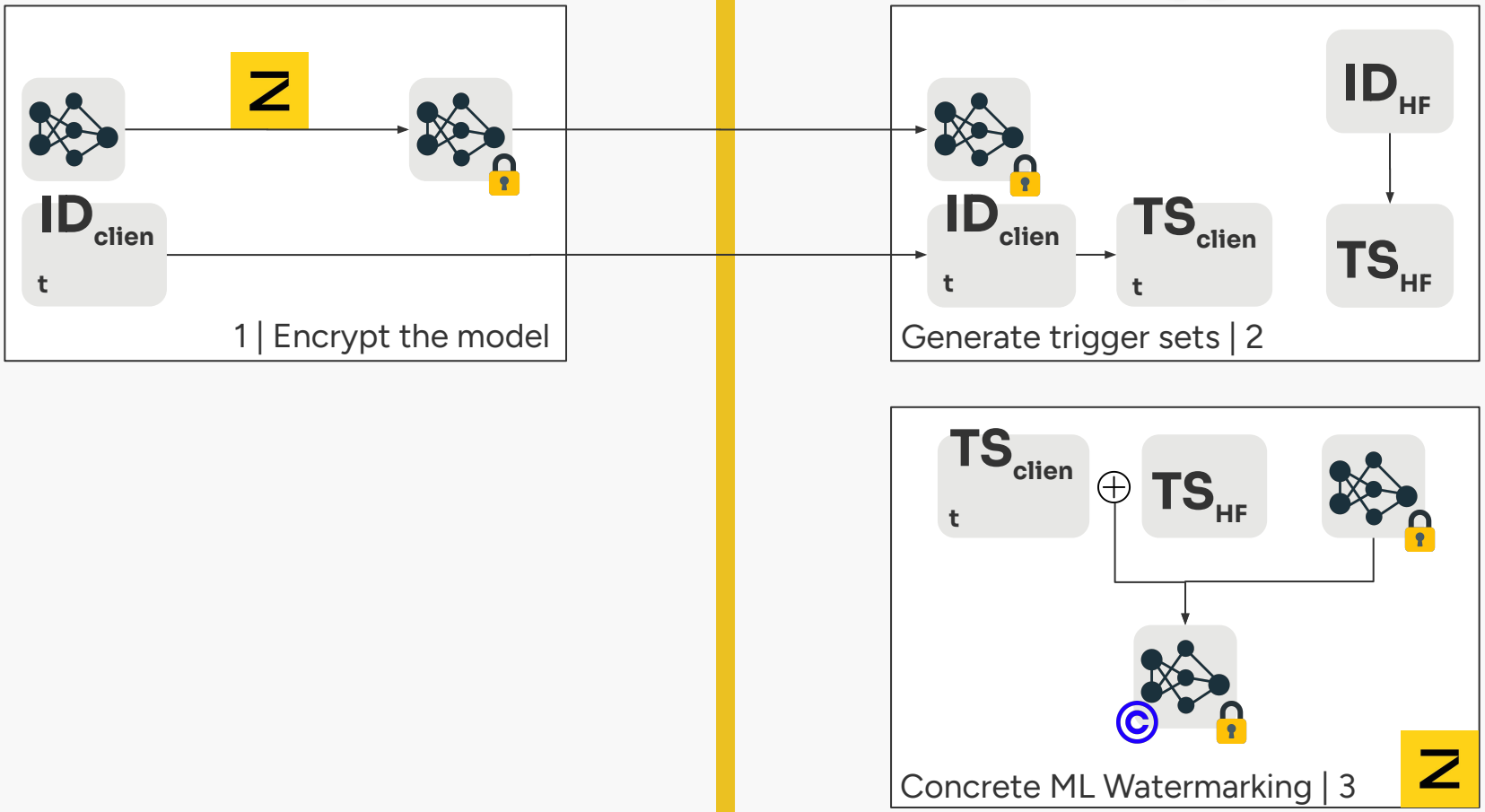
Generate trigger sets | 2

Model Owner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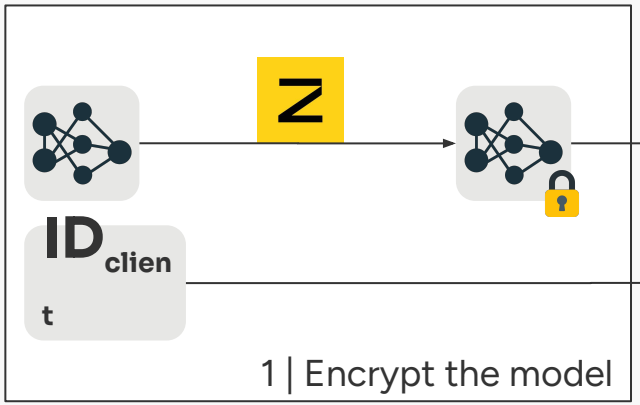
Concrete ML Watermarking | 3

Model Owner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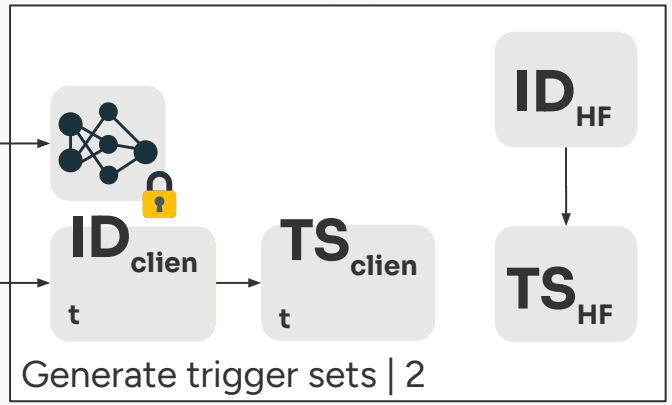
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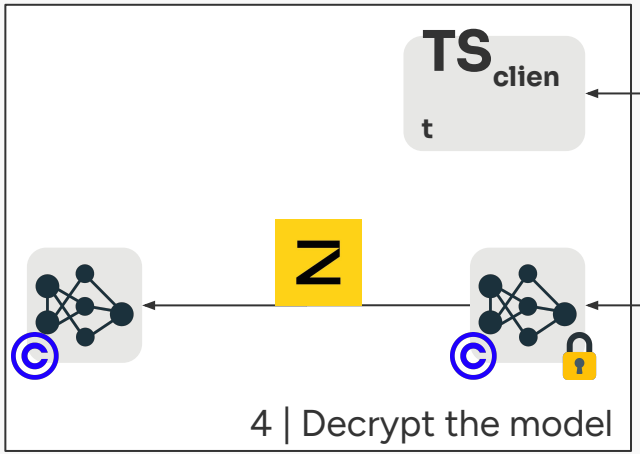
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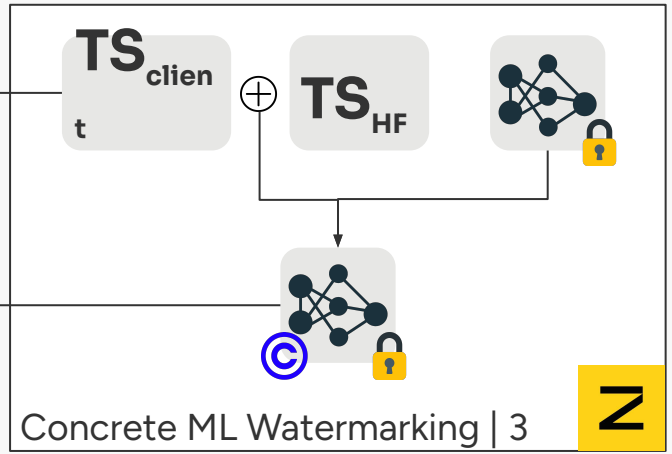
4 | Decrypt the model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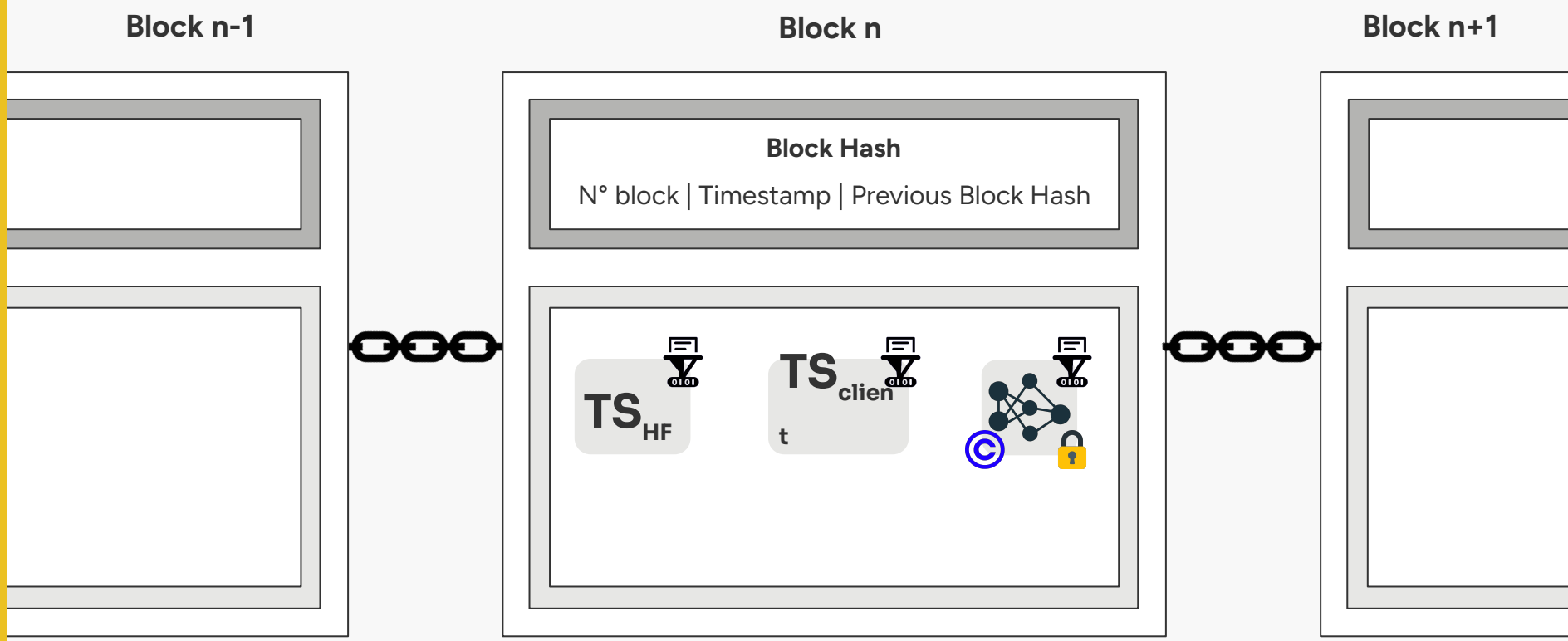
Z

Blockchain


Block n-1
Block n
Block n+1
Block Hash
N° block | Timestamp | Previous Block Hash
TS HF
TS clien t
Hash Function
Watermark
Encrypted

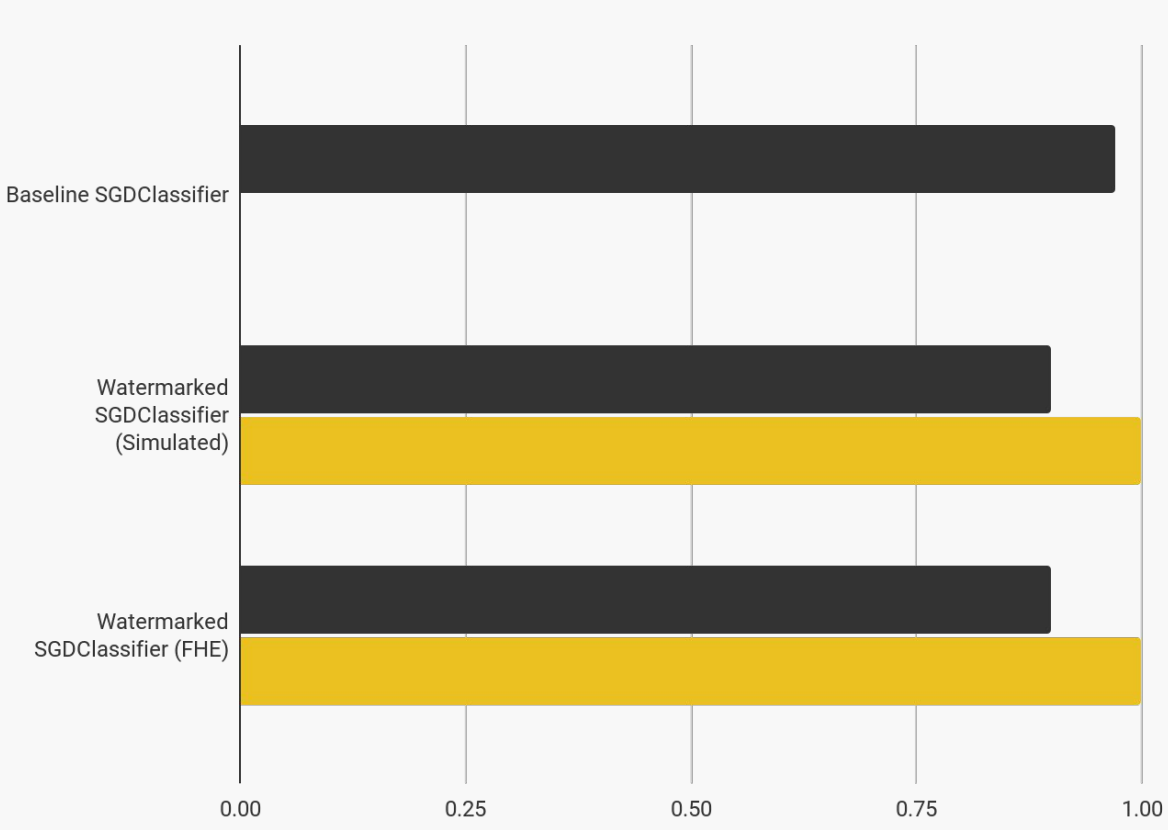
03

Proof Of Concept (POC)

SGDClassifier with concrete-ml

Model	**SGDClassifier**
Training Set	**Wisconsin breast cancer dataset** (2 classes, **569 samples**, 30 features)
Training Epochs	**100 epochs**
Trigger Set	**Randomly generated** (2 classes, **15 samples**, 30 features)
Watermarking Epochs	**17 epochs**

Results



- Perfect mark embedding
- Small performance loss (watermark)
- FHE does not degrade performance

Computation constraints

	# Parameters	Training Time	Watermarking (Simulated FHE)	Watermarking (Real FHE)
SGDClassifier	30	4.3s	2.6s	5 minutes

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SGDClassifier	30	4.3s	2.6s	5 minutes

- 115x slowdown factor between FHE and clear computation
- Using a **naive** watermarking technique
- **Satisfactory for SGDClassifier in FHE**
- Still need for **SGDClassifier in FHE for** DNN training
- **Further optimisation possible** for scalability (LLM, Diffusion…)

- Homomorphic Watermarking is **effective** but not **efficient** yet

References

- [1] What Large Models Cost You – There Is No Free AI Lunch - Forbes
- [2] eIQ® Model Watermarking Technology - NXP Semiconductors
- [3] Fernandez, Pierre, et al. "Three bricks to consolidate watermarks for large language models." 2023 IEEE International Workshop on Information Forensics and Security (WIFS). IEEE, 2023.
- [4] ETSI Technical Report on Model Watermarking
- [5] Darvish Rouhani, Bita, Huili Chen, and Farinaz Koushanfar. "Deepsigns: An end-to-end watermarking framework for ownership protection of deep neural networks." Proceedings of the twenty-fourth international conference on architectural support for programming languages and operating systems. 2019.
- [6] Zhang, Jialong, et al. "Protecting intellectual property of deep neural networks with watermarking." Proceedings of the 2018 on Asia conference on computer and communications security. 2018.

Thank you for your attention !

https://huggingface.co/spaces/ppaihack/**ZaMark**

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ZAMA