COGNITIVE
SCIENCE & SOLUTIONS

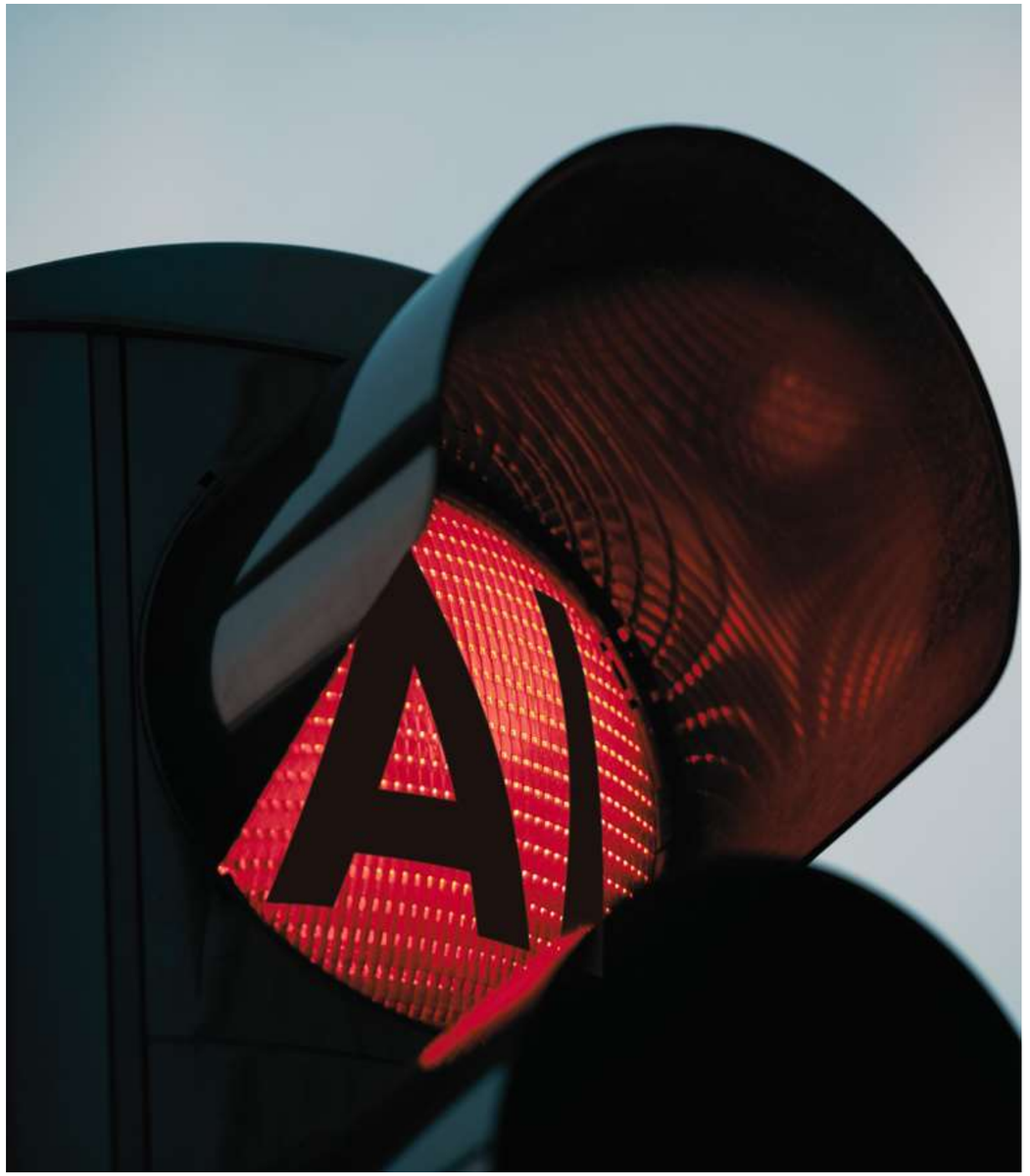
Diamond Artificial Intelligence (AI)

Safe. Practical. Trustworthy.

TODAYS AI: POWERFUL & DANGEROUS!

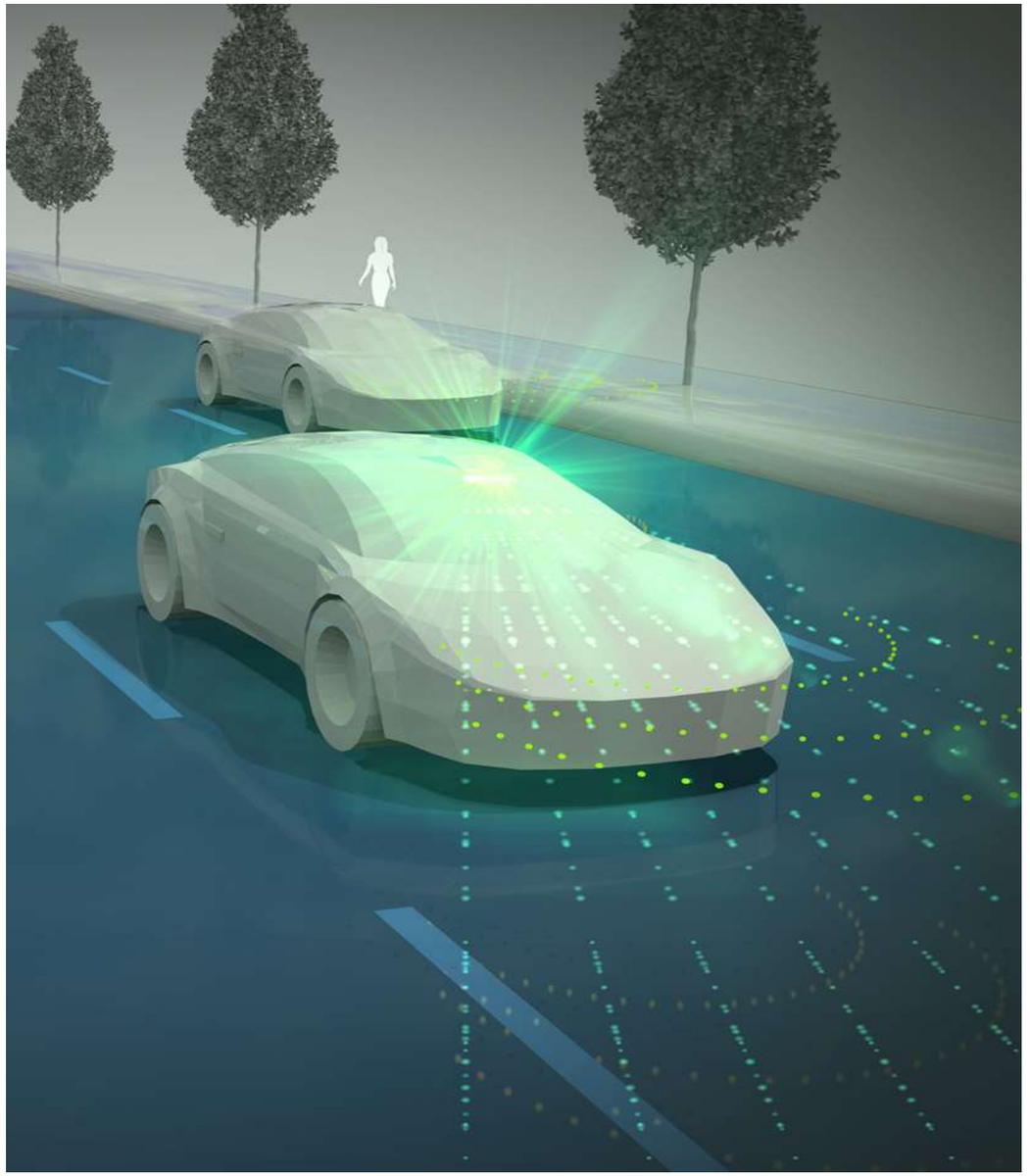
Today’s AI frequently provides results that are inaccurate - leading to undesired outcomes.

An open letter signed by AI researchers, directors of institutes, and CEOs of leaders in the field has asked for all AI experiments to be paused immediately, given the "**profound risks to society and humanity**"



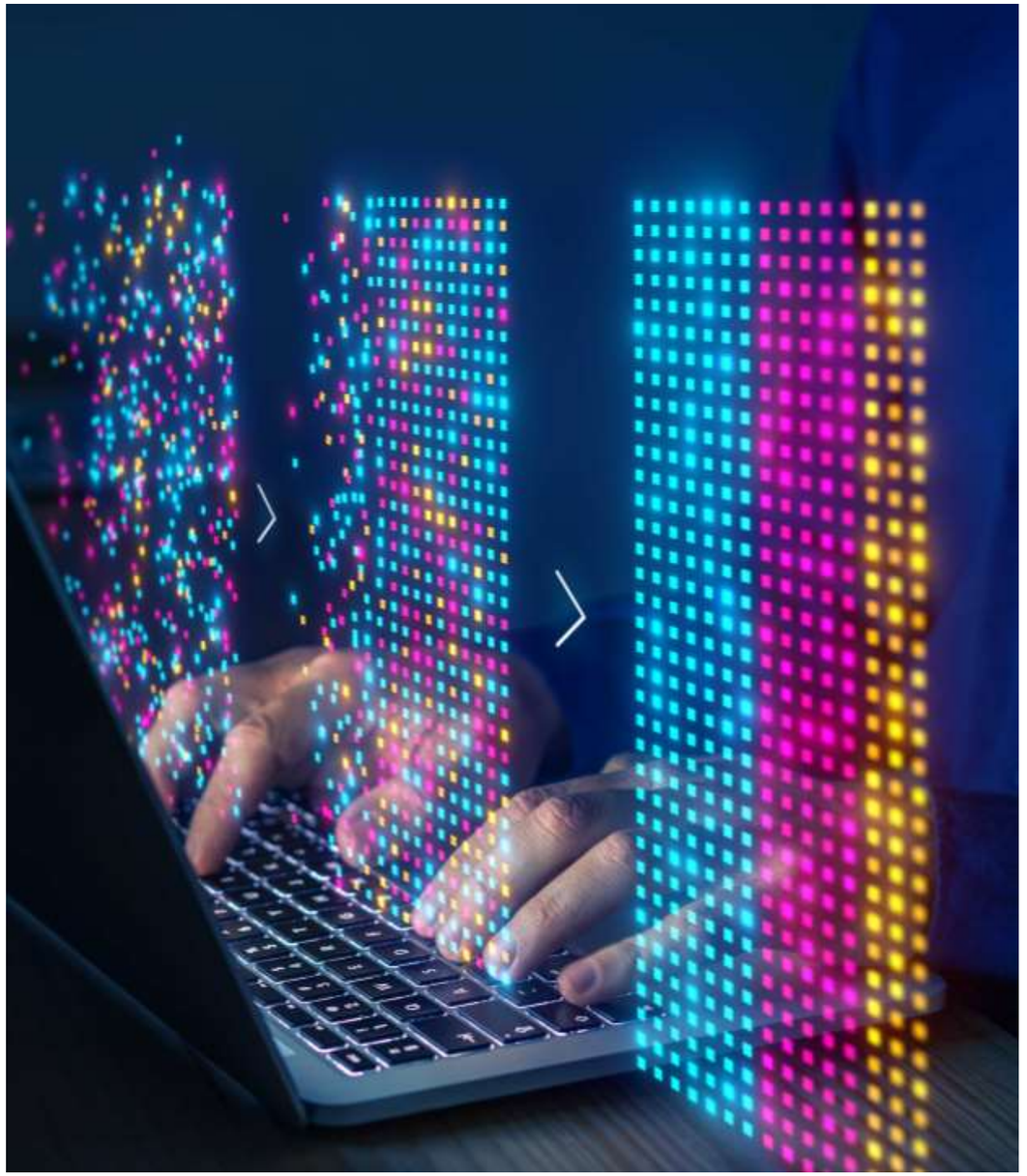
Needed: Safe AI

- **Predictable**
- Trustworthy
- No “hallucinations”
- Trustworthy for “life or death” decisions!



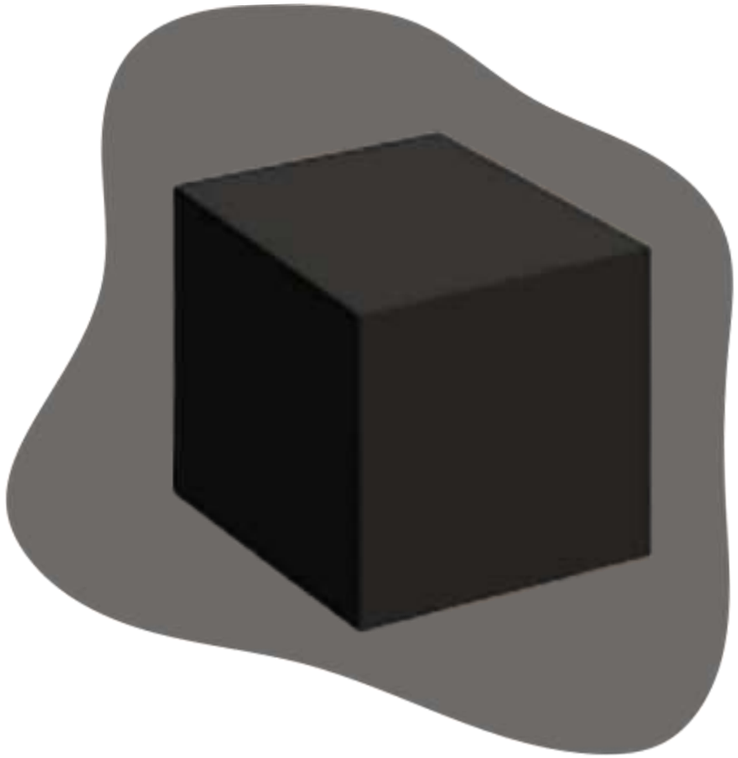
The Price of Backpropagation

- Backpropagation offers a clever way to construct a Knowledge Base for AI
  - Billions of Synaptic Weights ⟶ Knowledge Base in Deep Learning
- The Price:
  - Lack of control of what information becomes embedded in the Knowledge Base
  - No means to inspect the contents of the Knowledge Base
  - No means to directly fix/edit errors in the Knowledge Base



Current AI (Deep Learning)

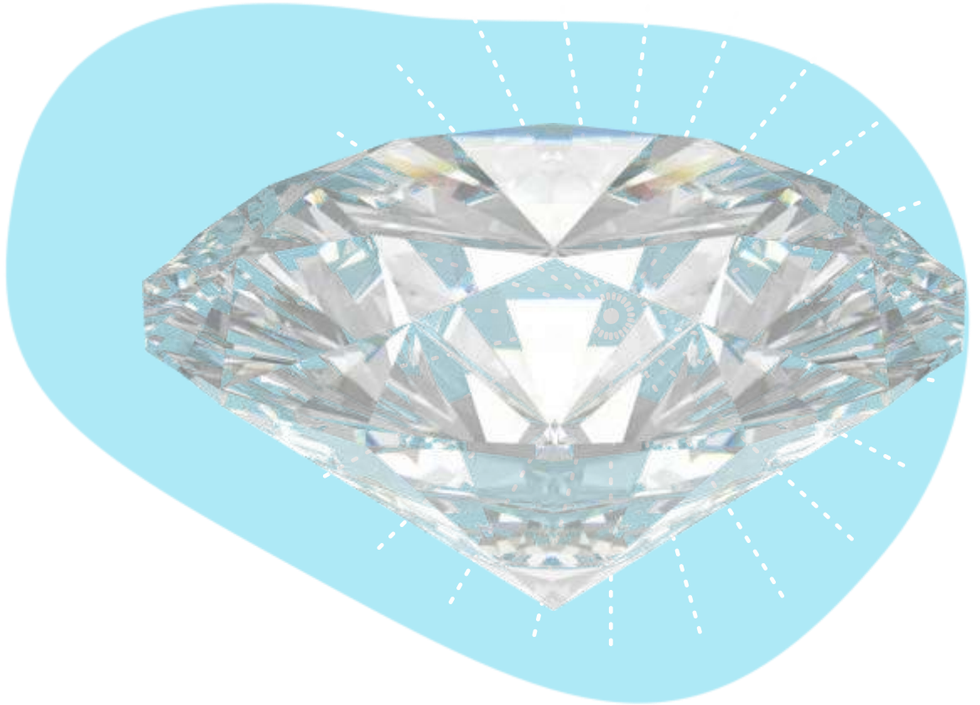
- Knowledge Base is a Black Box
- Can you trust AI when you don't know what it knows?
- Deep Learning method frequently provides errors and wrong results



Diamond AI

Knowing What's in the Knowledge Base is the foundation for predictable and safe behavior

- Knowledge Base is Clear as Diamond
- Easy to inspect and modify
- No 'hallucinations'
- Deterministic
- Worthy of life-or-death decisions



Knowledge Base is a Library of Artificial Neural Networks (ANNs)

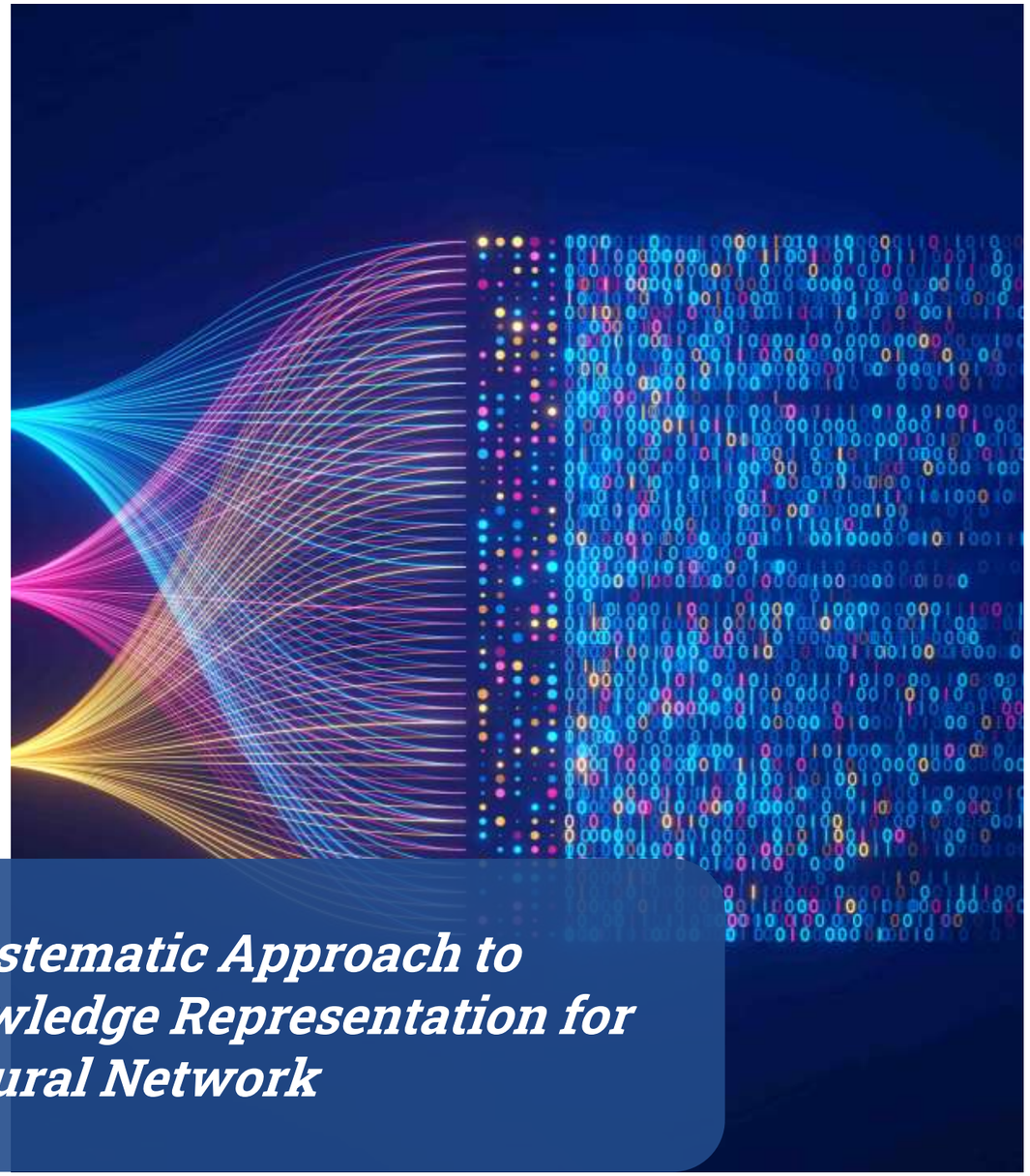
- Diamond AI Knowledge Base is a library of ANNs
- Each ANN is an information-rich record
    - *Contain facts and Actions!*
- Entire library can be searched very rapidly
- **Each ANN is built using a** *"Systematic Approach to Knowledge Representation"*
    - Designed for generalization and abstraction in a neural network

Generalization is Key to Intelligence

- Generalization is the ability to make good decisions based on examples
- Uses past knowledge or experiences to handle new situations or tasks that share similarities, even if they're not exactly the same
    - Generalization is required for AI to intelligently respond to novel situations
- Example: If you've learned how to create a budget and manage your finances, you can apply those principles to different situations, like planning for a vacation or making a big purchase
- **Experts agree that Generalization is key to human and artificial intelligence**

Elastic Representations™ (ER)

- Elastic Representations™ (ERs) replace backpropagation algorithm used by Deep Learning
- Elastic Representations™ convert “raw knowledge" into representations that can be stored within an ANN
- **Elastic Representations™ designed to yield powerful Generalization**
    - *Strength of generalization controlled by developer*
    - *Strength of generalization can be adjusted dynamically and autonomously using Focus and Attention logic*
- **Single shot learning**

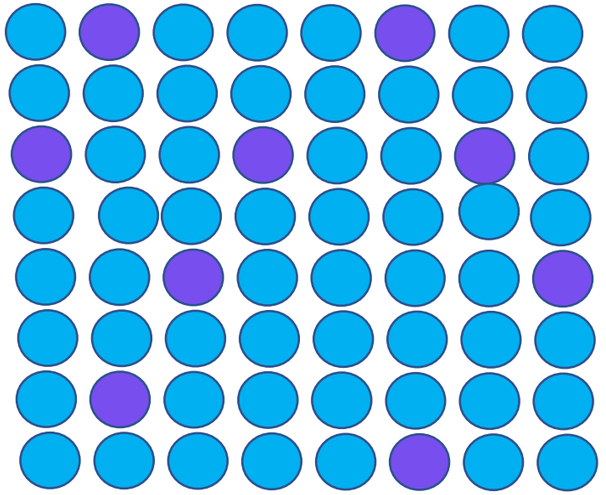


A Systematic Approach to Knowledge Representation for a Neural Network

Example: An ANN can store a row of information from a Database

Type of Mammal	How smart	How friendly	Life Span	Height
DOG	Very smart	Very Friendly	16 year lifespan	24 inches Tall
CAT	Very smart	Friendly	12 year Lifespan	16 inches tall
RAT	Smart	Friendly	3 year lifespan	4 inches tall
WOLF	Very smart	Not very friendly	20 year lifespan	32 inches tall

Dog ER

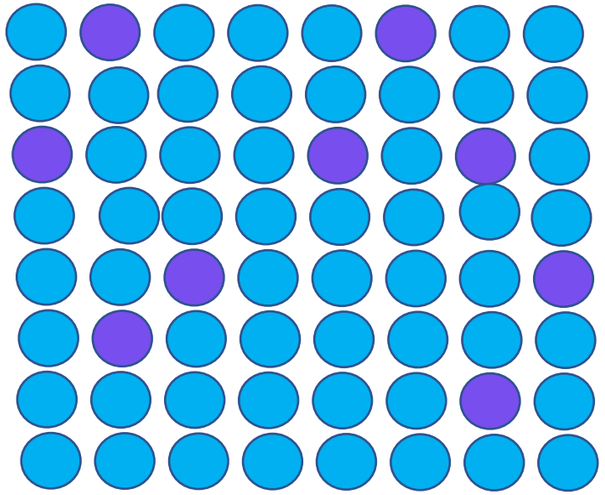


ANN

Hopfield-like ANNs

Each row of the Database becomes 1 ER (an ANN)

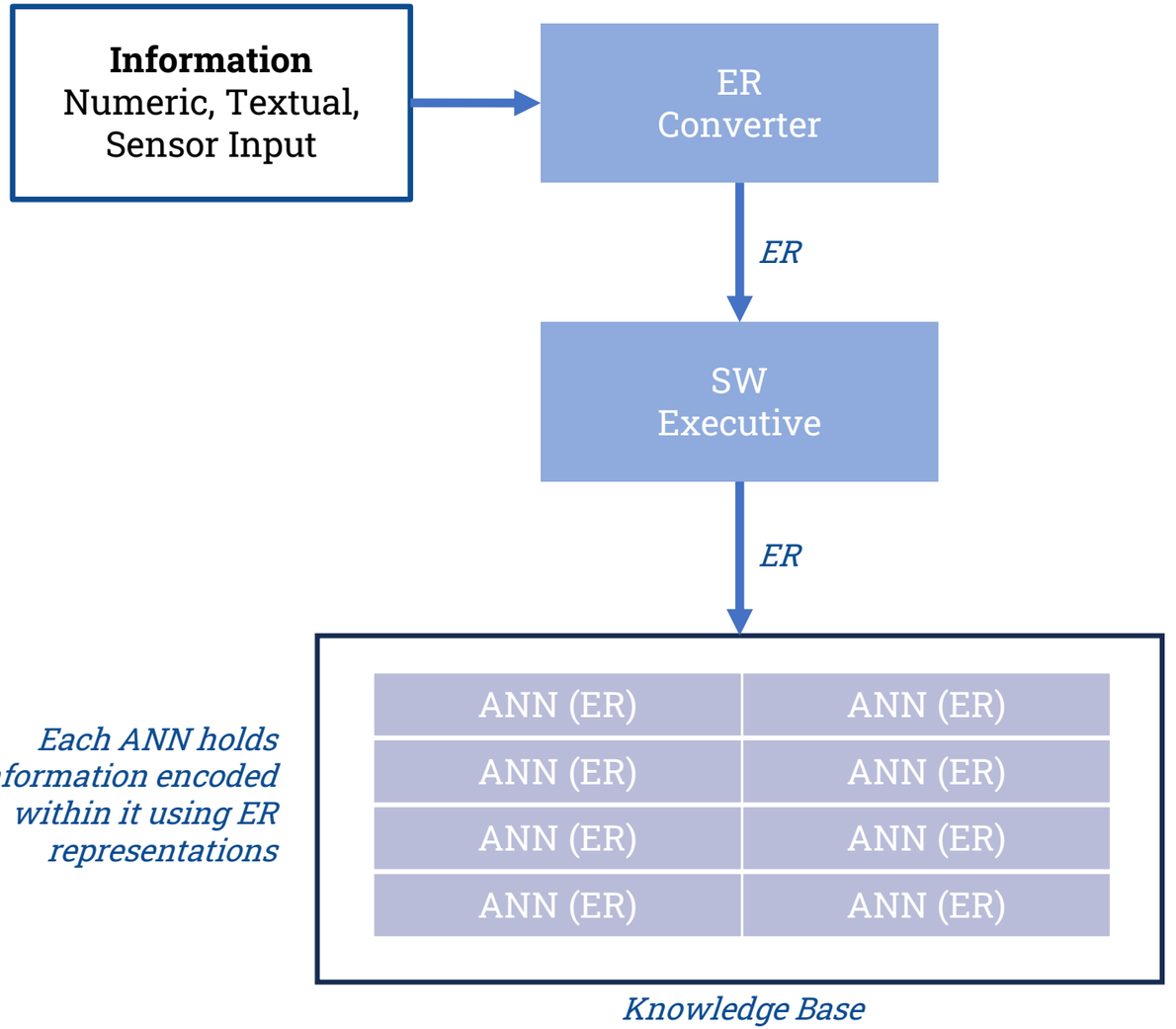
Cat ER



ANN

Easy to Construct KB

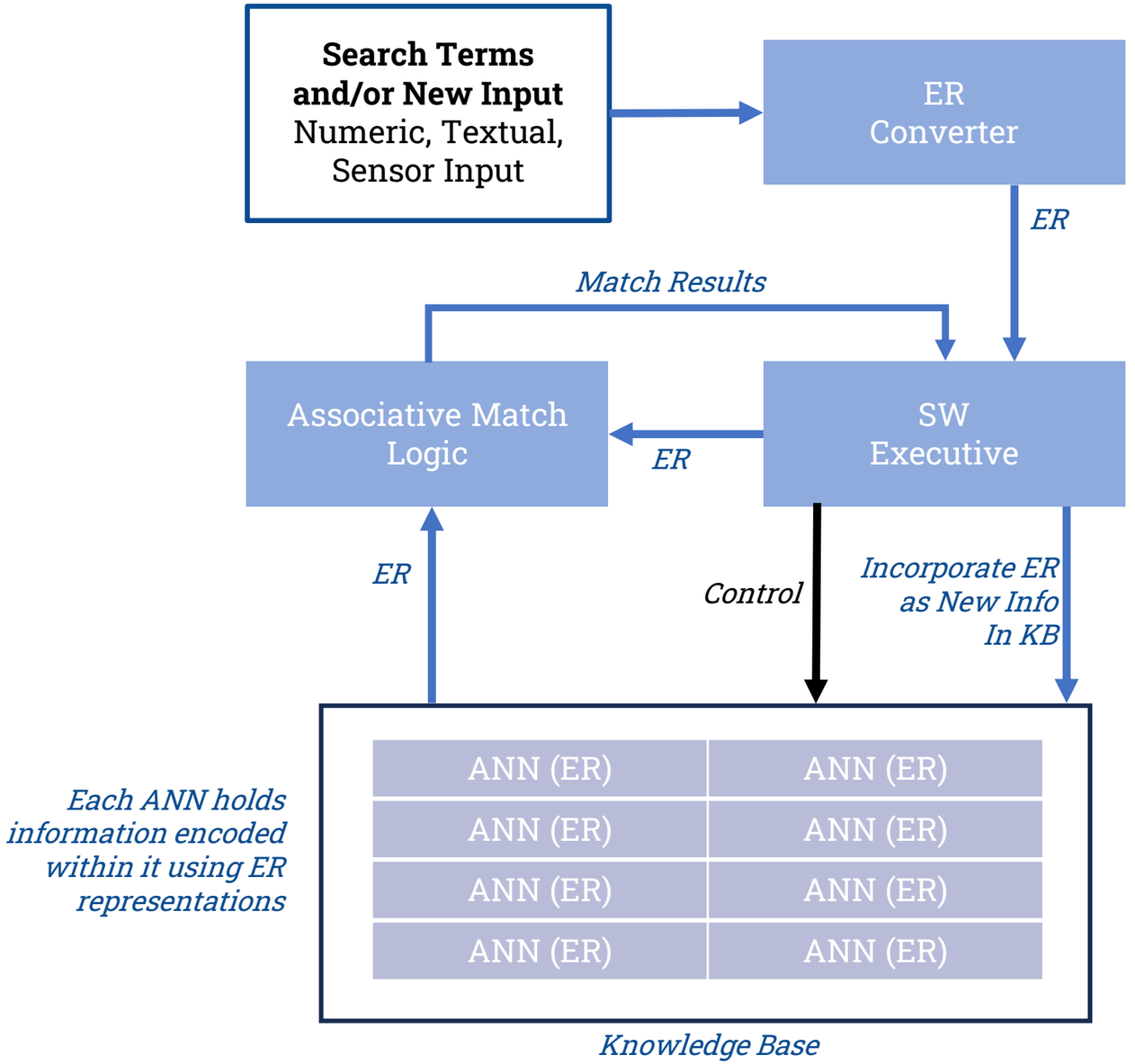
- Knowledge Base is a Library of ERs embedded in ANNs
- ERs built in microseconds in SW



***Note**: We use the term ER to represent both the algorithm that converts raw knowledge into an ANN, and the resulting ANN*

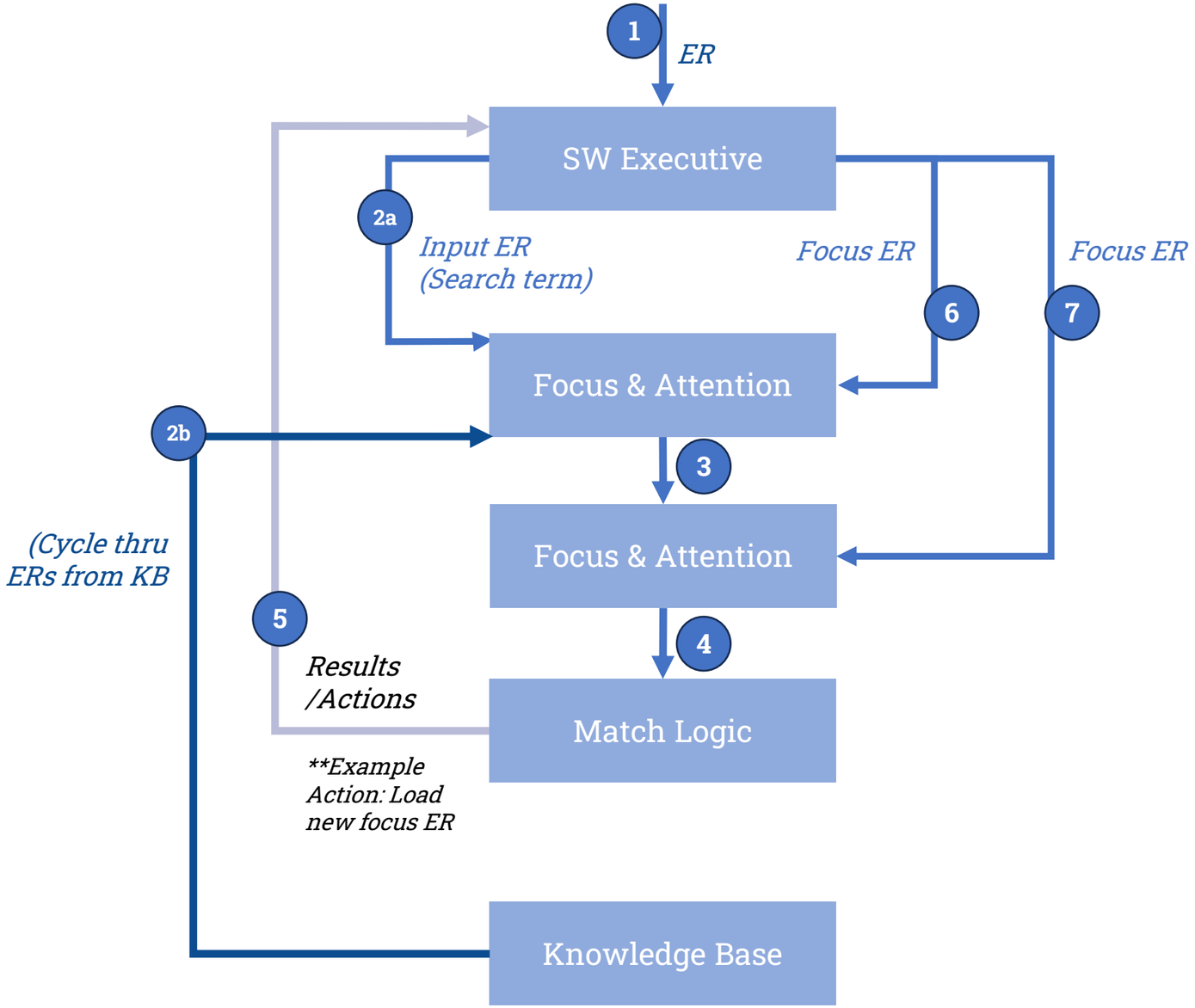
Rapid Search & Continuous Expansion of KB

- ERs are lightweight and easily processed



Focus, Attention and Actions!

- Focus and Attention amplify intelligence by adapting the processing to the Context, Goals, Risks, Constraints
- Generalization, Focus and Attention, and Actions allow Diamond AI to Intelligently Respond to Novel Situations



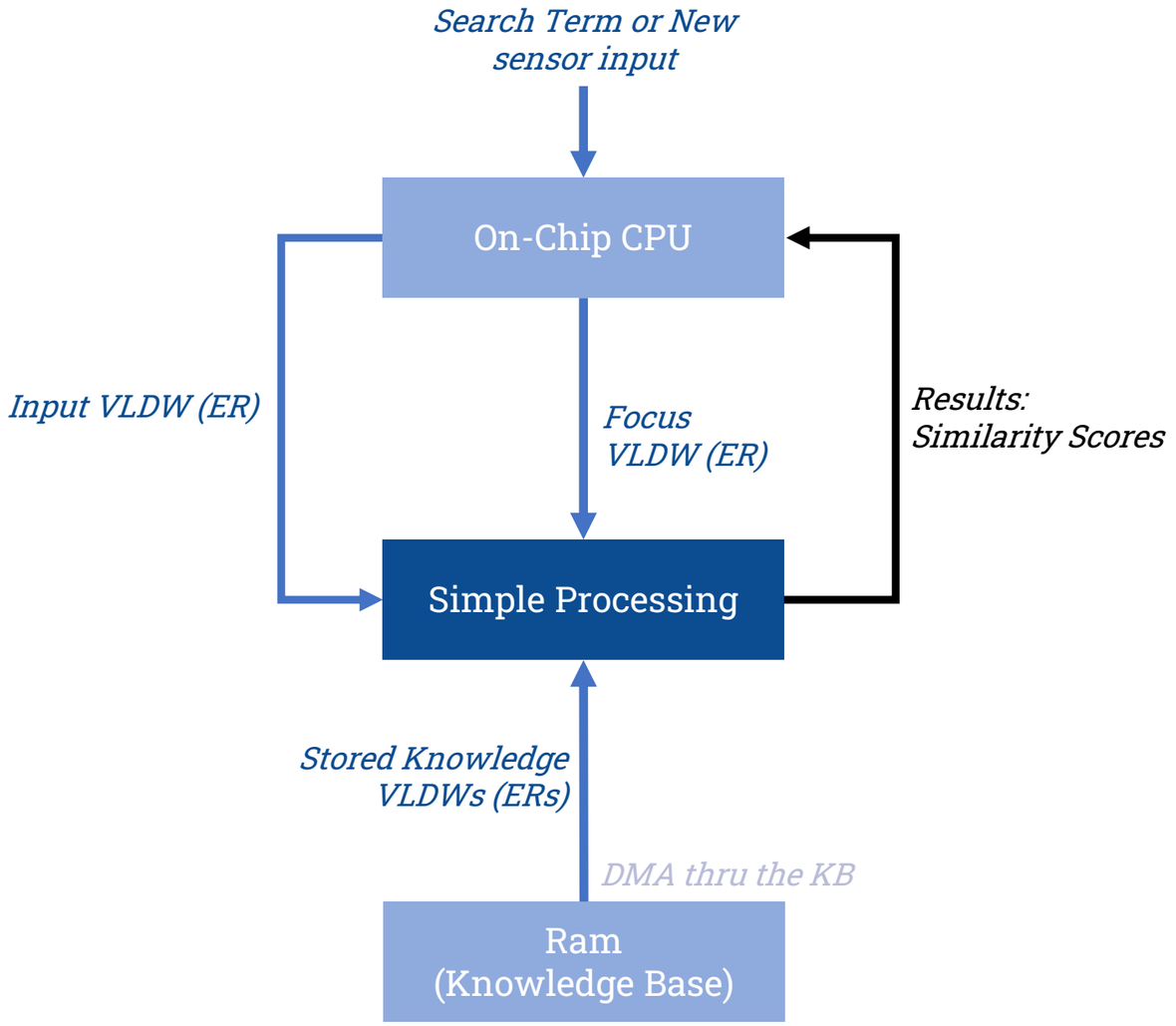
HERCULES ER Accelerator Chip

- **Co-processor computer chip**
  - Identified as “AI Synaptic Coprocessor” on the patent [#20220188116A1]
- **Developed as an accelerator**
  - Diamond AI does not require the chip to operate
  - Diamond AI executes much more quickly with the chip
- **Massively Parallel Processing on chip**
  - Disruptive new approach to massively parallel processing
  - Parallelism provided by the Very Long Data Words (VLDWs)
    - Each VLDW is an ER, an ANN entry in the Knowledge Base
    - Each VLDW is many thousands of bits long
    - Eliminates challenge of partitioning the processing load across a sea of computational hardware
- **Does not require new, expensive semiconductor manufacturing technology**
  - Newest chip manufacturing utilizes 3nm features
  - HERCULES expected to work fine with 10+nm features

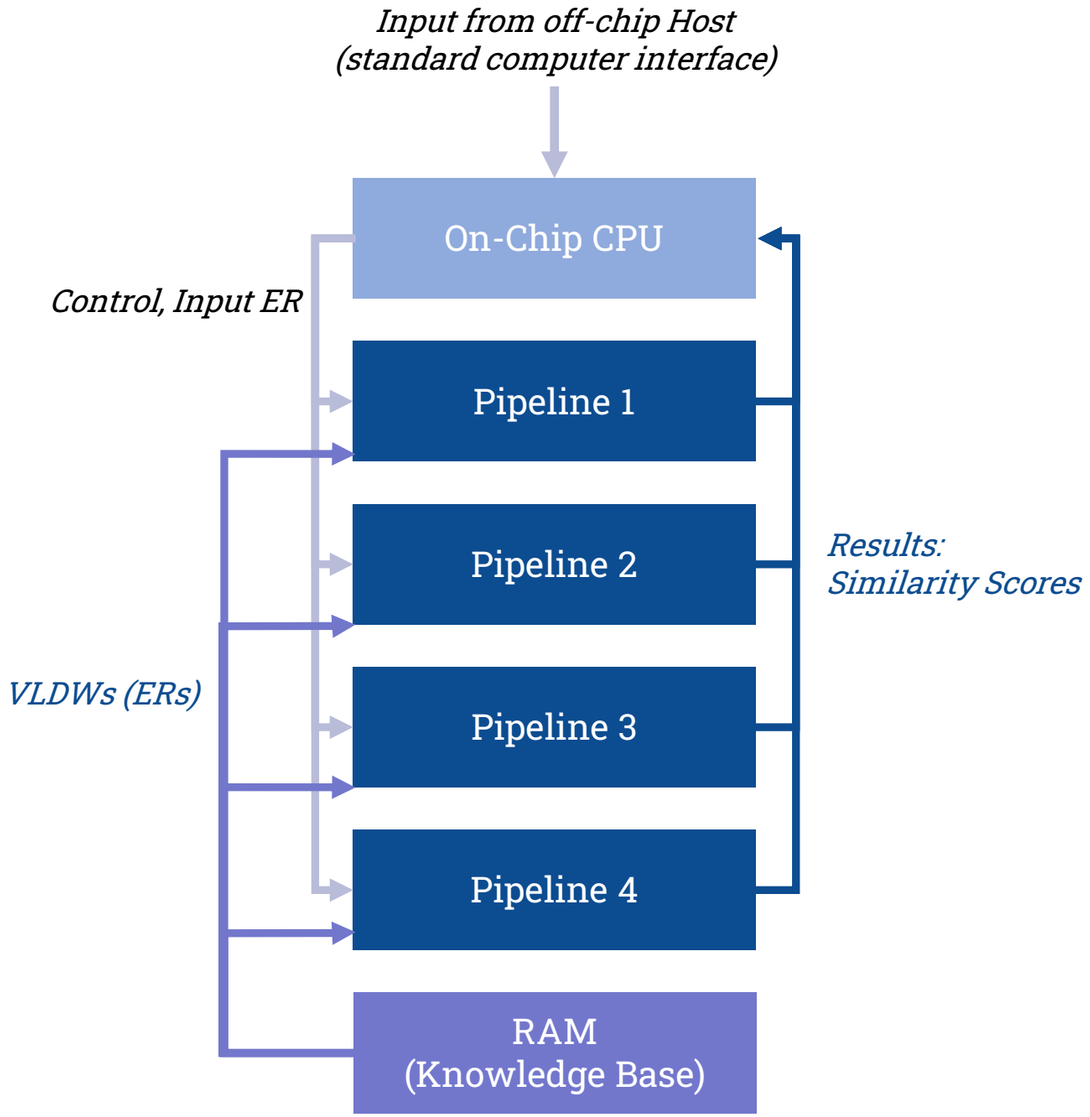
Idea Behind HERCULES ER

Massively Parallel Processing!

64 kb Input words are rapidly matched against the Knowledge Base



HERCULES ER: Overview of Functional Architecture



Pipeline Architecture

Externally create knowledge base

CPU loads KB into **RAM**

CPU loads **threshold logic** and **attention VLDW**

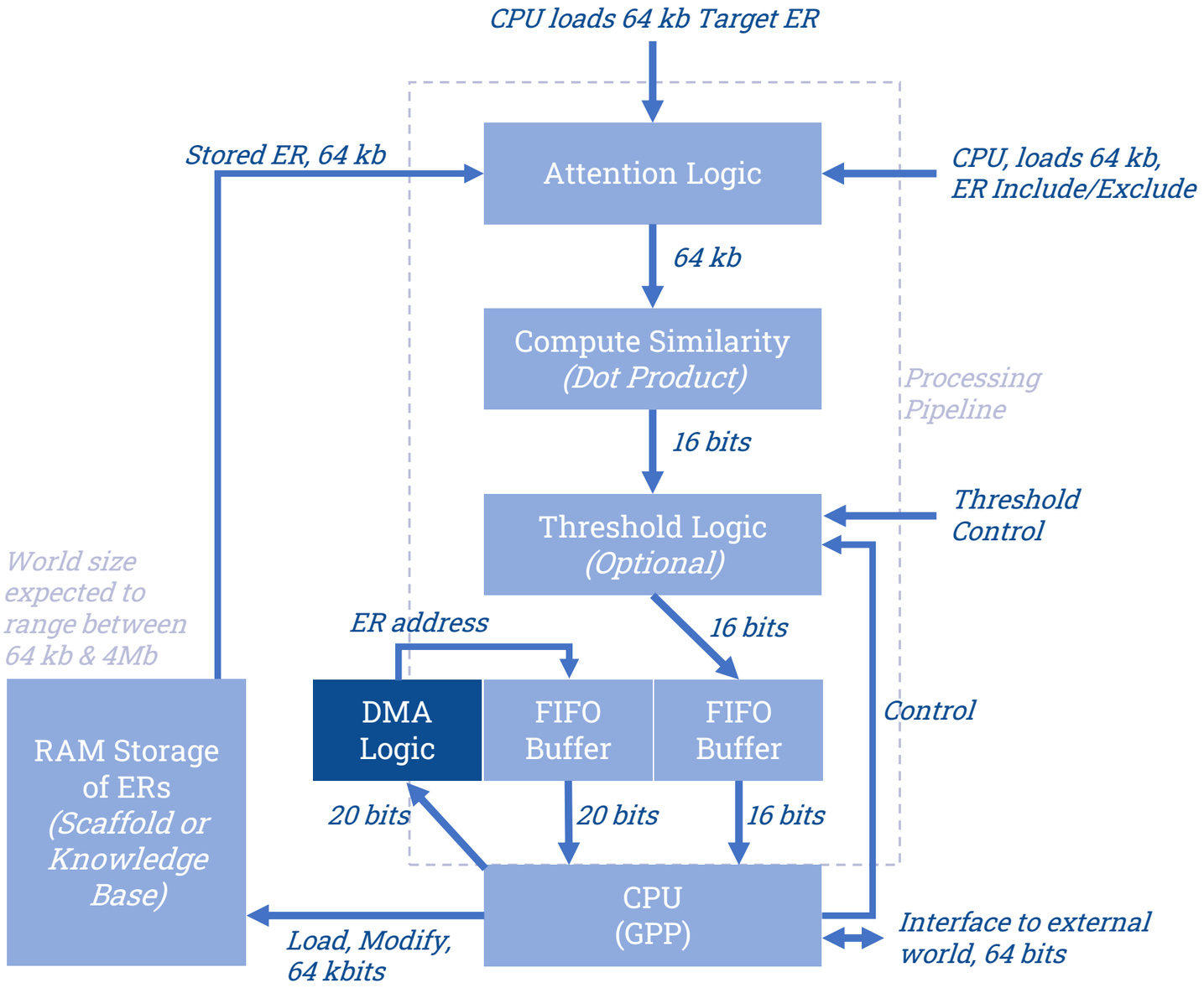
CPU fetches **Target ER**

Compute Similarity logic compares **Target ER** and single **KB ER**

Threshold Logic result is stored in **FIFO**

Scan remainder of **KB ERs**

CPU selects "best" result of those exceeding threshold



Power and Efficiency: HERCULES ER

- Reduces computational cost and electrical power by orders of magnitude
- Some Diamond AI applications will benefit from the accelerator chip
    - Real-time embedded processing
        - E.g. Diamond AI running on a chip in a missile nose-cone
    - Massive Knowledge Bases
        - Knowledge bases with million or billions of ANNs would benefit from HERCULES ER
        - Runs > 1,000 faster than software implementations
        - HERCULES ER further reduces power consumption by orders or magnitude
- HERCULES ER also adds layer of cybersecurity

QUESTIONS?

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