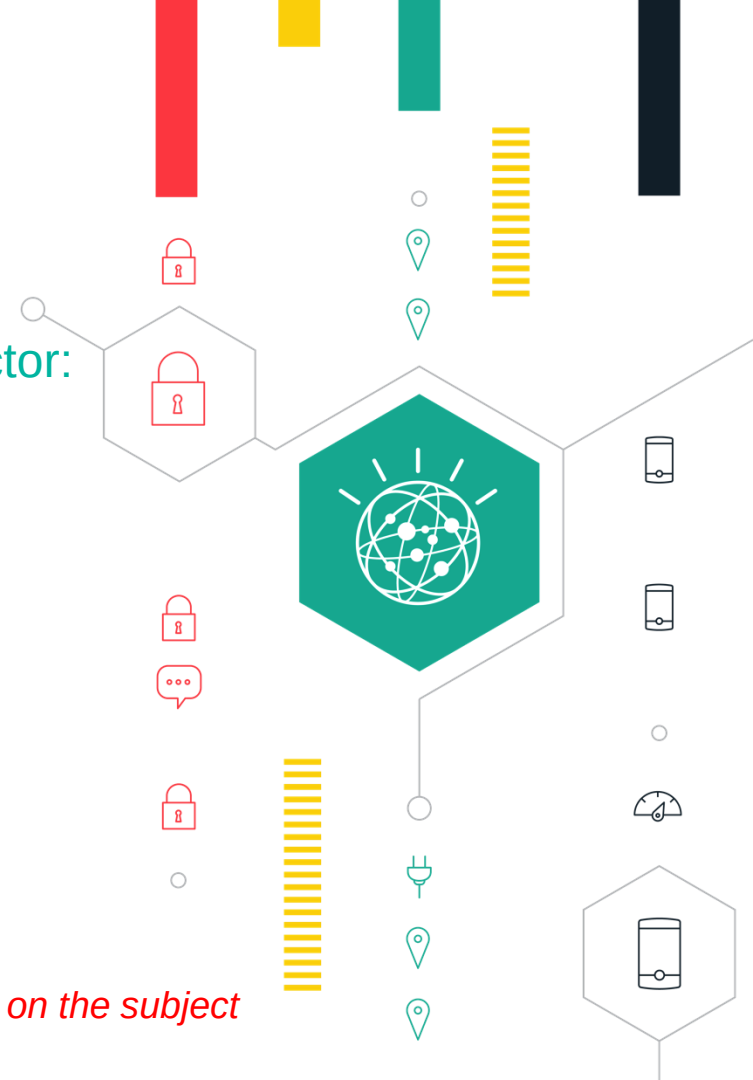
Impact of DDDAS/InfoSymbiotics in the Industrial Sector:

The Rise of Analytics

*José Moreira**, IBM Research

InfoSymbiotics/DDDAS2020 Conference



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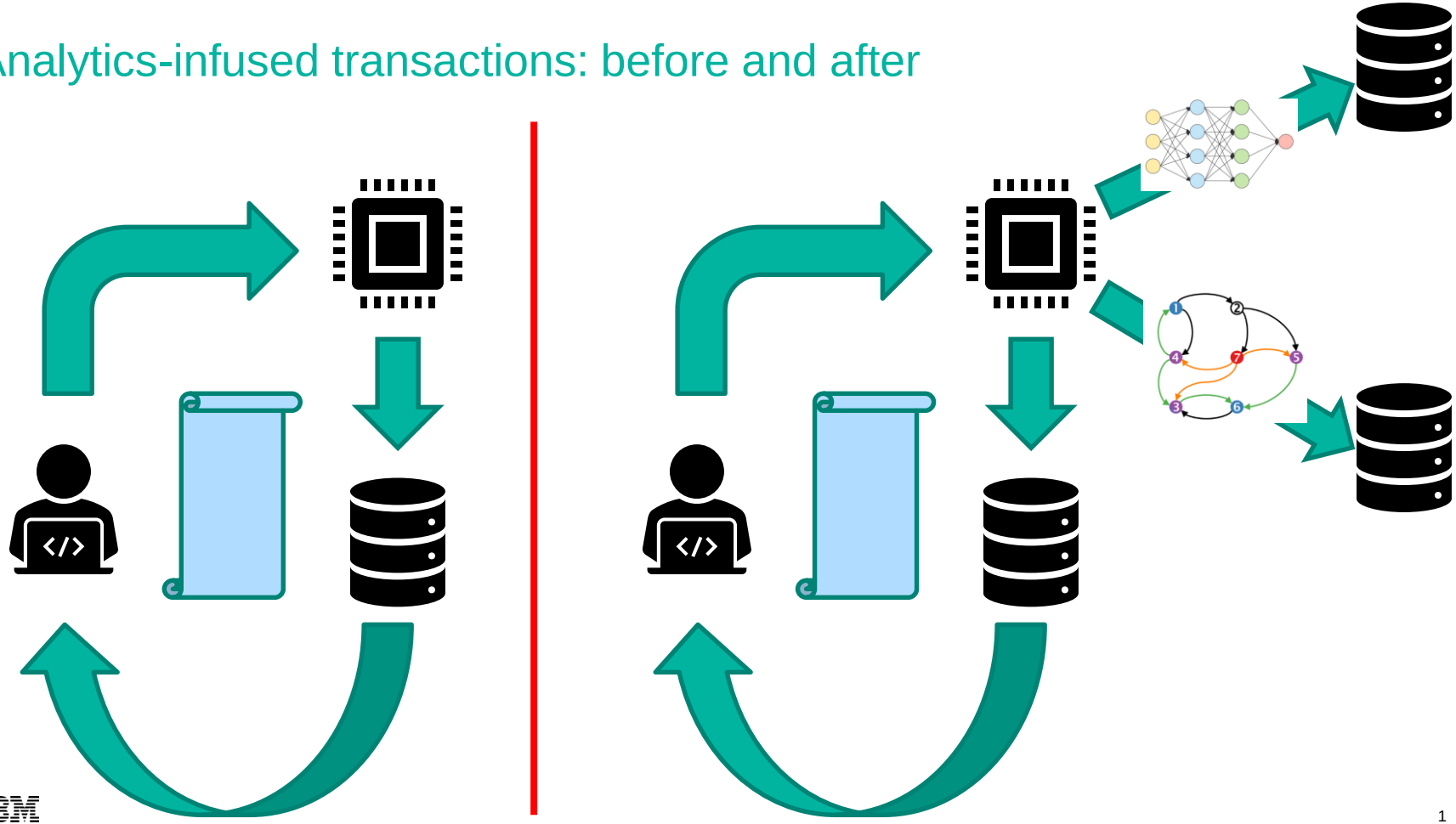
*These are my own views on the subject

Analytics-infused transactions: before and after



Business analytics is essential in today's world

- At its heart, business analytics, much like DDDAS, is a *data challenge*
- Whereas traditional transaction computing systems thrive on *prescribed scenarios*, analytics applications consume and generate *large, unstructured, real-time, and/or sensitive data*
- Much of the newer business analytics fall in the categorty of cognitive computing – systems that can: *learn, reason and interact*
- What cognitive computing brings to analytics:
  1. Deep human engagement
  2. Extended expertise
  3. Products and services infused with cognition
  4. Cognitive processes and operations
  5. Enhanced exploration and discovery

Computational structures in cognitive computing

Graph analytics

$$y \leftarrow A \cdot x$$

- x: current frontier
- A: adjacency matrix (transpose)
- y: next frontier

Neural networks

$$y \leftarrow A \cdot x$$

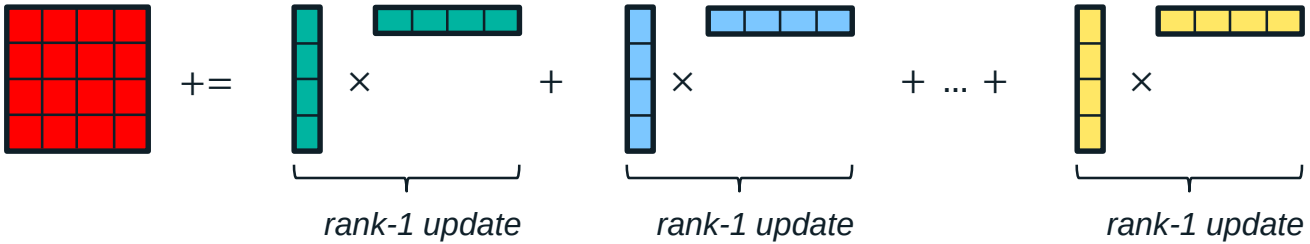
- x: current activations
- A: weights matrix
- y: next (pre-)activations

Particularities make life interesting

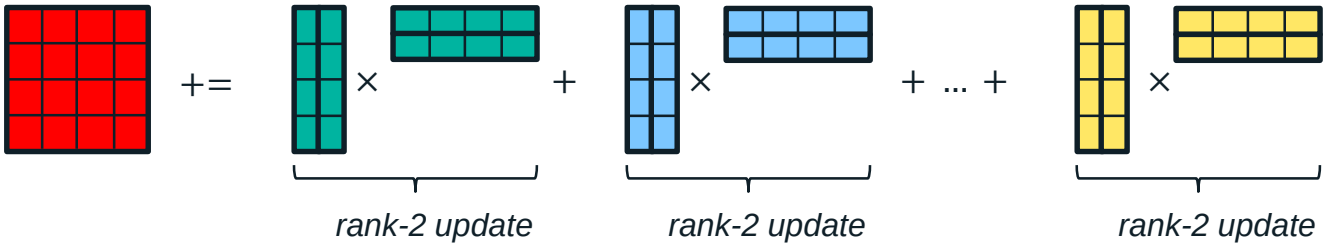
- In graph analytics,
  - the adjacency matrix can be very, very large and very, very sparse
  - the matrix-vector multiply may use “unusual” operators
  - more irregular behavior (memory and code)
- In neural networks,
  - matrices are much smaller, but much denser (may be changing)
  - approximate computing is often enough
  - almost always have a non-linear component
- Low latency/quick response is key for efficient operation in both spaces
- Run-time customization becomes very important

Matrix-Math Assist instructions in new Power ISA 3.1 (POWER10)

32-bit elements: rank-1 update of target accumulator



16-bit elements: rank-2 update of target accumulator



Conclusions

DDDAS/Analytics offers unique challenges and opportunities:

more data + more computation = more value

Cognitive computing will let us realize the full potential of these fields

A very simple kernel is at the center of graph analytics and neural networks: $y \leftarrow A \cdot x$

But the peculiarities of each application force a more dynamic and customizable solution in each case

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