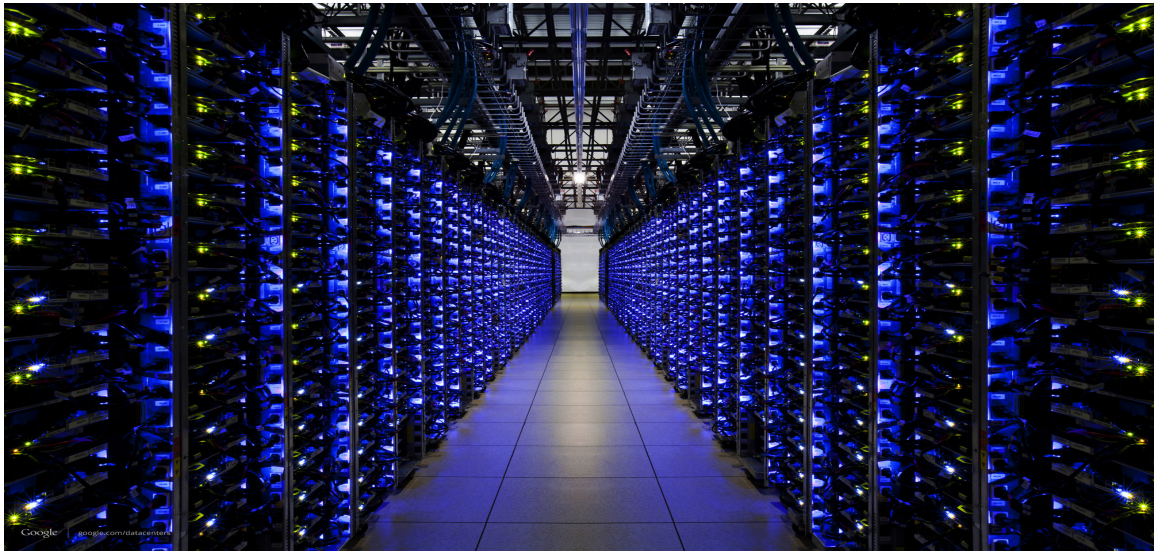
Seeing the (Near) Future: Data Centers, Software, and SDN



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http://www.1-4-5.net/~dmm/talks/dc_upperside_2014.pdf

Agenda

- A Few Macro Trends
- What Do These Trends Mean For DC Operators?
- What's Next?
- Q&A

Danger Will Robinson!!!

Standard Disclaimer

This talk might be controversial/provocative (and perhaps a bit "sciencey")

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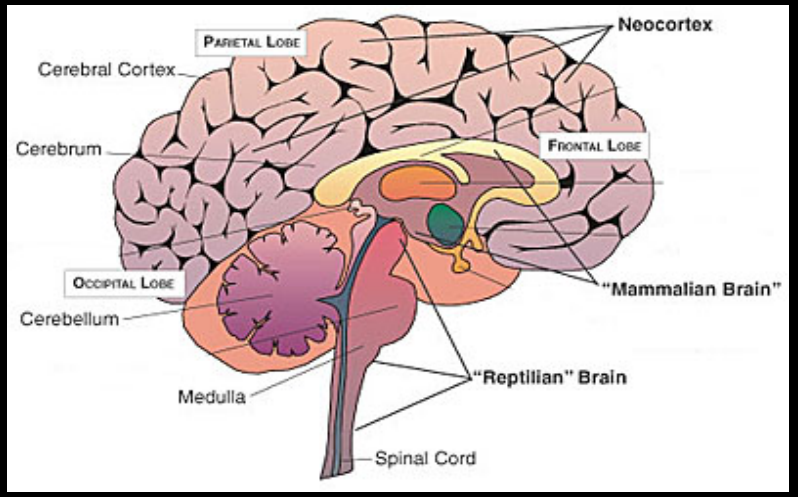
Trend: The Evolution of Intelligence

R-complex (Reptilian Brain) to Neocortex → Hardware to Software

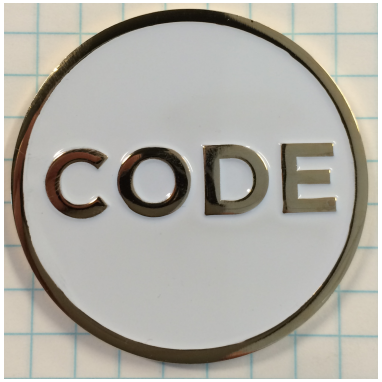
HARDWARE	SOFTWARE
	

- Key Architectural Features of Scalable/Evolvable Systems
  - Turing, Bode, and Shannon
  - **RYF-Complexity (behavior)**
  - **Layered Architecture**
  - **Bowties and Hourglasses**
  - **Horizontal Transfer (H*T)**
  - Protocol Based Architectures

Once you have HW
its all about code[1]…

1 http://www.joelonsoftware.com/articles/Biculturalism.html

Trend: Open Source (hardware *and* software)



- ***Community building*** **is a core objective**
- ***Code*** **is the coin of the realm**
- ***Engineering systems*** **are as important as artifacts**

Putting this all together →

Trend: Engineering artifacts are *no longer* the source of sustainable advantage and/or innovation

What you build isn't as important as how you build it

Perhaps surprisingly, the "hyper-scale" and open source communities have taught us that actual artifacts (in our case network applications as well as HW/SW) are ephemeral entities and that the only source of sustainable advantage/innovation consists of

- Engineering Systems[1]
- Culture
- People/Process
- Multi-disciplinary Approaches

http://en.wikipedia.org/wiki/Aeroelasticity - Flutter

[1] Note that our *Engineering Systems* evolve using the same mechanisms that are used to build artifacts. This is architecturally analogous to Horizontal Gene Transfer (HGT) and the acquisition of anti-bacterial resistance in the bacteria biosphere; the same mechanisms used to create the artifact (plasmid) are used to evolve the "Engineering System" (transcriptional network). Consider: Horizontal Application Transfer?

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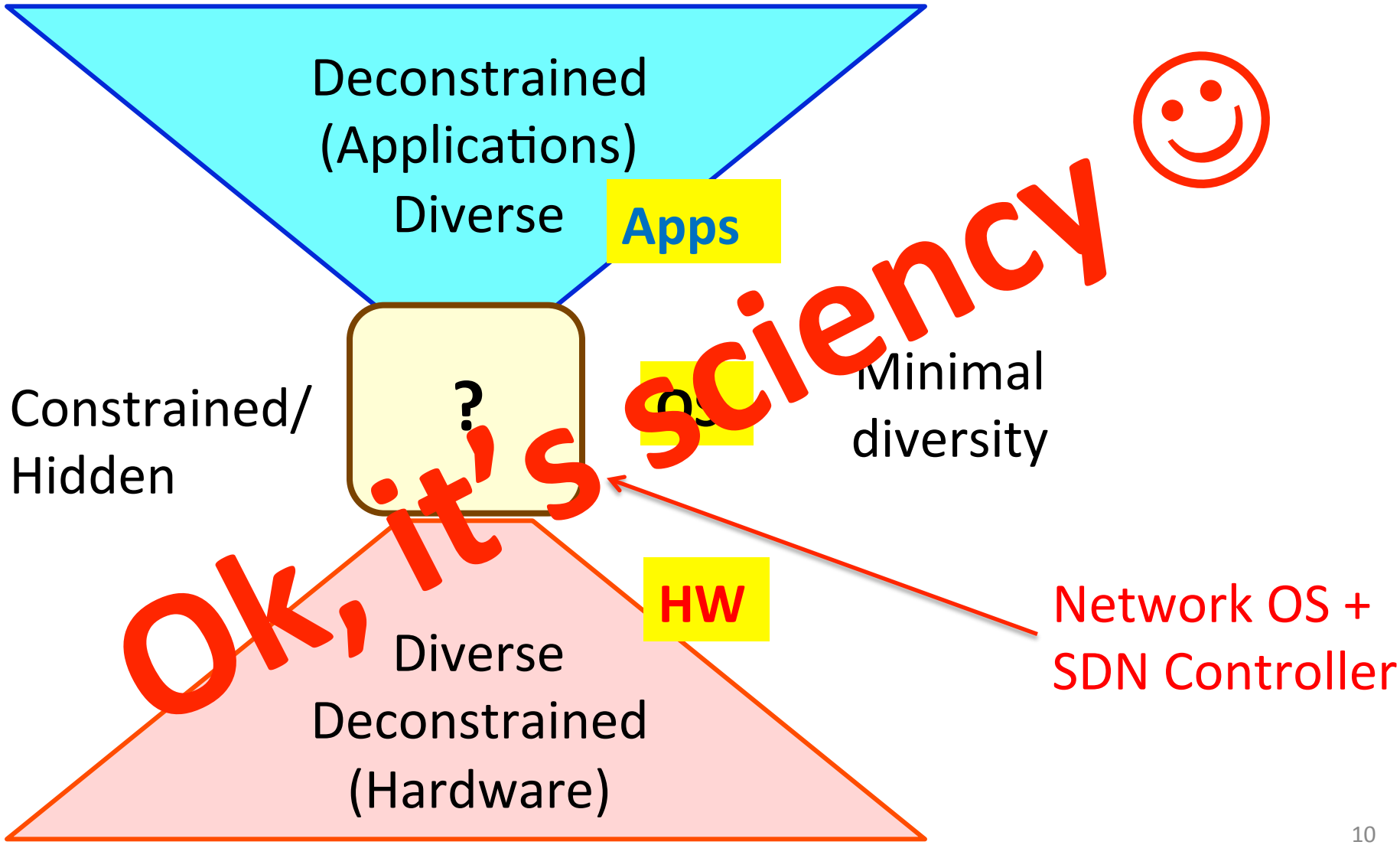
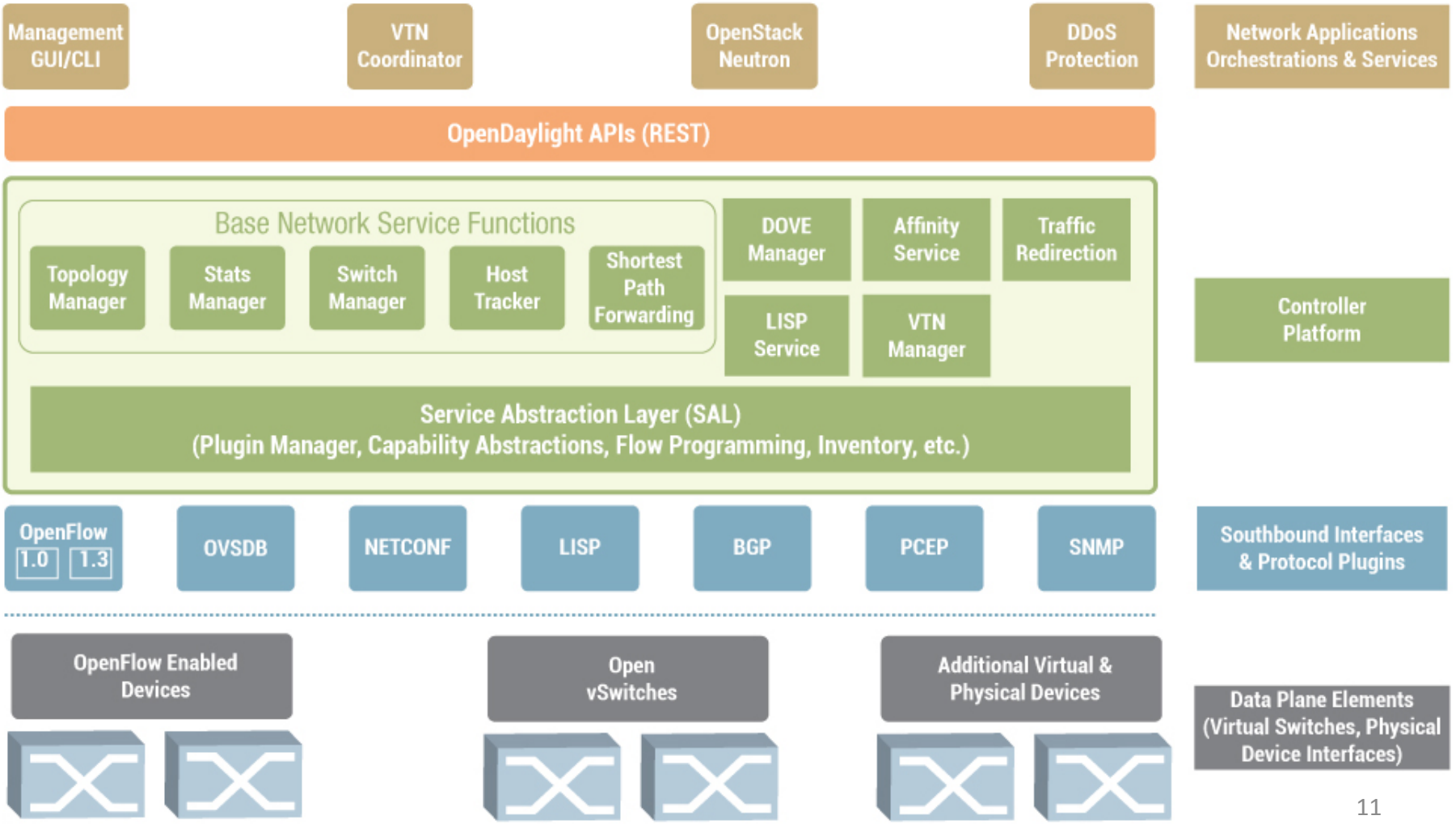
So What Does All This Mean For Data Center Operators?

- Today's Hyper-scale is tomorrow's Enterprise
  - So what's happening in say, Google (MSFT, FB, …) today is a view into the future of enterprise (and SP) data centers
- → Everything needs to scale and evolve
- Build for failure, not for <n>-nines
  - s/w and associated engineering more important than h/w
- Want Robustness *and* Evolvability

Layered architectures make robustness and evolvability *compatible*



Platform vs. Point Solution
OpenDaylight Controller Architecture



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So…What's Next?

Artificial Intelligence
The Wave of the (Very Near) Future

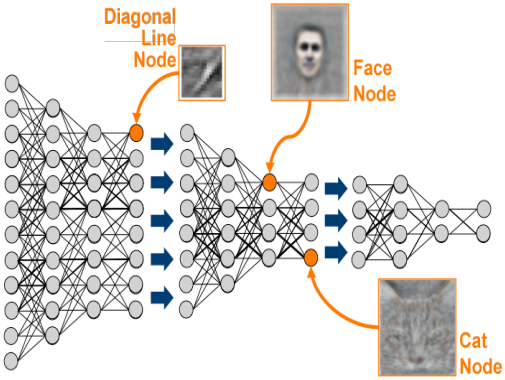
- Today's control and automation techniques are passive, low power, primitive

- Use of AI techniques is itself accelerating while at the same time causing acceleration
  - Major breakthroughs in machine learning circa 2006 – Deep Learning
  - More code is writing and deploying code every day
  - New forms of machine learning a very hot topic in DC control and automation

- Google, Facebook, Amazon, NetFlix, Apple and Microsoft (among others) continue to make significant investments in AI
  - http://techcrunch.com/2014/01/26/google-deepmind/
  - http://www.fastcolabs.com/3026423/why-google-is-investing-in-deep-learning
  - http://www.thepriceofrice.com/2013/11/googles-omega-is-it-alive.html
  - http://www.theverge.com/2013/12/17/5220914/how-artificial-intelligence-is-shaping-the-future-of-facebook
  - http://techblog.netflix.com/2014/02/distributed-neural-networks-with-gpus.html

- Complexity of DC control & resource allocation problem(s) outstripping human ability
  - Literally 10^9s of interacting dynamic processes in typical hyper-scale data center
  - Enterprise not far behind

Deep Learning?



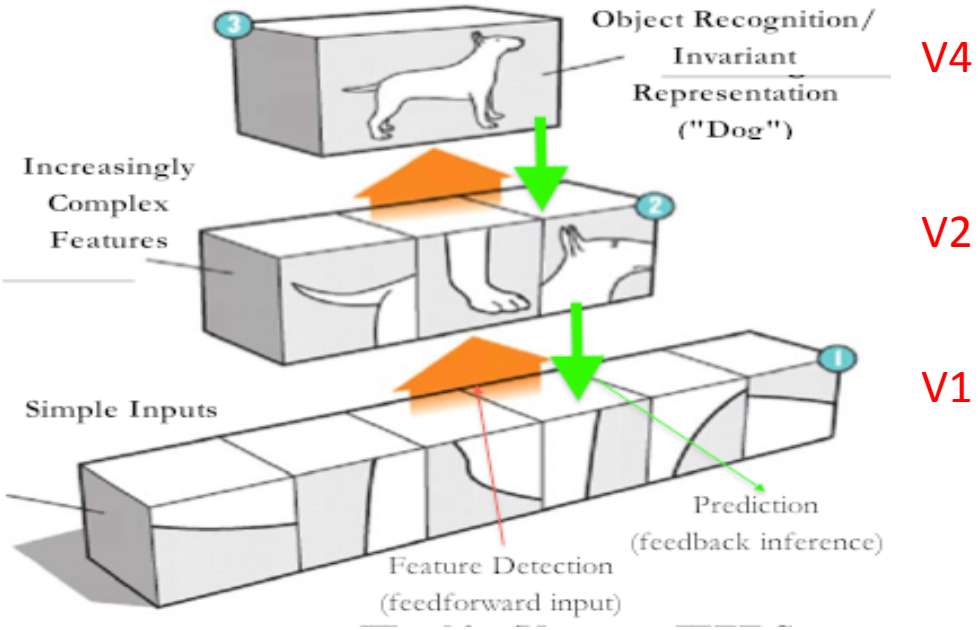
- Big data, analytics, control and orchestration systems all subject of advancements in AI
  - Deep Learning (DL) where all the action is[1]
    - Differs from traditional machine learning in that DL systems engineer their own features ("unsupervised")
  - "High-throughput" technologies (*-omics)
  - "RFC" Project

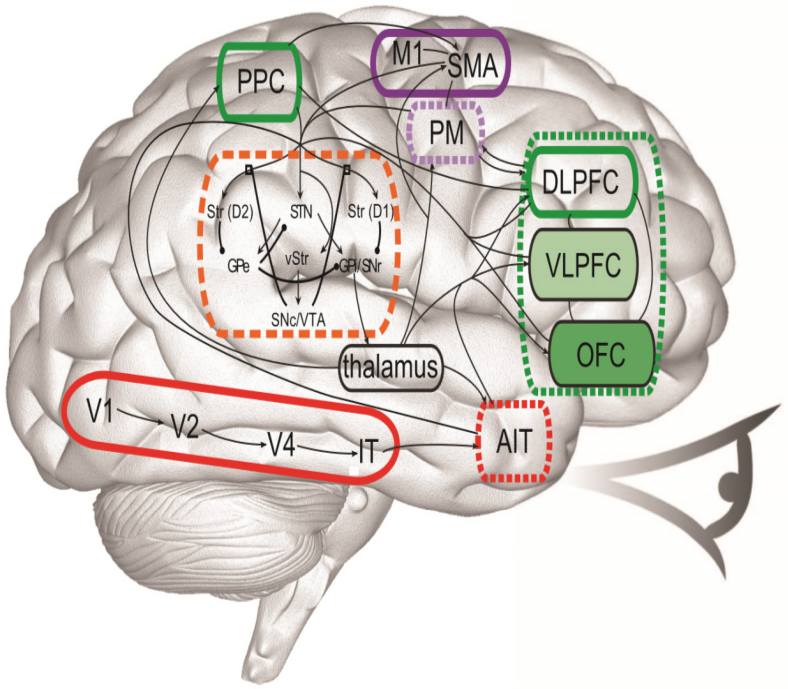
- Already seeing new applications in diverse domains such as EPC, DCI, …

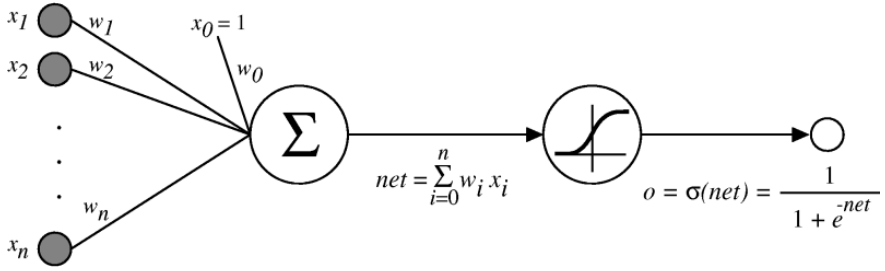
- Obvious growth opportunity
  - Gartner estimates TAM to be as much as $20 billion by 2016
  - But also table stakes in the very near future

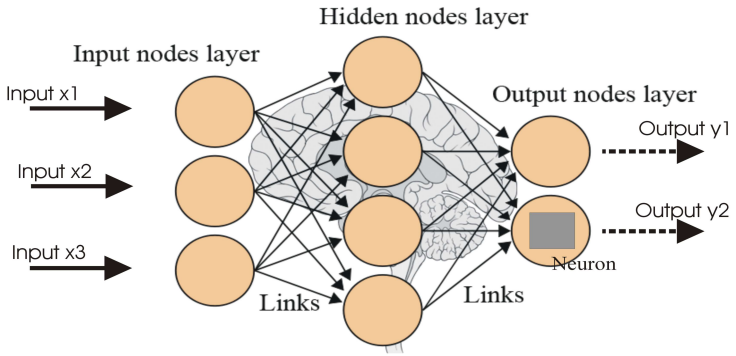
1 Y. Bengio, A. Courville, and P. Vincent., "Representation Learning: A Review and New Perspectives," IEEE Trans. PAMI, special issue Learning Deep Architectures, 2013

Deep Learning In One Slide









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Thanks!