Panel
Emerging Trends in AI/ML and Implications on Networking Research

The Networking Channel
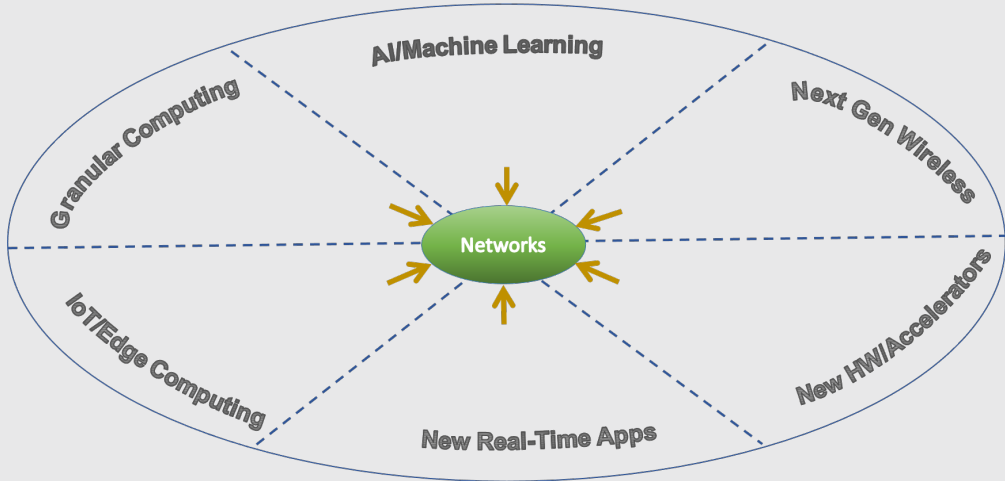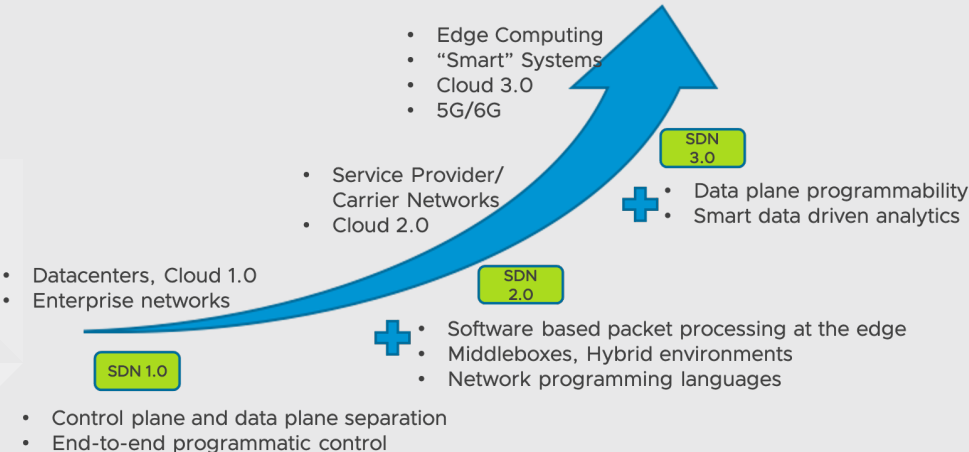
Sujata Banerjee

VMware Research

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Network transformation: automation and operational efficiency

- Edge Computing
- "Smart" Systems
- Cloud 3.0
- 5G/6G

SDN 3.0
- Data plane programmability
- Smart data driven analytics

- Service Provider/ Carrier Networks
- Cloud 2.0

- Datacenters, Cloud 1.0
- Enterprise networks

SDN 2.0
- Software based packet processing at the edge
- Middleboxes, Hybrid environments
- Network programming languages

SDN 1.0
- Control plane and data plane separation
- End-to-end programmatic control

Fueling the next evolution: emerging trends

AI/Machine Learning

Granular Computing

Next Gen Wireless

Networks

IoT/Edge Computing

New HW/Accelerators

New Real-Time Apps

On our way: Many "Smart" Network Components

Congestion Control	Wireless link adaptation
Self-driving network architectures	Performance bottleneck analysis
Prediction of Performance Issues	CDN Caching

Video Streaming	Job Scheduling
Routing	Verification
Network Monitoring	Traffic Classification and Optimization

Is the network operating correctly?
Verification and certification of ML models

Is your network verifiably correct, robust?

- does it make fair decisions?

What is the impact of a (wrong) decision?

- Cats vs Tumors vs Stop Signs

"It was working last week"
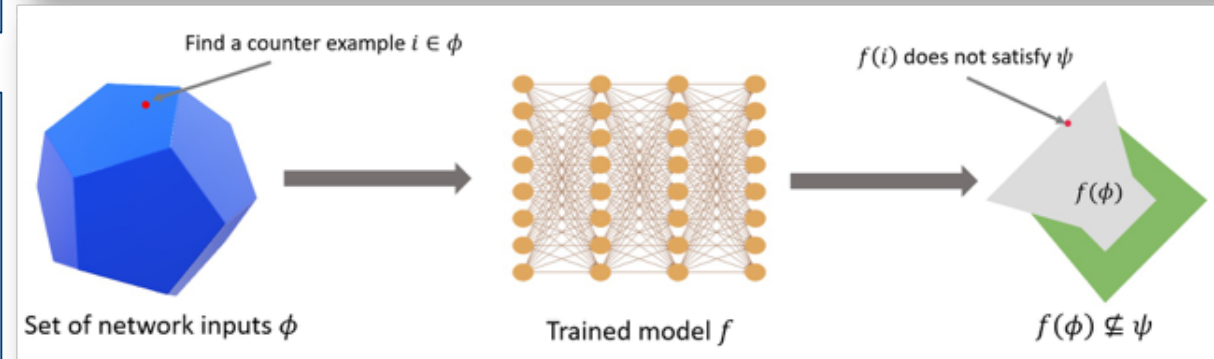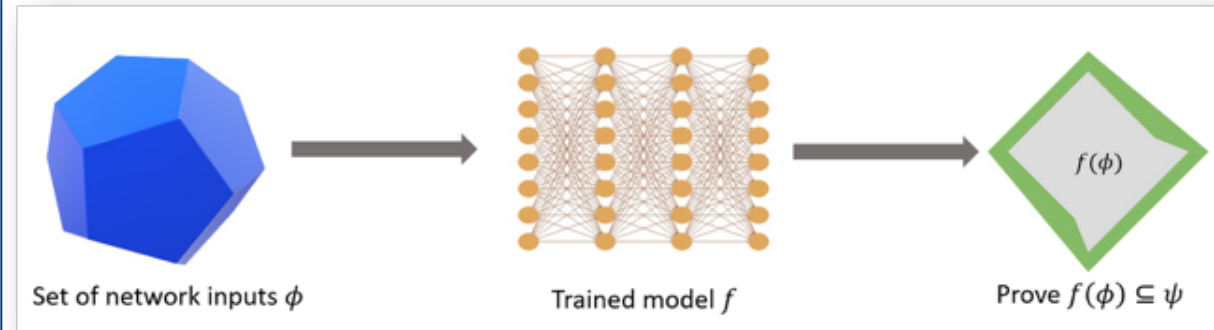
- Data Drift, Digital Twins, Transfer learning

Reason about and explain network decisions

- access control, rate limits, traffic routes, buffer allocation, workload placement, priority assignment, video bitrate selection

Decomposition of large complex models into smaller simpler models

Humans *in* the loop

New Tools to verify ML models

Set of network inputs ϕ → Trained model f → Prove $f(\phi) \subseteq \psi$

Find a counter example $i \in \phi$ → $f(i)$ does not satisfy ψ

Set of network inputs ϕ → Trained model f → $f(\phi) \nsubseteq \psi$

Both the sets ϕ and ψ need domain expertise

Source: Gagandeep Singh, Scalable automated reasoning for programs and deep learning

How much does your ML Ops *really* cost?
Accuracy tradeoffs

Compute, accelerators and data infrastructure

- Sustainability and carbon footprint

Labeling effort

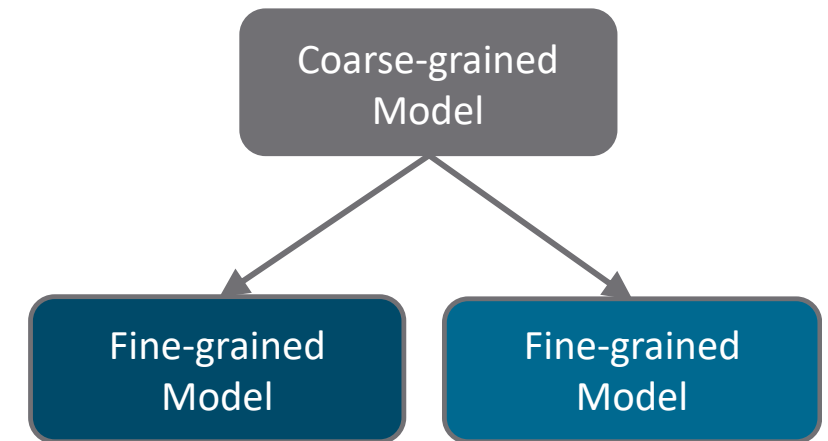- supervised vs. unsupervised

Economics of ML Ops

- holistic measurement and analysis of costs

Emerging Approaches

- Resource-efficient algorithms
- Model and Data distillation
- Integrating existing knowledge

"Trees in Forest with Green Groundcover" by Image Catalog is marked with CC0 1.0

Vargaftik, et. al., https://arxiv.org/pdf/1909.11877.pdf

Great opportunity for multi-disciplinary research

"Real problems are often interdisciplinary"
– Jennifer Rexford [Athena 2017 Keynote]