Benefits and use cases

Bright Data

Benefits and use cases continued

Limitations of LNNs

Spiking neural networks

Benefits and use cases

Limitations of SNNs

The future

How current AI works , Neuroplasticity

**🔹 1. Current AI Models Are Fundamentally Limited**

**Key Concepts:**

* **Current AI**: Includes models like ChatGPT, Stable Diffusion, Sora.
* **Built on Neural Networks**: Inspired by the human brain, composed of layers of interconnected nodes (neurons).
* **Deep Learning**: More layers = "deeper" networks.
* **Fixed Intelligence**: Post-training, models do not learn further.
* **Inefficient Training**: Requires massive compute and energy.

**Bullet Points:**

* Modern AI is based on **static neural networks**.
* Training involves tweaking weights using **backpropagation**.
* Once trained, the **weights are fixed** — the AI can't learn post-deployment.
* GPT-3 had **175 billion parameters**; GPT-4 has ~**1.76 trillion**.
* GPT-3 training used ~**1,287 MWh**; GPT-4 estimated at **~41,000 MWh**.
* Human brain uses **~175 kWh/year**, meaning GPT-4 = 234,000x more energy.

Biggest problems with current AI  
**🔹 2. Major Limitations of Current AI**

**Key Concepts:**

* **Fixed intelligence**: No on-the-fly learning.
* **Energy inefficiency**: Massive energy needs compared to the human brain.

**Bullet Points:**

* Current models are **pretrained and static**.
* Must retrain entirely to make models smarter (e.g., GPT-5 from GPT-4).
* **Neuroplasticity** (human brain’s ability to adapt) is missing.
* Existing systems are **unsustainable** without major architectural changes.

Liquid neural networks

**🔹 3. Introduction to Liquid Neural Networks (LNNs)**

**Key Concepts:**

* **Inspired by neuroplasticity**.
* Can **adapt in real time** to new inputs.
* Have a **liquid/reservoir layer** that captures dynamic temporal patterns.

**Bullet Points:**

* **LNNs retain memory** while learning new data.
* Composed of:
  + Input Layer
  + **Liquid Layer (Reservoir)**: Like ripples in water reacting to input.
  + Output Layer (Readout): Learns to interpret reservoir dynamics.
* Only the **output layer is trained**, reducing computation.
* The reservoir layer is **dynamic but fixed during training**, enabling fast processing.

**🔹 4. Efficiency Advantages of LNNs**

**Key Concepts:**

* **Fewer trainable parameters**.
* **Faster convergence** during training.
* **Lower memory and compute requirements**.

**Bullet Points:**

* MIT demo: **20,000 parameter LNN** piloted a drone (vs. GPT-4’s trillion+).
* Smaller models = **faster inference**, **less memory usage**.
* **Ideal for time-series data** and continuous input environments.
* Trains quicker due to **simplified training** of only output layer.

**🔹 5. Real-World Applications of Liquid Neural Networks**

**Key Concepts:**

* LNNs are ideal for environments where **adaptability and personalization** are crucial.

**Use Cases:**

**🤖 Autonomous Robots:**

* Can **learn new household tasks** post-deployment.
* Adapt to **user-specific behaviors** like laundry folding or cooking.

**🚗 Autonomous Driving:**

* Better performance in **unseen or unpredictable road conditions**.
* Can **adapt behavior** continuously based on sensor data.

**📈 Financial Markets:**

* Continuously **adjust trading strategies** based on live market data.
* Adaptive to volatile and evolving trends.

**🏥 Healthcare:**

* Embedded in **wearables** to monitor and respond to real-time patient data.
* Predicts potential health events before they become critical.

**🔐 Cybersecurity:**

* Monitors network traffic to **adapt policies** and detect anomalies dynamically.

**📺 Streaming Services:**

* Personalizes content by adapting to **real-time user preferences**.

**🏙️ Smart Cities:**

* Optimizes **traffic lights**, **energy grids**, and **utility loads** in real-time.

**🔹 6. Limitations of Liquid Neural Networks**

**Key Concepts:**

* **Early-stage technology**.
* **Limited real-world deployment** so far.
* Needs more **empirical validation** and **engineering maturity**.

**Bullet Points:**

* Promising in theory, but **requires broader real-world testing**.
* Still under **active research and development**.
* Potential to **revolutionize AI efficiency and adaptability**.

**🔹 7. Conclusion: The Future Path for AI**

**Summary Points:**

* Current AI is **fixed**, **inflexible**, and **computationally expensive**.
* Liquid neural networks offer a **paradigm shift** toward **adaptive**, **energy-efficient**, and **personalized AI**.
* If developed at scale, they could power **next-gen AI** for robotics, health, finance, and beyond.