

Energy Estimation of Spiking Neural Networks

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Content

- Research Introduction
- System architecture
- Research progress
 - Done
 - Doing
 - Todo
- Schedule

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Research introduction

- Estimation of energy consumption of SNNs.
- Estimation of solar energy.
- Part of carbon neutral E3STDP.
- Estimation provides energy requirements to achieve Net Zero.

Content

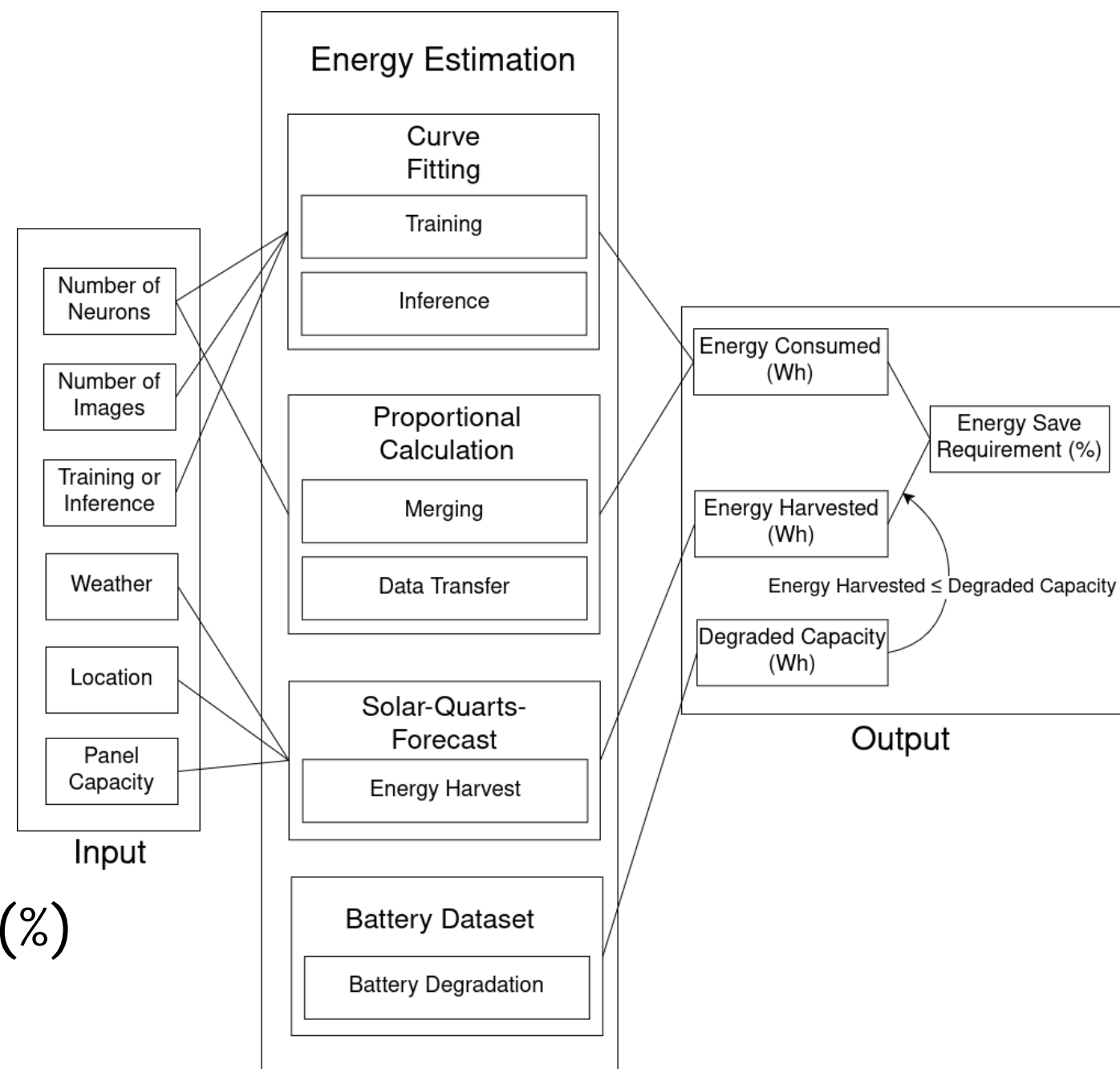
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Framework

Estimation:

- SNN Training / Inference
- Data Transfer / Merging
- Solar energy harvested
- Battery degradation

Output -> Energy requirement(%)



1. SNN Training / Inference

1.1 Collect data points.

n_neurons	n_input	Wh
50	3000	0.56
100	6000	1.93
150	6000	2.92
200	12000	5.14

1.2 Apply curve fitting method (scipy.optimize library)

```
n_neurons:50  
n_inputs:5000  
Estimated energy consumption (Wh): 0.93
```

2. Data Transfer / Merge

2.1 Obtain data size of trained models.

10 Bindsnet models: 6.2 MB

2.2 Calculate transfer energy from device specs.

For Raspberry Pi Pico W:

$$3.3 \text{ (V)} \times 0.072 \text{ (A)} \times 6.2 \text{ (MB)} / 6 \text{ (Mbps)} = 0.24 \text{ (J)} = 0.00066 \text{ (Wh)}$$

3. Solar Energy

open-sauce-quarts-solar-forecast

Input:

Location

Weather

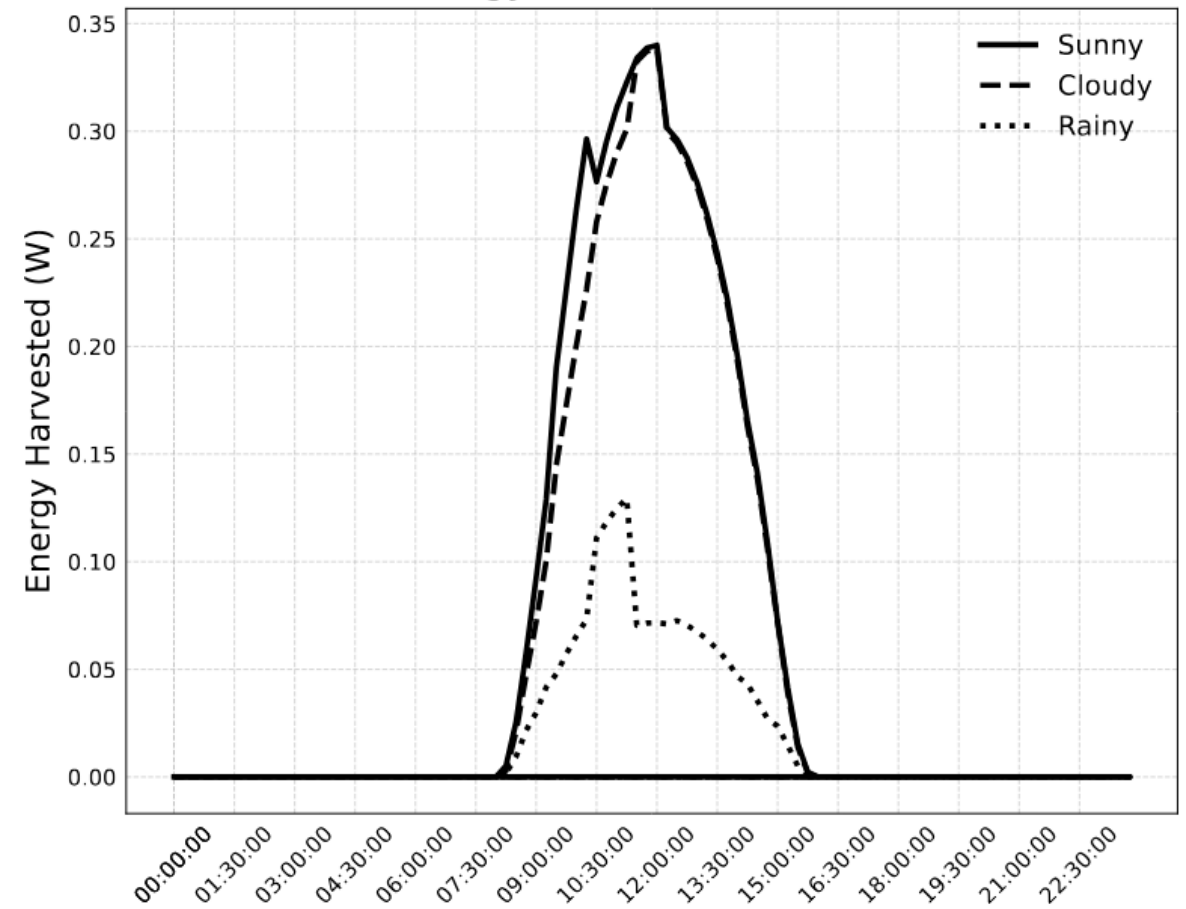
Panel Capacity

1.53 Wh (Sunny)

1.43 Wh (Cloudy)

0.43 Wh (Rainy)

(a) Energy Harvested in 24 Hours



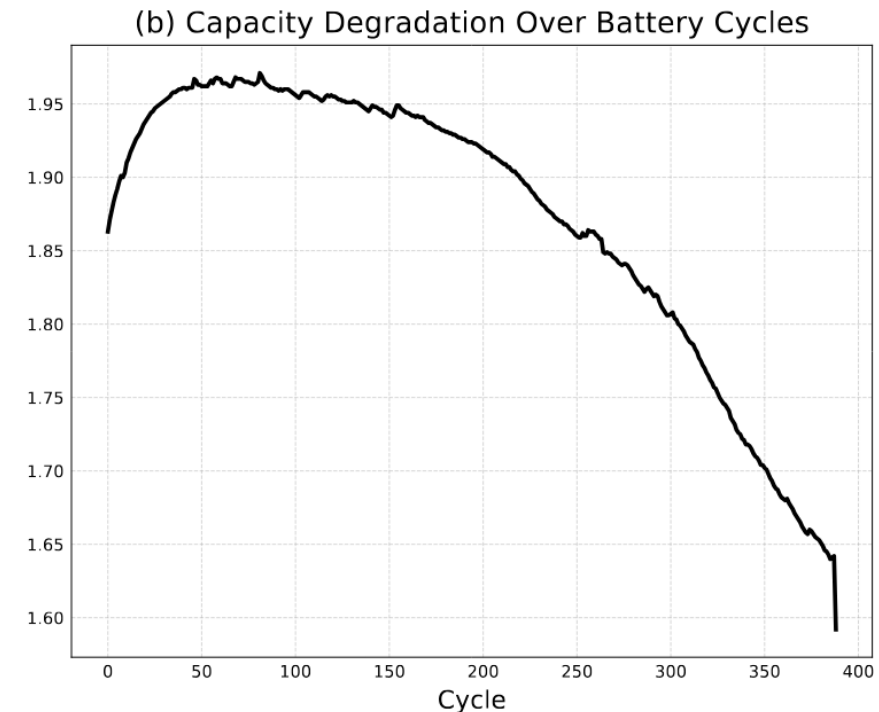
4. Battery Degradation (1)

4.1 Obtain capacity degradation data (battery dataset code library).

One battery cycle:

Charging to 100%, then discharging to 0%.

*In reality, battery does not follow perfect battery cycle.



4. Battery Degradation (2)

4.2 Take summation at each cycle

$$E_{\text{total}}(N) = \int_0^N E_{\text{cap}}(n), dn$$

Capacity Degradation: [1.0, 0.9, 0.8, 0.7...]

Total extracted energy at each cycle: [1.0, 1.9, 2.7, 3.4...]

4.3 Obtain current battery cycle N from total energy system used

4. Battery Degradation (3)

4.4 Capacity Degradation[N]: Degraded Capacity.

4.5 Set upper bound to the solar energy harvested.
(Solar Energy Harvested) \leq (Degraded Capacity)

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Research Progress | Done

- Framework to provide energy requirement in (%).

Research Progress | Doing

- Building the second framework to generate supply voltage (V) and refreshing frequency (F) for eDRAM that satisfies the energy requirement (+Accuracy prediction).
- Waiting for fault inserted Bindsnet model.

Research Progress | Todo

- Complete the second framework.
- Validate accuracy prediction.

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Schedule

Time	April. 13, 2025	April. 30, 2025
Task 1		
Task 2		

- Task 1: Build the second framework.
- Task 2: Run and validate fault inserted model.

Thank you for your attention!