Real-time Pedestrian Lane Detection for Assistive Navigation using Neural Architecture Search

Sui Paul Ang[1], Son Lam Phung[1], Abdesselam Bouzerdoum[1,2], Thi Nhat Anh Nguyen[1], Soan Thi Minh Duong[1], and Mark Matthias Schira[1]

[1]University of Wollongong, Australia, and [2]Hamad Bin Khalifa University, Qatar

Assistive navigation for blind people

- World: 36 million blind people,

  Australia: 384,000 vision-impaired people*

- Many of them need an assistive navigation system for mobility.
- A key component of such system is automatic pedestrian lane detection.
- This is a difficult task that is currently performed using a white cane or a guided dog.

*Sources: WHO and Vision Australia.

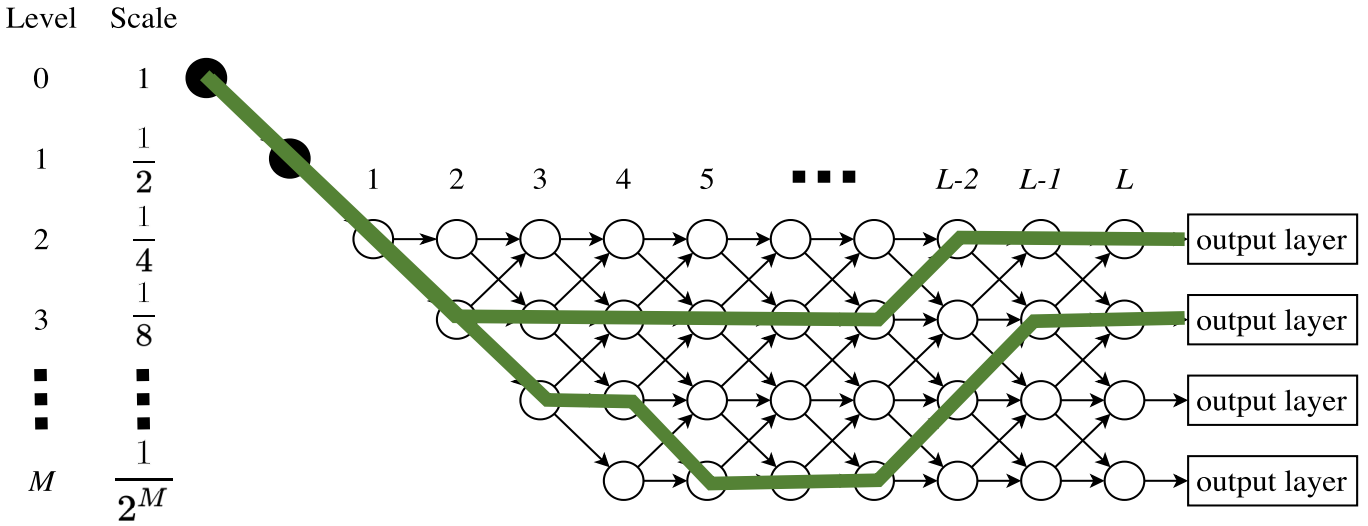
Why neural architecture search (NAS)?

- Assistive navigation systems are usually deployed in environments that require real-time processing.
- Many state-of-the-art deep neural networks only focus on detection accuracy but not inference speed.
- Depending on the complexity of the problem and the size of the dataset, a small model may be sufficient.
- However, the task of designing a high-performing deep model is time-consuming and requires experience.

Our proposed NAS algorithm

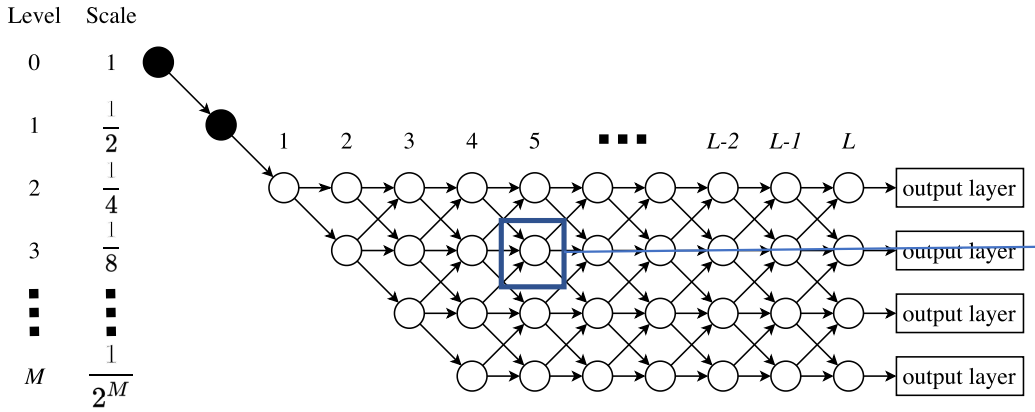
- The proposed NAS algorithm finds the best architecture in a network-level search space.
- The neural architecture search problem is casted to a continuous space so that gradient-descent can be used for searching.
- The skip-connection scheme is incorporated in the derived network.

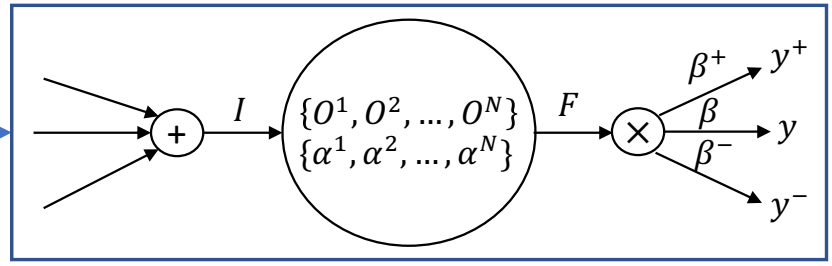
The search space



- Each node perform an operation, and each edge represents the data flow.
- The stem nodes are not involved in the search.
- All network configurations that can be derived from this graph are defined as the search space.

The search method





$$F = \sum_{j}^{N} \alpha^j O^j(I)$$

$$y = \beta \times F$$

$$y^+ = \beta^+ \times f^+(F)$$

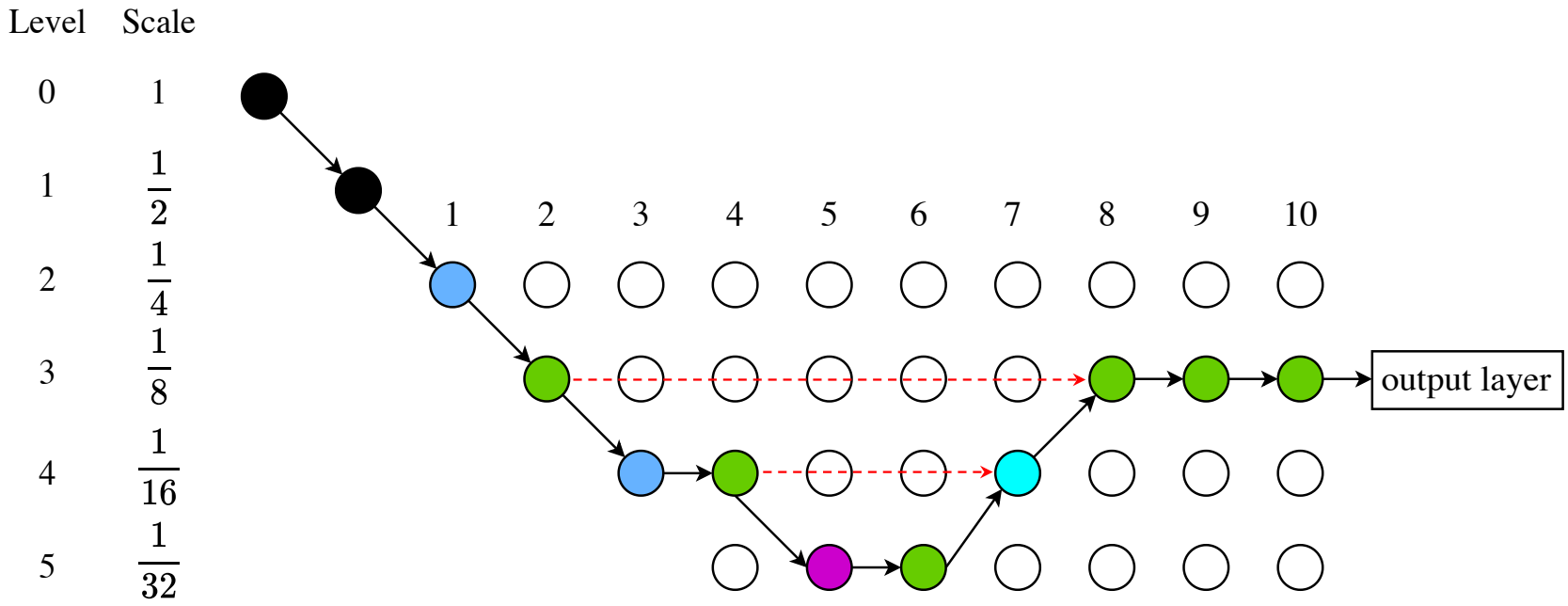
$$y^- = \beta^- \times f^-(F)$$

The search method

- This method is known as the differentiable architecture search [1].
- The $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ determine the final network architecture.
- Gradient-descent is used to optimise $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$.

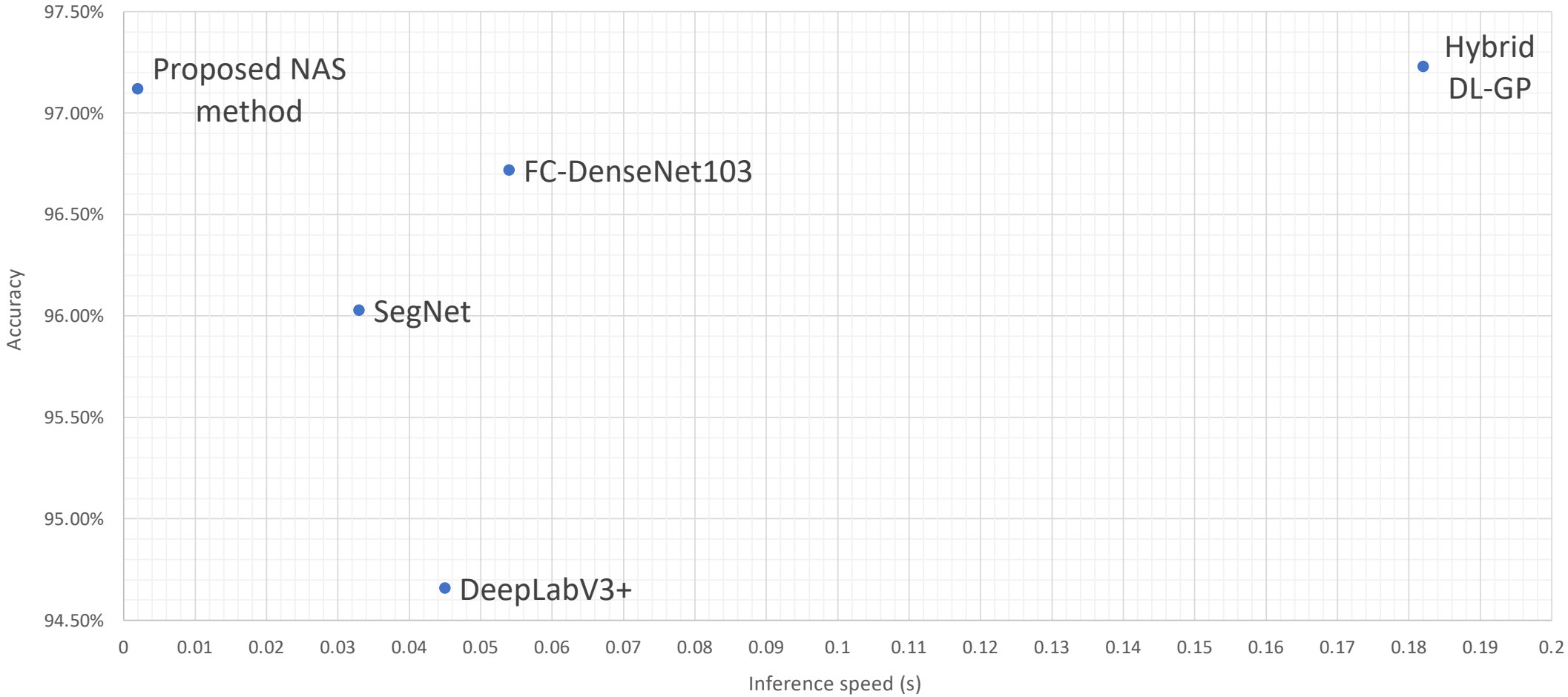
[1] H. Liu, K. Simonyan, and Y. Yang, “DARTS: Differentiable architecture search,” in *Proc. Int. Conf. Learn. Represent.*, 2019, pp. 1–13.

Deriving the final network architecture

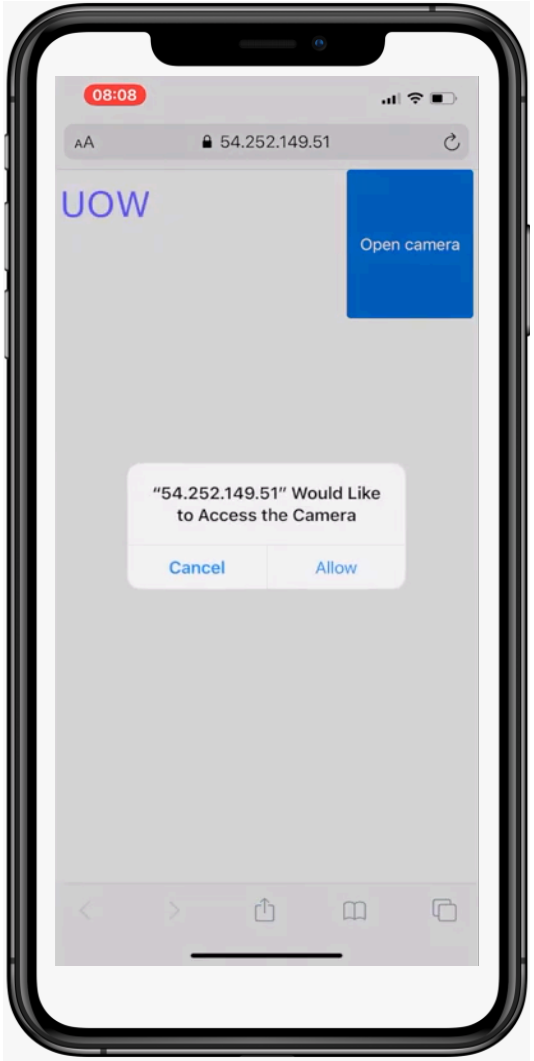


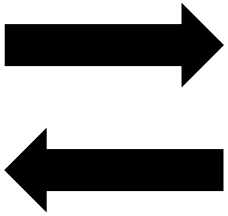
- Select paths associated with the greatest $\boldsymbol{\beta}$.
- Select operations associated with the greatest $\boldsymbol{\alpha}$.

Accuracy vs inference speed



Real-time pedestrian lane segmentation





Web server

*This video can be viewed on paul-ang.com/nas-lane.html.