

A better way to monitor People with Parkinson's using Interpretable Machine Learning

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- Every hour, someone in the UK is told they have Parkinson's¹
- Some 127,000 people
- But up to 25% of these are misdiagnosed²

¹ <https://www.parkinson.org/understanding-parkinsons/statistics>

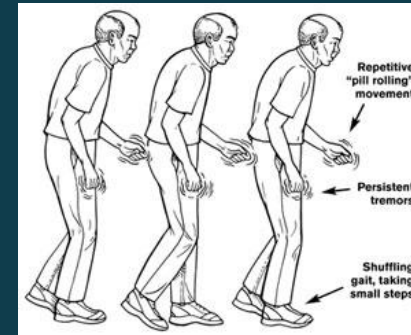
² M. B. Davidson, D. J. M. McGhee, and C. E. Counsell, "Comparison of patient rated treatment response with measured improvement in Parkinson's disease," J. Neurol. Neurosurg. Psychiatry, vol. 83, pp. 1001–1005, May 2012.



Photo: Parkinson's UK

Primary Symptoms of Parkinson's

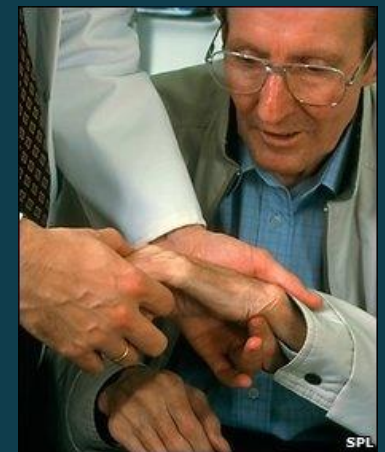
- Tremor
 - 3Hz-8Hz
- Rigidity
 - cogwheel
- Bradykinesia
 - slowing in movement
- Postural instability
 - poor balance



(Illustration by Kathryn Born)



healingwithnutrition.com



news.bbc.co.uk

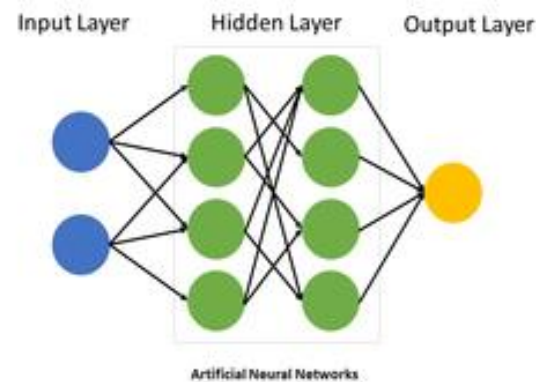
Computer-Based Assessment

- Based on conventional neuropsychological tasks, e.g.
 - figure copying tasks
 - finger tapping tasks
 - measurement of tremor at rest
- Movements digitised in real-time



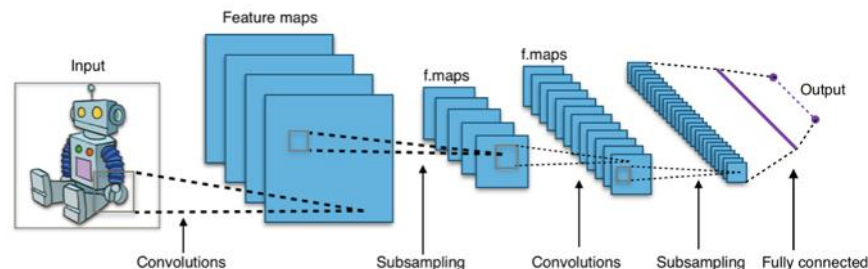
Can AI and Machine Learning Help?

- Common Machine Learning methods:
 - Deep learning (CNNs)
 - Neural networks (ANNs)
 - Support Vector Machine (SVM)
 - Clustering



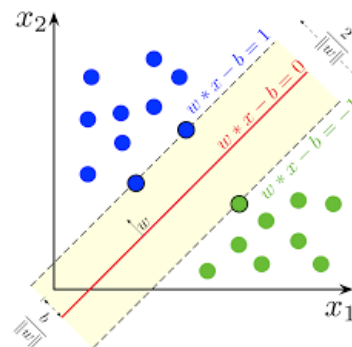
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- Not a simple solution:
 - All require good data
 - Understanding the fit of the algorithm to the data critical



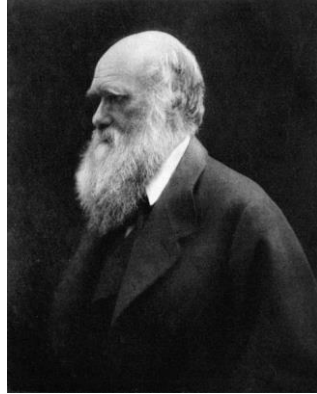
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- But above all:
 - Most are “black box” algorithms
 - Difficult to understand how data is manipulated
 - Difficult to validate the solutions obtained

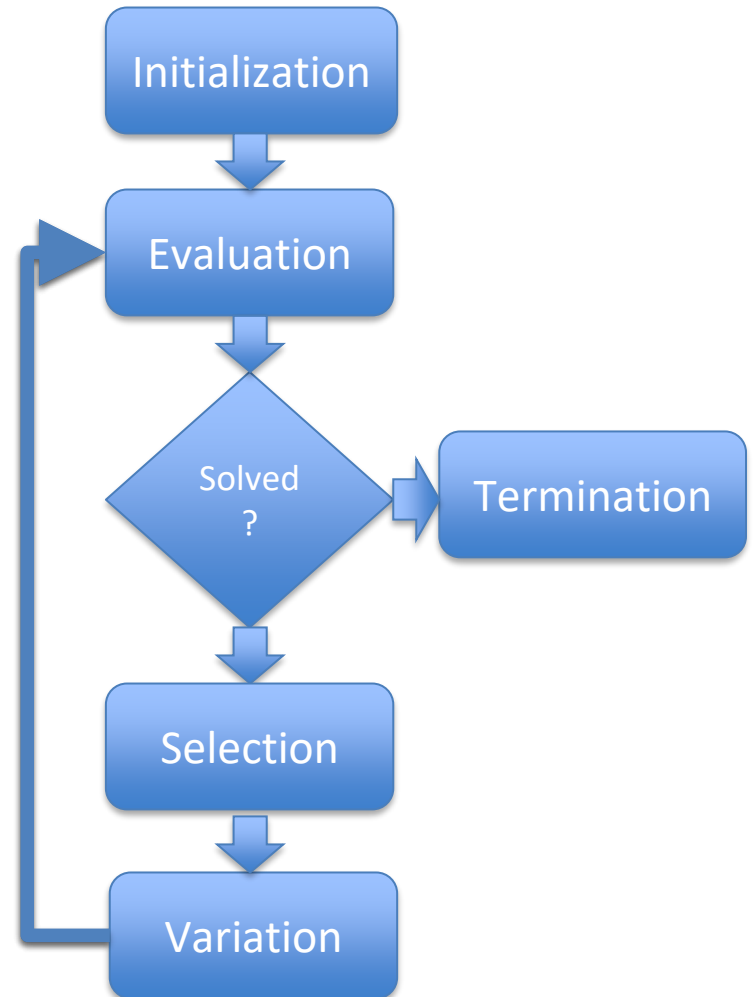


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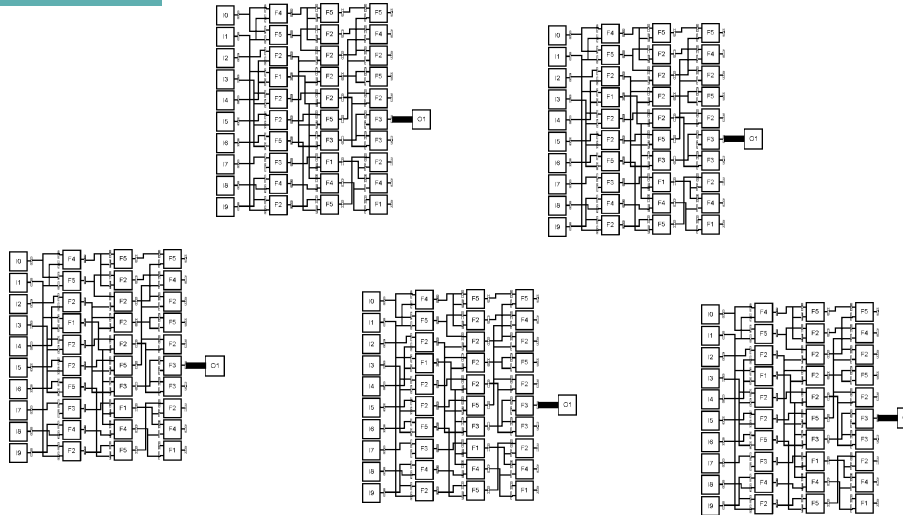
Evolutionary Algorithms



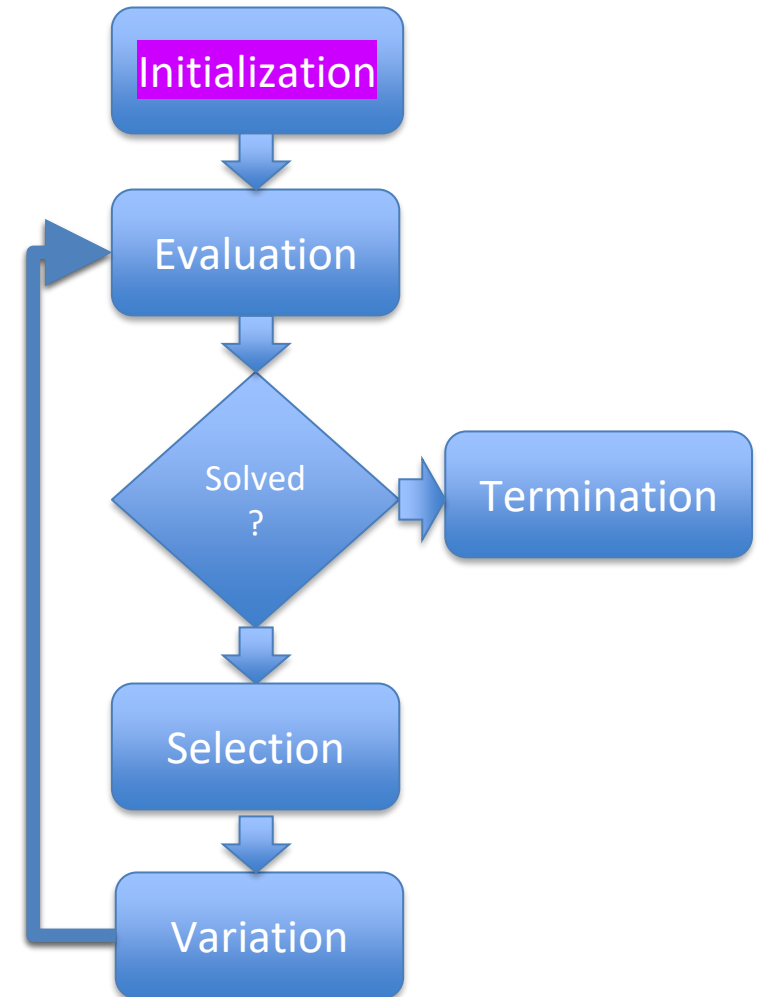
- Inspired by Darwinian evolution
- A population of *individuals* (candidate solutions) evolved by mutating the fittest in each generation



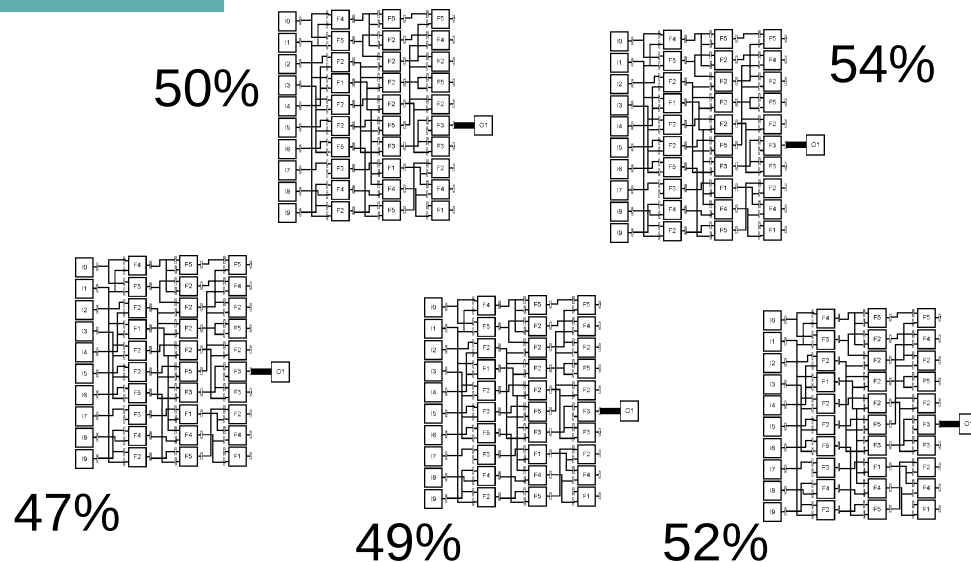
Training Evolutionary Algorithms



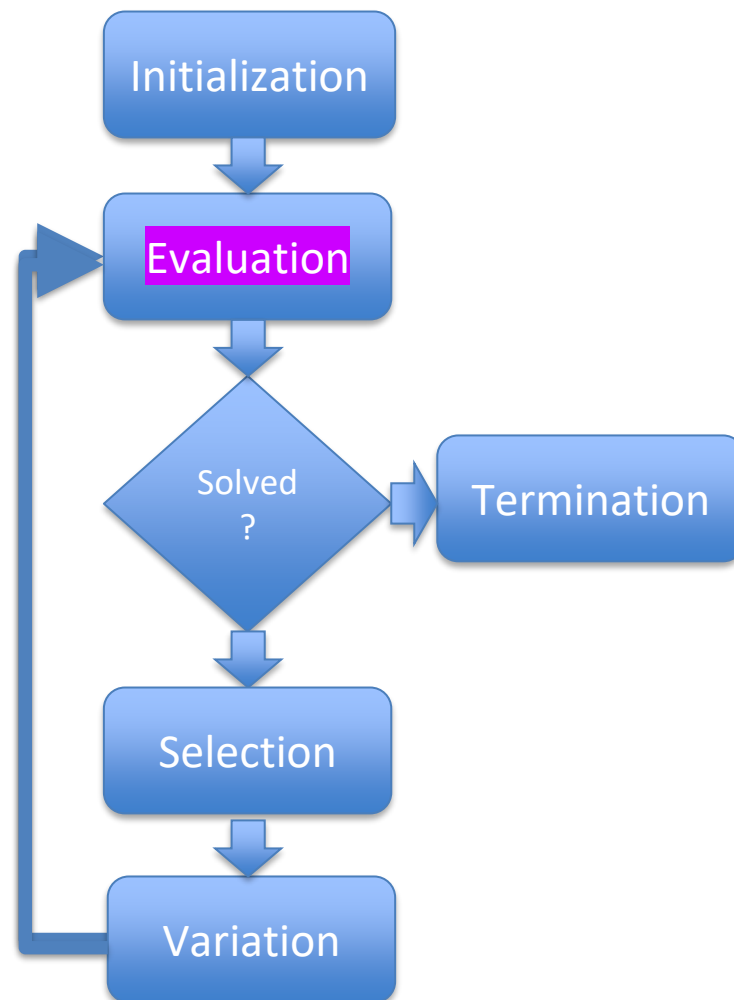
- Initialise a population of 5 *individuals*



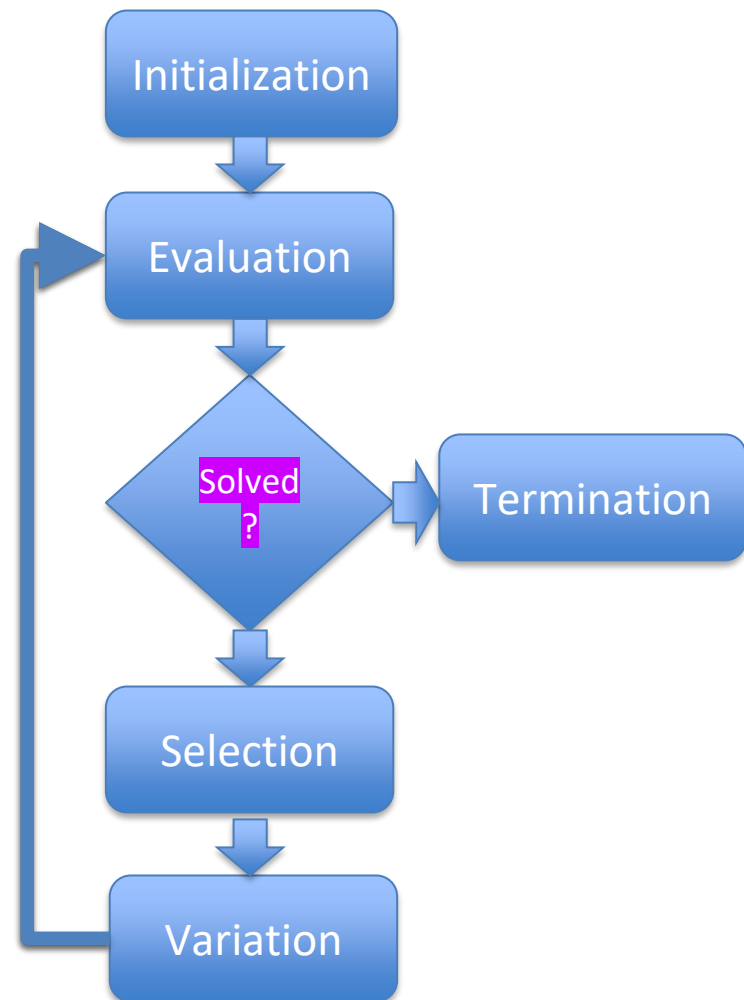
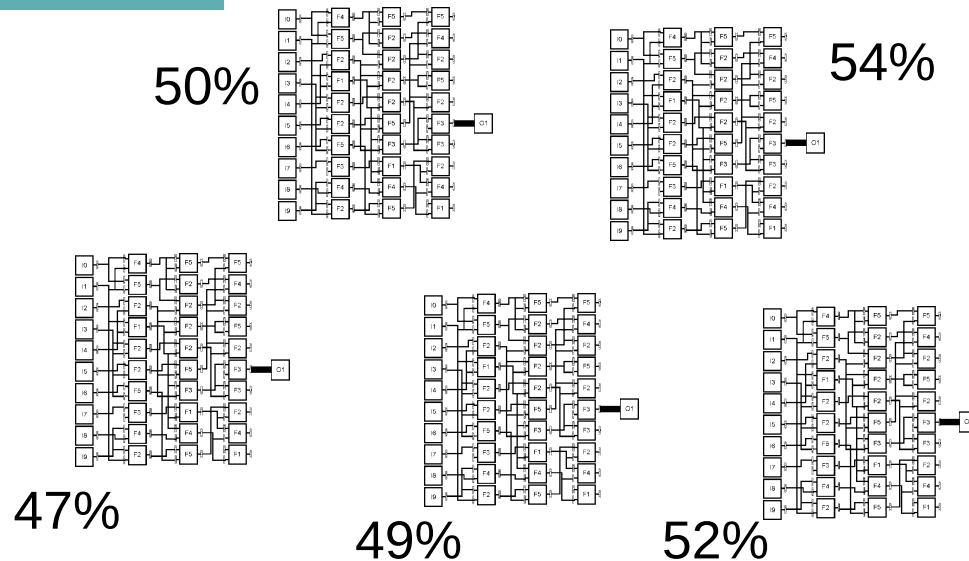
Evolutionary Algorithms



- Rate how well these work
- Using previously acquired measurements
- From subjects we know have Parkinson's ...and those that don't

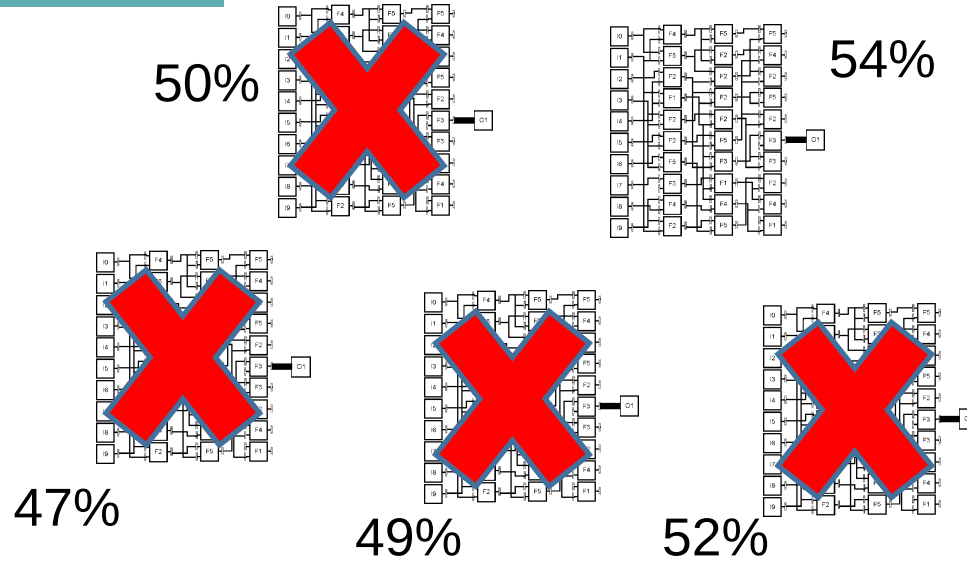


Evolutionary Algorithms

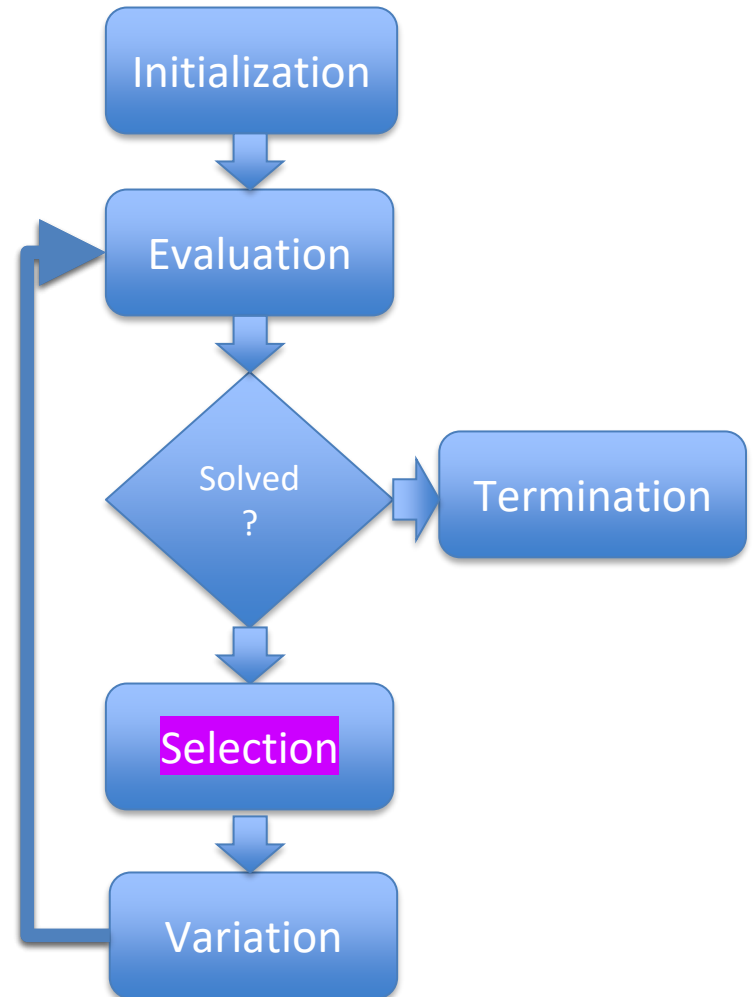


- Have we found a sufficiently good solution?

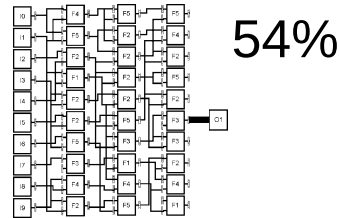
Evolutionary Algorithms



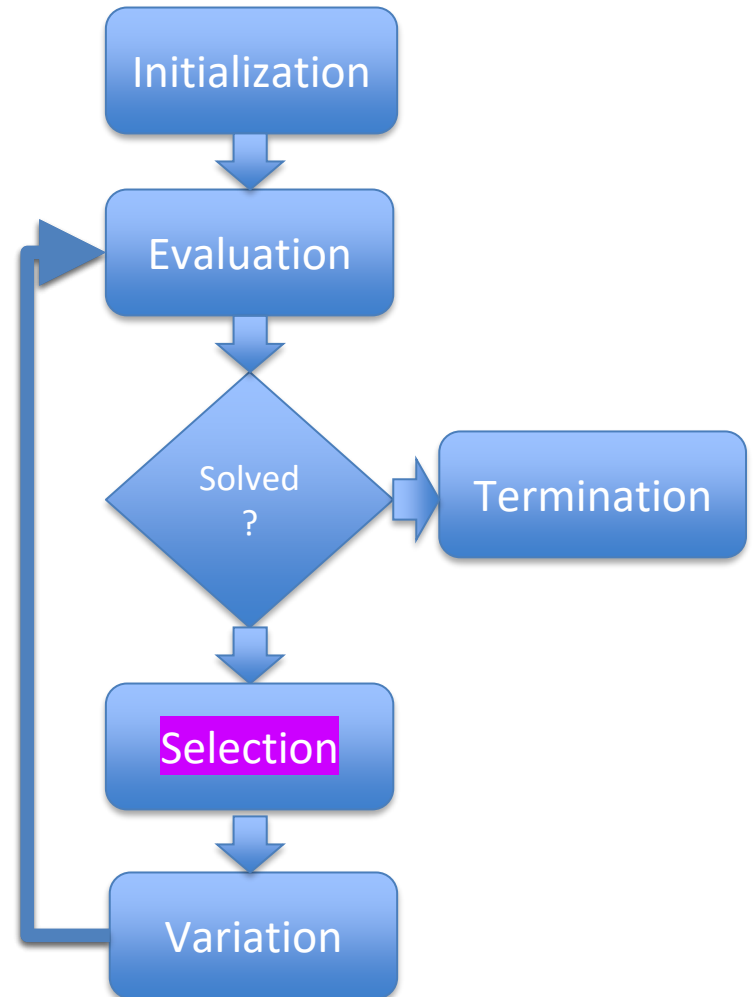
- Preserve the fittest solution in this generation



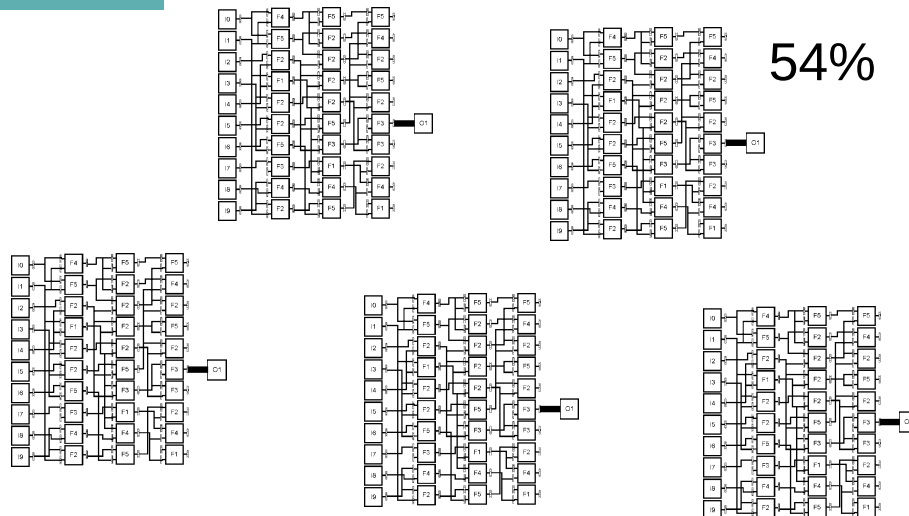
Evolutionary Algorithms



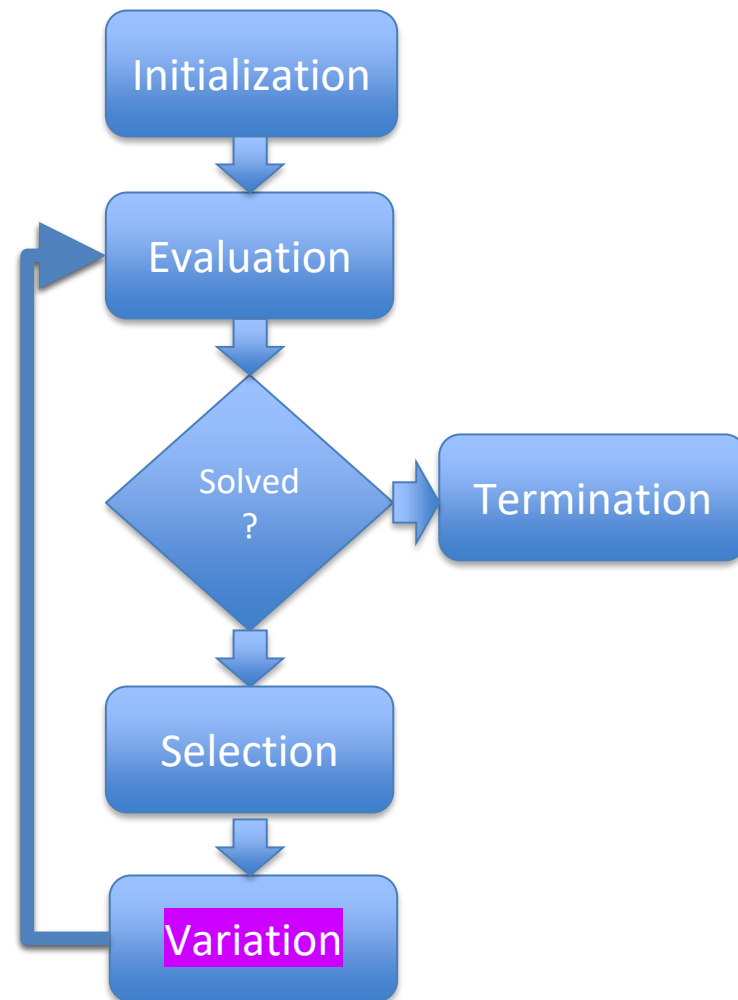
- Preserve the fittest solution in this generation



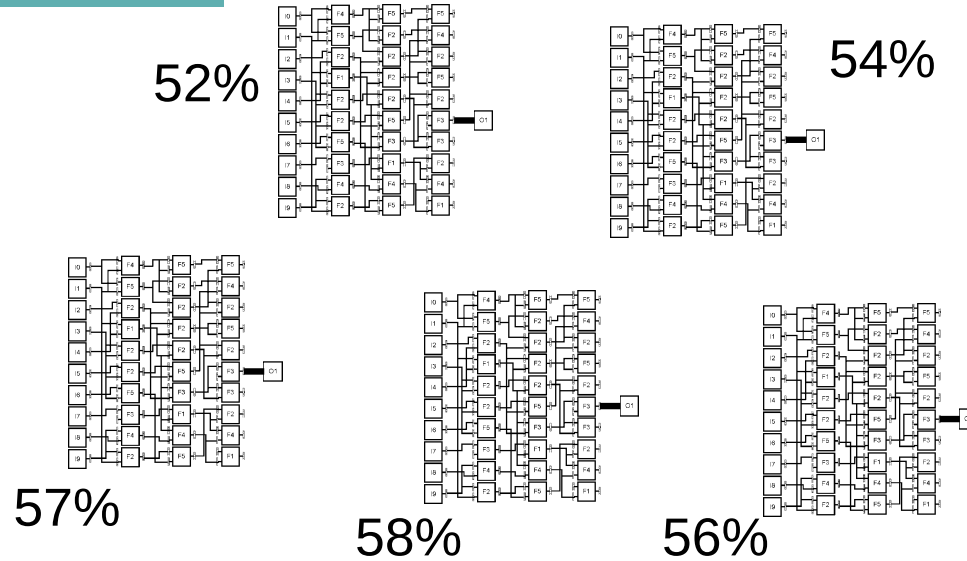
Evolutionary Algorithms



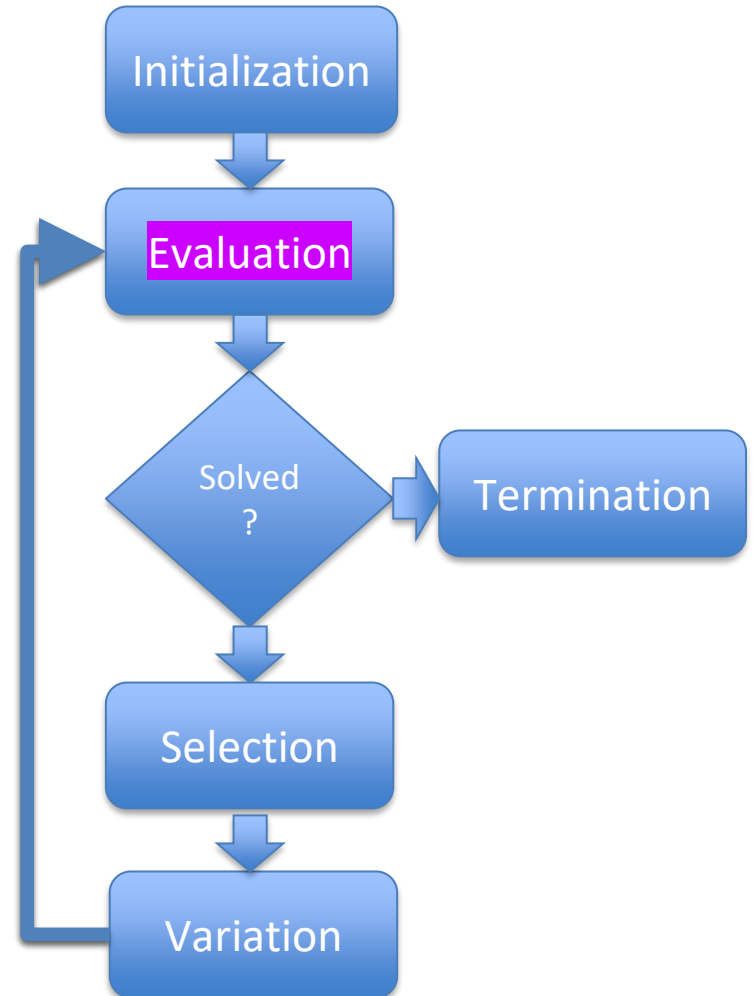
- Create 4 copies of the fittest
- Gently alter or *mutate* the copies



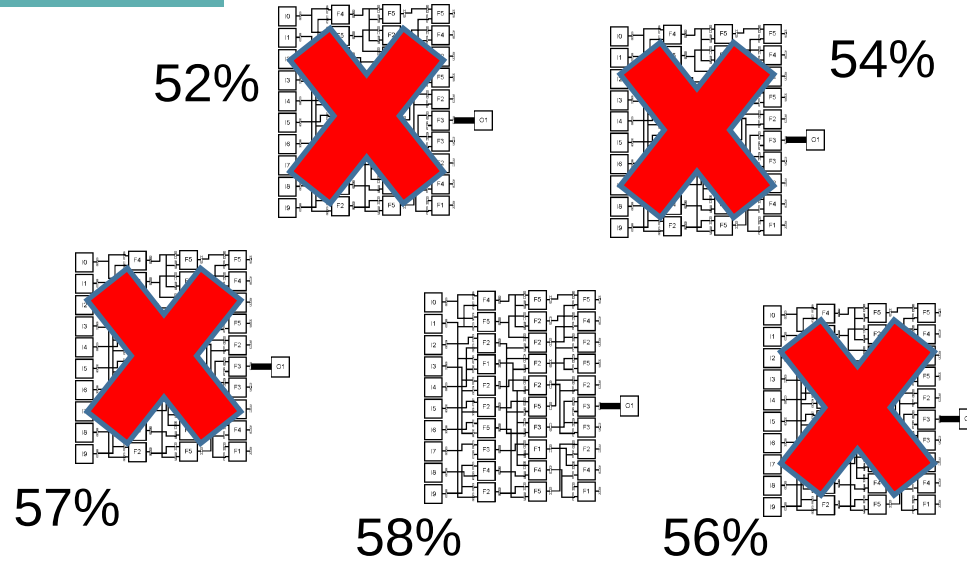
Evolutionary Algorithms



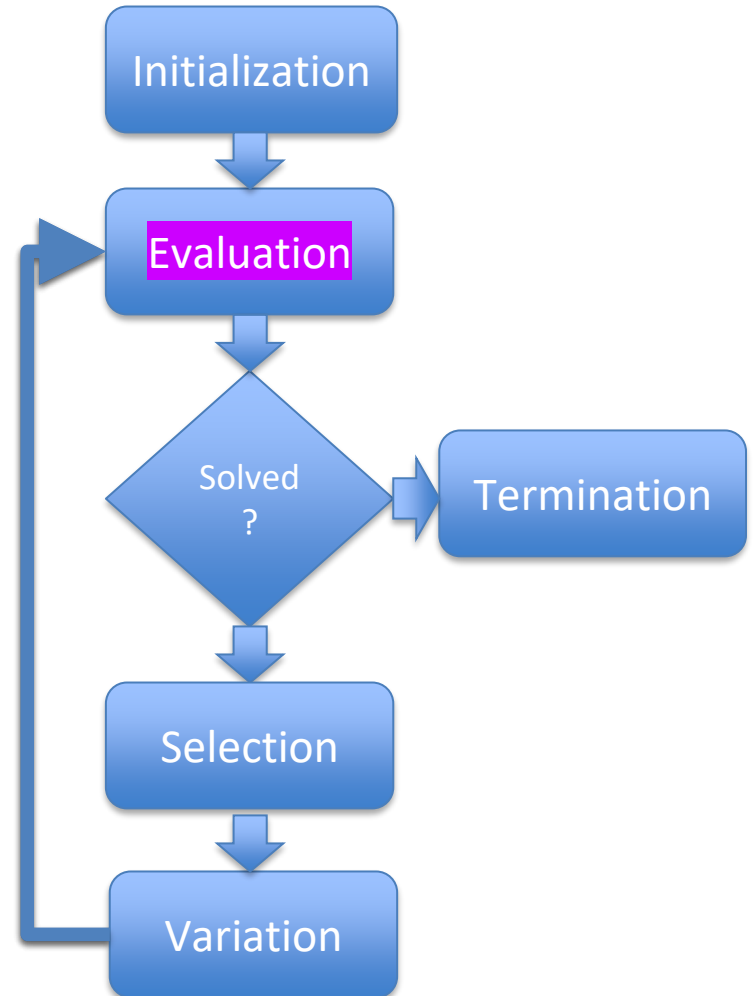
- Evaluate the new population



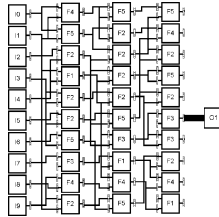
Evolutionary Algorithms



- Select the fittest

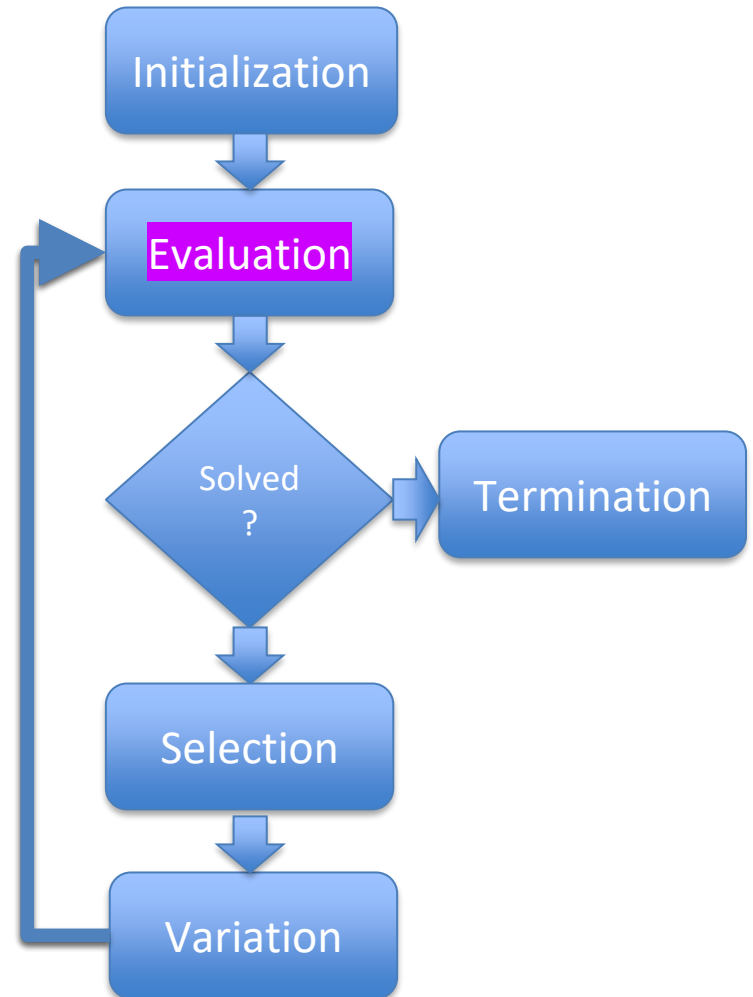


Evolutionary Algorithms

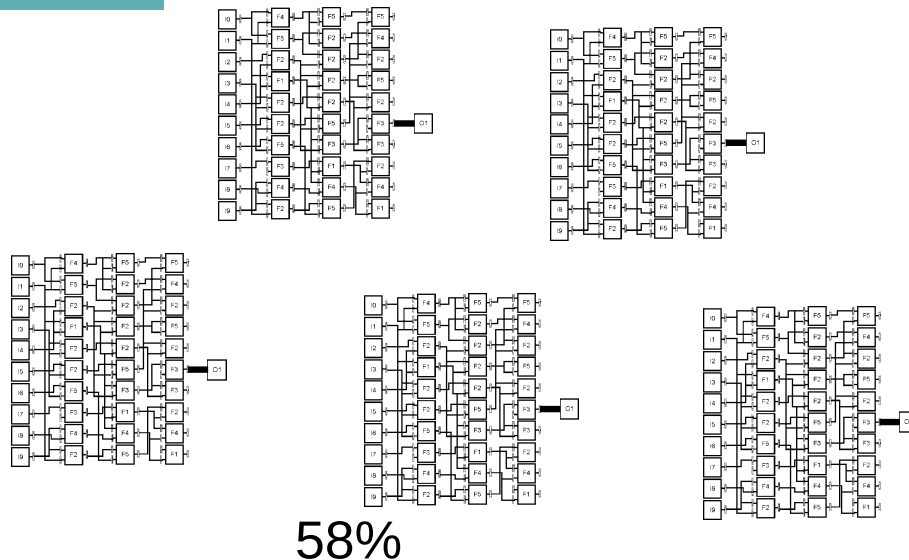


58%

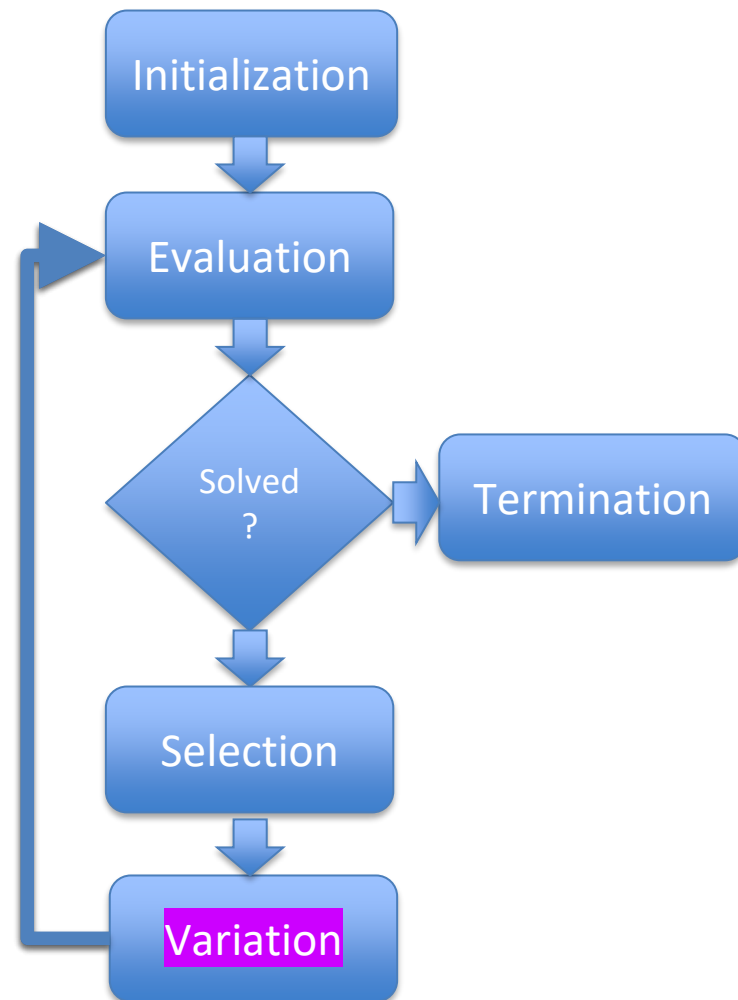
- Select the fittest



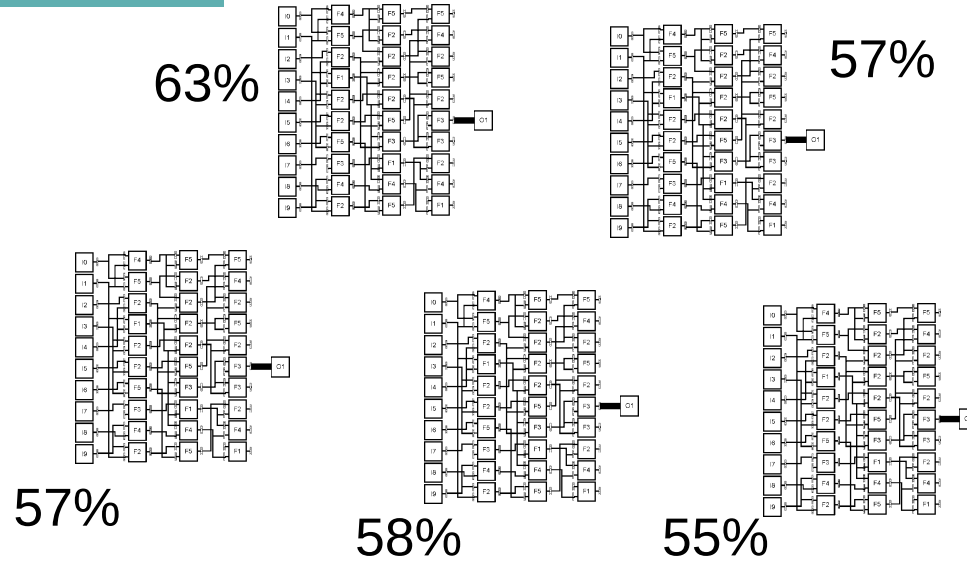
Evolutionary Algorithms



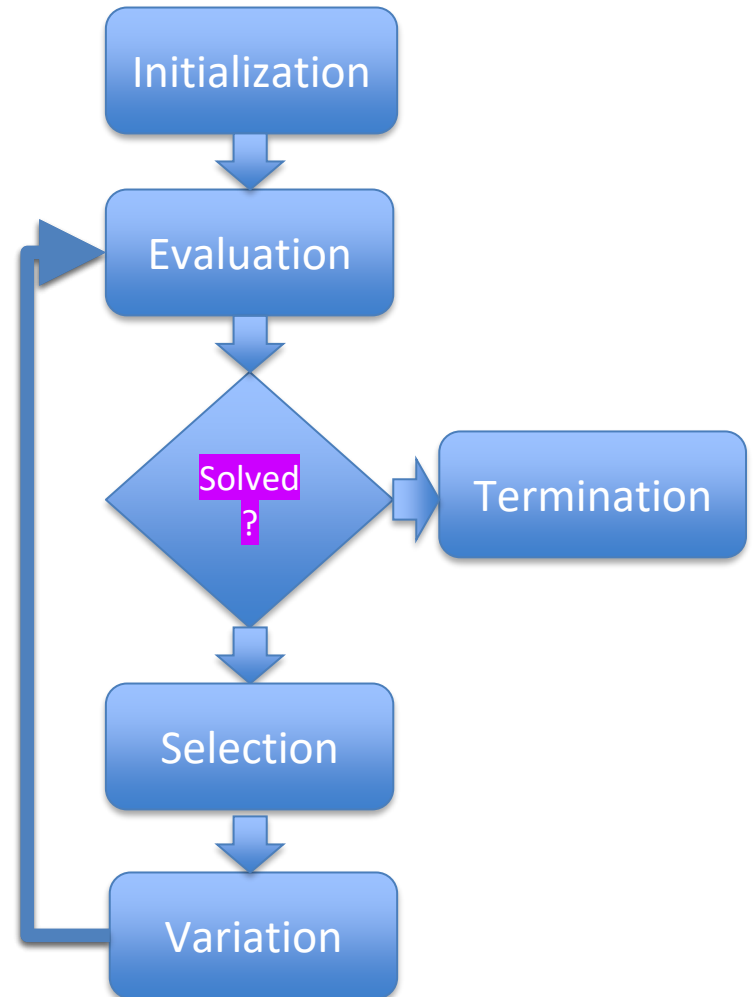
- Create 4 copies of the fittest
- Gently alter or *mutate* the copies



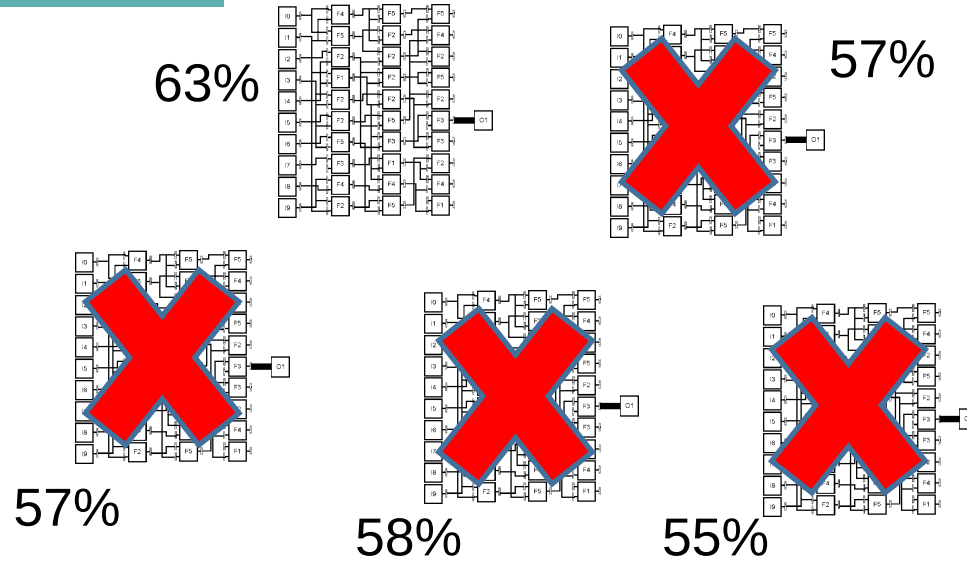
Evolutionary Algorithms



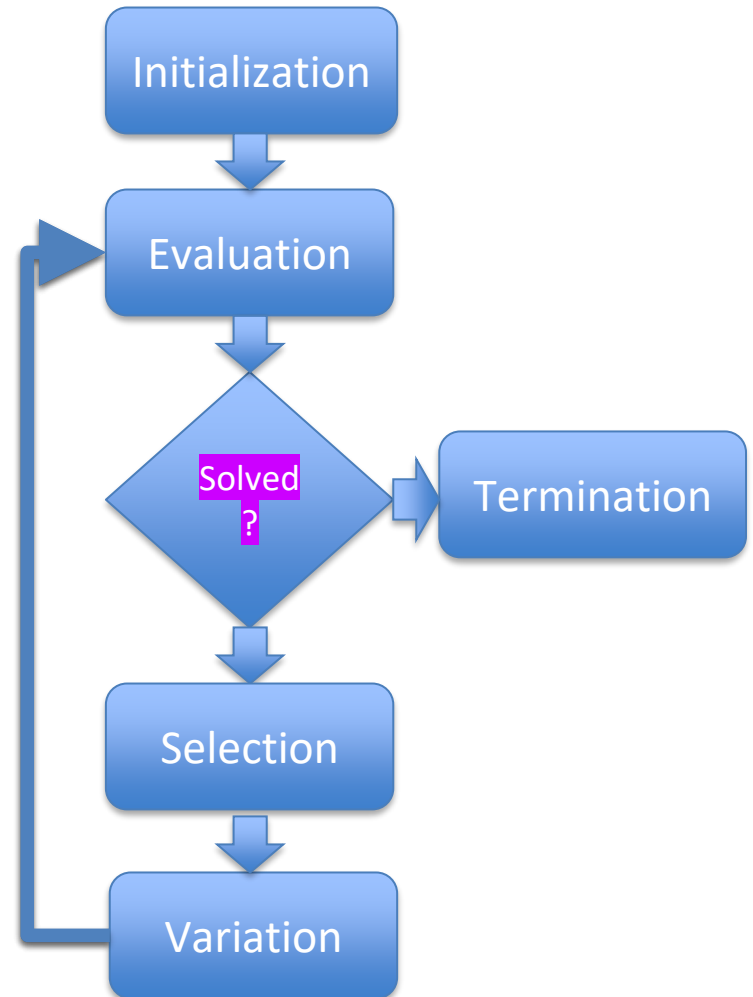
- Evaluate them



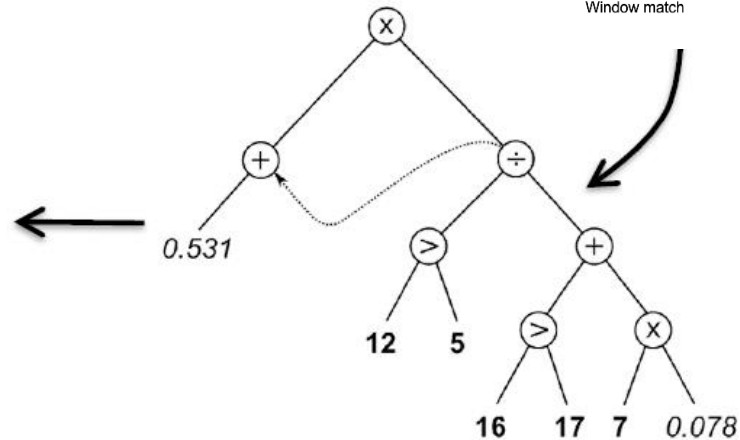
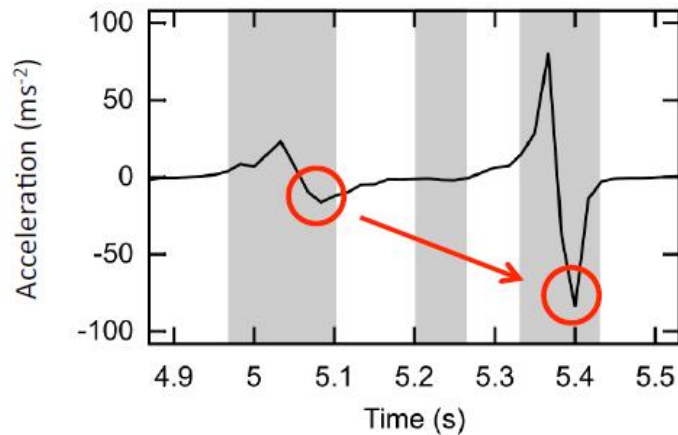
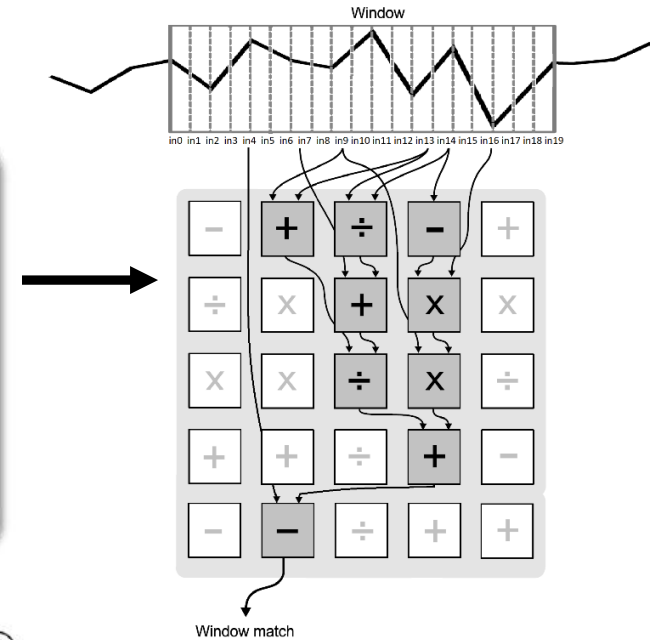
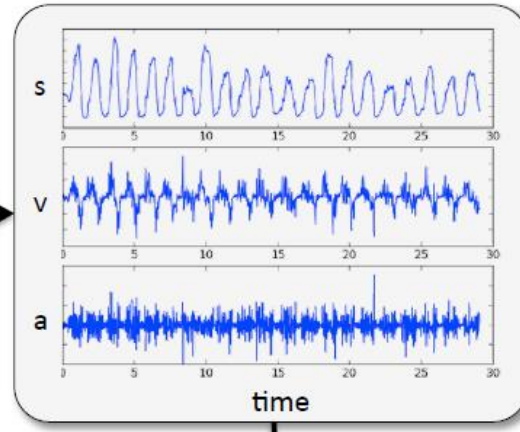
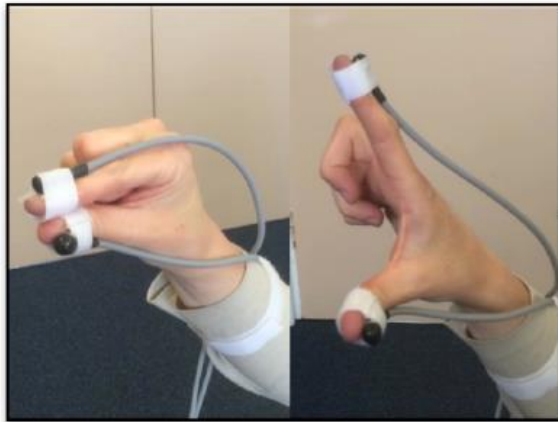
Evolutionary Algorithms



- Repeat!



Application



Lones MA, Smith SL, Alty JE, Lacy SE, Possin KL, Jamieson DS, Tyrrell AM. Evolving classifiers to recognize the movement characteristics of Parkinson's disease patients. IEEE Transactions on Evolutionary Computation. 2013 Sep 16;18(4):559-76.

UK Pharmaceutical Trials



PD-STAT: *Simvastatin* as a neuroprotective treatment for Parkinson's disease
Dr Camille Carroll



AZA-PD: *Azathioprine*, an immunosuppressor

Cambridge University Hospitals NHS Trust and the University of Cambridge.
Chief Investigator: Dr Caroline Williams-Gray.



EXENATIDE-PD: *Exenatide*, a glucagon-like peptide-1 receptor agonist
UCL Institute of Neurology and King's College Hospital NHS Foundation Trust.
Chief investigator: Dr Thomas Foltynie.

- Medication for Parkinson's can have side-effects
 - called **Dyskinesia**



The Solution: ClearSky's LID-Monitor



- 3 DoF accelerometers
- Non-invasive
- Easy to use



- Data uploaded to a PC and analysed



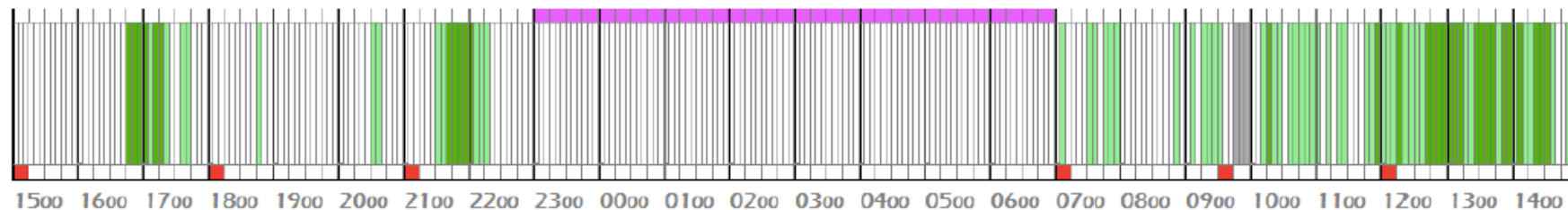
- Continuous monitoring
- In the home

Sample Output

ClearSky[®]
medical diagnostics

Patient ID: LNH001
Date: 22-09-2016 to 23-09-2016
Graph: Summary

Thursday 22-09-2016



Key	
High dyskinesia	
Moderate dyskinesia	
Medication	
No reading	
Sleeping	

Time	Type	Dose	Notes
23/09/2016 12:00	Fludrocortisone	0.025mg	
23/09/2016 12:00	Stalevo	125mg	
23/09/2016 09:30	Stalevo	125mg	
23/09/2016 07:00	Fludrocortisone	0.025mg	
23/09/2016 07:00	Amantadine	100mg	
23/09/2016 07:00	Stalevo	100mg	
23/09/2016 07:00	Rasagiline	1mg	
23/09/2016 07:00	Sinemet Plus	125mg	

Time	Type	Dose	Notes
22/09/2016 21:00	Stalevo	100mg	
22/09/2016 18:00	Stalevo	125mg	
22/09/2016 15:00	Amantadine	100mg	
22/09/2016 15:00	Stalevo	125mg	

Notes:
CA

Getting the Technology to the People Who Need it

- University spinout company
- Clinical validation
- Patent applications published
- CE Marking secured **CE**
- www.clearskymd.com

ClearSky[®]
medical diagnostics



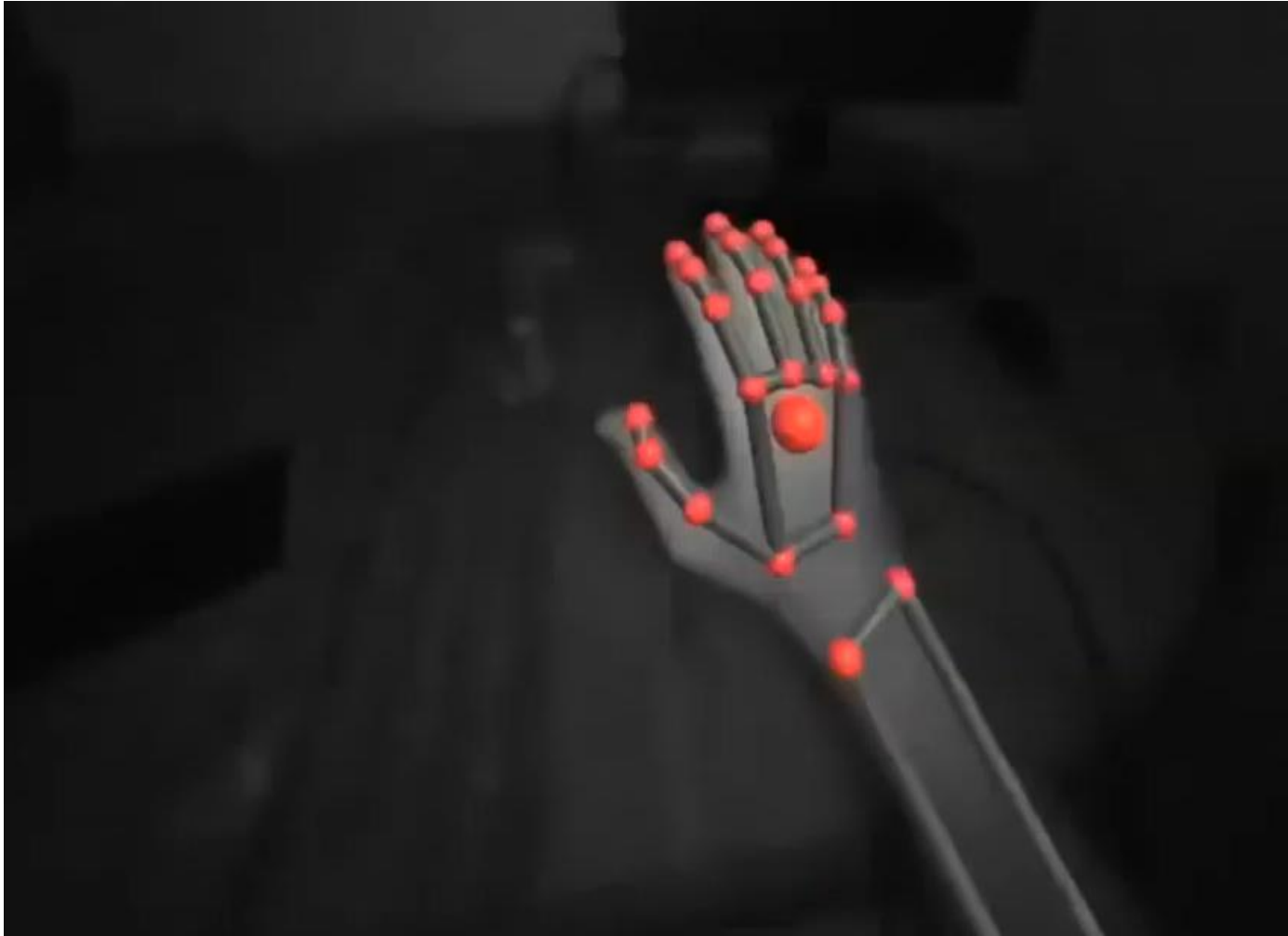
C₂ Centre for Chronic
D₂ Diseases & Disorders



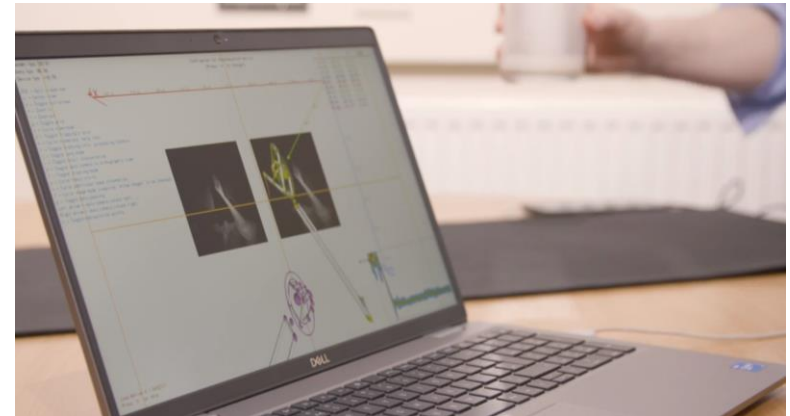
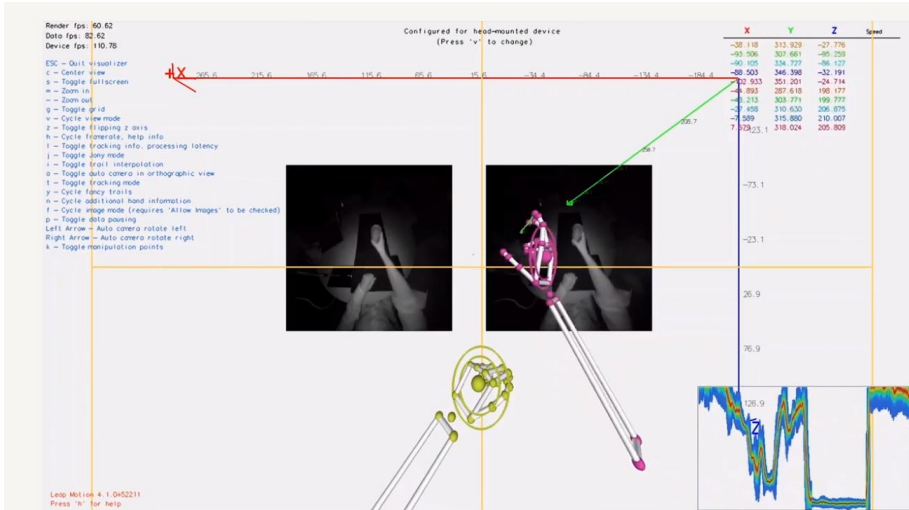
Beyond Parkinson's

- Monitoring Mild Cognitive Impairment
 - Sometimes a precursor to dementia
 - Assessment is difficult and resource intensive
- Huntington's Disease
- Essential Tremor

Wireless Sensing

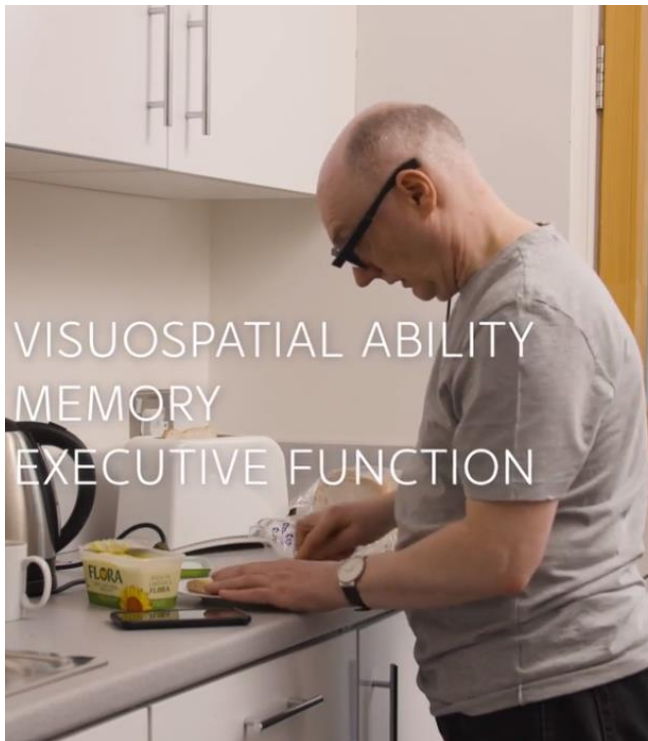


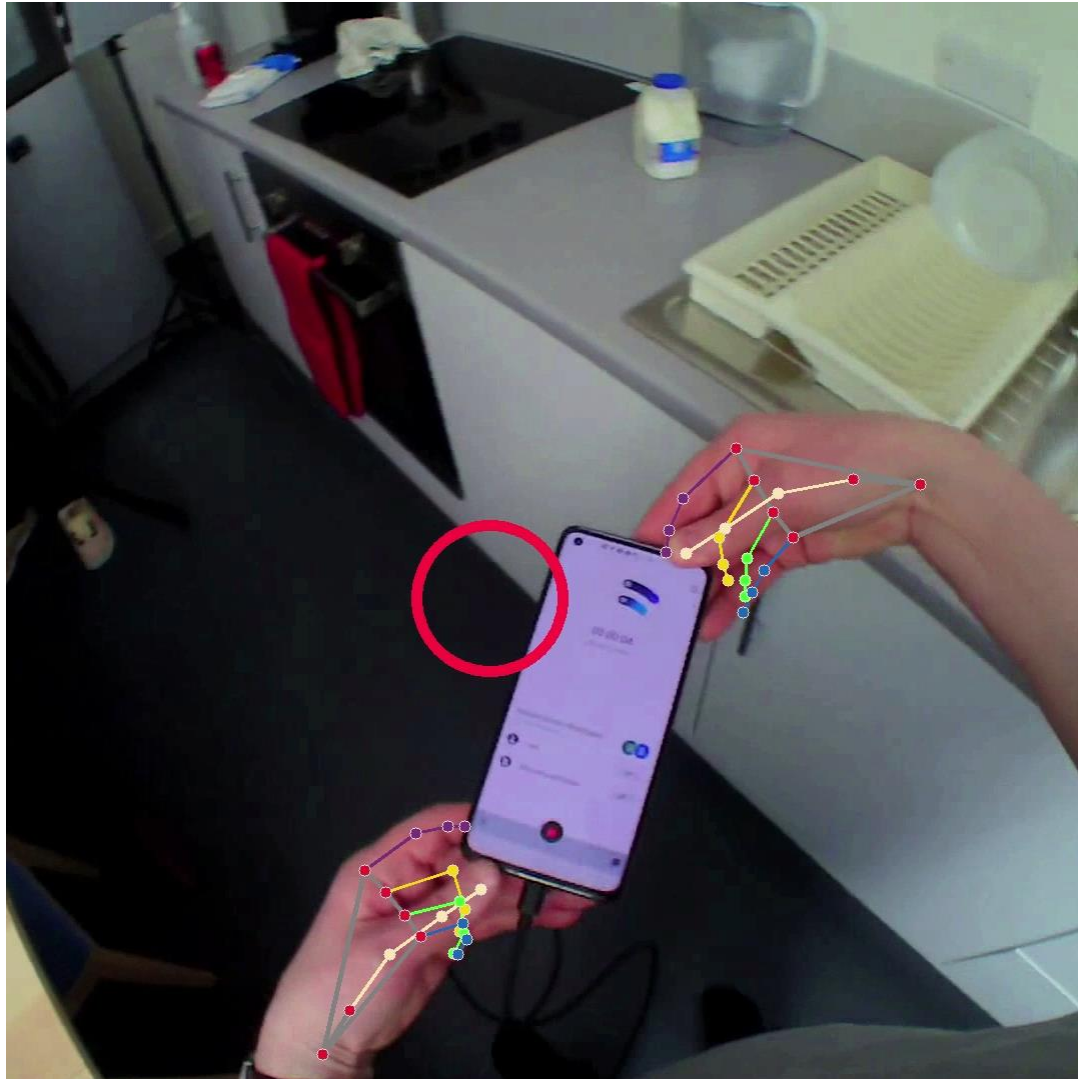
Assessment in the Clinic





Assessment in Everyday Activities





Summary

- Parkinson's and related conditions are difficult to assess objectively
- “White box” machine learning can provide an explainable AI solution

Opportunity to:

- Assist diagnosis
- Improve the quality of life
- Help identify new drugs