Week	Content	CO	Activity and Assessments	Percentage
19/08	•Introduction to Genetic Algorithms •GA Implementation	CO-1	Refreshing and Discussion	-
26/08	•Cycle of Basic GA •Holland's schema theorem.	CO-1	Quiz-1	2
02/09	Encoding in Genetic Algorithm	CO-3	Quiz-2	2
09/09	Selection	CO-2	Quiz-3	2
16/09	Crossover Part 1	CO-2	Quiz-4	2
23/09	Crossover Part 2	CO-2	Quiz-5	2
30/09	Proposal Presentation (Problem Formulation)	CO-3	Presentation and Discussion	10+2,5
../10	UTS		Holland's schema and What is GA GA Encoding GA Operators	5 5 5

Week	Content	CO	Activity and Assessments	Percentage
21/10	•Mutation •Genetic Algorithm Parameters	CO-2	Quiz-6	2.5
28/10	Hybrid Genetic Algorithm	CO-5	HW-1	2.5
04/11	Progress Report	CO-4	Presentation and Discussion	10 + 2.5
11/11	Applications of Genetic Algorithms	CO-5	HW-2	5
18/11	Final Project Report	CO-4	Presentation	10
25/11	Trend research on Genetic Algorithm	CO-6	Presentation of Lit Review → daring	5
02/12	Paper Report	CO-5	Draft paper	10
.../12	UAS	CO-2 CO-4 CO-6	GA Operator and Parameters GA Design Trend GA	5 5 5

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Hybrid Systems on GA

Aina Musdholifah Ph.D.

Combinations

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- The combination of evolutionary computation, knowledge-based systems, soft computing, neural networks, and others forms the core of an emerging approach to building hybrid intelligent systems capable of reasoning and learning in an uncertain and imprecise environment.

Hybridization

- Integrated architectures for machine learning have been shown to provide performance improvements over single representation architectures.

- Integration, or hybridization, is achieved using a spectrum of module or component architectures ranging from those sharing independently functioning components to architectures in which different components are combined in inherently inseparable ways.

Current Progress

- In recent years multiple module integrated machine learning systems have been developed to overcome the limitations inherent in single component systems.

- Integrations of neural networks (NN), fuzzy logic (FL) and global optimization algorithms have received considerable.

Degree of Integration

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- Besides differing in the types of component systems employed, different integrated architectures have emerged in a rather ad hoc way.
- Least integrated architectures consisting of independent components communicating with each other on a side-by-side basis.
- More integration is shown in transformational or hierarchical systems in which one technique may be used for development and another for delivery or one component may be used to optimize the performance of another component.
- More fully integrated architectures combine different effects to produce a balanced overall computational model.

Transformational, hierarchical and integrated

- Abraham categorizes such systems as stand-alone, transformational, hierarchical hybrid, and integrated hybrid system.

- In a transformational integrated system, the system may use one type of component to produce another which is the functional system.
- For example, a GA may be used to set the initial conditions for a neural network solution to a problem.

- Thus, to create a modern intelligent system it may be necessary to make a choice of complementary techniques.

Stand Alone Models

- Independent components that do not interact
- Solving problems that have naturally independent components

Figure 2. Stand –alone architecture

Transformational

- GA with neural networks
- Output from the GA is used to set the initial conditions and training set of the NN

Figure 3. Transformational hybrid architecture

Hierarchial Hybrid

- An ANN uses a GA to optimize its topology and the output fed into an ES which creates the desired output or explanation

Figure 4. Hierarchical hybrid architectures

Integrated – Fused Architectures

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- Combine different techniques in one computational model
- Share data structures and knowledge representations
- Extended range of capabilities – e.g., classification with explanation, or adaptation with classification

Evolutionary neural networks

Evolutionary neural networks

- Although neural networks are used for solving a variety of problems, they still have some limitations.

- One of the most common is associated with neural network training. The back-propagation learning algorithm cannot guarantee an optimal solution. In real-world applications, the back-propagation algorithm might converge to a set of sub-optimal weights from which it cannot escape. As a result, the neural network is often unable to find a desirable solution to a problem at hand.

Evolutionary neural networks

- Another difficulty is related to selecting an optimal topology for the neural network. The "right" network architecture for a particular problem is often chosen by means of heuristics and designing a neural network topology is still more art than engineering.

- Genetic algorithms are an effective optimization technique that can guide both weight optimization and topology selection.

Encoding a set of weights in a chromosome

From neuron:	1	2	3	4	5	6	7	8
To neuron: 1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0.9	-0.3	-0.7	0	0	0	0	0
5	-0.8	0.6	0.3	0	0	0	0	0
6	0.1	-0.2	0.2	0	0	0	0	0
7	0.4	0.5	0.8	0	0	0	0	0
8	0	0	0	-0.6	0.1	-0.2	0.9	0

Chromosome:

0.9	-0.3	-0.7	-0.8	0.6	0.3	0.1	-0.2	0.2	0.4	0.5	0.8	-0.6	0.1	-0.2	0.9

Evolutionary neural networks

- The second step is to define a fitness function for evaluating the chromosome's performance. This function must estimate the performance of a given neural network. We can apply here a simple function defined by the sum of squared errors.

- The training set of examples is presented to the network, and the sum of squared errors is calculated. The smaller the sum, the fitter the chromosome. The genetic algorithm attempts to find a set of weights that minimises the sum of squared errors.

Evolutionary neural networks

- The third step is to choose the genetic operators – crossover and mutation. A crossover operator takes two parent chromosomes and creates a single child with genetic material from both parents. Each gene in the child's chromosome is represented by the corresponding gene of the randomly selected parent.

- A mutation operator selects a gene in a chromosome and adds a small random value between -1 and 1 to each weight in this gene.

Crossover in weight optimisation

Mutation in weight optimisation

Can genetic algorithms help us in selecting the network architecture?

The architecture of the network (i.e., the number of neurons and their interconnections) often determines the success or failure of the application. Usually, the network architecture is decided by trial and error; there is a great need for a method of automatically designing the architecture for a particular application. Genetic algorithms may well be suited for this task.

- The basic idea behind evolving a suitable network architecture is to conduct a genetic search in a population of possible architectures.

- We must first choose a method of encoding a network's architecture into a chromosome.

Encoding the network architecture

- The connection topology of a neural network can be represented by a square connectivity matrix.
- Each entry in the matrix defines the type of connection from one neuron (column) to another (row), where 0 means no connection and 1 denotes connection for which the weight can be changed through learning.
- To transform the connectivity matrix into a chromosome, we need only to string the rows of the matrix together.

Encoding of the network topology

From neuron:	1	2	3	4	5	6
To neuron: 1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	1	1	0	0	0	0
4	1	0	0	0	0	0
5	0	1	0	0	0	0
6	0	1	1	1	1	0

Chromosome:

0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0

The cycle of evolving a neural network topology

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Terimakasih
n
Thank You

Homework of Hybrid GA

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- Find 7 papers (international journal that publish at least 4 years ago) about Hybrid GA
- Make a resume:
  - what is the objective of the research
  - what is the function of GA in the research
  - what is the schema of GA
  - References
- Discuss with your group.
- Submit to SIMASTER