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	HW-1	2.5
28/10	Hybrid Genetic Algorithm	CO-5	HW-2	2.5
04/11	Progress Report	CO-4	Presentation and Discussion	10 + 2.5
11/11	Applications of Genetic Algorithms	CO-5	HW	5
18/11	Final Project Report	CO-4	Presentation	10
25/11	Trend research on Genetic Algorithm	CO-6	Presentation of Lit Review	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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Cycle of Genetic Algorithm and Holland Schema

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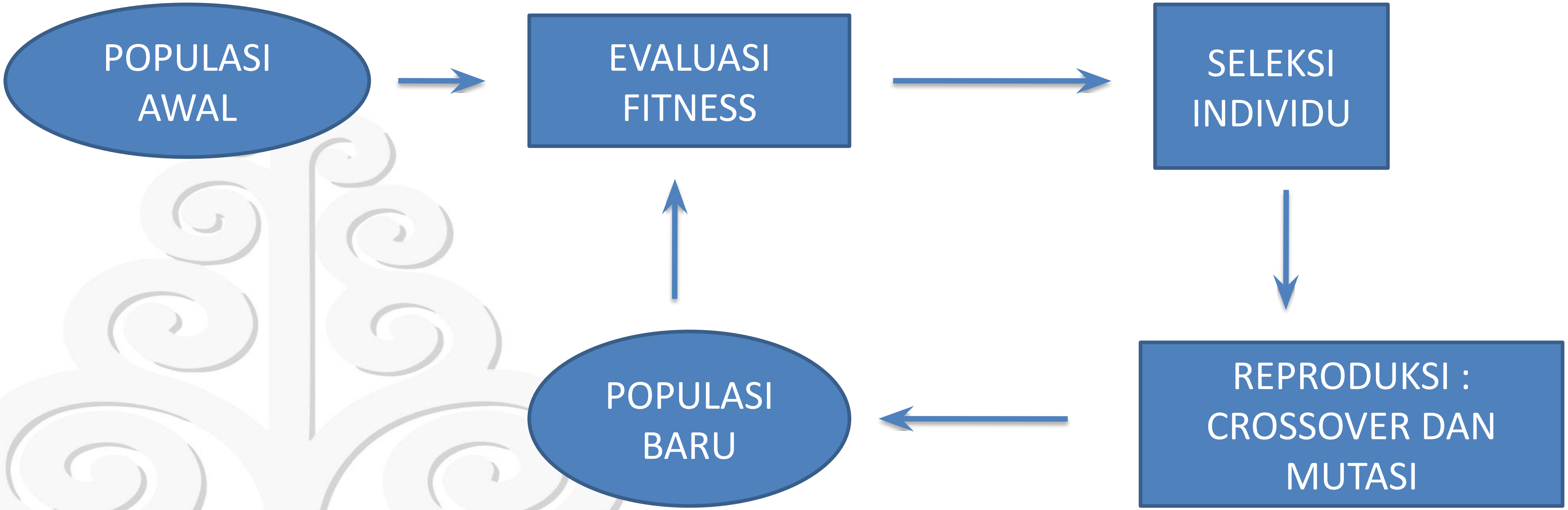
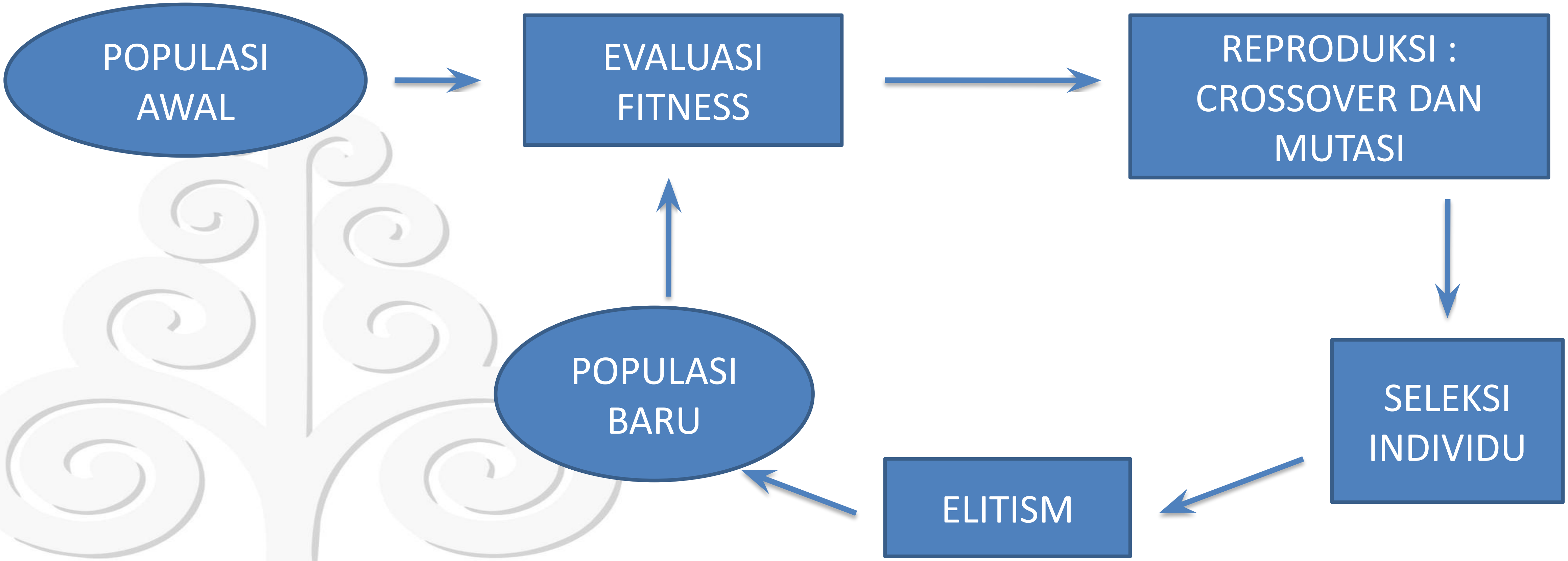
Start the journey

THEORY OF SIMPLE GENETIC ALGORITHMS

Cycle of Genetic algorithm (David Goldberg)



Cycle of Genetic algorithm (Michalewicz)



Basic Foundation GA (Michalewicz) - Gen and Cheng (2000)

- A genetic representation of solution to the problem
- A way to create an initial population of solution
- An evaluation function rating solutions in term their fitness
- Genetic operators that alter the genetic compositions of children during reproduction
- Values for the parameters of GA

Penjelasan -Gen dan Cheng (2000)

- Algoritma genetik memelihara populasi dari individu (P_i) pada setiap generasi $\mathbf{i}$
- Setiap individu merepresentasikan sebuah solusi potensial. Setiap individu dievaluasi untuk dinilai fitness-nya
- Setiap individu menjalani *stochastic transformations* dengan menggunakan operasi genetik untuk membentuk individu baru
- Ada dua jenis transformasi yang digunakan yaitu **mutasi** dan **persilangan** (**crossover**)

Penjelasan (2) -Gen dan Cheng (2000)

- Individu baru yang disebut offspring $\mathbf{C_i}$ dievaluasi kembali
- Setelah beberapa generasi diharapkan setiap individu menjadi konvergen menjadi individu terbaik
- Individu terbaik inilah yang diharapkan menjadi solusi optimal atau suboptimal dari masalah.
- Struktur umum dari algoritma genetik dijelaskan dalam **Teorema Skema Holland**

Teorema Skema Holland

- Algoritma genetika sederhana
- Menggunakan suatu populasi tunggal yang dihuni oleh beberapa individu (genome)
- Genome-genome direpresentasikan dalam barisan bit 1 atau 0 yang menyatakan alela yang ada pada gen
- Teorema skema merupakan dasar teori yang menjelaskan bagaimana Algoritma Genetik bekerja

Teorema Skema Holland

Konsep Dasar Skema Holland:

1. **Skema (Schema)**
2. **Order of Schema (o(H))**
3. **Defining Length (δ(H))**
4. **Fitness Skema (f(H))**

Theorem of Holland Schema

- Schema is the similarity of patterns in describing a set of parts of several strings that have similarities in a certain position.

- A scheme is formed by adding a special symbol, which is a symbol * (don't care) in the binary representation (0 or 1)

- Example: * 01 is 101 or 001 which is 5 or 1

Theorem of Holland Schema

- The level of an *S* scheme (denoted by o(S)) shows the number of fixed 0 or 1 position numbers (not a don't care position) in the scheme.
- This level shows the specialization of a scheme.
- Example:
  - ✔ S1 = (* * * 0 0 1 * 1 1 0)

    o(S1)=6
  - ✔ S2 = (* * * * 0 0 * * 0 *)
  - ✔ S3 = (1 1 1 0 1 * * 0 0 1)

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  - ✔ S3 = (1 1 1 0 1 * * 0 0 1) **o(S3)=8**

Theorem of Holland Schema

- The length limit of the *S* scheme (denoted by δ(S)) is the distance between the first to the last 0 or 1 digit position.

- This figure shows the density of information in a scheme.

- Example:
  1. S1 = (* * * 0 0 1 * 1 1 0)
  2. S2 = (* * * * 0 0 * * 0 *)
  3. S3 = (1 1 1 0 1 * * 0 0 1)

Theorem of Holland Schema

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  1. S1 = (* * * 0 0 1 * 1 1 0)
  2. S2 = (* * * * 0 0 * * 0 *)
  3. S3 = (1 1 1 0 1 * * 0 0 1)

δ(S1)= 10-4=6

δ(S2)= 9-5 =4

δ(S3)= 10-1=9

Theorem of Holland Schema

- Another example:
  1. S4 =110*10
  2. S5 =*110*00
  3. S6 =10*100*1*

Theorem of Holland Schema

Another example:

1. S4 =110*10 — o(S4)=5 — δ(S4)= 6-1=5
2. S5 =*110*00 — o(S5)=5 — δ(S5)= 7-2=5
3. S6 =10*100*1* — o(S6)=6 — δ(S5)= 8-1=7

Theorem of Holland Schema

- Relationship between Holland Scheme and Genome
  - S4 $\rightarrow$ 1 don't care $\rightarrow$ 2^1 = 2 possible genome sequences: 110010; 110110
  - S5 $\rightarrow$
  - S6 $\rightarrow$

Theorem of Holland Schema

- Relationship between Holland Scheme and Genome
  - S4 $\rightarrow$ 1 don't care $\rightarrow$ $2^1 = 2$ possible genome sequences: 110010; 110110
  - S5 $\rightarrow$ 2 don't care $\rightarrow$ $2^2 = 4$ possible genome sequences: 1110000; 1110100; 0110000; 0110100
  - S6 $\rightarrow$ 3 don't care

Theorem of Holland Schema

- Relationship between Holland Scheme and Genome
  - S4 $\rightarrow$ 1 don't care $\rightarrow$ $2^1 = 2$ possible genome sequences: 110010; 110110
  - S5 $\rightarrow$ 2 don't care $\rightarrow$ $2^2 = 4$ possible genome sequences: 1110000; 1110100; 0110000; 0110100
  - S6 $\rightarrow$ 3 don't care $\rightarrow$ $2^3 = 8$ possible genome sequences:

  101100111; 101100110; 101100010; 101100011; 100100111; 100100110; 100100011; 100100111

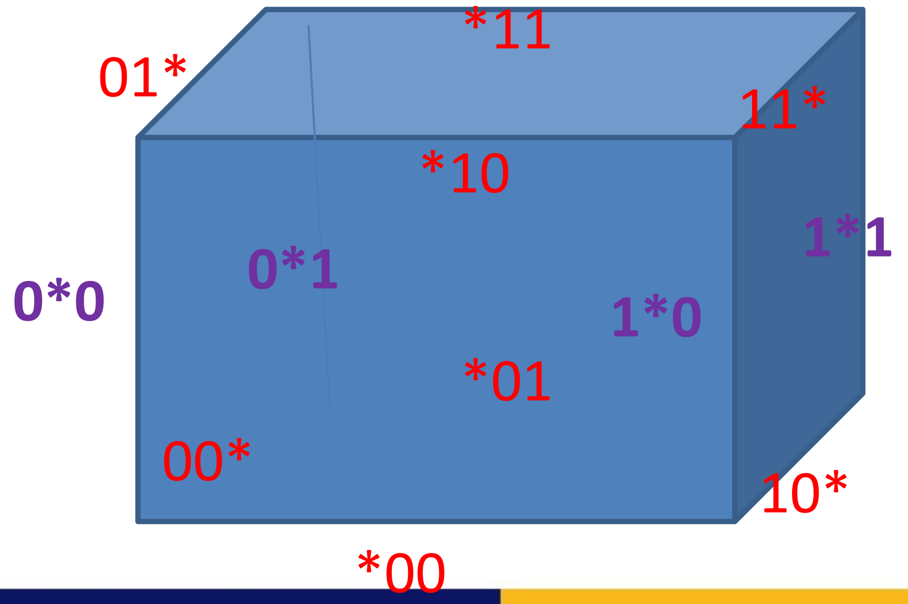
Theorem of Holland Schema

- Relationship between Holland Scheme and Genome
  - Formally, a scheme with *n* symbols from the o-order expresses an *n* dimension hyperplane with potential solution space.

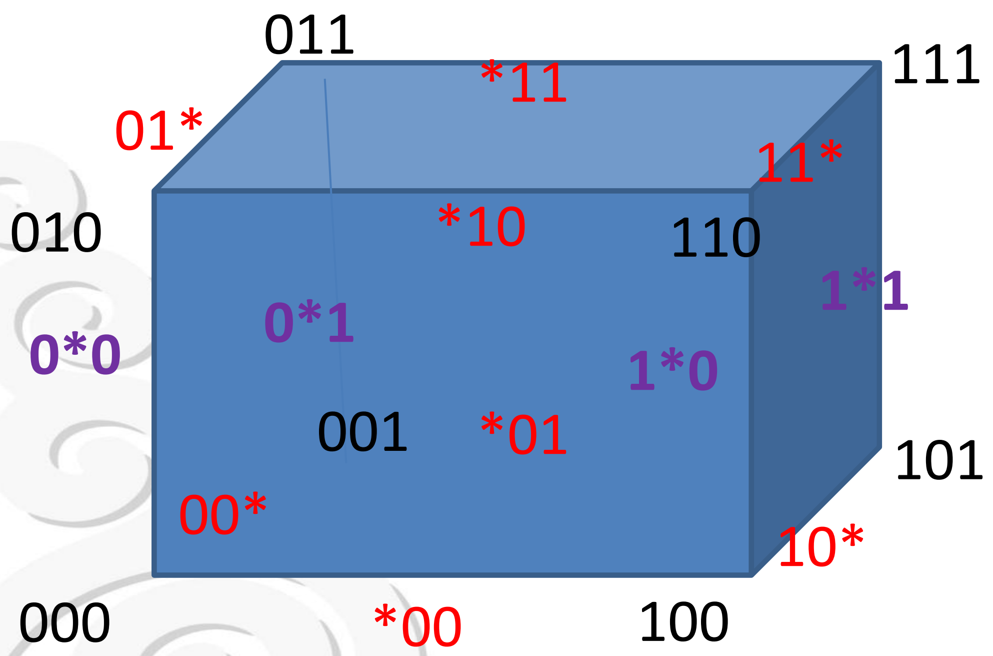
example

Genome ?

00 ; 01 ; 10 ; 11



Hyperplane schema



Theorem of Holland Schema

Holland membuktikan bahwa:

Skema dengan **(1) fitness rata-rata di atas rata-rata populasi**, **(2) order rendah**, dan **(3) defining length pendek** → memiliki peluang lebih besar untuk berkembang (propagasi) di generasi berikutnya.

Formula dasar jumlah rata-rata kromosom dalam skema H pada generasi t+1:

$$E[m(H,t+1)] \geq m(H,t) \cdot \frac{f(H)}{\bar{f}} \cdot \left[1 - p_c \frac{\delta(H)}{(l-1)} - o(H)p_m\right]$$

Keterangan:

- $m(H,t)$ = jumlah kromosom dalam populasi pada generasi t yang sesuai dengan skema H.
- $f(H)$ = fitness rata-rata skema H.
- $\bar{f}$ = fitness rata-rata populasi.
- p_c = probabilitas crossover.
- p_m = probabilitas mutasi per bit.
- l = panjang kromosom.
- δ(H) = defining length.
- o(H) = order schema.

Next…

- How to Generate Population
- Encoding