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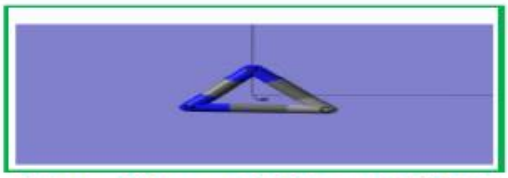
Journal of Applicable Chemistry

2020, 9 (6): 934-1018

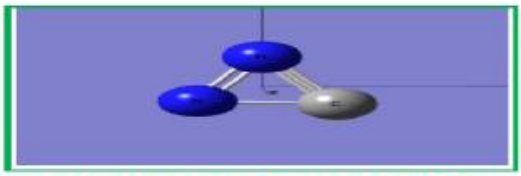
(International Peer Reviewed Journal)

New Chemistry News

$^{-}N=C=N^{-}$



New News of Chem (NNC)



ChemNewsNew (CNN)

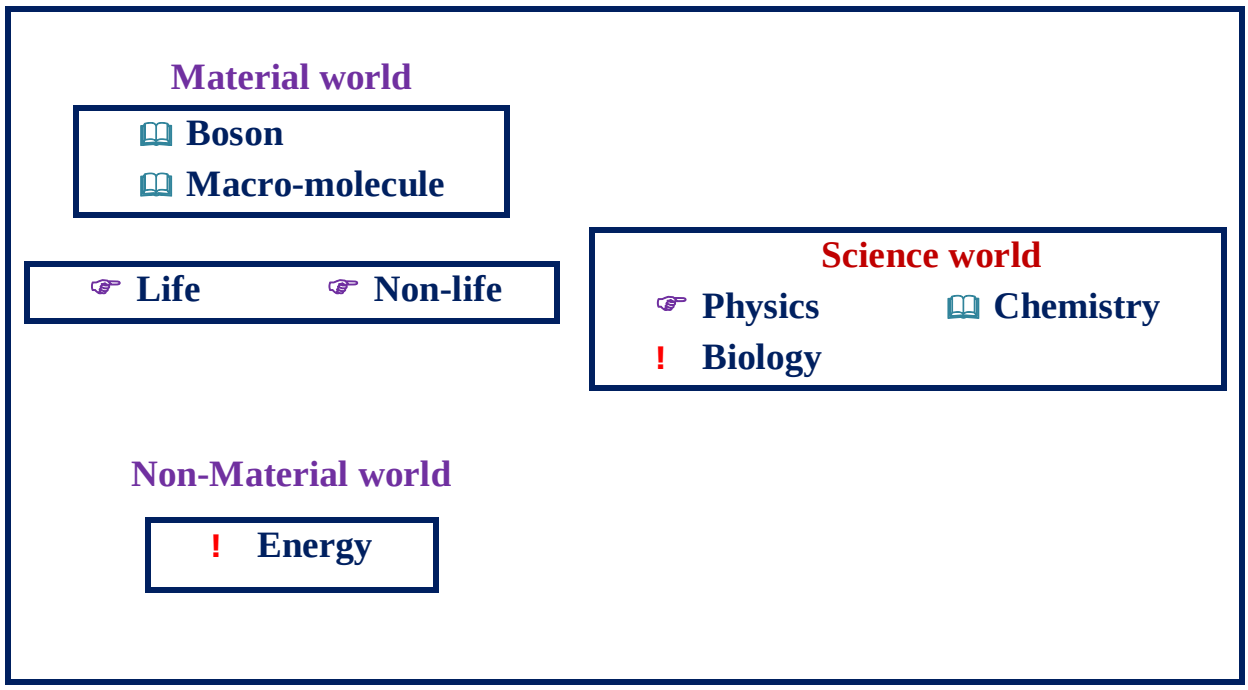
Evolution of Mimics of Algorithms of Nature (E-man)

10. Biology Inspired Optimization (Mathematical) Methods (Biol.IOm)

Information Source	ACS.org ; sciencedirect.com
K. Somasekhara Rao, Dept. of Chemistry, Acharya Nagarjuna Univ., Dr. M.R.Appa Rao Campus, Nuzvid-521 201, India	R. Sambasiva Rao, School of Chemistry, Andhra University, Visakhapatnam 530 003, India

Nature Inspired Algorithms (NIA)

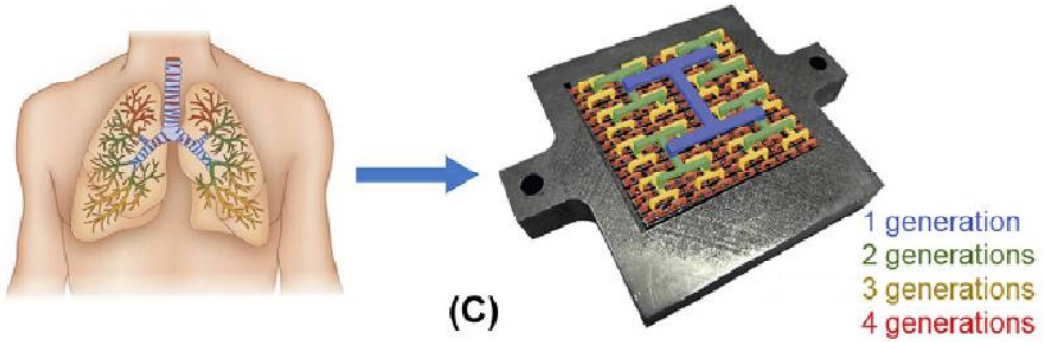
Universe ….



Human (genetics)

..... Sperm motility.....

a)	Sperm Motility Algorithm for Solving Fractional Programming Problems under Uncertainty	Title
	(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 8, No. 5, (2017)	Journal
	Osama Abdel Raouf, Bayoumi M. Ali Hassan, Ibrahim M. Hezam	Author(s)
b)	Sperm motility algorithm: a novel metaheuristic approach for global optimisation	Title
	Int. J. Operational Research, (2017), Vol. 28, No. 2, pp.143–163.	Journal
	Osama Abdel Raouf, Ibrahim M. Hezam	Author(s)
c)	Sperm Movement Algorithm for Solving Optimal Reactive Power Dispatch Problem	Title
	International Journal for Research in Engineering Application & Management (IJREAM) (2018)	Journal
	Dr. K. Lenin	Author(s)



Lung-inspired flow fields for proton exchange membrane fuel cells

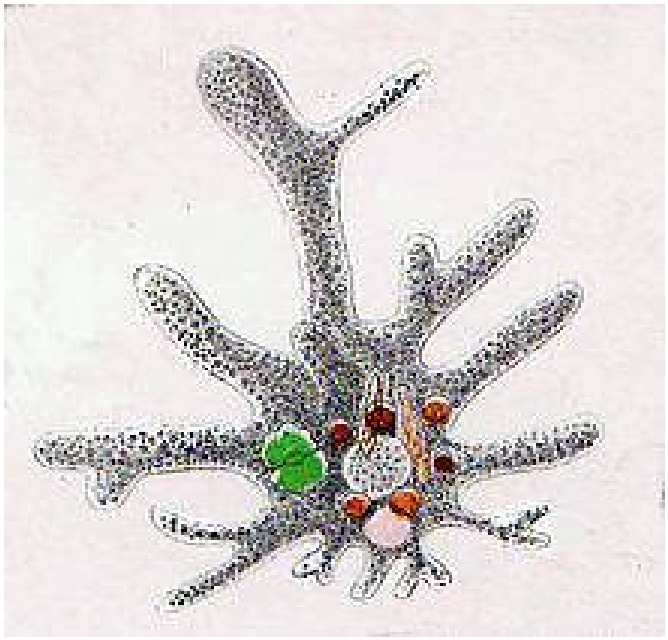
……. Amoeboid……. opt

inspired from ☞ Arriving at shortest path

☞ Amoeboid 🕮 Bacteria

☞ Parasitism

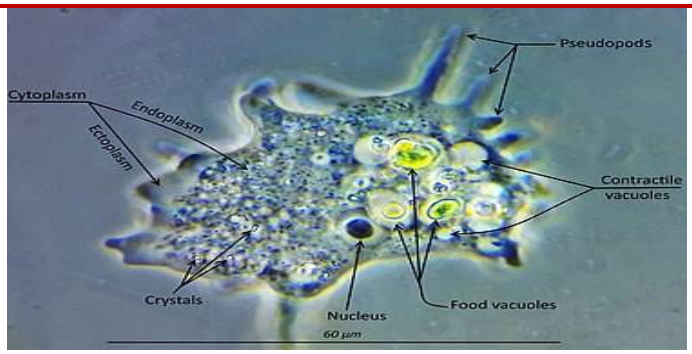
Amoeboid



Amoeba proteus

Kingdom	**Protozoa**
Domain:	**Eukaryota**
Phylum:	**Amoebozoa**
Class:	**Tubulinea**
Order:	**Euamoebida**
Family:	**Amoebidae**
Genus:	***Amoeba*** **Bory de Saint-Vincent, 1822**[1]
Species	
• ***Amoeba agilis*** **Kirk, 1907** • ***Amoeba gorgonia*** **Pen.** • ***Amoeba limicola*** **Rhumb.** • ***Amoeba proteus*** **Pal.** • ***Amoeba vespertilio*** **Pen.**	

- Amoeba or ameba also often called amoeboid,
- Amoeba is a type of cell or unicellular organism
- Best known amoeboid protists are Chaos carolinense ...



Morphology of a naked amoeba in the genus Mayorella

a)	Decision-making without a brain: how an amoeboid organism solves the two-armed bandit	Title
	J. R. Soc. Interface, (2016), http://dx.doi.org/10.1098/rsif.2016.0030	Journal
	Chris R. Reid, Hannelore MacDonald, Richard P. Mann, James A. R. Marshall, Tanya Latty and Simon Garnier	Author(s)
b)	Solving 0-1 knapsack problems based on amoeboid organism algorithm	Title
	Applied Mathematics and Computation, 219 (2013) 9959–9970, http://dx.doi.org/10.1016/j.amc.2013.04.023	Journal
	Xiaoge Zhang, Shiyan Huang, Yong Hu, Yajuan Zhang, Sankaran Mahadevan, Yong Deng	Author(s)

..... Bacteria.....

a)	A New Evolutionary Algorithm Based on Bacterial Evolution and Its Application for Scheduling a Flexible Manufacturing System	Title
	Jurnal Teknik Industri, Vol. 14, No. 1, (2012), 1-12	Journal
	ChandramouliAnandaraman, Arun Vikram Madurai Sankar, Ramaraj Natarajan	Author(s)
b)	Bacteria Inspired Algorithms	Title
	Innovative Computational Intelligence: A Rough Guide to 134 Clever Algorithms, Intelligent Systems Reference Library 62, DOI: 10.1007/978-3-319-03404-1_2	Journal
	B. Xing and W.J. Gao	Author(s)

..... Parasitism.....

a)	Parasitism – Predation algorithm (PPA): A novel approach for feature selection	Title
	Ain Shams Engineering Journal (2019), https://doi.org/10.1016/j.asej.2019.10.004	Journal
	Al-Attar A. Mohamed, S.A. Hassan, A.M. Hemeida, Salem Alkhalaf, M.M.M. Mahmoud, Ayman M. Baha Eldin	Author(s)

.....Flies .....

- Bees
- Beetle
- Butter fly
- Firefly
- Bumble bee
- Ants
- Fruitfly
- Dragon fly
- Glow warm
- Drosophila
- Honey bee
- Water strider

- Bug
- Wasp
- Locust
- Ant colony
- Termite
- Cockroach

KB

All bugs are insects;	But All insects are not bugs
Ants are not flies	But flying ants are there

..... Butterfly..... opt

Red Admiral. Its wingspan is about 60 mm

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Suborder:	Rhopalocera
	Butterfly

Male Orange Tip butterfly

A Large White (Pieris brassicae) with spread wings

- Butterflies are insects in the macrolepidopteran clade Rhopalocera from the order Lepidoptera, which also includes moths
- Adult butterflies have large, often brightly coloured wings, and conspicuous, fluttering flight
- Butterfly fossils date to the Paleocene, about 56 million years ago.

a)	A hybridization of Differential Evolution and Monarch Butterflyptimization for Solving Systems of Nonlinear Equations	Title
	Journal of Computational Design and Engineering (2018), https://doi.org/10.1016/j.jcde.2018.10.006	Journal
	A.M. Ibrahim, M.A. Tawhid,	Author(s)
b)	HybridizedMonarch Butterfly Algorithm for Global Optimization Problems	Title
	International Journal of Computers, Volume 3, (2018).	Journal
	Ivana Strumberger, Marko Sarac, Dusan Markovic, Nebojsa Bacanin	Author(s)
c)	A Novel Binary Butterfly Mating Optimization Algorithm with Subarray Strategy for Thinning of Large Antenna Array	Title
	Progress In Electromagnetics Research M, Vol. 60, (2017), 101–110.	Journal
	Hua-Ning Wu, Chao Liu, Bin Li*, and Xu Xie	Author(s)

d)	Chaotic Adaptive Butterfly Mating Optimization and Its Applications in Synthesis and Structure Optimization of Antenna Arrays	Title
	International Journal of Antennas and Propagation (2019), Article ID 1730868, https://doi.org/10.1155/2019/1730868	Journal
	Bin Li, Chao Liu, Huaning Wu, Yifeng Zhao and Yinghui Dong	Author(s)
e)	An Improved Adaptive-step Butterfly Mating Optimization Algorithm	Title
	2017, 3rd IEEE International Conference on Computer and Communications	Journal
	Yi-lei Yang, Chao Liu, Hua-ning Wu	Author(s)
f)	Improving monarch butterfly optimization through simulated annealing strategy	Title
	Journal of Ambient Intelligence and Humanized Computing (2020) https://doi.org/10.1007/s12652-020-01702-y	Journal
	DongfangYang, Xitong Wang, Xin Tian, Yonggang Zhang	Author(s)

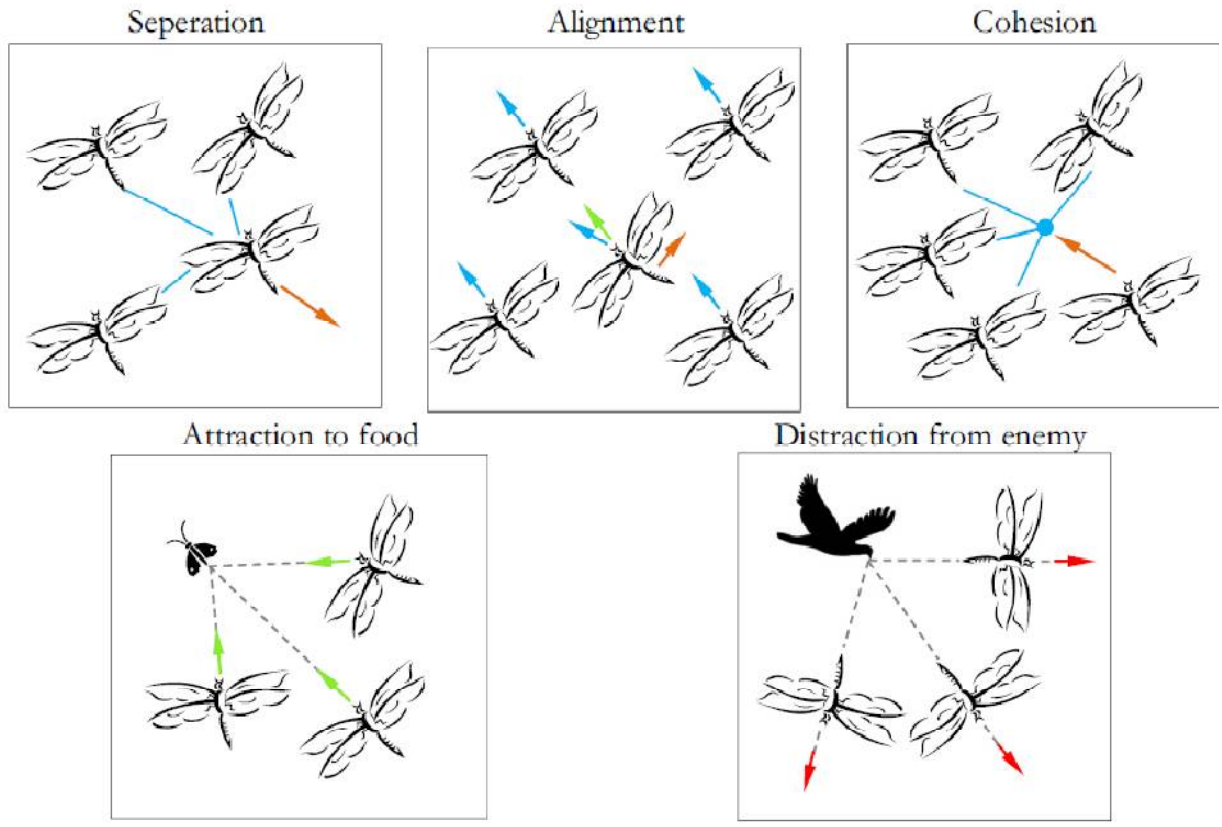
g)	Butterfly Mating Optimization	Title
	Intelligent Systems Technologies and Applications, Advances in Intelligent Systems and Computing 384, (2016), DOI: 10.1007/978-3-319-23036-8_1	Journal
	Chakravarthi Jada, Anil Kumar Vadathya, Anjumara Shaik, Sowmya Charugundla, Parabhaker Reddy Ravula and Kranthi Kumar Rachavarapu	Author(s)
h)	Improving Monarch Butterfly Optimization Algorithm with Self-Adaptive Population	Title
	Algorithms (2018), 11, 71; doi:10.3390/a11050071	Journal
	Hui Hu, ZhaoquanCai , Song Hu, Yingxue Cai, Jia Chen and Sibo Huang	Author(s)

i)	HybridButterfly Based Particle Swarm Optimization for Optimization Problems	Title
	2014, First International Conference on Networks & Soft Computing, DOI: 10.1109/CNSC.2014.6906650	Journal
	Aashish Kumar Bohre, Dr. Ganga Agnihotri, Dr. Manisha Dubey	Author(s)
j)	Butterfly Optimizer	Title
	Conference Paper · December 2015, DOI: 10.1109/WCI.2015.7495523	Journal
	Abhishek Kumar, Rakesh Kumar Misra, Devender Singh	Author(s)

k)	Binary butterfly optimization approaches for feature selection	Title
	Expert Systems With Applications 116 (2019) 147–160, https://doi.org/10.1016/j.eswa.2018.08.051	Journal
	Sankalap Arora, Priyanka Anand	Author(s)
l)	An improved butterfly optimization algorithm with chaos	Title
	Journal of Intelligent & Fuzzy Systems, 32 (2017) 1079–1088, DOI:10.3233/JIFS-16798	Journal
	Sankalap Arora and Satvir Singh	Author(s)

m)	Butterfly optimization algorithm: a novel approach for global optimization	Title
	Soft Computing (2018), https://doi.org/10.1007/s00500-018-3102-4	Journal
	Sankalap Arora, Satvir Singh	Author(s)
n)	Multi-strategy monarch butterfly optimization algorithm for discounted {0-1} knapsack problem	Title
	Neural Comput&Applic (2017), DOI 10.1007/s00521-017-2903-1	Journal
	YanhongFeng, Gai-Ge Wang, Wenbin Li, Ning Li	Author(s)
o)	A new meta-heuristic butterfly-inspired algorithm	Title
	Journal of Computational Science (2017), http://dx.doi.org/10.1016/j.jocs.2017.06.003	Journal
	Xiangbo Qi, Yunlong Zhu, Hao Zhang	Author(s)

……. Dragonfly……



Primitive corrective patterns between individuals in a swarm

..... Mayfly.....

March brown mayfly

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Subclass:	Pterygota
Division:	Palaeoptera
Superorder:	Ephemero-pteroidea Rohdendorf, 1968
Order:	Ephemeroptera

A mayfly in Kanjirappally, Kerala, India

Mayflies (known locally as shadflies) swarm briefly in enormous numbers in Ontario.

Couple of mayflies mating after forced copula

a)	A mayfly optimization algorithm	Title
	Computers & Industrial Engineering,2020; doi.org/10.1016/j.cie.2020.106559	Journal
	Konstantinos Zervoudakis, Stelios Tsafarakis	Author(s)

..... Locust. .....

Locust

Desert locust

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Orthoptera
Suborder:	Caelifera
Family:	Acrididae
Subfamily:	Cyrtacanthacridinae
Tribe:	Cyrtacanthacridini
Genus:	Schistocerca
Species:	**S. gregaria**
	Desert locust

Millions of swarming Australian plague locusts on the move

Desert locusts preparatory to mating, London Zoo

- Locusts (meaning grasshopper) are a collection of certain species of short-horned grasshoppers in the family Acrididae that have a swarming phase

Locusts are grasshoppers and entered into a migratory phase of their life.

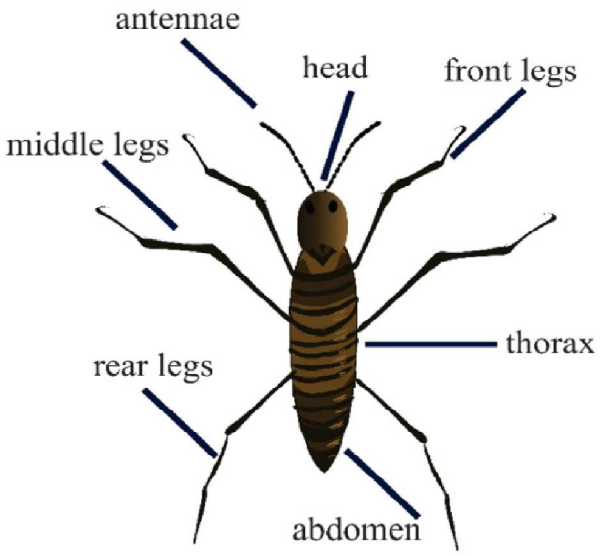
a)	Ls-II: An Improved Locust Search Algorithm for Solving Optimization Problems	Title
	Mathematical Problems in Engineering (2018), Article ID 4148975, https://doi.org/10.1155/2018/4148975	Journal
	Octavio Camarena, Erik Cuevas, MarcoPérez-Cisneros, Fernando Fausto, Adrián González and Arturo Valdivia	Author(s)

……. water strider…… opt

water strider

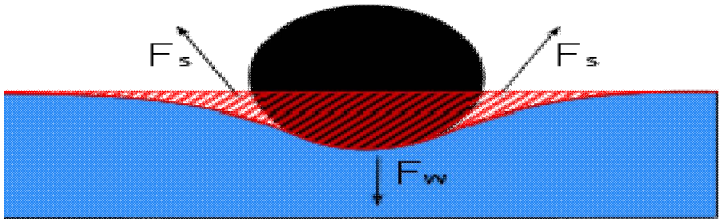
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hemiptera
Superfamily:	Gerroidea
Family:	Gerridae

☞ Hemiptera, commonly known as water striders, water skeeters, water scooters, water bugs, pond skaters, water skippers, Jesus bugs, or water skimmers



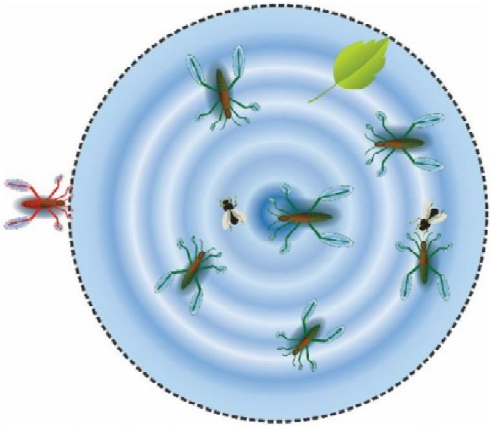
water strider (bug) anatomy

Water striders' leg impact on water surface

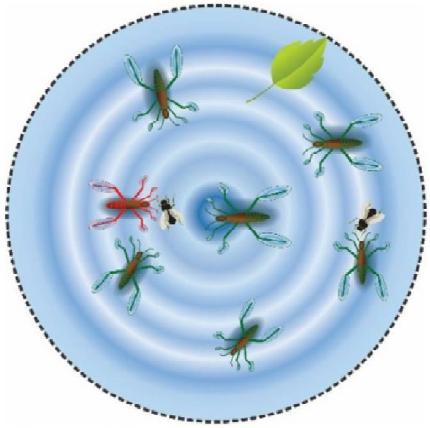


Buoyancy due to surface tension

- ☞ Water striders are able to walk on top of water due to a combination of several factors.
- ☞ Water striders use the high surface tension of water and long, hydrophobic legs to help them stay above water.
  - o Legs of a water strider are long and slender→allowing the weight of the water strider body to be distributed over a large surface area.
  - o Legs are strong, but have flexibility that allows the water striders to keep their weight evenly distributed and also flow with the water movement
  - o Hydrofuge hairs line the body surface of the water strider.



(a). Foraging for food if the new position is not enough rich

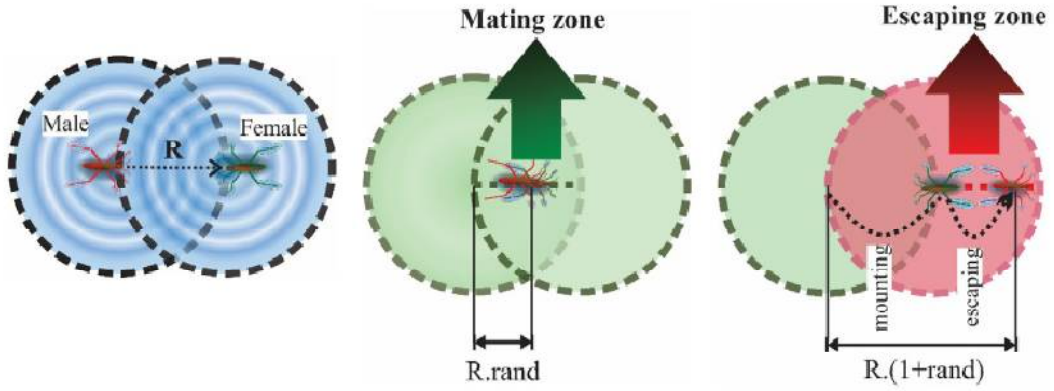


(b). Moved toward the best strider

Foraging process after that the water strider could not find enough food in the new position after mating behavior

A group of water striders devouring a honey bee

The ripple communication between two water striders

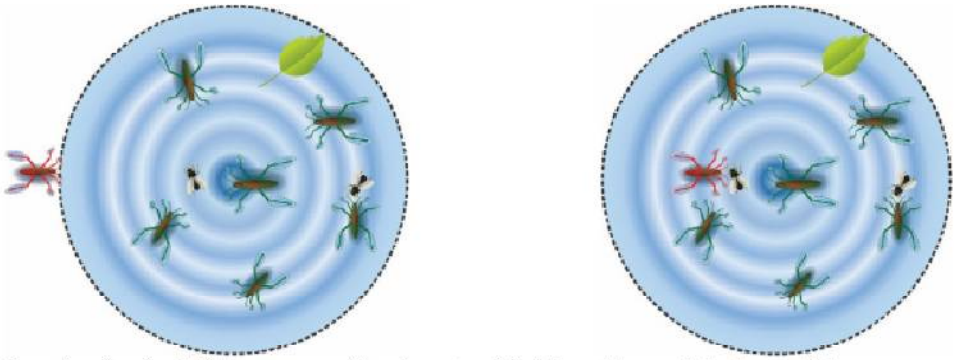


(a). The signal exchange between male and female WSs for mating

(b). Successful mating of WSs after attraction

(c). Unsuccessful mating of WSs consisting of mating and escaping levels

Mating behavior of water striders and position updating



(a). Foraging for food if the new position is not enough rich

(b). Moved toward the best strider

3333333

Water striders using surface tension when mating

Mating-

- ☞ Sex discrimination in Gerridae is determined through communication of ripple frequency produced on the water surface. Males predominantly produce these ripples in the water.
- ☞ There are three main frequencies found in ripple communication: 25 Hz as a repel signal, 10 Hz as a threat signal, and 3 Hz as a courtship signal
- ☞ An approaching gerrid will first give out a repel signal to let the other water strider know they are in its area. If the other gerrid does not return the repel signal, then the bug knows it is a female and will switch to the courtship signal.
- 🕮 A receptive female will lower her abdomen and allow the male to mount her and mate.
- 🕮 A non-receptive female will raise her abdomen and emit a repel signal
- 🕮 Males that are allowed to mate stay attached to the same female for the entire reproductive season. This is to ensure that the female's young belong to the mounting male and thus guarantee the spread of his genes.
- o Females oviposit, or lay their eggs, by submerging and attaching the eggs to stable surfaces such as plants or stones

a)	Water strider algorithm: A new metaheuristic and applications Structures, 25 (2020) 520–541. doi.org/10.1016/j.istruc.2020.03.033 A. Kaveh, A. DadrasEslamlou

……. Fire fly…… opt

Kingdom:	**Animalia**
Phylum:	**Arthropoda**

Class:	Insecta
Order:	Coleoptera
Suborder:	Polyphaga
Infraorder:	Elateriformia
Superfamily:	Elateroidea
Family:	Lampyrida
	Firefly

Firefly (Photurislucicrescens)

Fireflies in Georgia, U.S., 8-second exposure

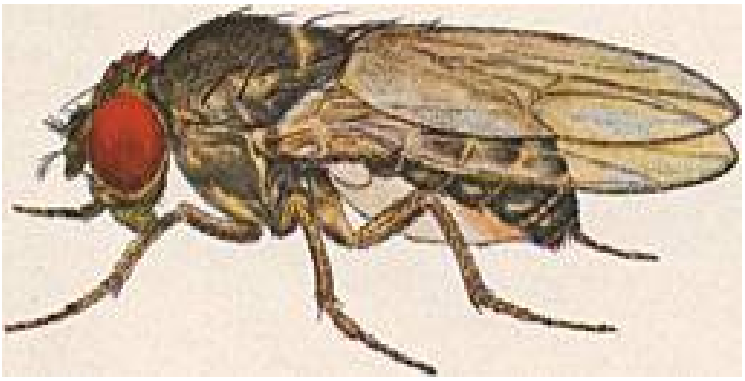
Fireflies in the woods near Nuremberg, Germany, exposure time 30 seconds

Firefly female

Photuris firefly captured in eastern Canada–the top picture is taken with a flash, the bottom with only the self-emitted light

a)	Remit Accretion in IOT Networks Encircling Ingenious Firefly Algorithm Correlating Water Drop Algorithm	Title
	Procedia Computer Science 167 (2020) 551–561, DOI: 10.1016/j.procs.2020.03.316	Journal
	Neha Sharma, Usha Batra, Sherin Zafar	Author(s)
b)	Improving K-means clustering with enhanced Firefly Algorithms	Title
	Applied Soft Computing Journal 84 (2019) 105763, https://doi.org/10.1016/j.asoc.2019.105763	Journal
	HailunXie, Li Zhang, Chee Peng Lim, Yonghong Yu, Chengyu Liu, Han Liu, Julie Walters	Author(s)

……. Drosophila……



Drosophila pseudoobscura is a species of fruit fly, used extensively in lab studies of speciation. It is native to western

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Diptera
Family:	Drosophilidae
Subfamily:	Drosophilinae
Genus:	***Drosophila***

North America

Drosophila

Adult D. melanogaster

- Drosophila is a genus of flies, belonging to the family Drosophilidae.
- The members are often called "small fruit flies" or (less frequently) pomace flies, vinegar flies, or wine flies
- Characteristic of many species to linger around overripe or rotting fruit.
- One species of Drosophila in particular, D. melanogaster, has been heavily used in research in genetics
- It is a common model organism in developmental biology
- The terms "fruit fly" and "Drosophila" are often used synonymously with D. melanogaster in modern biological literature

a)	Drosophila-inspired 3D moving object detection based on point clouds	Title
	Information Sciences, 534 (2020) 154–171, https://doi.org/10.1016/j.ins.2020.05.006	Journal
	Li Wang, Dawei Zhao, Tao Wu, Hao Fu, Zhiyu Wang, Liang Xiao, Xin Xu, Bin Dai	Author(s)

……. Fruitfly……

a)	A new improved fruit fly optimization algorithm IAFOA and its application to solve engineering optimization problems	Title
	Knowledge-Based Systems (2017), doi: 10.1016/j.knosys.2017.12.031	Journal
	Lei Wu, Qi Liu, Xue Tian, Jixu Zhang, Wensheng Xiao	Author(s)

……. Honey bees…..... opt

inspired from

- Foraging behavior, communication, defense of honeybees
- Foraging Honey bee dance
- Honey bee mating
- Hive selection
- Mutable smart bee Instead of classical bees
- search equation of onlooker bee

☞ Queens set is constructed to maintain the non-dominated solutions

a)	Genetic Bee Colony (GBC) algorithm: A new gene selection method for microarray cancer classification	Title
	Computational Biology and Chemistry 56 (2015) 49–60, http://dx.doi.org/10.1016/j.compbiolchem.2015.03.001	Journal
	Hala M. Alshamlan, Ghada H. Badr, Yousef A. Alohali	Author(s)
b)	A Novel Global Convergence Algorithm: Bee Collecting Pollen Algorithm	Title
	ICIC 2008, LNAI 5227, (2008), 518–525.	Journal
	Xueyan Lu and Yongquan Zhou	Author(s)
c)	Bee Foraging Algorithm Based Multi-Level Thresholding for Image Segmentation	Title
	IEEE Access, (2020), DOI: 10.1109/ACCESS.2020.2966665	Journal
	ZHICHENG ZHANG AND JIANQIN YIN	Author(s)
d)	Bee-Inspired Algorithms Applied to Vehicle Routing Problems: A Survey and a Proposal	Title
	Mathematical Problems in Engineering (2017), https://doi.org/10.1155/2017/3046830	Journal
	Thiago A. S. Masutti and Leandro N. de Castro	Author(s)

e)	Chapter 4 Bee Inspired Algorithms	Title
	Innovative Computational Intelligence, (2014), DOI: 10.1007/978-3-319-03404-1_4	Journal
	B. Xing and W.J. Gao	Author(s)
f)	A genetic Artificial Bee Colony algorithm for signal reconstruction based big data optimization	Title
	Applied Soft Computing Journal, 88 (2020) 106053, https://doi.org/10.1016/j.asoc.2019.106053	Journal
	Selcuk Aslan, DervisKaraboga	Author(s)
g)	Multiobjective Optimization of Irreversible Thermal Engine Using Mutable Smart Bee Algorithm	Title
	Applied Computational Intelligence and Soft Computing (2012), doi:10.1155/2012/652391	Journal
	M. Gorji-Bandpy and A.Mozaffari	Author(s)

h)	Discrete honey bees mating optimization (DHBMO) for solving environmental optimization problem using single and multi-objectives optimization	Title
	IOP Conf. Series: Earth and Environmental Science 230 (2019) 012010, doi:10.1088/1755-1315/230/1/012010	Journal
	Y Hendrawan, M R Fauzy and C Umam	Author(s)
i)	Natural selection methods for artificial bee colony with new versions of onlooker bee	Title
	Soft Computing (2018), https://doi.org/10.1007/s00500-018-3299-2	Journal
	Mohammed A. Awadallah, Mohammed Azmi Al-Betar, AsajuLaaro Bolaji, Emad Mahmoud Alsukhni, Hassan Al-Zoubi	Author(s)

j)	Modified honey bees mating optimization algorithm for multiobjective uncertain integrated process planning and scheduling problem	Title
	International Journal of Advanced Robotic Systems (2020) 1–17, DOI: 10.1177/1729881420925236	Journal
	Xiaoyu Wen, Xinyu Li, Liang Gao, Kanghong Wang and Hao Li	Author(s)
k)	An Adaptive Multi-populationArtificial Bee Colony Algorithm for Dynamic Optimisation Problems	Title
	Knowledge-Based Systems (2016), doi: 10.1016/j.knosys.2016.04.005	Journal
	Shams K. Nseef, Salwani Abdullah, Ayad Turky, Graham Kendall	Author(s)

l)	An Adaptive Bumble Bees Mating Optimization Algorithm	Title
	Applied Soft Computing Journal, (2017), http://dx.doi.org/10.1016/j.asoc.2017.01.032	Journal
	Yannis Marinakis, Magdalene Marinaki, Athanasios Migdalas	Author(s)

……. Bees + NN…….

a)	Ensemble mutablesmart bee algorithm and a robust neural identifier for optimal design of a large scale power system	Title
	Journal of Computational Science, 5 (2014) 206–223, http://dx.doi.org/10.1016/j.jocs.2013.10.007	Journal
	Ahmad Mozaffari, Mohammadreza Azimi, MofidGorji-Bandpy	Author(s)

b)	Machine learning for medical diagnosis: A neural network classifier optimized via the directed bee colony optimization algorithm	Title
	Chapter 9, https://doi.org/10.1016/B978-0-12-815370-3.00009-8	Journal
	SaurabhKumar Agrawal, BhanuPratap Singh, Rajesh Kumar, Nilanjan Dey	Author(s)

……. Glow worm……. opt

a)	Glowwormswarm optimization algorithm for solving multi-objective optimization problem	Title
	2013 Ninth International Conference on Computational Intelligence and Security, IEEE, DOI 10.1109/CIS.2013.10	Journal
	HE Deng-xu Liu Gui-qing, ZHU Hua-zheng	Author(s)
b)	Glowworm Swarm Optimization: Algorithm Development	Title
	Glowworm Swarm Optimization, Studies in Computational Intelligence (2017), 698, DOI 10.1007/978-3-319-51595-3_2	Journal
	K.N. Kaipa and D. Ghose,	Author(s)

c)	Dynamic global maximum power point tracking of the PV systems under variant partial shading using hybridGWO-FLC	Title
	Solar Energy 177 (2019) 306–316, https://doi.org/10.1016/j.solener.2018.11.028	Journal
	Ali M. Eltamaly, Hassan M.H. Farh	Author(s)
d)	Dispersive Flies Optimisation	Title

	Proceedings of the 2014 Federated Conference on Computer Science and Information Systems pp. 529–538, DOI: 10.15439/2014F142	Journal
	Mohammad Majid al-Rifaie	Author(s)

..... Termite colony.....

Termite mound in Namibia

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Cohort:	Polyneoptera
Superorder:	Dictyoptera
Order:	Blattodea
Infraorder:	Isoptera Brullé, 1832

Families

† Cratomastotermitidae
Mastotermitidae
† Termopsidae
Archotermopsidae

Nasute termite soldiers on rotten wood

Mounds of "compass" or "magnetic" termites (Amitermes) oriented north-south, thereby avoiding mid-day heat

a)	Termite Colony Optimization: A Novel Approach for Optimizing Continuous Problems	Title
	Proceedings of ICEE (2010)	Journal
	RaminHedayatzadeh, FoadAkhavanSalmassi, Manijeh Keshtgari, Reza Akbari, KoorushZiarati	Author(s)

b)	Optimal Coverage of Wireless Sensor Network using Termite Colony Optimization Algorithm	Title
	2nd Int'I Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT) (2015)	Journal
	Pronaya Pros un Das, Nirjhar Chakraborty, Shaikh Muhammad Allayear	Author(s)

Ant colony

Ant bridge

Kingdom:	**Animalia**
Phylum:	**Arthropoda**
Class:	**Insecta**
Order:	**Hymenoptera**
Infraorder:	**Aculeata**
Superfamily:	**Formicoidea**
Family:	**Formicidae**

- Ants are not flies; flying ants are there
- Lifespan: Black garden ant: 15 years, Pharaoh ant: 4 – 12 months
  Length: Carpenter ant: 0.64 – 2.5 cm, Black garden ant: 0.5 – 0.7 cm, Pharaoh ant: 0.2 cm

a)	Ant colony optimization theory: A survey	Title
	Theoretical Computer Science, 344 (2005) 243 – 278, doi:10.1016/j.tcs.2005.05.020	Journal
	Marco Dorigo, Christian Blum	Author(s)

b)	Ant Colony Optimization Artificial Ants as a Computational Intelligence Technique	Title
	IEEE COMPUTATIONAL INTELLIGENCE MAGAZINE, (2006) 28-39.	Journal
	Marco Dorigo, Mauro Birattari, and Thomas St¨utzle	Author(s)
c)	Ant Colony Optimization: A New Meta-Heuristic	Title
	Evolutionary Computation (1999). CEC 99. Proceedings of the 1999 Congress on, Volume: 2, DOI: 10.1109/CEC.1999.782657	Journal
	Marco Dorigo, Gianni Di Caro	Author(s)
d)	A4SDN - Adaptive Alienated Ant Algorithm for Software-Defined Networking	Title
	10th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, (2015), DOI 10.1109/3PGCIC.2015.120	Journal
	Antonella Di Stefano, Giovanni Cammarata, Giovanni Morana,Daniele Zito	Author(s)
e)	Ant Colony Optimization: A Tutorial Review	Title
	Conference Paper (2015)	Journal
	Sapna Katiyar, Ibraheem, Abdul Quaiyum Ansari	Author(s)

Ant virtual **opt**

inspired from

- Simulating the swarm interactions of social ants +nonlinear Finite Element analysis
- Used virtual ant algorithm to solve the function optimizations without knowing the shape of the fitness function

a)	Application of Virtual Ant Algorithms in the Optimization of CFRP Shear Strengthened Precracked Structures	Title
	ICCS 2006, Part I, LNCS 3991, (2006), 834–837	Journal
	Xin-She Yang, Janet M. Lees, and Chris T. Morley	Author(s)
b)	Ant colony optimization based modified termite algorithm (mta) with efficient stagnation.Avoidance strategy for manets	Title
	International journal on applications of graph theory in wireless ad hoc networks and sensor networks (GRAPH-HOC) Vol.4, No.2/3, (2012), DOI : 10.5121/jgraphoc.2012.4204	Journal
	Sharvani G S, Dr. A G Ananth and Dr T M Rangaswamy	Author(s)

..... Cockroach.....

Scientific classification
Cockroach

Kingdom:	Animalia
Phylum:	Arthropoda

Class:	Insecta
Superorder:	Dictyoptera
Order:	Blattodea

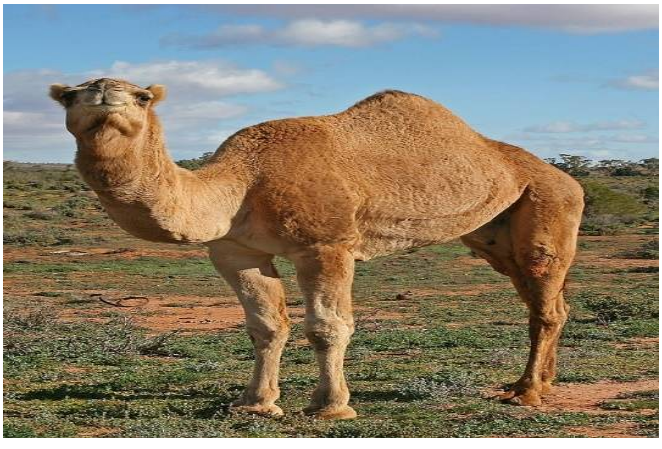
a)	Cockroach Swarm Optimization Algorithm for TSP	Title
	Advanced Engineering Forum Vol 1 (2011) 226-229, doi:10.4028/www.scientific.net/AEF.1.226	Journal
	Le Cheng, Zhibo Wang, Song Yanhong, Aihua Guo	Author(s)

Terrestrial Animals

- Camel
- Chicken
- Cat
- Lizard
- Parasitism
- Amoeboid
- **Bison**
- **Monkey king**
- **Monkey**
- Coyote
- Squirrel
- Earthworm
- Bacteria
- Grater Snake

……. Camel……. opt

Camel



Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Artiodactyla
Family:	Camelidae
Tribe:	Camelini
Genus:	*Camelus*

Camels in the Gueltad' Archei, in northeastern Chad

A shaggy two-humped camel

A camel's thick coat is one of its many adaptations that aid it in desert-like conditions.

a)	A Modified Camel Traveling Behaviour Algorithm for Engineering applications	Title
	Australian Journal of Electrical and Electronics Engineering, (2019) DOI: 10.1080/1448837X.2019.1640010	Journal
	Ramzy S. Ali, Falih M. Alnahwi and Abdulkareem S. Abdullah	Author(s)
b)	Hybrid based Energy Efficient Cluster Head Selection using Camel Series Elephant Herding Optimization Algorithm in WSN	Title
	(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 11, No. 5, (2020).	Journal
	N. Lavanya, T. Shankar	Author(s)
c)	Camel Herds Algorithm: a New Swarm Intelligent Algorithm to solve optimization problems	Title
	International Journal on Perceptive and Cognitive Computing, Vol 3, Issue 1(2017)	Journal
	Prof.Dr.AhmedT.Sadlq Al-Obaldl, Dr.HasanenS.Abdullah, ZledO.Ahmed	Author(s)

d)	Novel Optimization Algorithm Inspired by Camel Traveling Behavior	Title
	Iraq J. Electrical and Electronic Engineering, Vol.12 No.2, (2016)	Journal
	Mohammed Khalid Ibrahim, Ramzy Salim Ali	Author(s)
e)	A modified camel travelling behaviour algorithm for engineering applications	Title
	Australian Journal Of Electrical And Electronics Engineering (2019), https://doi.org/10.1080/1448837X.2019.1640010	Journal
	Ramzy S. Ali, Falih M. Alnahwi&Abdulkareem S. Abdullah	Author(s)

……. Bison…….. opt

inspired from

- Swarming movement of endangered bison herds
- When endangered by predators, bisons form a circle, with the outline of the strongest individuals, protecting the calves and the weak ones inside

a)	New Running Technique for the Bison Algorithm	Title
	ICAISC 2018, LNAI 10841, (2018), 417–426, https://doi.org/10.1007/978-3-319-91253-0_39	Journal
	Anezka Kazikova, Michal Pluhacek, Adam Viktorin, and Roman Senkerik	Author(s)
b)	Performance of the Bison Algorithm on Benchmark IEEE CEC 2017	Title
	CSOC 2018, AISC 764, (2019), 445–454, https://doi.org/10.1007/978-3-319-91189-2_44	Journal
	Anezka Kazikova, Michal Pluhacek, and Roman Senkerik	Author(s)
c)	Tuning of the bison algorithm control parameters	Title
	Proceedings 32nd European Conference on Modelling and Simulation ©ECMS Lars Nolle, Alexandra Burger, Christoph Tholen, Jens Werner, Jens Wellhausen (Editors) ISBN: 978-0-9932440-6-3/ ISBN: 978-0-9932440-7-0 (CD)	Journal
	Anezka Kazikova, Michal Pluhacek and Roman Senkerik	Author(s)
d)	Border strategies of the bison algorithm	Title
	Communications of the ECMS, Volume 33, Issue 1, Proceedings, ©ECMS Mauro Iacono, Francesco Palmieri, Marco Gribaudo, Massimo Ficco (Editors) ISBN: 978-3-937436-65-4/978-3-937436-66-1(CD) ISSN 2522-2414	Journal
	Anezka Kazikova, Zuzana KominkovaOplatkova, Michal Pluhacek and Roman Senkerik	Author(s)
e)	Regarding the behavior of bison runners within the bison algorithm	Title
	MENDEL-Soft Computing Journal, Volume 24, No.1, (2018), Brno, Czech RepublicX	Journal
	Anezka Kazikova, Michal Pluhacek, Roman Senkerik	Author(s)

……. Chicken……..

Chicken

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Galliformes
Family:	Phasianidae
Genus:	*Gallus*
Species:	*G. gallus*
Subspecies:	**G. g. domesticus**
Trinomial name	
Gallus gallusdomesticus	

Hen with chicks, India.

Hen with chicks, Portugal

Mating involves sequence

a) Male approaching the hen
b) Male pre-copulatory waltzing (Courting)
c) Male waltzing.
d) Female
e) Crouching (receptive posture) ; she responds to his "call"
f) Stepping aside or running away (if unwilling to copulate)
g) Mating

📖 **Courting:** To initiate some roosters may dance in a circle around or near a hen ("a circle dance"), often lowering the wing which is closest to the hen

📖 Mating
- Male mounting
- Male treading with both feet on hen's back. Male tail bending;
- following successful copulation

a)	A New Bio-inspired Algorithm: Chicken Swarm Optimization	Title
	ICSI 2014, Part I, LNCS 8794, (2014), 86–94.	Journal
	Xianbing Meng, Yu Liu, Xiaozhi Gao and Hengzhen Zhang	Author(s)

……. Monkey king…… opt

a)	Monkey King Evolution: an enhanced ebb-tide-fish algorithm for global optimization and its application in vehicle navigation under wireless sensor network environment	Title
	TelecommunSyst (2016), DOI 10.1007/s11235-016-0237-4	Journal
	Jeng-ShyangPan, Zhenyu Meng, Shu-Chuan Chu, Hua-Rong Xu	Author(s)

……. Monkey….. opt

a)	Monkey search: a novel metaheuristic search for global optimization	Title
	Data Mining, Systems Analysis, and Optimization in Biomedicine, AIP Conf. Proc. 953, 162 (2007); doi: 10.1063/1.2817338	Journal
	Antonio Mucherino and OnurSeref	Author(s)

……. Cat…… opt

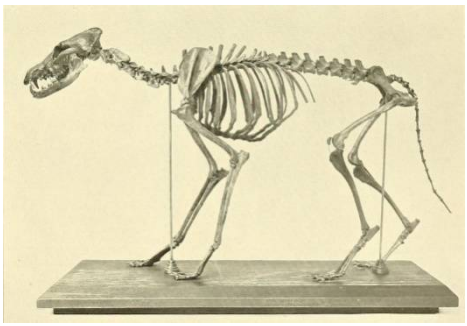
a)	Gaussian cat swarm optimisation algorithm based on Monte Carlo method for data clustering	Title
	Int. J. Computational Science and Engineering, Vol. 14, No. 2, (2017), DOI: 10.1504/IJCSE.2017.082883	Journal
	Yugal Kumar and Gadadhar Sahoo	Author(s)
b)	A neighborhood search based cat swarm optimization algorithm for clustering problems	Title
	Evolutionary Intelligence (2020), https://doi.org/10.1007/s12065-020-00373-0	Journal
	Hakam Singh, Yugal Kumar	Author(s)

……..Coyote…… Opt.

coyote (Canis latrans)

Mountain coyote (C. l. lestes)

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Carnivora
Family:	Canidae
Genus:	*Canis*
Species:	***C. latrans***
Binomial name	
Canis latrans	



Skeleton of Pleistocene coyote (C. l. orcutti)

- Coyote (Canis latrans) is a species of canine native to North America.
- Smaller than its close relative, the wolf
- Slightly smaller than the closely related eastern wolf and red wolf

a)	Binary Coyote Optimization Algorithm For Feature Selection	Title
	Pattern Recognition (2020), https://doi.org/10.1016/j.patcog.2020.107470	Journal

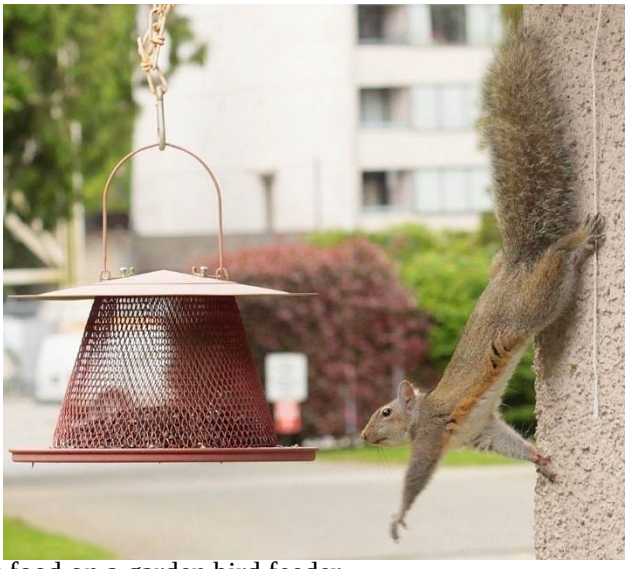
	Rodrigo Clemente Thom de Souza, Camila Andrade de Macedo, Leandro dos Santos Coelho, JulianoPierezan, Viviana CoccoMariani	Author(s)

b)	Developed Coyote Optimization Algorithm and its application to optimal parameters estimation of PEMFC model	Title
	Energy Reports, 6 (2020) 1106–1117, https://doi.org/10.1016/j.egyr.2020.04.032	Journal
	Zhi Yuan, Weiqing Wang, Haiyun Wang, Abdullah Yildizbasi	Author(s)

..... Squirrel.....

Squirrel eating a fruit in Manyara National Park, Tanzania

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Rodentia
Suborder:	Sciuromorpha
Family:	Sciuridae
	Squirrel



- Reaching out for food on a garden bird feeder,
- This squirrel can rotate its hind feet, allowing it to descend a tree head-first

☞ Squirrel family includes tree squirrels, ground squirrels, chipmunks, marmots (including groundhogs), flying squirrels, and prairie dogs amongst other rodents.

- Squirrels mate either once or twice a year; following a gestation period of three to six weeks,give birth to a number of offspring depends on species.
- The young are altricial, being born naked, toothless, and blind.
- In most species of squirrel, the female alone looks after the young, which are weaned at six to ten weeks and become sexually mature by the end of their first year

Altricial species : In altricial species, the young are incapable of moving around on their own soon after hatching or being born

- Indicates the need for young to be fed and taken care of for a long duration
- By contrast, species whose young are immediately or quickly mobile are called precocial
- The word is derived from the Latin root alere, meaning "to nurse, to rear, or to nourish"

A human baby. Humans are among the best-known altricial organisms.

a)	A novel nature-inspired algorithm for optimization: Squirrel search algorithm	Title
	Swarm and Evolutionary Computation (2018) 1–28, https://doi.org/10.1016/j.swevo.2018.02.013	Journal
	Mohit Jain, Vijander Singh, Asha Rani	Author(s)

..... Lizard.....

a)	Side-Blotched Lizard Algorithm: A polymorphic population approach	Title
	Applied Soft Computing Journal (2019), https://doi.org/10.1016/j.asoc.2019.106039.	Journal
	Oscar Maciel C., Erik Cuevas, Mario A. Navarro, Daniel Zaldívar, Salvador Hinojosa	Author(s)

……. Earthworm……..

Earthworm

Kingdom:	Animalia
Phylum:	Annelida
Class:	Clitellata
Subclass:	Oligochaeta
Order:	Opisthopora

Earthworm copulation

Close up of an earthworm in garden soil

a)	Earthworm optimisation algorithm: a bio-inspired metaheuristic algorithm for global optimisation problems	Title
	Int. J. Bio-Inspired Computation, Vol. 12, No. 1, 2018	Journal
	Gai-Ge Wang, Suash Deb, Leandro dos Santos Coelho	Author(s)

……. Grater Snake……

a)	GSO: A New Solution for Solving Unconstrained Optimization Tasks Using Garter Snake's Behavior	Title
	2017 International Conference on Computational Science and Computational Intelligence, IEEE, DOI 10.1109/CSCI.2017.55	Journal
	Maryam Naghdiani , Mohsen Jahanshahi	Author(s)

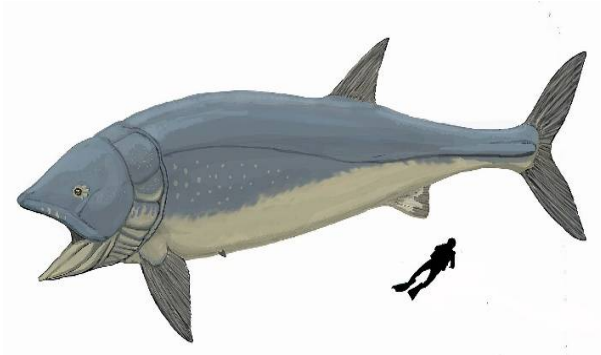
Marine .....

- Dolphine
- Killer whale
- Cuttlefish
- ***Shark***
- ***Krill herd***
- Mussels
- Fish
- ***Mouth Brooding Fish***
- ***Jelly fish***
- ***Sail fish***
- ***Manta ray foraging***
- ***Heron green***

..... Fish..... opt

inspired from
- Fish school behavior in nature

Fish



- Leedsichthys of the subclass Actinopterygii,
- Largest known fish; maximum size at 16 metres

Kingdom:	Animalia
Phylum:	Chordata
***Clade*:**	Olfactores
Subphylum:	Vertebrata

Groups included

Jawless fish
†Armoured **fish**
†Spiny sharks
Cartilaginous fish
Bony fish
Ray-finned fish
Lobe-finned fish

- A relative of the seahorse
- leafy seadragon's appendages
- allow it to camouflage (in the form of crypsis) with the surrounding seaweed.

- Psychedelic mandarin dragonet
- Blue colour←due to cellular pigment

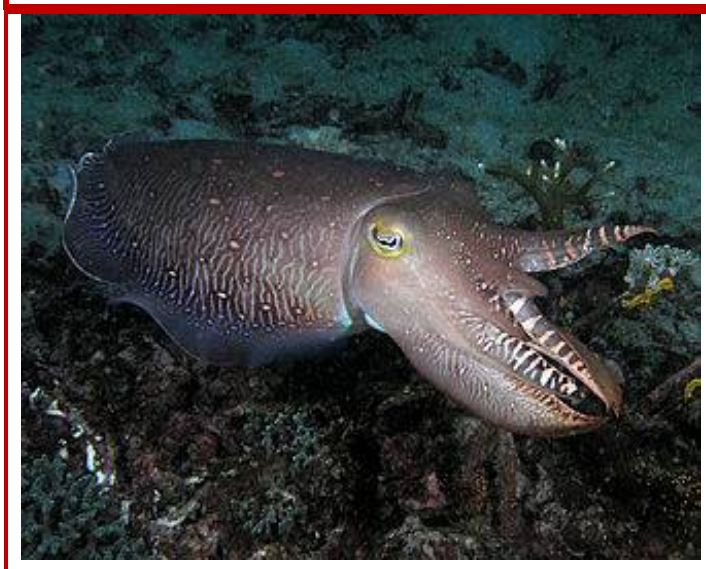
- Gold and fusiliers are schooling because their swimming is synchronised

- Giant grouper swimming among schools of other fish

a)	Chapter 9, Fish Inspired Algorithms	Title
	A Rough Guide to 134 Clever Algorithms, Intelligent Systems Reference Library 62, DOI: 10.1007/978-3-319-03404-1_9,	Journal
	B. Xing and W.J. Gao	Author(s)

b)	Reliability enhancement in radial distribution system using Fish Electrolocation Optimization	Title
	IEEE (2016)	Journal
	Vivekananda Haldar, Niladri Chakraborty	Author(s)
c)	Electric fish optimization: a new heuristic algorithm inspired by electrolocation	Title
	Neural Computing and Applications (2019), https://doi.org/10.1007/s00521-019-04641-8	Journal
	Selim Yilmaz, Sevil Sen	Author(s)

..... Cuttlefish.....



! Giant cuttlefish (Sepia apama)
! Largest cuttlefish species

Kingdom:	Animalia
Phylum:	Mollusca
Class:	Cephalopoda
Superorder:	Decapodiforme
	Cuttlefish

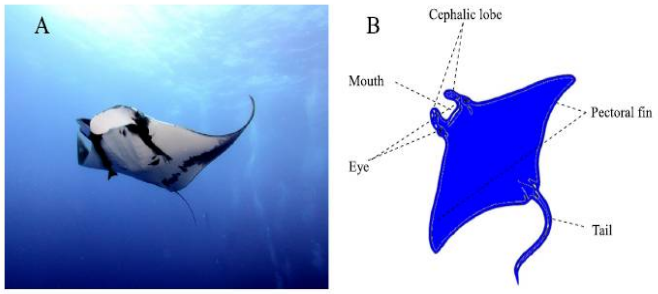
Suborders and families

- Vasseuriina
- Vasseuriidae
- Belosepiellida

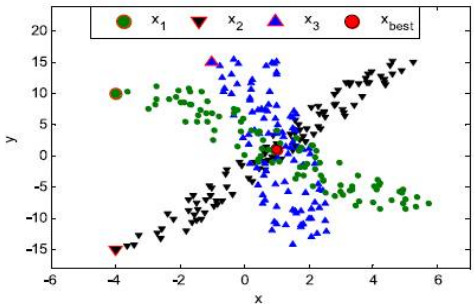
- Cuttlefish or cuttlesare marine molluscs of the order Sepiida.
- They belong to the class Cephalopoda, which also includes squid, octopuses, and nautiluses. Cuttlefish have a unique internal shell, the cuttlebone, which is used for control of buoyancy
- Cuttlefish have large, W-shaped pupils, eight arms; two tentacles furnished with denticulated suckers, with which they secure their prey

a)	A New Tool for Global Optimization Problems-Cuttlefish Algorithm	Title
	International Science, Index Vol:8, No:9, 2014	Journal
	Adel Sabry Eesa, Adnan Mohsin AbdulazeezBrifcani, Zeynep Orman	Author(s)
b)	A novel feature-selection approach based on the cuttlefish optimization algorithm for intrusion detection systems	Title
	Expert Systems with Applications, (2014), http://dx.doi.org/10.1016/j.eswa.2014.11.009	Journal
	Adel Sabry Eesa, Zeynep Orman, Adnan Mohsin AbdulazeezBrifcani	Author(s)
c)	Discrete cuttlefish optimization algorithm to solve the travelling salesman problem	Title
	2015 Third World Conference on Complex Systems (WCCS); DOI: 10.1109/ICoCS.2015.7483231	Journal
	Mohammed EssaidRiffi, MoradBouzidi	Author(s)
d)	A Migration-Based Cuttlefish Algorithm With Short-Term Memory for Optimization Problems	Title
	Access,VOLUME 8, (2020), Digital Object Identifier 10.1109/ACCESS.2020.2986509	Journal
	Muatazsalam al daweri, Salwaniabdullah, and K. A. Zainolariffin	Author(s)

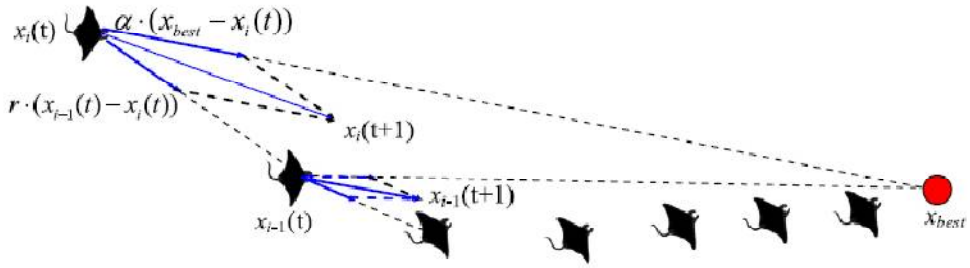
..... manta ray.....



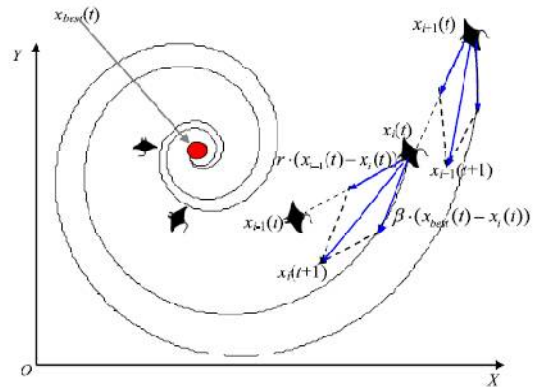
(A) A foraging manta ray, and (B) structure of a manta ray.



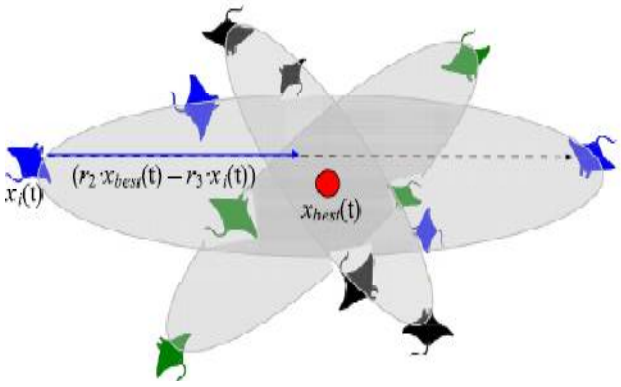
Somersault foraging behavior of three individuals in a 2-D space.



Chain foraging behavior in a 2-D space



Cyclone foraging behavior in a 2-D space.



Somersault foraging behavior in MRFO.

a)	Manta ray foraging optimization: An effective bio-inspired optimizer for engineering applications	Title
	Engineering Applications of Artificial Intelligence 87 (2020) 103300 doi.org/10.1016/j.engappai.2019.103300	Journal
	Weiguo Zhao, Zhenxing Zhang, Liying Wang	Author(s)

..... Sailfish.....

(a) To drive school of smaller fish

(b) To encircle the sardines

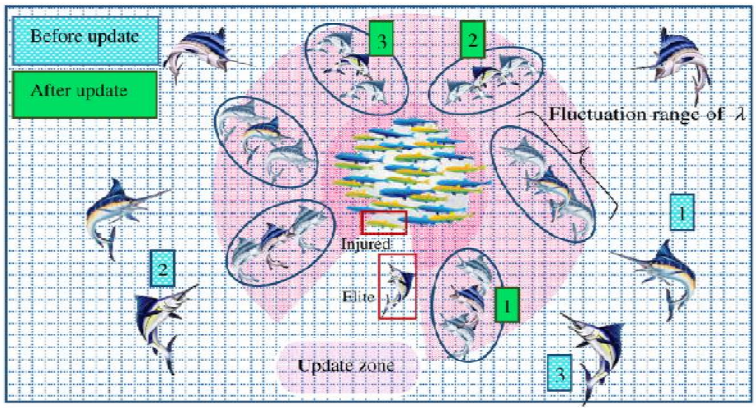
(c) The maneuverability of sardines

(d) To injure the sardine

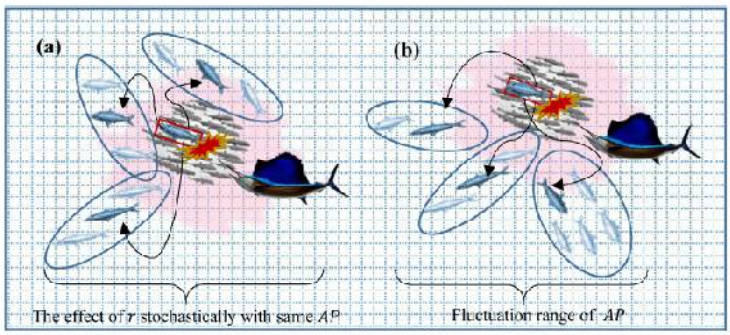
(e) To hunt the sardine

(f) To change their body color

Behavioral state of sailfish's group hunting



Swimming sailfish around the prey school in the search space



Slashing the prey school by sailfish
Update the position of sardines in the search space

a)	The Sailfish Optimizer: A novel nature-inspired metaheuristic algorithm for solving constrained engineering optimization problems	Title
	Engineering Applications of Artificial Intelligence 80 (2019) 20–34	Journal
	Shadravan, H.R. Naji, V.K. Bardsiri	Author(s)

..... Dolphine.....

Dusky dolphin

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Artiodactyla
Infraorder:	Cetacea
Parvorder:	Odontoceti
Family:	Delphinidae
Genus:	*Delphinus* Linnaeus, 1758
Species	
Delphinus capensis *Delphinus delphis*	
dolphin	

Dauphin à long bec (Stenellalongirostris) à la Réunion.

- Dolphin is a common name of aquatic mammals within the infraorder Cetacea.
- Term dolphin refers to the extant families
  - Delphinidae (Oceanic dolphins)
  - Platanistidae (Indian river dolphins)
  - Iniidae (New World river dolphins)
  - Pontoporiidae (brackish dolphins)

Spotted dolphin

Long-beaked common dolphin; Delphinus capensis

Photo of a Chinese white dolphin off the coast of Lantau Island, Hong Kong

Atlantic spotted dolphin (Stenella frontalis) The original NOAA image has been modified by adjusting tone and brightness

a)	Learning From Nature: Bottlenose Dolphin Care and Husbandry	Title
	Zoo Biology, (2009) 28 : 1–17 , DOI 10.1002/zoo.20252	Journal
	Randall S. Wells	Author(s)
b)	Dolphin partner optimization based secure and qualified virtual machine for resource allocation with streamline security analysis	Title
	Peer-to-Peer Networking and Applications (2019), https://doi.org/10.1007/s12083-019-00765-9	Journal
	D. Dhanya& D. Arivudainambi	Author(s)
c)	A Dolphin Partner Optimization	Title
	IEEE, DOI 10.1109/GCIS.2009.464	Journal
	YANG Shiqin, JIANG Jianjun, Yan Guangxing	Author(s)

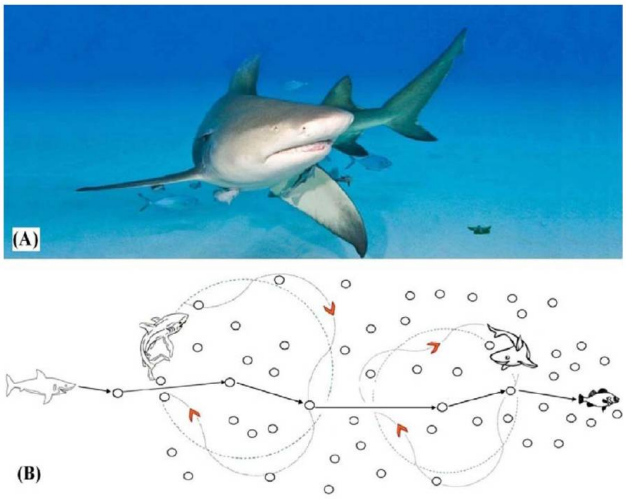
d)	Dolphin Pod Optimization: A Nature-Inspired Deterministic Algorithm for Simulation-Based Design	Title
	Machine Learning, Optimization, and Big Data: Second International Workshop, MOD 2017, Volterra, Italy, (2017) September 14-17.	Journal
	Andrea Serani and Matteo Diez	Author(s)
e)	Dolphin partner optimization based secure and qualified virtual machine for resource allocation with streamline security analysis	Title
	Peer-to-Peer Networking and Applications (2019), https://doi.org/10.1007/s12083-019-00765-9	Journal
	D. Dhanya& D. Arivudainambi	Author(s)

f)	Social Differentiation in Common Bottlenose Dolphins (Tursiops truncatus) that Engage in Human-Related Foraging Behaviors	Title
	PLOS ONE, (2017), DOI:10.1371/journal.pone.0170151	Journal
	Carolyn J. Kovacs, Robin M. Perrtree, Tara M. Cox	Author(s)
g)	A Novel Bio-inspired Algorithm based on the Foraging Behaviour of the Bottlenose Dolphin	**Title**
	2015 International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC), 22-23 April 2015 DOI: 10.1109/ICCPEIC.2015.7259465	Journal
	G.Kiruthiga, S.Krishnapriya, V.karpagambigai,N.Pazhaniraja, P.Victer Paul	Author(s)

Killer-Whale opt

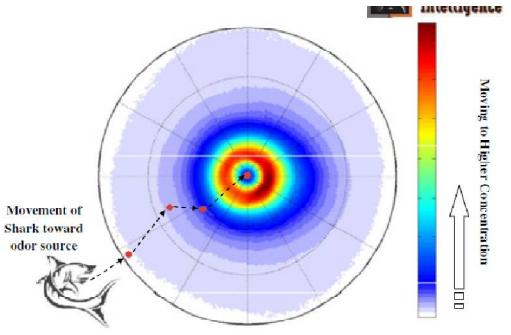
inspired from ☞ Smell (of blood drops) recognition from a few miles in open ocean

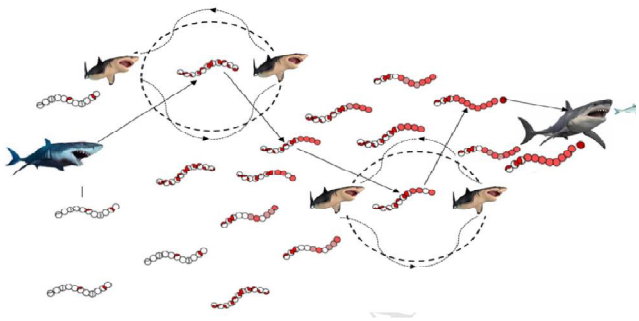
Shark

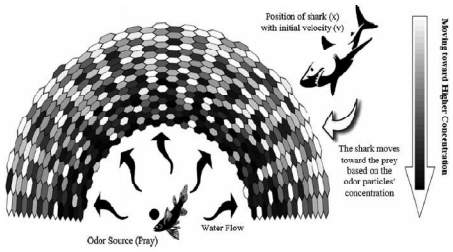


Rotational movement of (A) shark ; (B) simulation

Shark movement to odor source







……. Mussels…..... opt

inspired from

- Wandering of Mussels
- Mussel, any of numerous bivalve mollusks belonging to the marine family Mytilidae and to the freshwater family Unionidae

a)	Mussels Wandering Optimization: An Ecologically Inspired Algorithm for Global Optimization	Title
	CognComput (2013) 5:188–199, DOI: 10.1007/s12559-012-9189-5	Journal
	Jing An, Qi Kang, Lei Wang, Qidi Wu	Author(s)
b)	Adapting and enhancing mussels wandering Optimization algorithm for supervised training of neural networks	Title
	Thesis submitted in fulfilment of the requirements of the degree of Doctor of Philosophy April (2015)	Journal
	Ahmed A. A. Abusnaina	Author(s)

c)	Self-Adaptive Mussels Wandering Optimization Algorithm with Application for Artificial Neural Network Training	Title
	J. Intell. Syst. (2020) 29(1): 345–363, https://doi.org/10.1515/jisys-2017-0292	Journal
	Ahmed A. Abusnaina, Rosni Abdullah and Ali Kattan	Author(s)
d)	Automatic Image Pixel Clustering based on Mussels Wandering Optimization	Title
	International Journal of Pattern Recognition and Artificial Intelligence,2020 https://doi.org/10.1142/S0218001421540057	Journal
	Xin Zhong, Frank Y. Shih, Xiwang Guo	Author(s)

……. Krill herd.……

a)	An efficient krill herd algorithm for color image multilevel thresholding segmentation problem	Title
	Applied Soft Computing Journal (2020), https://doi.org/10.1016/j.asoc.2020.106063.	Journal
	Lifang He, Songwei Huang	Author(s)

b)	Stud krill herd algorithm	Title
	Neurocomputing 128 (2014) 363–370, http://dx.doi.org/10.1016/j.neucom.2013.08.031	Journal
	Gai-Ge Wang, AmirH.Gandomi, AmirH.Alavi	Author(s)
c)	A comprehensive review: krill herd algorithm (KH) and its applications	Title
	Applied Soft Computing Journal (2016), http://dx.doi.org/10.1016/j.asoc.2016.08.041	Journal
	AsajuLa'aro Bolaji Mohammed Azmi Al-Betar Mohammed A. Awadallah Ahamad Tajudin Khader Laith Mohammad Abualigah	Author(s)

Amphibians …….

☞ ***Tree Frog***	🕮 Shuffled frog
o ***Japanese Tree Frog***	
o ***American green tree frog***	

Japanese Tree Frog

Japanese Tree Frog

Kingdom:	Animalia
Phylum:	Chordata
Class:	Amphibia
Order:	Anura
Family:	Hylidae
Genus:	*Dryophytes*
Species:	***D. japonicus***
Binomial name	
Dryophytes japonicus	

- ☞ Japanese tree frog (Dryophytes japonicus) is a species of tree frog
- ☞ Distributed from Hokkaidō to Yakushima in Japan a from Korea along the Ussuri River to north-eastern China, northern Mongolia
- ☞ Southern parts of the Russian Far East

American green tree frog

Hyla cinerea (American green tree frog) Appalachian Mountains, United States

- The American green tree frog (Dryophytes cinereus) is a common species of New World tree frog belonging to the family Hylidae
- The frog is green, medium-sized, and up to 6 cm long
- Their bodies are usually green in shades ranging from bright yellowish-olive to lime green. The color can change depending on lighting or temperature
- Small patches of gold or white may occur on the skin, and they may also have a white, pale yellow, or cream-colored lines running from their jaws or upper lips to their groins.
- They have smooth skin and large toe pads. Their abdomens are pale yellow to white.
- Males have wrinkled throats (indicating the vocal pouch) and are slightly smaller than females

American green tree frogs vary in color.

With distended vocal sac

……. Tree Frog…... opt

a)	Design of Japanese Tree Frog Algorithm for Community Finding Problems:	Title
	19th International Conference, Madrid, Spain, November 21–23, (2018), Proceedings, Part II, DOI: 10.1007/978-3-030-03496-2_34	Journal
	Antonio Gonzalez-Pardo and David Camacho	Author(s)
b)	Implementing a Model of Japanese Tree Frogs' Calling Behavior in Sensor Networks: A Study of Possible Improvements	Title
	13th Annual Genetic and Evolutionary Computation Conference, GECCO 2011, Companion Material Proceedings, Dublin, Ireland, July 12-16, 2011 DOI: 10.1145/2001858.2002057	Journal
	Hugo Hernández, Christian Blum	Author(s)
c)	Distributed graph coloring: an approach based on the calling behavior of Japanese tree frogs	Title
	Swarm Intell (2012) 6:117–150, DOI 10.1007/s11721-012-0067-2	Journal
	Hugo Hernández, Christian Blum	Author(s)

Frog

Tyler's tree frog (Litoriatyleri) has large toe pads and webbed feet.

- ☞ In the male frog, the two testes are attached to the kidneys and semen passes into the kidneys through fine tubes called efferent ducts.
- ☞ It then travels on through the ureters, which are consequently known as urinogenital ducts.
- ☞ Sperm is ejected from the cloaca directly onto the eggs as the female lays them
- o The ovaries of the female frog are beside the kidneys and the eggs pass down a pair of oviducts and through the cloaca to the exterior

Frog

Kingdom:	Animalia
Phylum:	Chordata
Class:	Amphibia
Clade:	Salientia
Order:	Anura

- 🕮 A frog is any member of a diverse and largely carnivorous group of short-bodied, tailless amphibians composing the order Anura
- ! All toads are frogs, but not all frogs are toads

Mating of forgs

- 🕮 Male climbs on the back of the female
- 🕮 Wraps his fore limbs round her body, either behind the front legs or just in front of the hind legs.
  - 🕮 This position is called amplexus
  - 🕮 May be held for several days
- 🕮 The male frog has certain hormone-dependent secondary sexual characteristics
- 🕮 These include the development of special pads on his thumbs in the breeding season, to give him a firm hold
- 🕮 The grip of the male frog during amplexus stimulates the female to release eggs, usually wrapped in jelly, as spawn

- In many species male is smaller and slimmer than the female. Males have vocal cords and make a range of croaks, particularly in the breeding season,
- In some species they also have vocal sacs to amplify the sound

a)	An evolutionary framework based microarray gene selection and classification approach using binary shuffled frog leaping algorithm	Title
	Journal of King Saud University – Computer and Information Sciences (2019), https://doi.org/10.1016/j.jksuci.2019.04.002	Journal
	Rasmita Dash, Rajashree Dash, RasmitaRautray	Author(s)

Aves (Animal Kingdom)

Cuckoo	Bald eagle
Pigeon	
Geese	

Beetle Pity	Slime molds
Helicoidea	Caenorhabditis elegans
Tunicate	Barnacles

Bird Mating	Bird Swarm
Feeding Birds	Satin new Bird
Chaos Bird	Bower Bird
Andean Condor	

…….. **Birds** …… **opt**

inspired from

- Foraging approaches
- Mate choice
- Courting, gift offer and communication with mates
- Mating strategies of bird species

- A real hummingbird gathering nectar

..... Bower Bird. .....

Bower bird

- Bowerbirds belong to Ptilonorhynchidaebird family
- Unique courtship behaviour
  - Males build a structure and decorate it with sticks and brightly coloured objects in an attempt to attract a mate

Bower of the Satin Bowerbird after sunset

Bower of a great bowerbird

Female satin bowerbird

..... Satin new Bird.....

a)	Satin bowerbird optimizer: A new optimization algorithm to optimize ANFIS for software development effort estimation	Title
	Engineering Applications of Artificial Intelligence 60 (2017) 1–15, http://dx.doi.org/10.1016/j.engappai.2017.01.006	Journal
	Seyyed Hamid SamarehMoosavi, Vahid KhatibiBardsiri	Author(s)
b)	Real-Power Rescheduling of Generators for Congestion Management Using a Novel Satin Bowerbird Optimization Algorithm	Title
	Energies 2018, 11, 183; doi:10.3390/en11010183	Journal
	Jagadeeswar Reddy Chintam and Mary Daniel	Author(s)
c)	A Complex-Valued Encoding Satin Bowerbird Optimization Algorithm for Global Optimization	Title
	ICIC 2018, LNAI 10956, (2018), 834–839, https://doi.org/10.1007/978-3-319-95957-3_89	Journal
	Sen Zhang, YongquanZhou, Qifang Luo and Mohamed Abdel-Baset	Author(s)

d)	Discrete Bird Swarm Algorithm Based on Information Entropy Matrix for Traveling Salesman Problem	Title
	Mathematical Problems in Engineering (2018), Article ID 9461861, https://doi.org/10.1155/2018/9461861	Journal
	Min Lin, Yiwen Zhong, Juan Lin and Xiaoyu Lin	Author(s)
e)	A new bio-inspired optimisation algorithm: Bird Swarm Algorithm	Title
	Journal of Experimental & Theoretical Artificial Intelligence (2015) http://dx.doi.org/10.1080/0952813X.2015.1042530	Journal
	Xian-Bing Meng, X.Z. Gao, Lihua Lu, Yu Liu &Hengzhen Zhang	Author(s)

f)	Bird Mating Optimizer for Combinatorial Optimization Problems	Title
	DOI: 10.1109/ACCESS.2020.2993491, IEEE Access (2017)	Journal
	Anas Arram, MasriAyob, Graham Kendall and Alaa Sulaiman	Author(s)
g)	A Hybrid Bird Mating Optimizer Algorithm with Teaching-Learning-Based Optimization for Global Numerical Optimization	Title
	Stat., Optim. Inf. Comput., Vol. 3, (2015), 54–65, DOI: 10.19139/soic.v3i1.86	Journal
	Qingyang Zhang, Guolin Yu, Hui Song	Author(s)

i)	A Novel Hybrid Bird Mating Optimizer with Differential Evolution for Engineering Design Optimization Problems	Title
	Recent Trends in Information and Communication Technology, Lecture Notes on Data Engineering and Communications Technologies 5, (2018), DOI 10.1007/978-3-319-59427-9_55	Journal
	HavalSadeeq , Adnan Abdulazeez, NajdavanKako, and ArazAbrahim	Author(s)

j)	Bird mating optimizer for structural damage detection using a hybrid objective function	Title
	Swarm and Evolutionary Computation (2017), http://dx.doi.org/10.1016/j.swevo.2017.02.006	Journal
	J.J. Zhu, M. Huang, Z.R. Lu	Author(s)

k)	An Improved Chaos Bird Swarm Optimization Algorithm	Title
	IOP Conf. Series: Journal of Physics: Conf. Series 1176 (2019) 022016 IOP Publishing doi:10.1088/1742-6596/1176/2/022016	Journal
	Damin Zhang, ,Juqing Yang and Ping Yang	Author(s)
l)	Artificial Feeding Birds (AFB): a new metaheuristic inspired by the behavior of pigeons	Title
	Advances in nature-inspired computing and applications, (2019), 10.1007/978-3-319-96451-5_3. hal-02264232	Journal
	Jean-Baptiste Lamy	Author(s)

……. Cuckoo……

a)	Parameter optimization of advanced machining processes using cuckoo optimization algorithm and hoopoe heuristic	Title
	J IntellManuf (2014), DOI 10.1007/s10845-014-0925-4	Journal
	Mohamed Arezki MELLAL, Edward J. WILLIAMS	Author(s)
b)	New Hoopoe Heuristic Optimization	Title
	Neural and Evolutionary Computing (cs.NE); Artificial Intelligence (cs.AI),2012 arXiv:1211.6410v1	Journal
	Mohammed El-Dosuky, Ahmed EL-Bassiouny, Taher Hamza and Magdy Rashad	Author(s)
c)	A new quantum chaotic cuckoo search algorithm for data clustering	Title
	Expert Systems With Applications 96 (2018) 358–372, https://doi.org/10.1016/j.eswa.2017.12.001	Journal
	Saida Ishak Boushaki, Nadjet Kamel, Omar Bendjeghaba	Author(s)
d)	A hybrid model based on modified multi-objective cuckoo search algorithm for short-term load forecasting	Title
	Applied Energy, 237 (2019) 896–909, https://doi.org/10.1016/j.apenergy.2019.01.046	Journal
	Zhuochun Wu, Xiaochen Zhao, Yuqing Ma, Xinyan Zhao	Author(s)

……. Pigeon……

a)	A clustering-based ensemble approach with improved pigeon-inspired optimization and extreme learning machine for air quality prediction	Title
	Applied Soft Computing Journal 85 (2019) 105827, https://doi.org/10.1016/j.asoc.2019.105827	Journal
	Feng Jiang, Jiaqi He, Tianhai Tian	Author(s)

b)	A Feature Selection Algorithm for Intrusion Detection System Based on Pigeon Inspired Optimizer	Title
	Expert Systems With Applications (2020), https://doi.org/10.1016/j.eswa.2020.113249	Journal
	Hadeel Alazzam, Ahmad Sharieh, KhairEddin Sabri	Author(s)

……. Andean Condor…... opt

inspired from ☞ Movement pattern of the Andean Condor in foraging
- o Pattern of movement corresponds to the flight distance traveled by the Andean Condor from its nest to the place where food is found

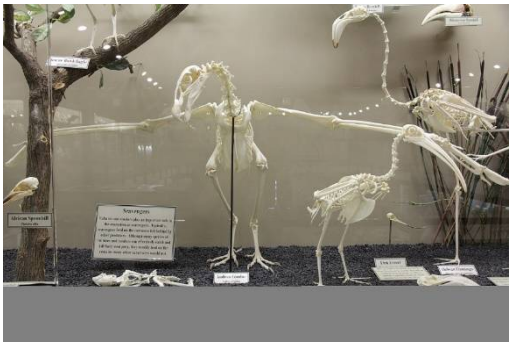
Andean condor

Image of Andean Condor taken in Arequipa, Per

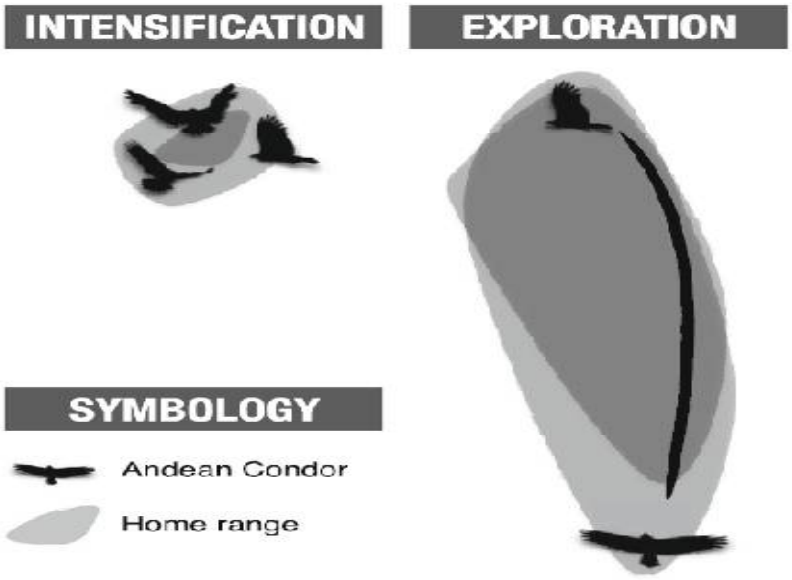
Scientific name: Vulturgryphus Birds

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Cathartiformes
Family:	Cathartidae
Genus:	Vultur Linnaeus, 1758
Species:	**V. gryphus**

Andean condors often spend much of their time soaring on montane updraughts.



Andean condor skeleton (Museum of Osteology)



- Andean condor is the largest flying bird in the world
  - Weight and wingspan
- The Andean condor is a South American bird in the New World vulture family Cathartidae
- Found in the Andes mountains and adjacent Pacific coasts of western South America

a)	Andean Condor Algorithm for cell formation problems	Title
	Natural Computing, (2018), https://doi.org/10.1007/s11047-018-9675-0	Journal
	Boris Almonacid, Ricardo Soto	Author(s)

b)	Foraging-Inspired Optimisation Algorithms,	Title
	Natural Computing Series (2018), https://doi.org/10.1007/978-3-319-59156-8_15	Journal
	A. Brabazon, S. McGarraghy	Author(s)

Bald eagle

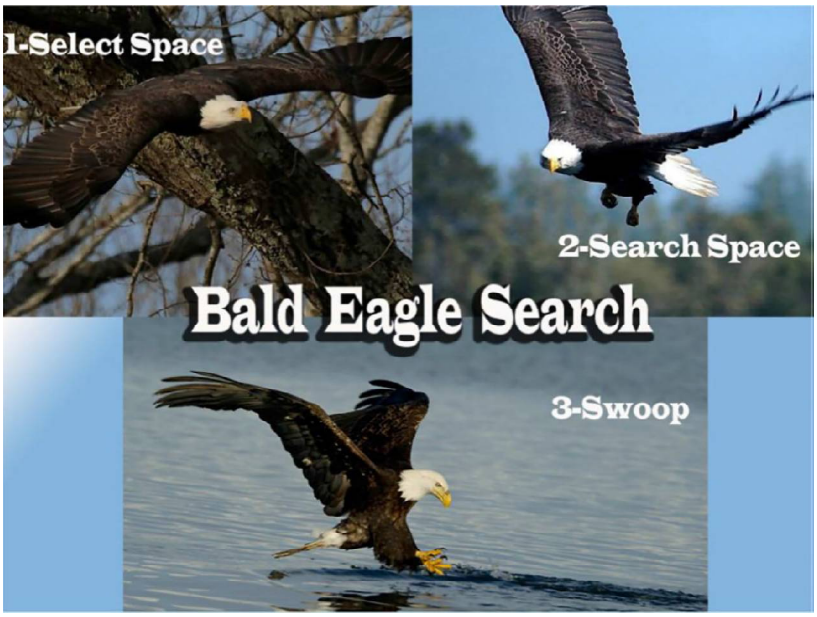
Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Accipitriformes
Family:	Accipitridae
Genus:	*Haliaeetus*
Species:	***H. leucocephalus***

Head details

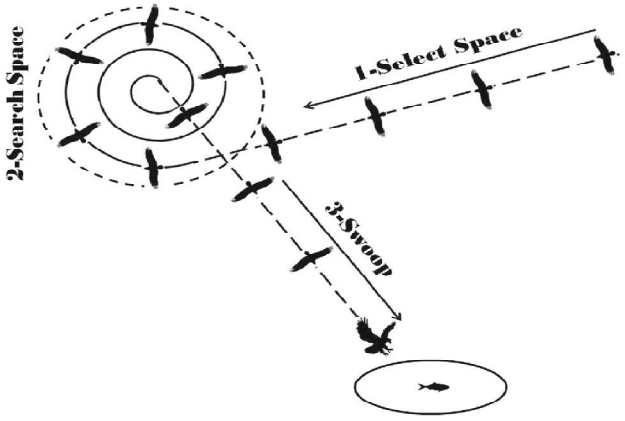
Mating

Bald eagle

☞ Bald eagle (Haliaeetus leucocephalus) is a bird of prey found in North America.



Behaviour of bald eagle during hunting



Co-sequences for the three main stages of hunting by BES

a)	Novelmeta-heuristic baldeagle search optimisation algorithm	Title
	Artificial Intelligence Review, https://doi.org/10.1007/s10462-019-09732-5	Journal
	H. A. Alsattar, A. A. Zaidan, B. B. Zaidan	Author(s)

b)	The raven roosting optimisation algorithm	Title
	Soft Comput (2015), DOI 10.1007/s00500-014-1520-5	Journal
	Anthony Brabazon · Wei Cui · Michael O'Neill	Author(s)

..... Geese.....

a)	Geese-inspired Hybrid Particle Swarm Optimization Algorithm for Traveling Salesman Problem	Title
	2009 International Conference on Artificial Intelligence and Computational Intelligence, IEEE, DOI 10.1109/AICI.2009.425	Journal
	Jingjing Sun, Xiujuan Lei	Author(s)

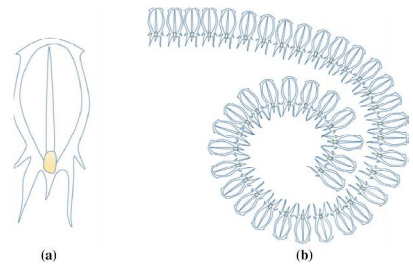
..... PSO.....

a)	Optimal Power Flow using hybridDA-APSO Algorithm in Renewable Energy Resources	Title
	Energy Procedia 117 (2017) 1085–1092, 10.1016/j.egypro.2017.05.232	Journal
	C. Shilija, K.Ravi	Author(s)

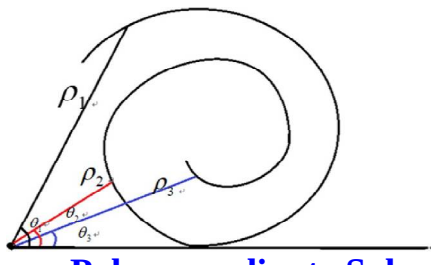
b)	Phasor particle swarm optimization: a simple and efficient variant of PSO	Title
	Soft Computing (2018), https://doi.org/10.1007/s00500-018-3536-8	Journal
	MojtabaGhasemi, Ebrahim Akbari, AbolfazlRahimnejad, Seyed Ehsan Razavi, SahandGhavidel, Li Li	Author(s)
c)	Detecting botnet by using particle swarm optimization algorithm based on voting system	Title
	Future Generation Computer Systems 107 (2020) 95–111, https://doi.org/10.1016/j.future.2020.01.055	Journal
	Mehdi Asadi, Mohammad Ali Jabraeil Jamali (Ph.D.), SaeedParsa, Vahid Majidnezhad	Author(s)
d)	Intelligent leukaemia diagnosis with bare-bones PSO based feature optimization	Title
	Applied Soft Computing 56 (2017) 405–419, http://dx.doi.org/10.1016/j.asoc.2017.03.024	Journal
	WorawutSrisukkham, Li Zhang, Siew Chin Neoh, Stephen Todryk, Chee Peng Lim	Author(s)
e)	A Direction Aware Particle Swarm Optimization with Sensitive Swarm Leader	Title
	Big DataResearch (2018), https://doi.org/10.1016/j.bdr.2018.03.001	Journal
	KrishnKumarMishra, HemantBisht, TribhuvanSingh, VictorChang	Author(s)
f)	A New Optimizer Using Particle Swarm Theory	Title
	Sixth International Symposium on Micro Machine and Human Science (1995)	Journal
	Russell Eberhart, James Kennedy	Author(s)

g)	Ground-glass opacity nodules detection and segmentation using the snake model	Title
	Bio-Inspired Computation and Applications in Image Processing (2016), http://dx.doi.org/10.1016/B978-0-12-804536-7.00005-3	Journal
	C.W. Bong, C.C. Liew, H.Y. Lam	Author(s)

..... Polar Co-ord PSO.....

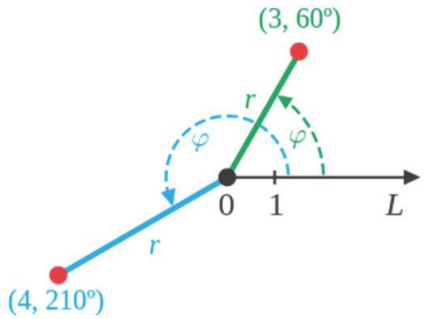


Salpschain

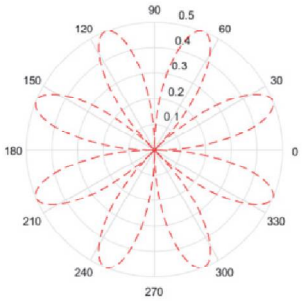


Polar coordinate Salpmodel

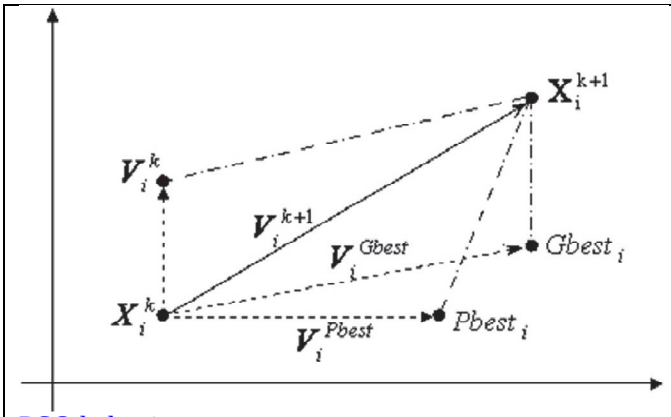
a)	Polar Coordinate Salp Swarm Algorithm for Curve Design Problems	Title
	Neural Processing Letters (2020); doi.org/10.1007/s11063-020-10271-2	Journal
	Zhehong Xiang, Yongquan Zhou, Qifang Luo, Chunming Wen	Author(s)



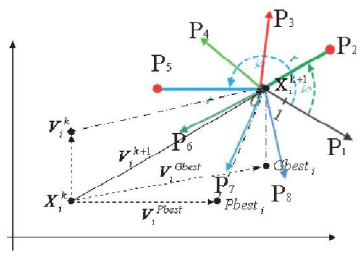
Polar Coordinate Representation



Polar Coordinate Grid (Rose Curve)

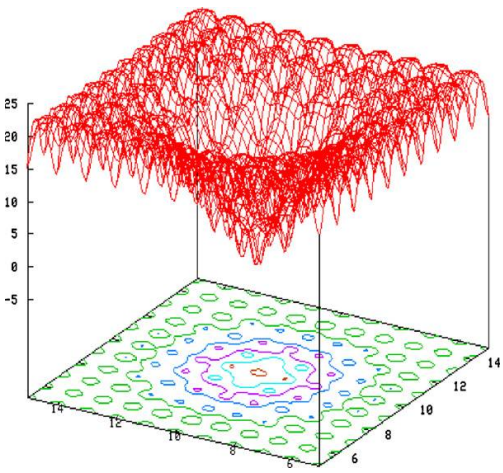


PSO behavior

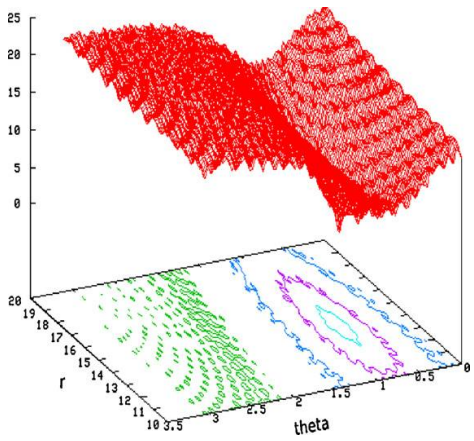


POLARPSO behavior at each iteration

a)	Polar Particle Swarm Algorithm for Solving Cloud Data Migration Optimization Problem	Title
	Modern Applied Science; Vol. 11, No. 8; 2017 ;doi:10.5539/mas.v11n8p98	Journal
	Rizik M. H. Al-Sayyed1, Hussam N. Fakhouri1, Ali Rodan1 & Colin Pattinson	Author(s)



2-dimensional Cartesian version of the Ackley function with horizontal offset of −10.



The 2-dimensional, distorted, polar coordinate version of the Ackley function in Fig. 1.

a)	Polar Particle Swarm Algorithm for Solving Cloud Data Migration Optimization Problem	Title
	Modern Applied Science; Vol. 11, No. 8; (2017), doi:10.5539/mas.v11n8p98	Journal
	Rizik M. H. Al-Sayyed, Hussam N. Fakhouri, Ali Rodan& Colin Pattinson	Author(s)
b)	Polar particle swarm optimization algorithm for solving optimal reactive power problem	Title
	International Journal of Research - Granthaalayah, 6(6), 335-345. https://doi.org/10.5281/zenodo.1308976	Journal
	Dr.K. Lenin	Author(s)
c)	Polar coordinate particle swarm optimiser	Title
	Applied Soft Computing 11 (2011) 1322–1339 doi:10.1016/j.asoc.2010.04.005	Journal
	WiehannMatthysen, Andries P. Engelbrecht	Author(s)

..... Slime molds. .....

Physarumpolycephalum

Kingdom:	Protista
Phylum:	Mycetozoa
Class:	Myxogastria
Order:	Physarales
Family:	Physaraceae
Genus:	*Physarum*
Species:	***P. polycephalum***

slime mold foraging

a)	Physarum-energy optimization algorithm	Title
	Soft Comput (2017), DOI 10.1007/s00500-017-2796-z	Journal
	Xiang Feng, Yang Liu, Huiqun Yu, Fei Luo	Author(s)
b)	An Improved Physarumpolycephalum Algorithm for the Shortest Path Problem	Title
	The Scientific World Journal, (2014), Article ID 487069, http://dx.doi.org/10.1155/2014/487069	Journal
	Xiaoge Zhang, Qing Wang, Andrew Adamatzky, Felix T. S. Chan, Sankaran Mahadevan, and Yong Deng	Author(s)

Beetle Pity

inspired from ☞ Aggregation behaviour of searching nest and food

a)	BAS: Beetle Antennae Search Algorithm for Optimization Problems	Title
	arXiv:1710.10724v1 (2017)	Journal
	Xiangyuan Jiang, Shuai Li	Author(s)

Helicoidal

Weinbergschnecke, Helix pomatia

Kingdom:	Animalia
Phylum:	Mollusca
Class:	Gastropoda
Subclass:	Heterobranchia
Superorder:	Eupulmonata
Order:	Stylommatophora
Infraorder:	Helicoidei
Superfamily:	**Helicoidea**

Mating Cornuaspersum

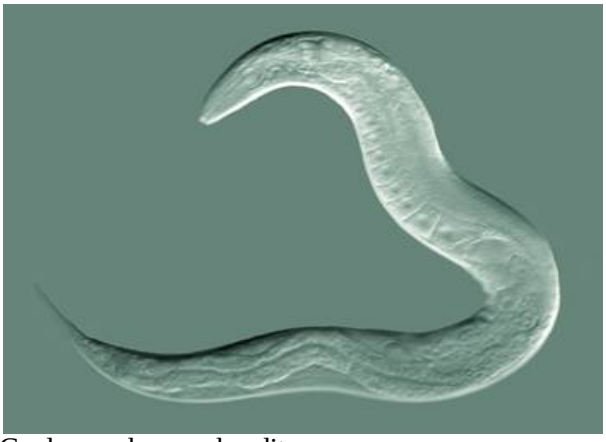
Cornuaspersum in warm regions commonly emerges in moist weather in winter

- Helicoidea is from air-breathing land snails
- Helicoidea developed a simple lung for respiration
  - Oxygen is carried by the blood pigment hemocyanin.
  - Both oxygen and carbon dioxide diffuse in and out of blood through the capillaries.
  - A muscular valve regulates the process of opening and closing the entrance of the lung.
  - When valve opens, air can either leave or come into lung.
  - The valve plays an important role in reducing water loss and preventing drowning
- Hemocyanins are respiratory proteins with copper binding sites to bind and transport oxygen in a variety of arthropods and mollusks

a)	Impact and blast performance enhancement in bio-inspired helicoidal structures: a numerical study	Title
	Journal of the Mechanics and Physics of Solids (2020), https://doi.org/10.1016/j.jmps.2020.104025	Journal
	Fan Yang ,WeihuaXie , Songhe Meng	Author(s)

Caenorhabditis elegans

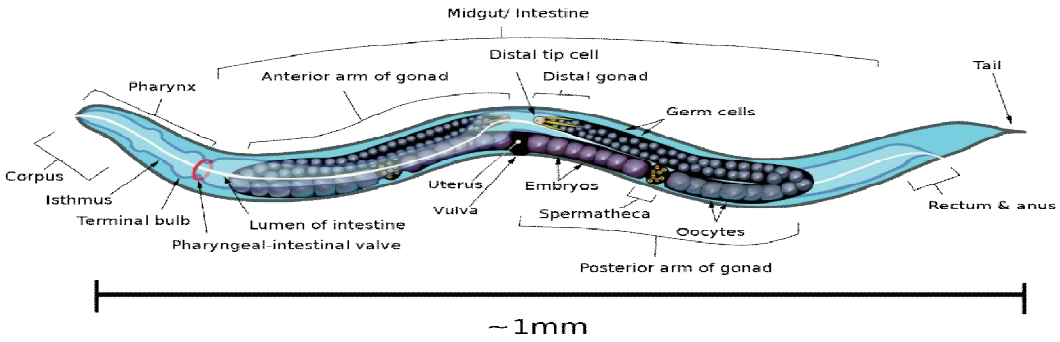
OPt.



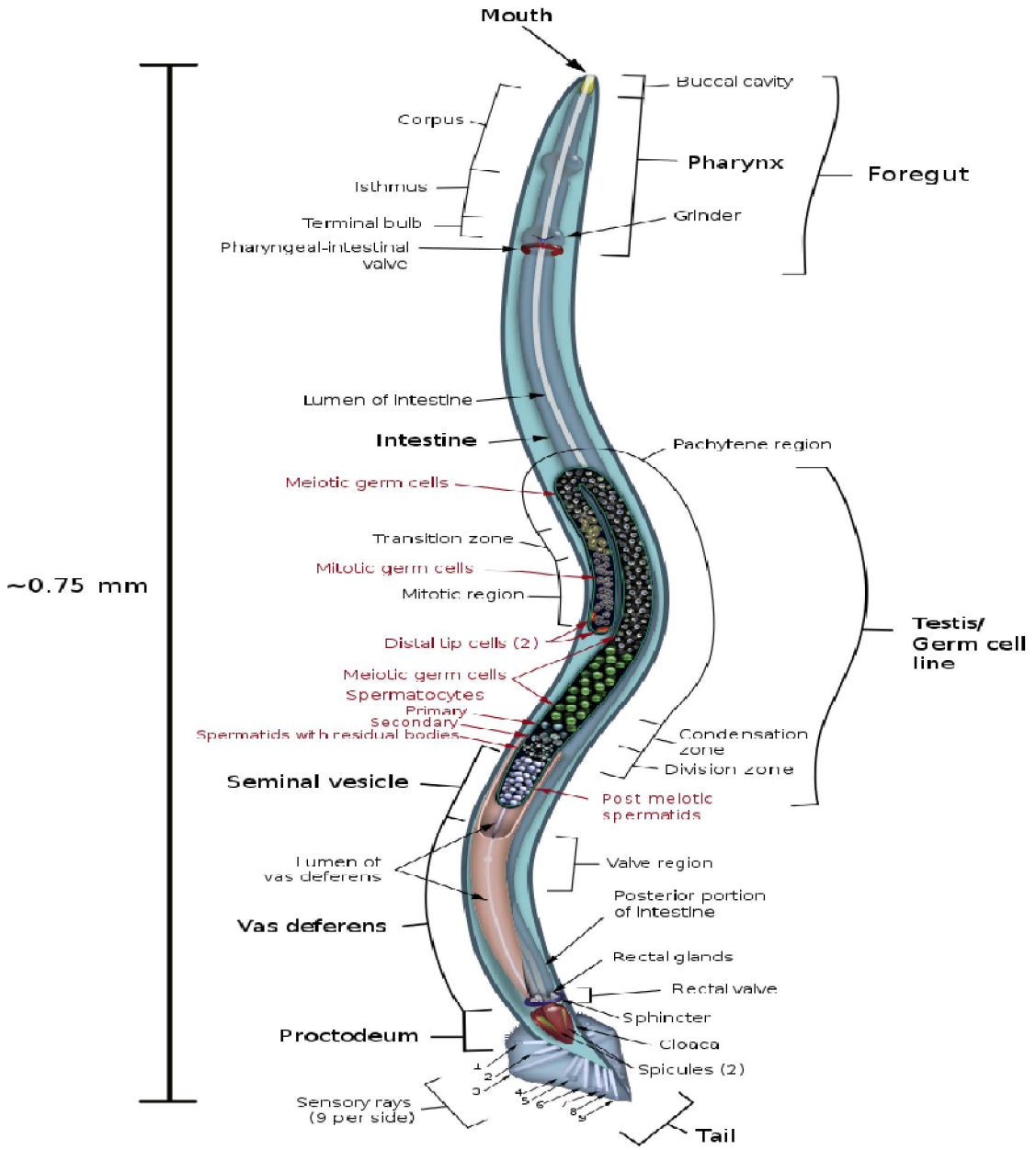
C. elegans hermaphrodite

Kingdom:	Animalia
Phylum:	Nematoda
Class:	Chromadorea
Order:	Rhabditida
Family:	Rhabditidae
Genus:	*Caenorhabditis*
Species:	***C. elegans***

- Caenorhabditis elegans is a free-living transparent nematode
- About 1 mm in length
- Lives in temperate soil environments



A lateral (Left) side anatomical diagram of an adult-stage *C. elegans* hermaphrodite (aprox 1 mm)



Anatomical diagram of a male C. elegans

a)	Maximally informative foraging by Caenorhabditis elegans	Title
	eLife 2014;3:e04220. DOI: 10.7554/eLife.04220	Journal
	Adam J Calhoun, Sreekanth H Chalasani, Tatyana O Sharpee	Author(s)

…… Tunicate …… opt

inspired from
- ☞ Small marine animals
- ☞ Tunicate is a marine invertebrate animal

Clavelinamoluccensis, the bluebell tunicate

Kingdom:	Animalia
Phylum:	Chordata
Subphylum:	Tunicata Lamarck
Classes and unplaced genera[2][5]	
• Ascidiacea (paraphyletic)[4] • Thaliacea • Larvacea • †*Yarnemia*?	
Scientific name: Tunicata	

Gold-mouth sea squirt (Polycarpaaurata) Komodo National Park sea squirt (Polycarpaaurata)

Colonial tunicate with multiple openings in a single tunic

a)	Tunicate Swarm Algorithm: A new bio-inspired based metaheuristic paradigm for global optimization	Title
	Engineering Applications of Artificial Intelligence 90 (2020) 103541, https://doi.org/10.1016/j.engappai.2020.103541	Journal
	Satnam Kaur, Lalit K. Awasthi, A.L. Sangal, Gaurav Dhiman	Author(s)

Barnacles opt

inspired from	☞ Mating behavior of barnacles in nature ☞ Natural evolution of sexual systems

Barnacle,

Kingdom:	Animalia
Phylum:	Arthropoda

Barnacles and limpets compete for space in the intertidal zone

Subphylum:	Crustacea
Class:	Maxillopoda
Subclass:	Thecostraca
Infraclass:	Cirripedia Burmeister, 1834

Whale barnacles attached to the throat of a humpback whale

Goose barnacles, with their cirri extended for feeding

- Barnacle, also called cirripede, is marine crustaceans of the subclass Cirripedia
- Highly modified for sedentary life
- There are about 850 free-living species (all marine)
  about 260 species that are internal parasites of crabs and other crustaceans

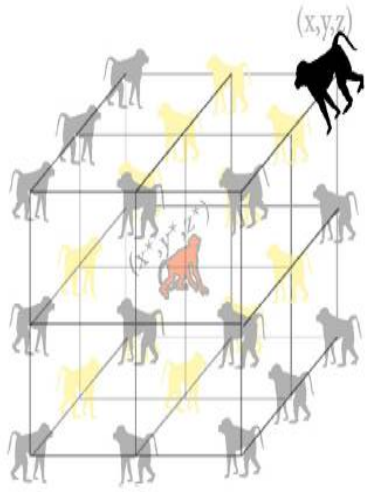
Barnacles slowly reclaim pilings along the Siuslaw River in Oregon.

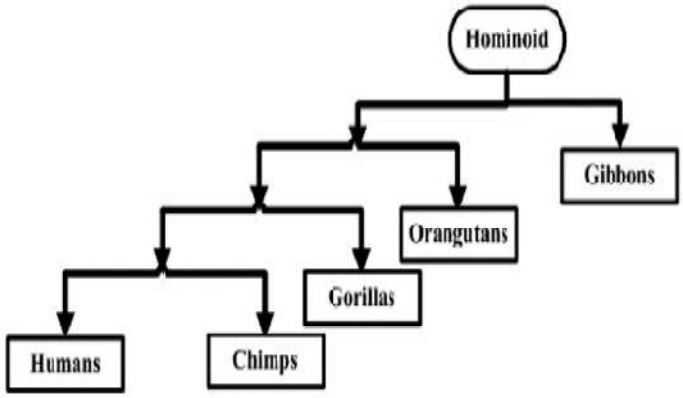
a)	Barnacles Mating Optimizer: A new bio-inspired algorithm for solving engineering optimization problems	Title
	Engineering Applications of Artificial Intelligence, 87 (2020) 103330, https://doi.org/10.1016/j.engappai.2019.103330	Journal
	MohdHerwanSulaiman, ZurianiMustaffa, MohdMawardiSaari, Hamdan Daniyal	Author(s)

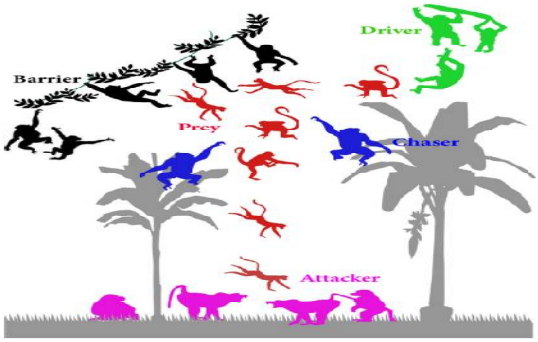
b)	Adaptive evolution of sexual systems in pedunculate barnacles	Title
	Proc. R. Soc. B (2012) 279, 959–966, doi:10.1098/rspb.2011.1554	Journal
	Yoichi Yusa, Mai Yoshikawa, Jun Kitaura, Masako Kawane, Yuki Ozaki, Shigeyuki Yamato and Jens T. Høeg	Author(s)

Chimp- Hunting

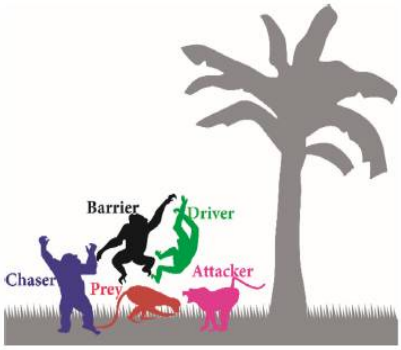
inspired from — Individual intelligence and sexual motivation of chimps in their group hunting



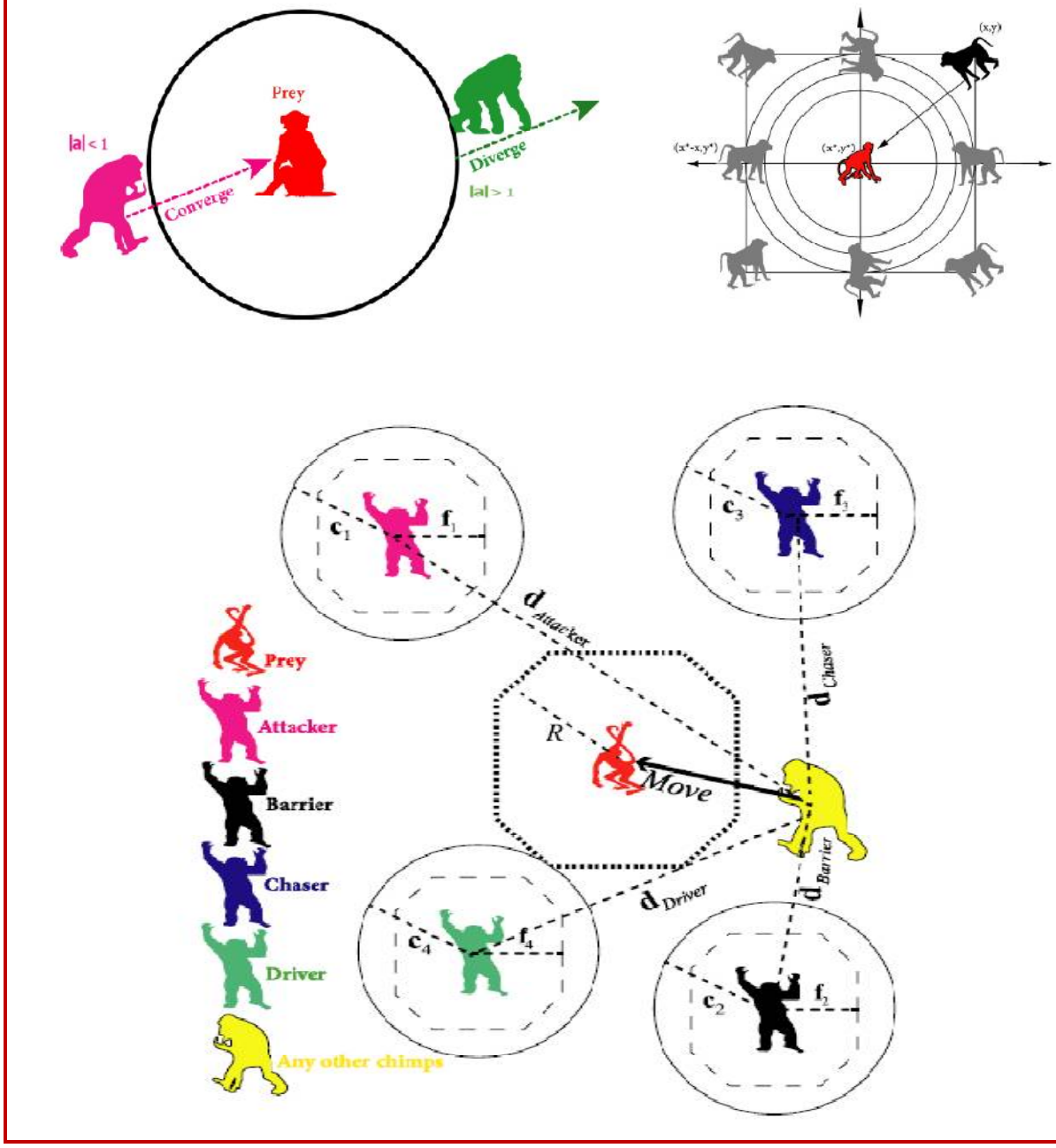


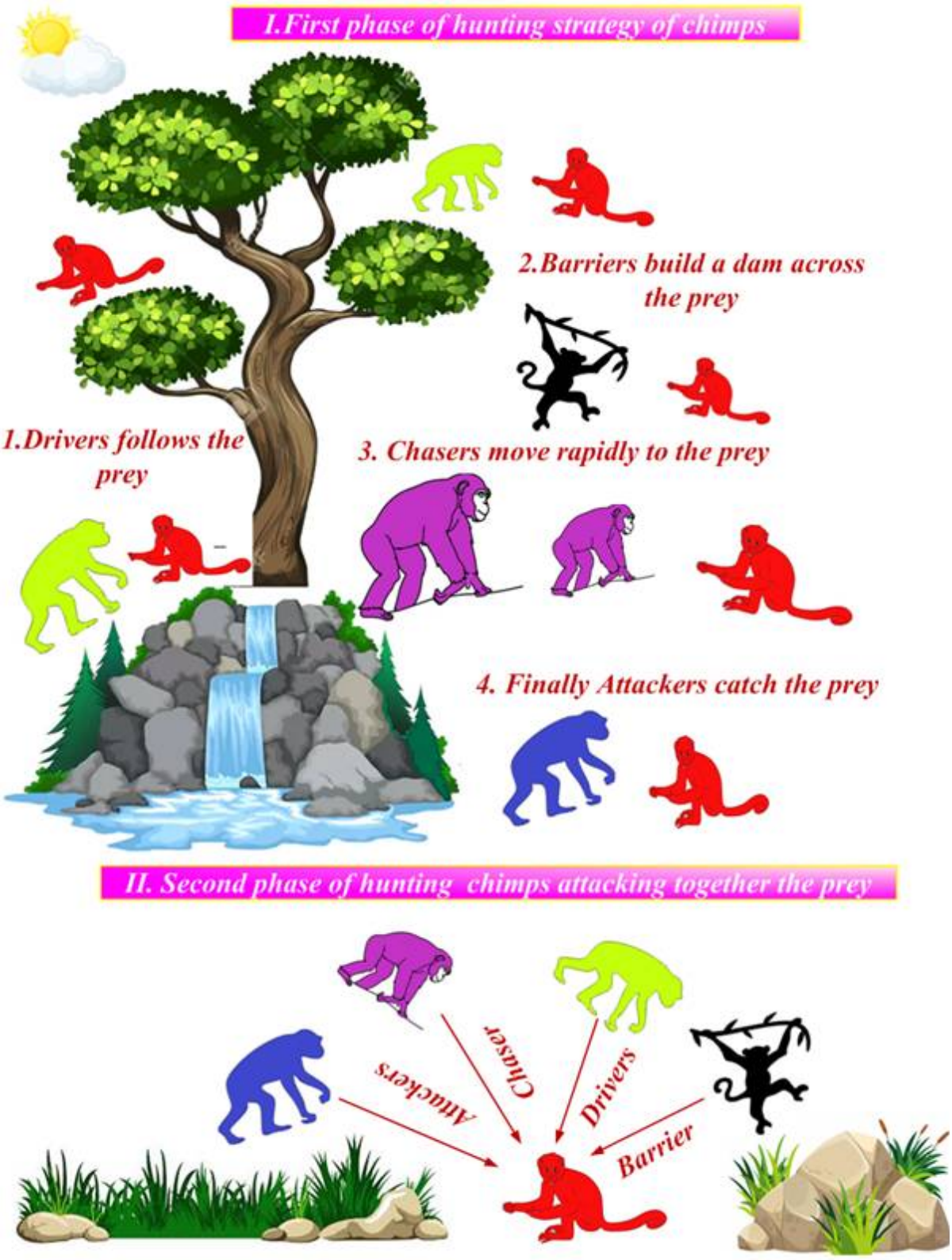


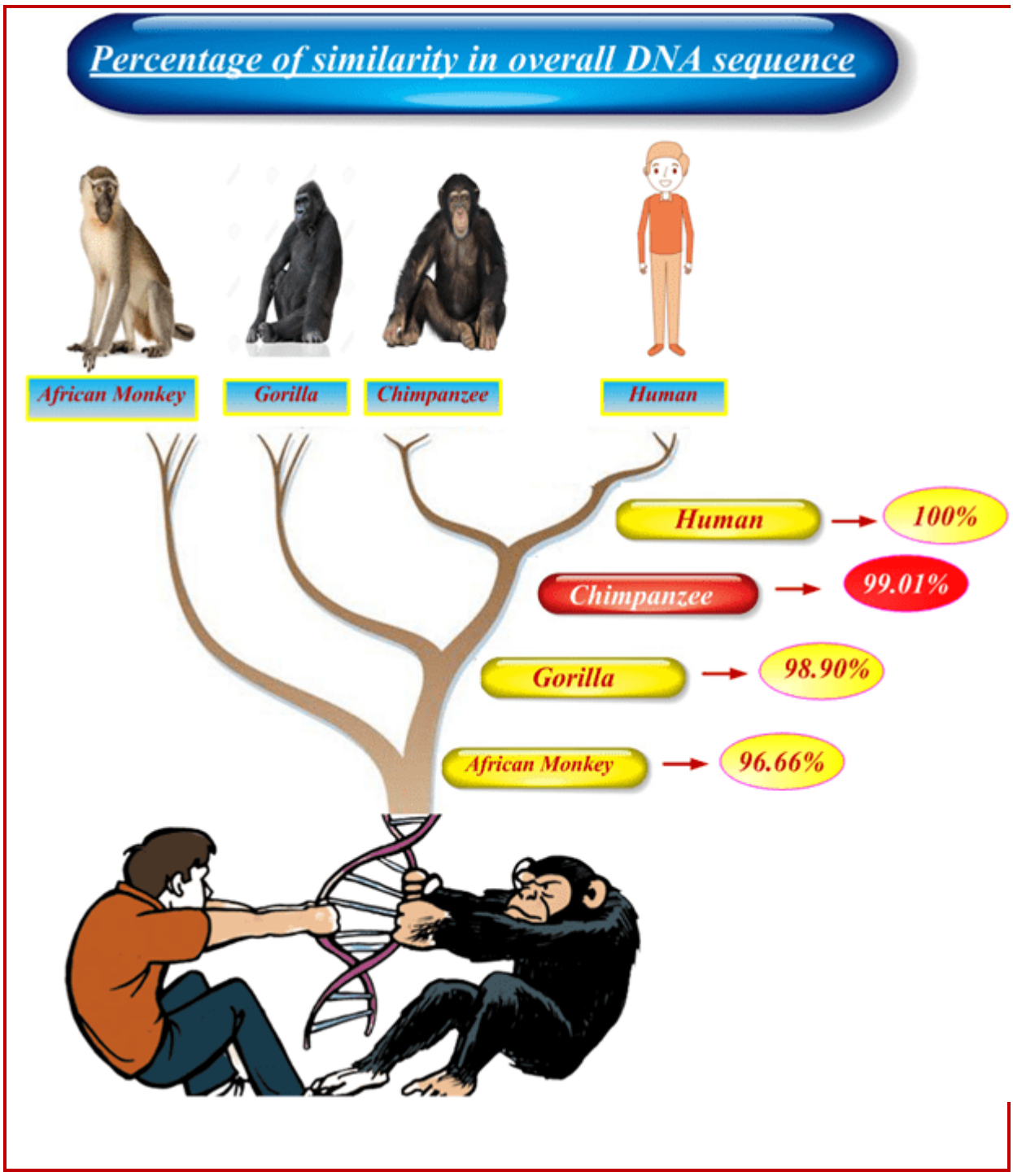
Exploration
(First phase of hunting process)



Exploitation
(Second phase of hunting process)


Prey
|a| < 1
Converge
Diverge
|a| > 1
(x,y)
Prey
Attacker
Barrier
Chaser
Driver
Any other chimps
Move
R


I.First phase of hunting strategy of chimps
2.Barriers build a dam across the prey
1.Drivers follows the prey
3. Chasers move rapidly to the prey
4. Finally Attackers catch the prey
II. Second phase of hunting chimps attacking together the prey
Attackers
Chaser
Drivers
Barrier


Percentage of similarity in overall DNA sequence
African Monkey
Gorilla
Chimpanzee
Human
Human
100%
Chimpanzee
99.01%
Gorilla
98.90%
African Monkey
96.66%

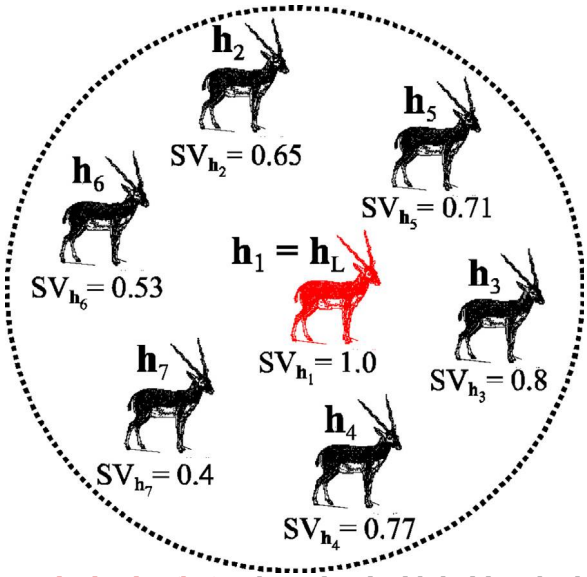
Pseudo code of CHOA

```
While ( t < maximum number of iterations)
 for each chimp;
Define the chimp's group
By using its group strategy to update
 end for
 for each search climb
 if x<1
Update the position of the current search agent
 else if x >1
Select a random search agent
 end if
 else if
Update the position of the current search
  end if
   end for
Update X Attacker, Barrier, Driver & Chaser
 t=t+1
 end while
```

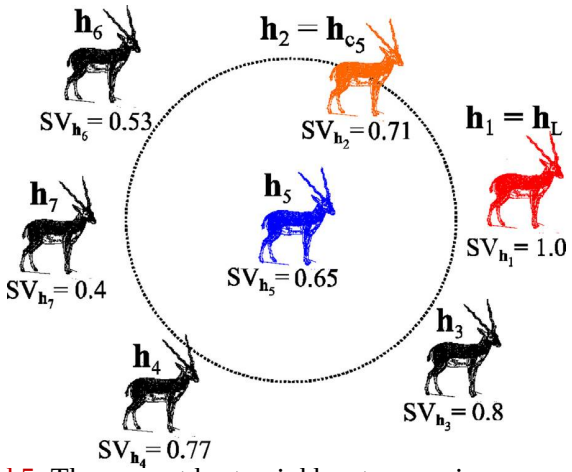
a)	Chimp Optimization Algorithm	Title
	Expert Systems With Applications (2020), https://doi.org/10.1016/j.eswa.2020.113338	Journal
	M. Khishe , M.R. Mosavi	Author(s)
b)	Cooperative hunting roles among taï chimpanzees	Title
	Human Nature 13(2002) 27-46. doi: 10.1007/s12110-002-1013-6	Journal
	Boesch C	Author(s)

Selfish herd opt

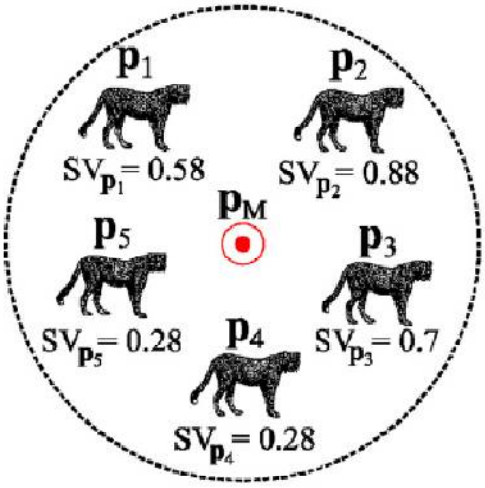
inspired from ☞ Selfishherd behavior manifested by individuals within a herd of animals subjected to some form of predation risk

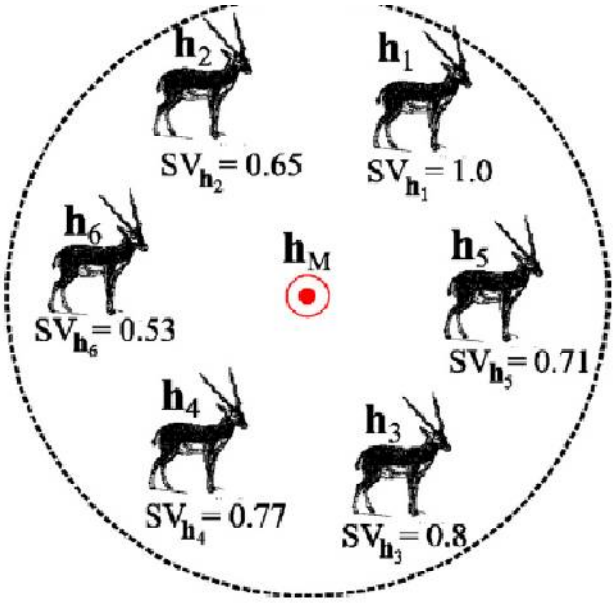


Herd's leader (hL): The individual hiholding highest survival value from among all othermembers within the herd's population



h5 :The nearest best neighbor to any given prey individual





pM:Predator's center of mass; Relatively riskier positions
hM: Herd's center of mass ; Relatively safer positions

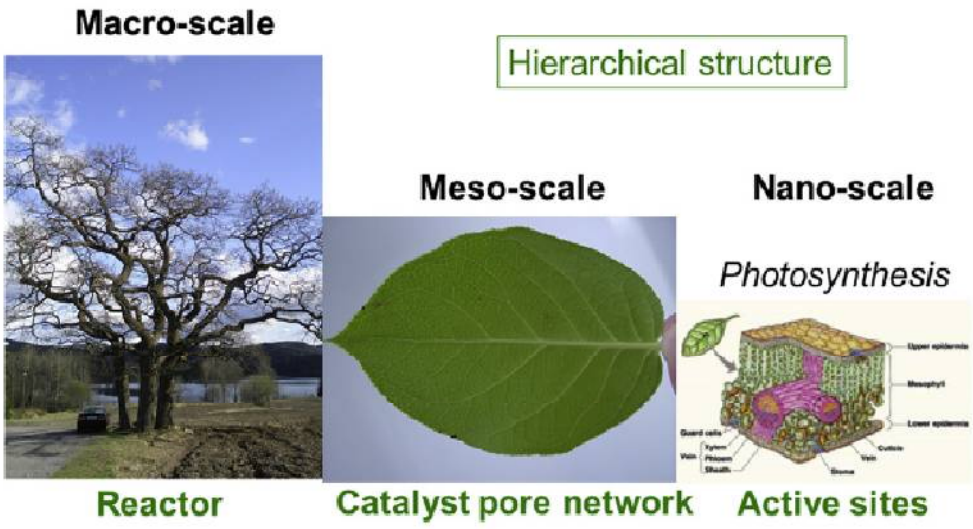
a)	A global optimization algorithm inspired in the behavior of selfish herds	Title
	BioSystems 160 (2017) 39–55, http://dx.doi.org/10.1016/j.biosystems.2017.07.010	Journal
	Fernando Fausto, Erik Cuevas, Arturo Valdivia, Adrián González	Author(s)

Plant kingdom

- Plant Intelligence
- Plant leaf
- Plant saplings sowing and growing
- Firm land
- Pollination Flower
- Sunflower
- Weed

..... Sunflower....

a)	A sunflower optimization (SFO) algorithm applied to damage identification on laminated composite plates	Title
	Engineering with Computers (2018), https://doi.org/10.1007/s00366-018-0620-8	Journal
	Guilherme Ferreira Gomes, SebastiaoSimões da Cunha Jr., Antonio Carlos Ancelotti Jr.	Author(s)
b)	A new technique for optimal estimation of the circuit-based PEMFCs using developed Sunflower Optimization Algorithm	Title
	Energy Reports 6 (2020) 662–671, https://doi.org/10.1016/j.egyr.2020.03.010	Journal
	Zhi Yuan, Weiqing Wang, Haiyun Wang, NavidRazmjooy	Author(s)



A tree as an example of nature inspiration for the design of chemical reactors

..... Weed.....

a)	Improved invasive weed optimization algorithm (IWO) based on chaos theory for optimal design of PID controller	Title
	Journal of Computational Design and Engineering 6 (2019) 284–295, https://doi.org/10.1016/j.jcde.2019.01.001	Journal
	MojganMisaghi, Mahdi Yaghoobi	Author(s)

..... Firm land.....

a)	An Improved Farmland Fertility Algorithm for Global Function Optimization	Title
	IEEE Access, VOLUME 8, (2020), DOI:10.1109/ACCESS.2020.3002555	Journal
	YAN-JIAO WANG AND YE CHEN	Author(s)

... Nature inspired Algs. (NIAs) ...

- Nature inspired Algs.
- Meta heuristics
- Swarm Intelligence
- Computational Intelligence
- Domain knowledge

a)	Nature Inspired Computing: An Overview and Some Future Directions	Title
	CognComput (2015) 7:706–714, DOI 10.1007/s12559-015-9370-8	Journal
	Nazmul Siddique, HojjatAdeli	Author(s)
b)	A comprehensive database of Nature-Inspired Algorithms	Title
	Data in Brief (2020), https://doi.org/10.1016/j.dib.2020.105792	Journal
	Alexandros Tzanetos, IztokFister Jr., Georgios Dounias	Author(s)
c)	Nature-Inspired Optimization Algorithms: Challenges and Open Problems	Title
	Journal of Computational Science (2020), https://doi.org/10.1016/j.jocs.2020.101104	Journal
	Xin-She Yang	Author(s)
d)	Nature-inspired computation and swarm intelligence: a state-of-the-art overview	Title
	https://doi.org/10.1016/B978-0-12-819714-1.00010-5	Journal
	Xin-She Yang, Mehmet Karamanoglu	Author(s)

e)	Implementation of nature-inspired optimization algorithms in some data mining tasks	Title
	Ain Shams Engineering Journal (2019), https://doi.org/10.1016/j.asej.2019.10.003	Journal
	A.M. Hemeida, Salem Alkhalaf, A. Mady, E.A. Mahmoud, M.E. Hussein, Ayman M. Baha Eldin	Author(s)
f)	A novel statistical performance evaluation of most modern optimization based global MPPT techniques for partially shaded PV system	Title
	Renewable and Sustainable Energy Reviews 115 (2019) 109372, https://doi.org/10.1016/j.rser.2019.109372	Journal
	HegazyRezk, Mazen AL-Oran, Mohamed R. Gomaa, Mohamed A. Tolba, Ahmed Fathy, Mohammad Ali Abdelkareemh, A.G. Olabih, AbouHashema M. El-Sayed	Author(s)
g)	Mapping of Real World Problems to Nature Inspired Algorithm using Goal based Classification and TRIZ	Title
	Procedia Computer Science 171 (2020) 729–736, 10.1016/j.procs.2020.04.079	Journal
	Palak Sukharamwala, Manojkumar Parmar,	Author(s)
h)	A Survey on Nature-Inspired Optimization Algorithms and Their Application in Image Enhancement Domain	Title
	Archives of Computational Methods in Engineering (2018), https://doi.org/10.1007/s11831-018-9289-9	Journal
	Krishna Gopal Dhal, Swarnajit Ray, Arunita Das, Sanjoy Das	Author(s)
i)	An application-based taxonomy of Nature Inspired Intelligent algorithms	Title
	An application-based taxonomy of Nature Inspired Intelligent algorithms (2019)	Journal
	Alexandros Tzanetos and Georgios Dounias	Author(s)
j)	Comparison of nature-inspired population-based algorithms on continuous optimisation problems	Title
	Swarm and Evolutionary Computation 50 (2019) 100490, https://doi.org/10.1016/j.swevo.2019.01.006	Journal
	Petr Bujok, Josef Tvrdík, Radka Poláková	Author(s)
k)	A Brief Review of Nature-Inspired Algorithms for Optimization	Title
	ELEKTROTEHNI˙SKI VESTNIK (2013), 80(3): 116–122.	Journal
	IztokFister Jr., Xin-She Yang, IztokFister, Janez Brest, DusanFister	Author(s)
l)	Parameter Tuning of PI Control for Speed Regulation of a PMSM Using Bio-Inspired Algorithms Algorithms, (2019), 12, 54; doi: 10.3390/a12030054, 1-21. Juan Luis Templos-Santos, Omar Aguilar-Mejia, Edgar Peralta-Sanchez, and Raul Sosa-Cortez	
m)	Investigation on the dynamic response of circular sandwich panels with the bio-inspired gradient core Thin–Walled Structures, 149 (2020) 106667. doi.org/10.1016/j.tws.2020.106667 Hairen Wang, Shiqiang Li, Zhifang Liu, Zhihua Wang, Zhiqiang Li	
n)	Comprehensive Taxonomies of Nature- and Bio-inspired Optimization: Inspiration versus Algorithmic Behavior, Critical Analysis and Recommendations	Title
	arXiv:2002.08136v2; Feb 2020	Journal
	Daniel Molina, Javier Poyatos, Javier Del Ser, Salvador García, Amir Hussain and Francisco Herrera	Author(s)

Computational Intelligence …….

a)	An extensive review of computational intelligence-based optimization algorithms: trends and applications	Title
	Soft Computing (2020), https://doi.org/10.1007/s00500-020-04958-w	Journal
	Lavika Goel	Author(s)

Domain knowledge ……

a)	Incorporating domain knowledge into reinforcement learning to expedite welding sequence optimization	Title
	Engineering Applications of Artificial Intelligence 91 (2020) 103612, https://doi.org/10.1016/j.engappai.2020.103612	Journal
	Jesus Romero-Hdz, Baidya Nath Saha, SeiichiroTstutsumi, Riccardo Fincato	Author(s)

Meta heuristics ……

a)	A new meta-heuristic optimizer: Pathfinder algorithm	Title
	Applied Soft Computing Journal 78 (2019) 545–568, https://doi.org/10.1016/j.asoc.2019.03.012	Journal
	Hamza Yapici, Nurettin Cetinkaya	Author(s)
b)	Metaheuristic research: a comprehensive survey	Title
	ArtifIntell Rev (2018), https://doi.org/10.1007/s10462-017-9605-z	Journal
	Kashif Hussain, Mohd Najib Mohd Salleh, Shi Cheng, Yuhui Shi	Author(s)
c)	Historical survey on metaheuristics algorithms	Title
	International Journal of Scientific World, 7 (1) (2019) 1-12	Journal
	Saman M. Almufti	Author(s)
d)	Parallel Meta-heuristics	Title
	DOI: 10.1007/978-1-4419-1665-5_17	Journal
	Teodor Gabriel Crainic, Michel Toulouse	Author(s)
e)	KU Battle of Metaheuristic Optimization Algorithms 1: Development of Six New/Improved Algorithms	Title
	Advances in Intelligent Systems and Computing (2016) 382, DOI: 10.1007/978-3-662-47926-1_19	Journal
	JoongHoon Kim, Young Hwan Choi, Thi Thuy Ngo, Jiho Choi,Ho Min Lee, Yeon Moon Choo, EuiHoon Lee, Do GuenYoo,Ali Sadollah and Donghwi Jung	Author(s)
f)	Complex metaheuristics	Title
	Journal of Computational Science (2016), http://dx.doi.org/10.1016/j.jocs.2016.06.001	Journal
	C. Cotta, R. Schaefer	Author(s)
g)	Hybridizing four wise neural-metaheuristic paradigms in predicting soil shear strength	Title
	Measurement 156 (2020) 107576, https://doi.org/10.1016/j.measurement.2020.107576	Journal
	Hossein Moayedi, Mesut Gör, Mahdy Khari, Loke KokFoong, Mehdi Bahiraei, Dieu Tien Bui	Author(s)

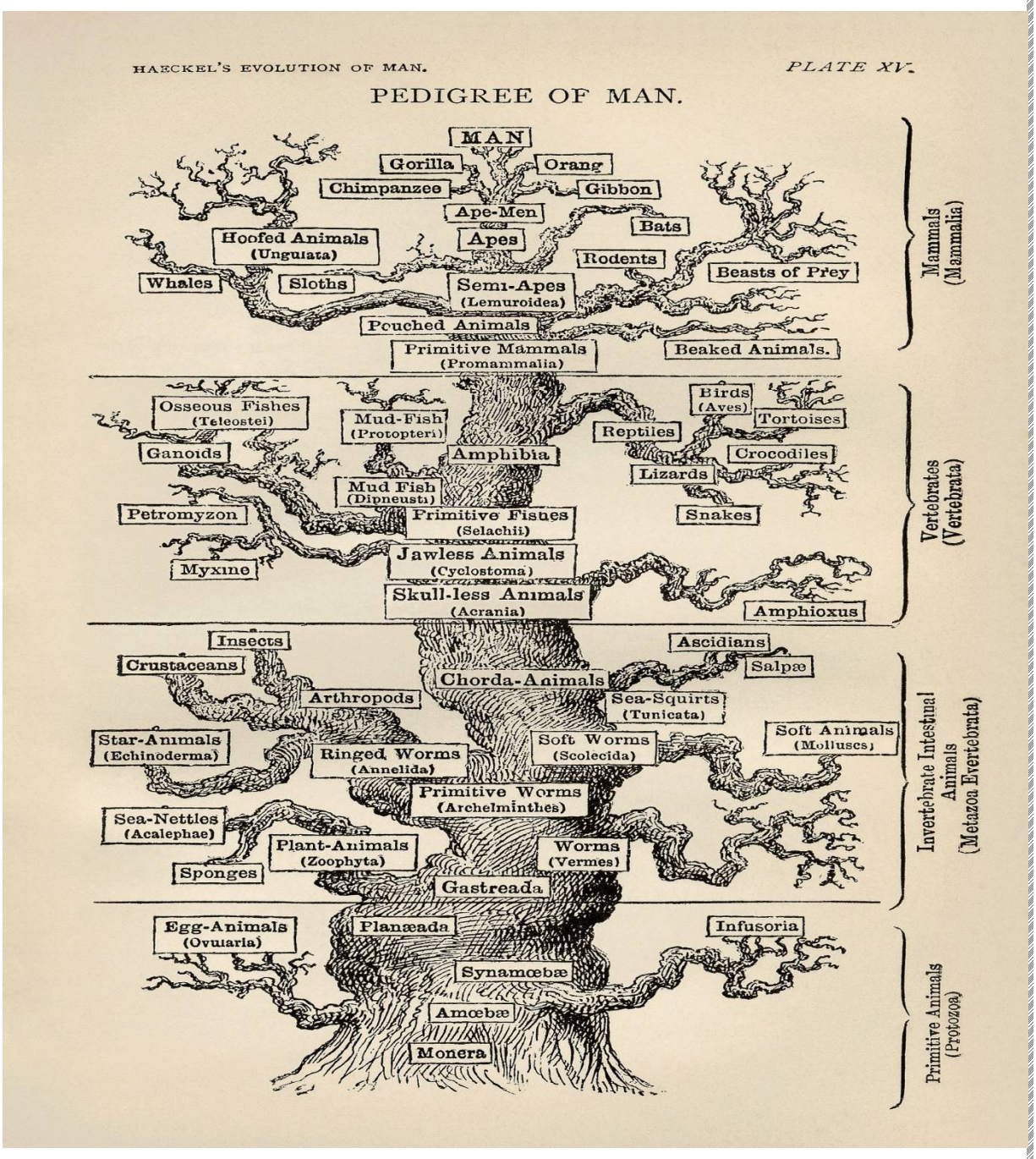
……. Swarm Intelligence ……

a)	Swarm Intelligence Algorithms for Feature Selection: A Review	Title
	Appl. Sci. (2018), 8, 1521; doi:10.3390/app8091521	Journal
	LucijaBrezocnik, IztokFister, Jr. and ViliPodgorelec	Author(s)
b)	A New Compound Swarm Intelligence Algorithms for Solving Global Optimization Problems	Title
	International journal of computers & technology, vol 10, no 9, (2013)	Journal
	Ibrahim M. Hezam, Osama Abdel Raouf, Mohey M. Hadhoud	Author(s)
c)	New Advancements in Swarm Algorithms: Operators and Applications	Title
	New Advancements in Swarm Algorithms: Operators and Applications (2020), https://doi.org/10.1007/978-3-030-16339-6	Journal
	Erik Cuevas, Fernando Fausto, Adrián González	Author(s)
d)	Swarm intelligence algorithm based on competitive predators with dynamic virtual Teams	Title
	JAISCR, (2017), Vol. 7, No. 2, 87-101, DOI: 10.1515/jaiscr-2017-0006	Journal
	Shiqin Yang, Yuji Sato	Author(s)
e)	A swarm-inspired projectionalgorithm	Title
	Pattern Recognition, 42(2009) 2764—2786, doi:10.1016/j.patcog.2009.03.020	Journal
	Mu-Chun Su, Shi-YongSu, Yu-XiangZhao	Author(s)
f)	A comparative evaluation of swarm intelligence techniques for solving combinatorial optimization problems	Title
	International Journal of Advanced Robotic Systems, (2017) 1–11, DOI: 10.1177/1729881417705969	Journal
	Julius Odili, Mohd Nizam Mohmad Kahar, A Noraziah and Syafiq F Kamarulzaman	Author(s)
g)	Nature-inspired hybrid techniques of IWO, DA, ES, GA, and ICA, validated through a k-fold validation process predicting monthly natural gas consumption	Title
	Energy & Buildings 217 (2020) 110023, https://doi.org/10.1016/j.enbuild.2020.110023	Journal
	WeibiaoQiao , Hossein Moayedi, Loke KokFoong	Author(s)

Human

- Learning
- Consultant
- Rank aptitude
- Games
- Soccer League Competition
- Human society
- Teaching and learning
- Duellist fight
- Single seeker
- League Championship
- Group Counselling
- Brain

- Harmony Search
- Sheep-shepherd
- Group Search
- Exchange Market
- Tabu (Taboo) Search
- Imperialist Competitive
- Social-Based
- Firework Algorithm



Pedigree of man

[[[[[[[[[[~~~~~~~~~~(Human) learning

a)	A context sensitive energy thresholding-based 3D Otsu function for image segmentation using human learning optimization Applied Soft Computing Journal, 82 (2019) 105570. doi.org/10.1016/j.asoc.2019.105570 Ashish Kumar Bhandari, Immadisetty Vinod Kumar

b)	New feature selection methods based on opposition-based learning and self-adaptive cohort intelligence for predicting patient no-shows Applied Soft Computing Journal 86 (2020) 105866, https://doi.org/10.1016/j.asoc.2019.105866 Mohammed Aladeemy, Linda Adwan, Amy Booth, Mohammad T. Khasawneh, Srikanth Poranki

[[[[[[[[[[~~~~~~~~~~(Human) Teaching and learning

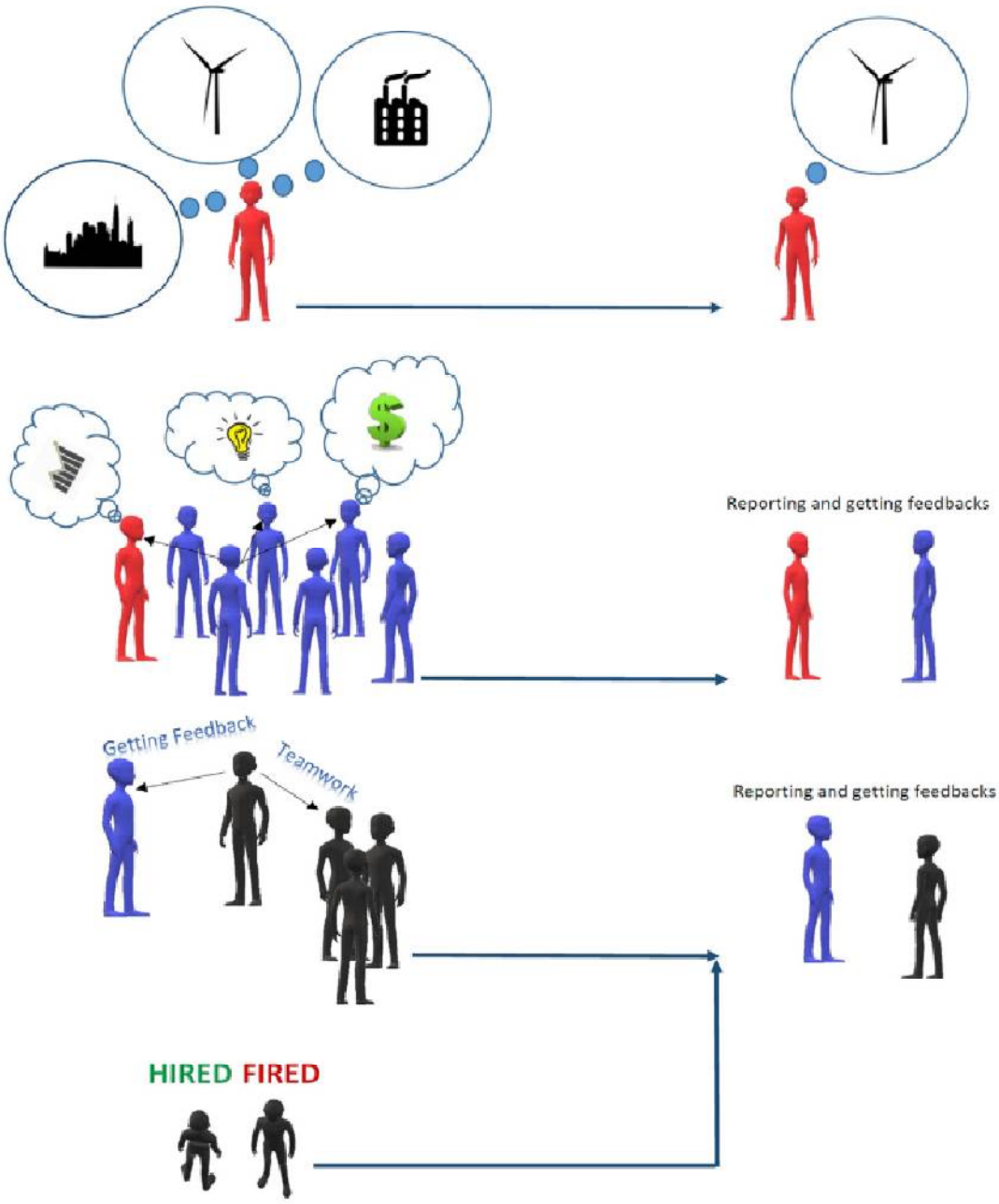
Inspired by	☞ Knowledge interactions between a class of students or learners
	☞

a)	A chaotic teaching learning-based optimization algorithm for clustering problems Applied Intelligence https://doi.org/10.1007/s10489-018-1301-4 Yugal Kumar, Pradeep Kumar Singh
b)	Techno-economic analysis of a grid-connected PV/battery system using the teaching-learning-based optimization algorithm Solar Energy, 203 (2020) 69–82. doi.org/10.1016/j.solener.2020.04.007 Mina Najafi Ashtiani, Ashkan Toopshekan, Fatemeh Razi Astaraei, Hossein Yousefi, Akbar Maleki
c)	An elitist teaching-learning-based optimization algorithm for solving complex constrained optimization problems International Journal of Industrial Engineering Computations, 3 (2012) 535–560. doi: 10.5267/j.ijiec.2012.03.007 R. Venkata Rao and Vivek Patel
d)	A survey of teaching–learning-based optimization Neurocomputing 335 (2019) 366–383, https://doi.org/10.1016/j.neucom.2018.06.076 Feng Zou, Debao Chen, Qingzheng Xu

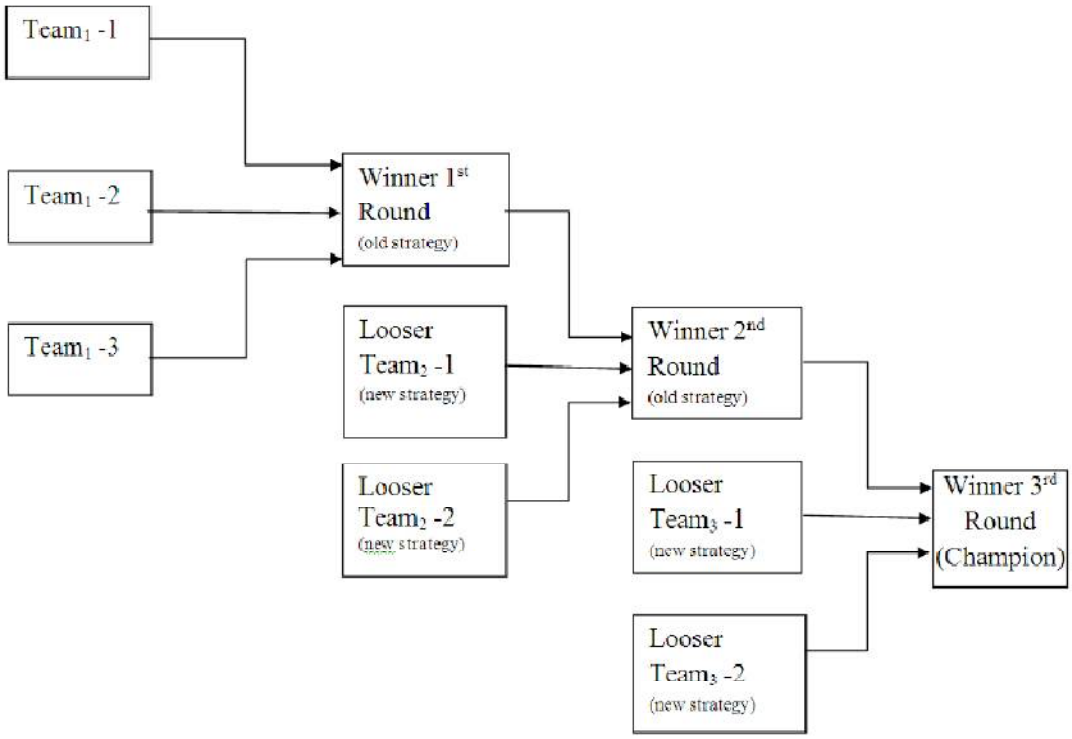
[[[[[[[[[[[[[~~~~~~~~~~ (Human) rank aptitude….

a)	A New Class Topper Optimization Algorithm with an Application to Data Clustering DOI 10.1109/TETC.2018.2812927 Pranesh Das, Dushmanta Kumar Das and Shouvik Dey
b)	A Distributed Auction-Based Algorithm for the Nonconvex Economic Dispatch Problem IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, 10, 2 (2014). Giulio Binetti, Ali Davoudi, DavidNaso, BiagioTurchiano, and Frank L. Lewis
c)	An efficient algorithm for constrained global optimization and application to mechanical engineering design: League championship algorithm (LCA) Computer-Aided Design 43 (2011) 1769–1792, doi:10.1016/j.cad.2011.07.003 Ali Husseinzadeh Kashan

[[[[[[[[[[~~~~~~~~~~Games. Human	
Inspired by	☞ World Cup based on human society's intelligent contests. FIFA ▪ FiFA: Fédération Internationale de FootballAssociation ▪ FIFAWorld Cup Origin. (2007).

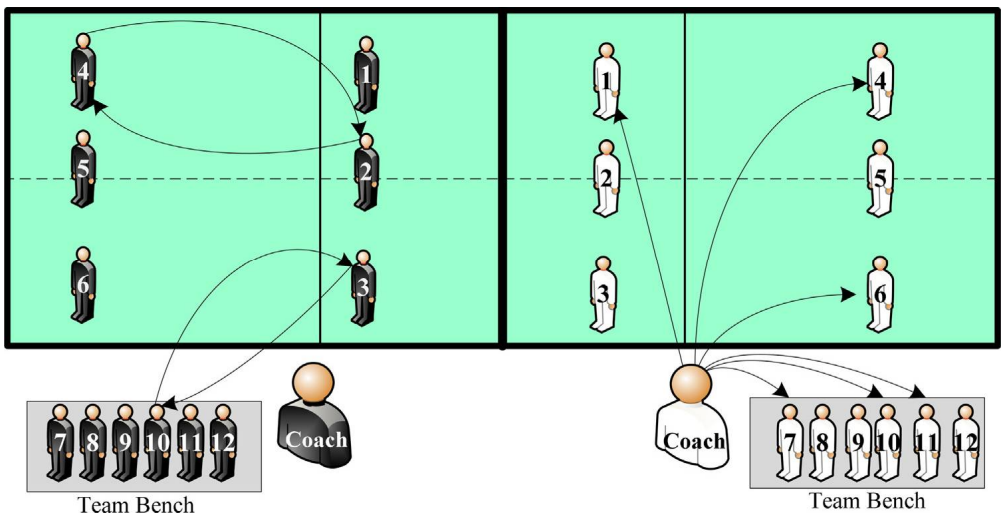


Graphical explanation of the Team arrangement algorithm (Red: CEO, Blue: Director, Black: Employee)

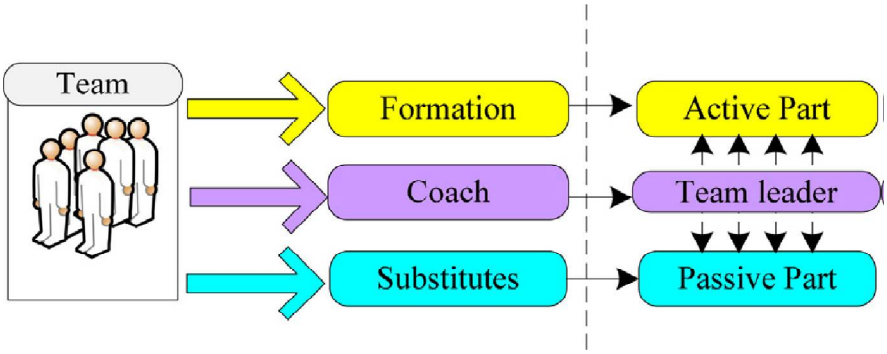


Flow graph of League Championship Algorithm

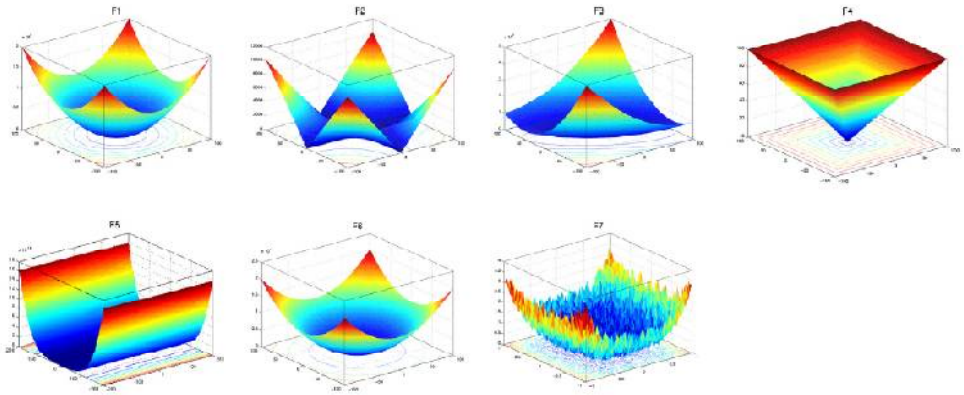
a)	Soccer league competition algorithm for solving knapsack problems Swarm and Evolutionary Computation, (2014). doi.org/10.1016/j.swevo.2014.10.002 Naser Moosavian



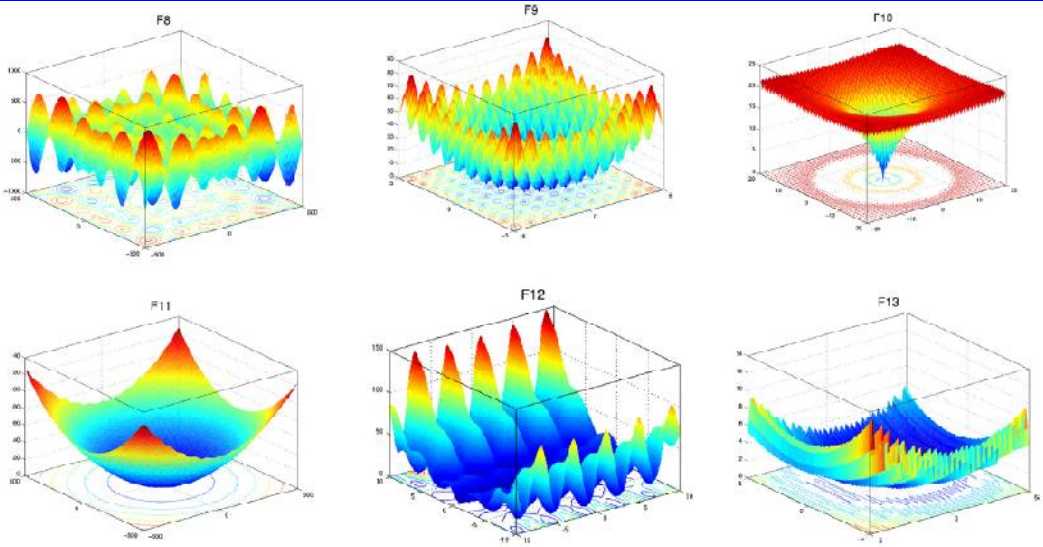
Typical court of the volleyball game and interactions involved



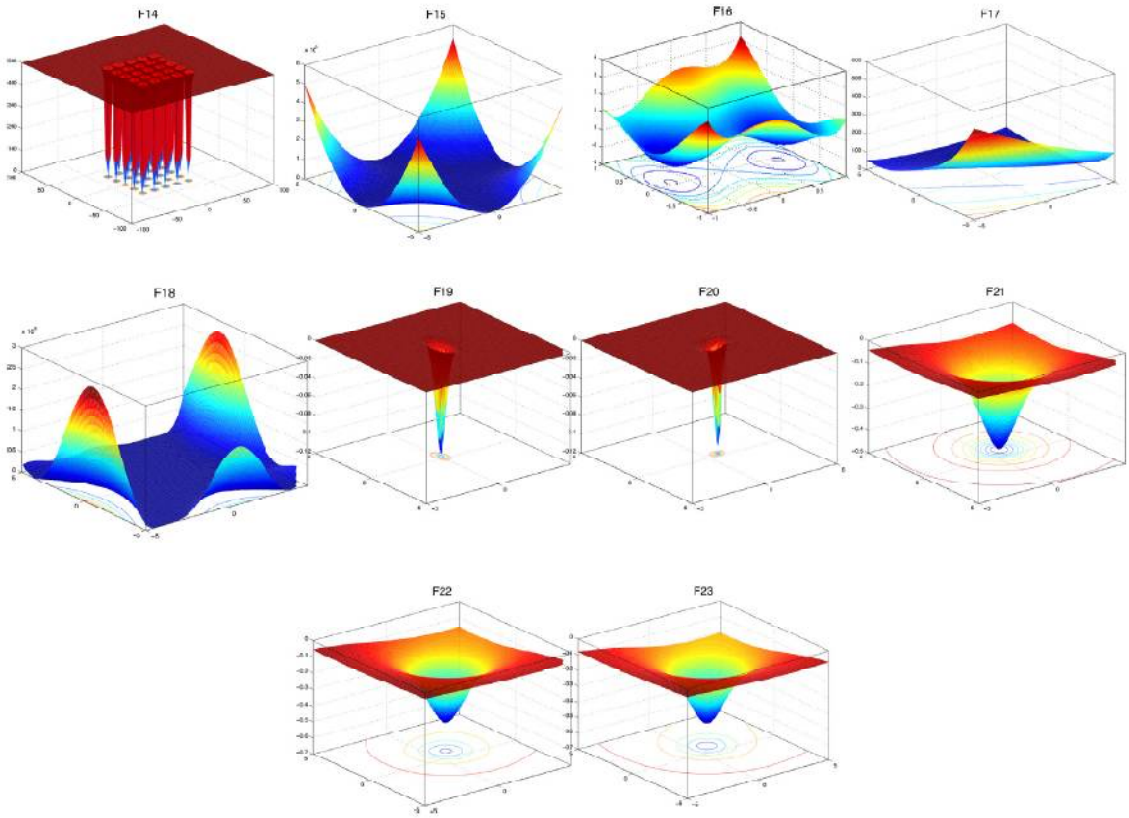
Relationship between team structure and the solution representation.



Unimodal functions



Multimodal functions



Fixed-dimension multimodal functions

a)	Team Arrangement Heuristic Algorithm (TAHA): Theory and application Mathematics and Computers in Simulation, 166 (2019) 155–176. doi.org/10.1016/j.matcom.2019.05.007 Narek Babayan, Mojtaba Tahani
b)	Volleyball Premier League Algorithm Applied Soft Computing, 64 (2018) 161–185. doi.org/10.1016/j.asoc.2017.11.043 Reza Moghdani, KhodakaramSalimifard
c)	A new metaheuristic optimization method: the algorithm of the innovative gunner(AIG) Engineering Optimization (2019), https://doi.org/10.1080/0305215X.2019.1565282 PawełPijarski& Piotr Kacejko

[[[[[[[[[[~~~~~~~~~~ (Human) Duelist fight OPt.

inspired from
- ☞ Human fight
- ☞ Learning from each duelist

Duelist's Classification.

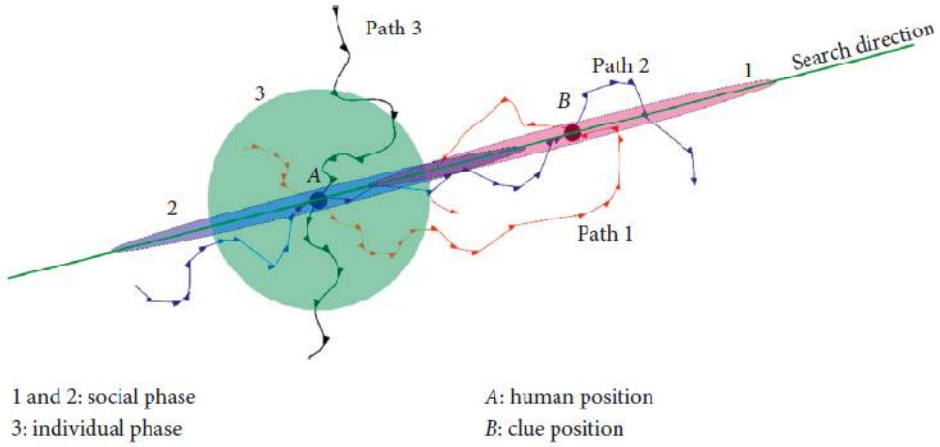
a)	Techno Economic Optimization of Petlyuk Distillation Column Design Using Duelist Algorithm	Title
	Procedia Engineering 170 (2017) 520 – 527, doi: 10.1016/j.proeng.2017.03.083	Journal
	Totok R. Biyanto, Jovi A. Rahman, Sarwono, Roekmono, Nur Laila H, AriefAbdurrakhman, Purwadi A Darwito	Author(s)
b)	Simultaneous Optimization of Tuning PID Cascade Control System Using Duelist Algorithms	Title
	2016 International Seminar on Intelligent Technology and Its Applications (ISITIA), 28-30 July 2016, DOI: 10.1109/ISITIA.2016.7828728	Journal
	TotokRukiBiyanto, Muhammad Salman Alfarisi, Abu Hasan, Hendrik Setiawan, NaindarAfdanny	Author(s)
c)	Duelist Algorithm: An Algorithm Inspired by How Duelist Improve Their Capabilities in a Duel	Title
	arXiv:1512.00708v1; DOI: 10.1007/978-3-319-41000-5_4	Journal
	TotokRukiBiyanto, HenokhYerniasFibrianto, Gunawan Nugroho, ErnyListijorini, TitikBudiati, Hairul Huda	Author(s)

[[[[[[[[[[[[[[~~~~~~~~~~Single seeker society

a)	Single Seekers Society (SSS): Bringing together heuristic optimization algorithms for solving complex problems Knowledge-Based Systems doi.org/10.1016/j.knosys.2018.11.016 Adil Baykasoğlu, AlperHamzadayi, SenerAkpinar
b)	Solving combinatorial optimization problems with single seekers society algorithm Knowledge-Based Systems, 201–202 (2020) 106036. doi.org/10.1016/j.knosys.2020.106036 AlperHamzaday, Adil Baykasoğlu, ŞenerAkpınar

c)	Seeker optimization algorithm for global optimization: A case study on optimal modelling of proton exchange membrane fuel cell (PEMFC) Electrical Power and Energy Systems 33 (2011) 369–376, doi:10.1016/j.ijepes.2010.08.032 Chaohua Dai, Weirong Chen, Zhanli Cheng, Qi Li, Zhiling Jiang, Junbo Jia

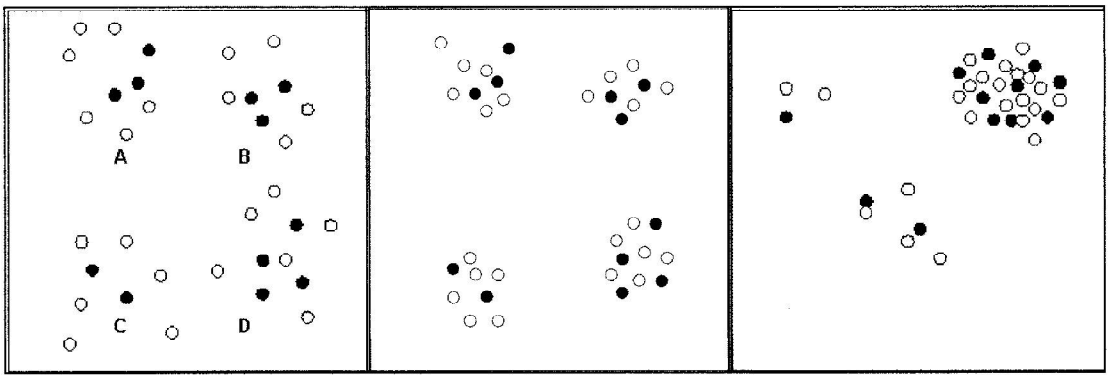
[[[[[[[[[[[[[[~~~~~~~~~~~~~~~~~~Human Society



Two types of human searches in search and rescue operations.

a)	A new metaheuristic optimization algorithm inspired by human dynasties with an application to the wind turbine micrositing problem Applied Soft Computing Journal, (2020). https://doi.org/10.1016/j.asoc.2020.106176 S.u.R. Massan, A.I. Wagan and M.M. Shaikh
b)	Society and Civilization: An Optimization Algorithm Based on the Simulation of Social Behavior IEEE TRANSACTIONS ON EVOLUTIONARY COMPUTATION, VOL. 7, NO. 4, (2003) DOI 10.1109/TEVC.2003.814902 Tapabrata Ray and K. M. Liew

c)	Artificial Tribe Algorithm and Its Performance Analysis	Title
	JOURNAL OF SOFTWARE, VOL. 7, NO. 3, (2012), doi:10.4304/jsw.7.3.651-656	Journal
	Tanggong Chen, Youhua Wang and Jianwei Li	Author(s)
d)	An introduction to cultural algorithms	Title
	Conference Paper · (1994)	Journal
	Robert G. Reynolds	Author(s)
e)	Adaptive group search optimization algorithm for multi-objective optimal power flow problem	Title
	Applied Soft Computing, (2015), http://dx.doi.org/10.1016/j.asoc.2015.10.057	Journal
	Narges Q1 Daryani, Mehrdad TarafdarHagh, Saeed Teimourzadeh	Author(s)



Social behavior; a) Clusters A, B, C, and D. (b) Individuals in every cluster migrating toward their leaders. (c) Leaders of the clusters migrated to cluster B.

a)	Political Optimizer: A novel socio-inspired meta-heuristic for global optimization, Knowledge-Based Systems, (2020). https://doi.org/10.1016/j.knosys.2020.105709 Q. Askari, I. Younas and M. Saeed

(Human)Consultant

OPt.

inspired from ☞ People utilizing their expertise to provide optimum advices professionally

a)	Consultant-Guided Search – A New Metaheuristic for Combinatorial Optimization Problems	Title
	Genetic and Evolutionary Computation Conference, GECCO 2010, Proceedings, Portland, Oregon, USA, July 7-11, 2010; DOI: 10.1145/1830483.1830526	Journal
	SerbanIordache	Author(s)
b)	Parallel Consultant-Guided Search with Crossover	Title
	Rev Socionetwork Strat (2017), DOI 10.1007/s12626-017-0016-z	Journal
	Yota Ueda, Hiroyuki Ebara, Koki Nakayama, Syuhei Iida	Author(s)

(Human) brain

OPt.

inspired from ☞ Logical thinking, decision making adaptivity even in unknown situation

a)	Feature selection through binary brain storm optimization	Title

	Computers and Electrical Engineering, 72 (2018) 468–481, https://doi.org/10.1016/j.compeleceng.2018.10.013	Journal
	Joao P. Papa, Gustavo H. Rosa, André N. de Souza, Luis C.S. Afonso	Author(s)
b)	The foraging brain	Title
	Current Opinion in Behavioral Sciences (2015), 5:24–31, http://dx.doi.org/10.1016/j.cobeha.2015.07.003	Journal
	Adam J Calhoun and Benjamin Y Hayden	Author(s)
c)	Cognitive behavior optimization algorithm for solving optimization problems	Title
	Applied Soft Computing (2015), http://dx.doi.org/10.1016/j.asoc.2015.11.015	Journal
	Hui Zhao, Xingwei Weng, Tong Han	Author(s)

Sheep-Shepherd

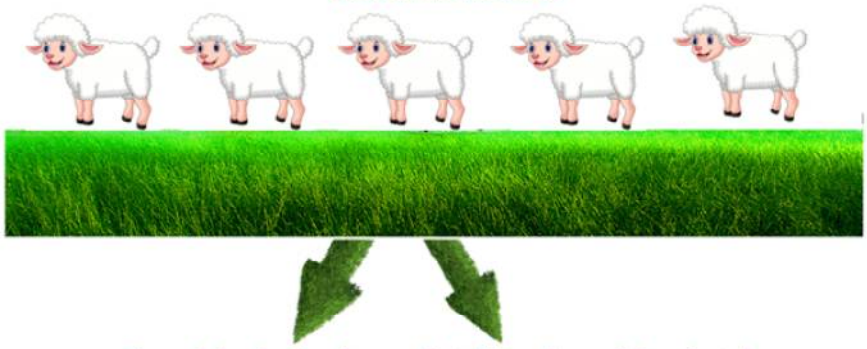
OPt.

inspired from

- Herding behavior of shepherds
- Shepherds steer their herds to the right direction with horses or herding dogs
- Use the herding instinct of these animals to direct the herd and guard them from predation and theft

SSOA Algorithm

Each Sheep is arranged by its objective function value and divided into two herds



In each herds sheep's are selected in order and the selected sheep is called shepherd and sheep with best objective function is called horse.

A shepherd tries to guide by moving to one of the sheep & horse and new position is achieved

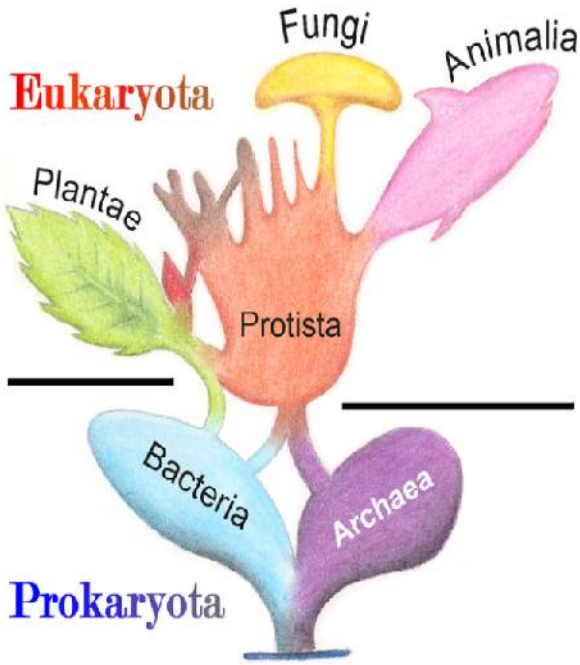
Advantages of SSOA

- ★ Accuracy
- ★ Convergence Rate
- ★ Reducing the parameter dependency
- ★ Utilized to solve truss layout

Ref : Transpire Online
Shuffled Shepherd Optimization Algorithm (SSOA): To Find the Right Parameters for Each Problem

a)	Advances in Intelligent Systems and Computing 382, DOI: 10.1007/978-3-662-47926-1_19 JoongHoon Kim, Young Hwan Choi, Thi Thuy Ngo, Jiho Choi,Ho Min Lee, Yeon Moon Choo, EuiHoon Lee, Do GuenYoo,Ali Sadollah and Donghwi Jung
b)	KU Battle of Metaheuristic OptimizationAlgorithms 1: Development of SixNew/Improved Algorithms Springer-Verlag Berlin Heidelberg 2016 J.H. Kim and Z.W. Geem (eds.), Harmony Search Algorithm,

Supl. Information 1.



Five Kingdoms of Life

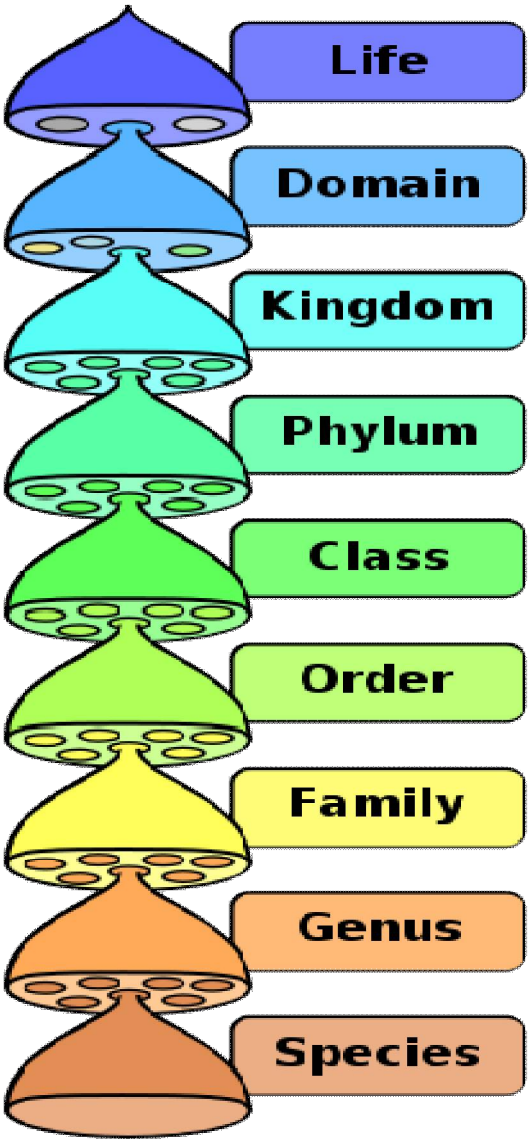
Protista	🕮 Unicellular or simple multicellular plant &animal-like forms, heterotrophic & autotrophic
Plantae	🕮 Multicellular photosynthetic autotrophs
Fungi	🕮 Heterotrophic decomposers
Anima-lia	🕮 Heterotrophic feeders
Monera	🕮 Unicellular bacteria and blue-green algae 🕮 Heterotrophic & autotrophic

What is a Species?

Morphological Species Concept	Biological Species Concept
☞ Applicable to living and extinct species	☞ Applicable onlyto living species
☞ Organisms can be sexual or asexual	☞ Organisms must be sexual
☞ Applicable to widely separated populations	☞ Applicable only to reproductive populations
☞ Physical characteristics can be confusing	☞ Not dependent upon physical appearance
o In artificial environments mating between species can take place that would not occur in the wild	

Taxonomic Classification of

Living species **Man**



Scientific classification	
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Suborder	Haplorhini
Infraorder	Simiiformes
Family	Hominidae
Subfamily	Homininae
Tribe	Hominini
Genus	*Homo*
Species	***sapiens***

Binomial name
Homo sapiens **Linnaeus, 1758**
Subspecies
H. s. sapiens †***H. s. idaltu*** †***H. s. neanderthalensis*****(?)** †***H. s. rhodesiensis*****(?)**

Humans (*Homo sapiens*) are highly intelligent primates

- Humans became the dominant species on Earth.
- Scientific name for the human species: Homo sapiens (Meaning: Latin: "wise man")
- They are the only extant members of the subtribe Hominina
- Humans are terrestrial animals, characterized by their
  - Erect posture and bipedal locomotion; high manual dexterity
  - Heavy tool use compared to other animals
- Open-ended and complex language use compared to other animal communications
- Larger, more complex brains than other primates
- Highly advanced and organized societies

King fisher

Japanese high speed train (Shinkansen in Kyoto)

Information Source	ACS.org ; sciencedirect.com
K. Somasekhara Rao, Dept. of Chemistry, Acharya Nagarjuna Univ., Dr. M.R.Appa Rao Campus, Nuzvid-521 201, India	R. Sambasiva Rao, School of Chemistry, Andhra University, Visakhapatnam 530 003, India