

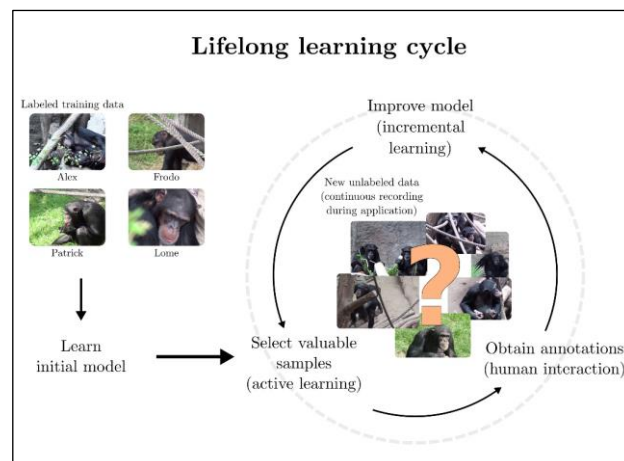
Pre-trained models are not enough: active and lifelong learning is important for long-term visual monitoring of mammals in biodiversity research — Individual identification and attribute prediction with image features from deep neural networks and decoupled decision models applied to elephants and great apes

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Highlights:

- Lifelong learning concept for long-term visual monitoring studies
- Continuous improvements of the recognition models by incorporating expert feedback via human-in-the-loop
- Active learning strategies for selecting valuable samples and reducing annotation efforts for humans during the application
- Individual identification and attribute prediction (gender, age group, age) via general approach using deep image features and decoupled decision models that can be updated efficiently with incremental learning methods
- Individual identification for several species: African forest elephants (*Loxodonta cyclotis*) in images, Asian elephants (*Elephas maximus*) in videos, gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes*) in images



This article is part of a thematic collection of articles (Special Issue) of *Mammalian Biology* and covers the following topics and taxa (marked with ☒) addressed in the Special Issue:

Article Type				
☒ Original Research	☒ Techniques	☐ Review	☐ Short Communication	☐ Concept Note
Taxon		Topic		
Terrestrial				
☐ Bats (Order Chiroptera)	☒ Primates : Great Apes (Family Hominidae)	☐ Acoustic ID	☒ Identification techniques	
☐ Carnivores : Bears (Family Ursidae)	☐ Primates : Old World monkeys (Family Cercopithecidae)	☐ Aerial surveys	☐ Life-history	
☐ Carnivores : Canids (Family Canidae)	☐ Ungulates : Bovids (Family Bovidae)	☐ Analytical innovations	☒ Machine learning	
☐ Carnivores : Felids (Family Felidae)	☐ Ungulates : Deers (Family Cervidae)	☒ Automated pattern recognition	☐ Mark-recapture analysis	
☐ Carnivores : Hyenas (Family Hyaenidae)	☐ Ungulates : Giraffes (Family Giraffidae)	☐ Behavioural ecology	☐ Morphometrics	
☐ Carnivores : Mustelids (Family Mustelidae)	☐ Ungulates : Horses (Family Equidae)	☐ Camera-trapping	☐ Network analysis	
☒ Elephants (Family Elephantidae)	☐ Multiple taxa (3 or more Families/Orders)	☐ Conservation management	☐ Photogrammetry	
Marine		☐ Data management	☐ Population ecology	
☐ Baleen whales : Right whales (Family Balaenidae)	☐ Large toothed whales (Families Delphinidae & Hyperoodontidae)	☐ Demographic parameters	☐ Site fidelity & Movement	
☐ Baleen whales : Rorquals (Family Balaenopteridae)	☐ Pinnipeds : True seals (Family Phocidae)	☐ Field methodology	☐ Social ecology	
☐ Carnivores : Bears (Family Ursidae)	☐ Porpoises (Family Phocoenidae)	☐ Genetic ID	☐ Software/Package development	
☐ Carnivores : Mustelids (Family Mustelidae)	☐ Sirenians : Manatees (Family Trichechidae)	☐ Health conditions	☐ Thermal imagery	
☐ Dolphins (Family Delphinidae)	☐ Multiple taxa (3 or more Families/Orders)	☐ Other: (please specify)		

References

- Karczmarski L, Chan SCY, Rubenstein DI, Chui SYS, Cameron EZ (2022a). Individual identification and photographic techniques in mammalian ecological and behavioural research – Part 1: Methods and concepts. *Mammalian Biology* (Special Issue), 102 (3) <https://link.springer.com/journal/42991/volumes-and-issues/102-3>
- Karczmarski L, Chan SCY, Chui SYS, Cameron EZ (2022b). Individual identification and photographic techniques in mammalian ecological and behavioural research – Part 2: Field studies and applications. *Mammalian Biology* (Special Issue), 102 (4) <https://link.springer.com/journal/42991/volumes-and-issues/102-4>