KU Leuven Open Science Day

Building a paper bridge between biology and engineering

Mart Willocx¹

¹KU Leuven

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Abstract

Nature has already solved many of our problems, even before we knew we had them. From the flying machines of Leonardo Da Vinci, up to the upcoming mosquito-inspired needles and mussel-based bandages for organs, we can learn a lot from biology. Even more exciting, biologists have been capturing their observations of these solutions in biological literature for centuries. Sadly, engineers trying to learn from nature encounter many hurdles.

More generally speaking, it is hard to find relevant knowledge outside of your area of expertise in scientific literature without consulting an expert of the domain.

Furthermore, understanding the technical literature often requires very specific domain knowledge. Keyword-based search engines (e.g. Google) require familiarity with the vocabulary of the target domain. For example, engineers who did not follow an introductory biology course are blocked from effectively finding bio-inspiration.

By linking the vocabulary applied in different domains using continuous word representations from natural language processing, we translate a search using domain-specific terms to the other domain. This approach automatically bridges the language barrier between both domains, but requires access to a large representative dataset of both domains, and allows for retrieving relevant documents. Recent text-mining policies have started to accommodate the use of academic literature for this purpose.

Whilst trying to integrate knowledge from biology, an automatically generated summary explaining the strategy would further lower the barrier. Automatically combining the retrieved publications per organism or strategy applied and extracting the most interesting common points and technical drawings is a technical and legal challenge. Even though automatic transformation would allow for creative new uses of academic literature, some of the current Open Access licenses do not completely allow the reuse of scholarly content in this novel way. Most notably, the [CC-BY-NC-ND](#) license explicitly disallows creating derivative works that are not a collection of the original works.

As natural language processing evolves, new and exciting ways of using scientific literature will open up. With an open rights management policy on scholarly content, scientific literature can be accessible to everyone looking to adopt findings from another domain. This also ensures a future proof ability to use existing research in new and exciting ways.

The iconic nose shape of the Shinkansen high speed train allows it to quickly exit tunnels without causing a large sonic boom and was inspired by the beak of the kingfisher, which allows the bird to dive into water without causing a large disruption. Whilst biologists have known about the kingfisher's ability, it took a birdwatching engineer to make this innovation possible. The image of the train is licensed under the CC BY SA 3.0

license (Mitsuki-2368, <https://commons.wikimedia.org/wiki/File:JRW-500-nozomi.jpg>), the kingfisher under CC BY SA 3.0 (Joefrei, https://commons.wikimedia.org/wiki/File:Ein_Eisvogel_im_Schwebflug.jpg) and the books under CC BY SA 4.0 (Inayaysad, https://commons.wikimedia.org/wiki/File:College_Textbooks.jpg).

Author biography

Mart Willocx (KU Leuven) finished his studies as a mechanical engineer but was promptly convinced by the inspiring genius of nature. His current research focuses on bridging the gap between engineering and biology, giving mechanical engineers the tools to find relevant biological strategies.