Identifying conditions that sculpted bedforms - Human insights to build an effective AI

https://gc.copernicus.org/articles/4/493/2021/gc-4-493-2021.pdf

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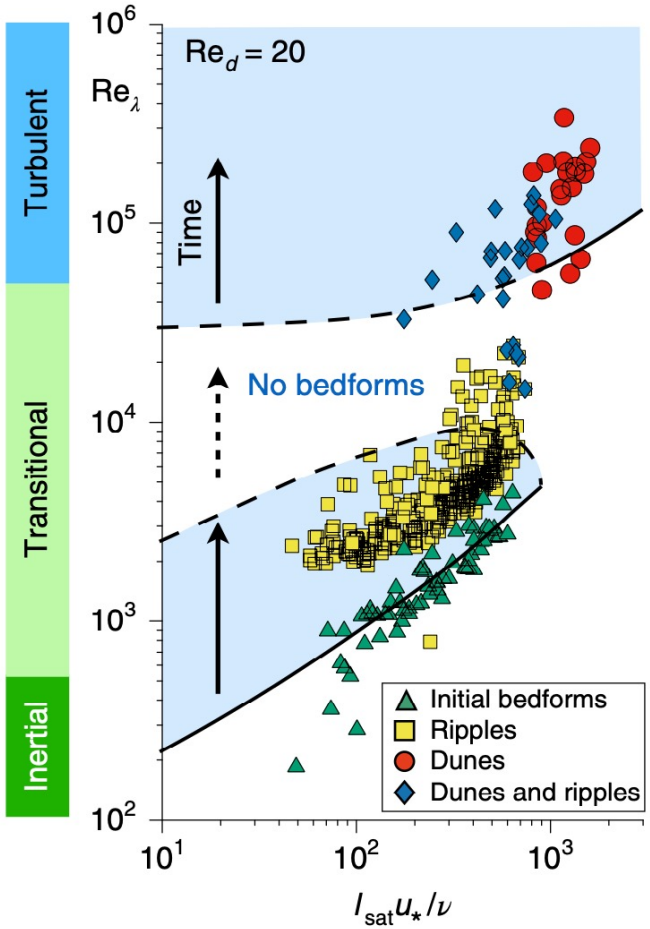
MOTIVATION

It is difficult to construct a 1-to-1 link between bedform type (e.g. ripples or dunes) and specific flow conditions.

This is annoying as we'd like to reliably infer flow conditions from bedform morphology.

Machine learning or 'Artificial Intelligence' might help.



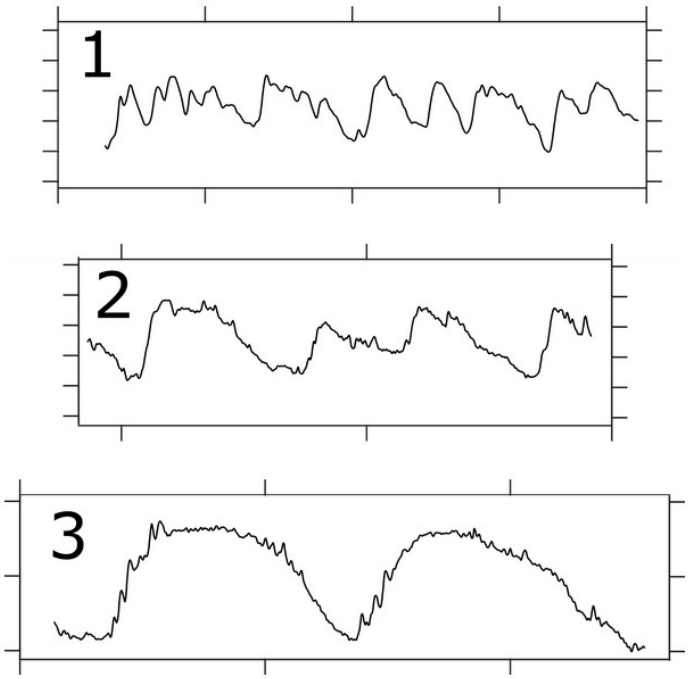
Duran Vinent et al (2019)

Loughborough University

QUIZ (https://forms.gle/qjSfJVk1FRuoy1u19)

For non-artificial intelligence i.e. you lot!

Your 'training' dataset. Examples of Bedforms. 1 = lowest stage (i.e. stress), 3 = highest stage (i.e. stress)



Question

In the fluvial environment, is it possible to distinguish flow conditions?

Result

Participants ranked the 3 flow strengths (Expts. 1-3) correctly 60% of the time, much better than the 16% expected of guesswork ($p \ll 0.01$).

QUIZ (https://forms.gle/qjSfJVk1FRuoy1u19)

So, one training dataset sufficed for the survey's participants to do a pretty good job, a stark contrast to the 1000s of datasets required to train ANNs performing pure pattern recognition (e.g. Bishop, 1996).

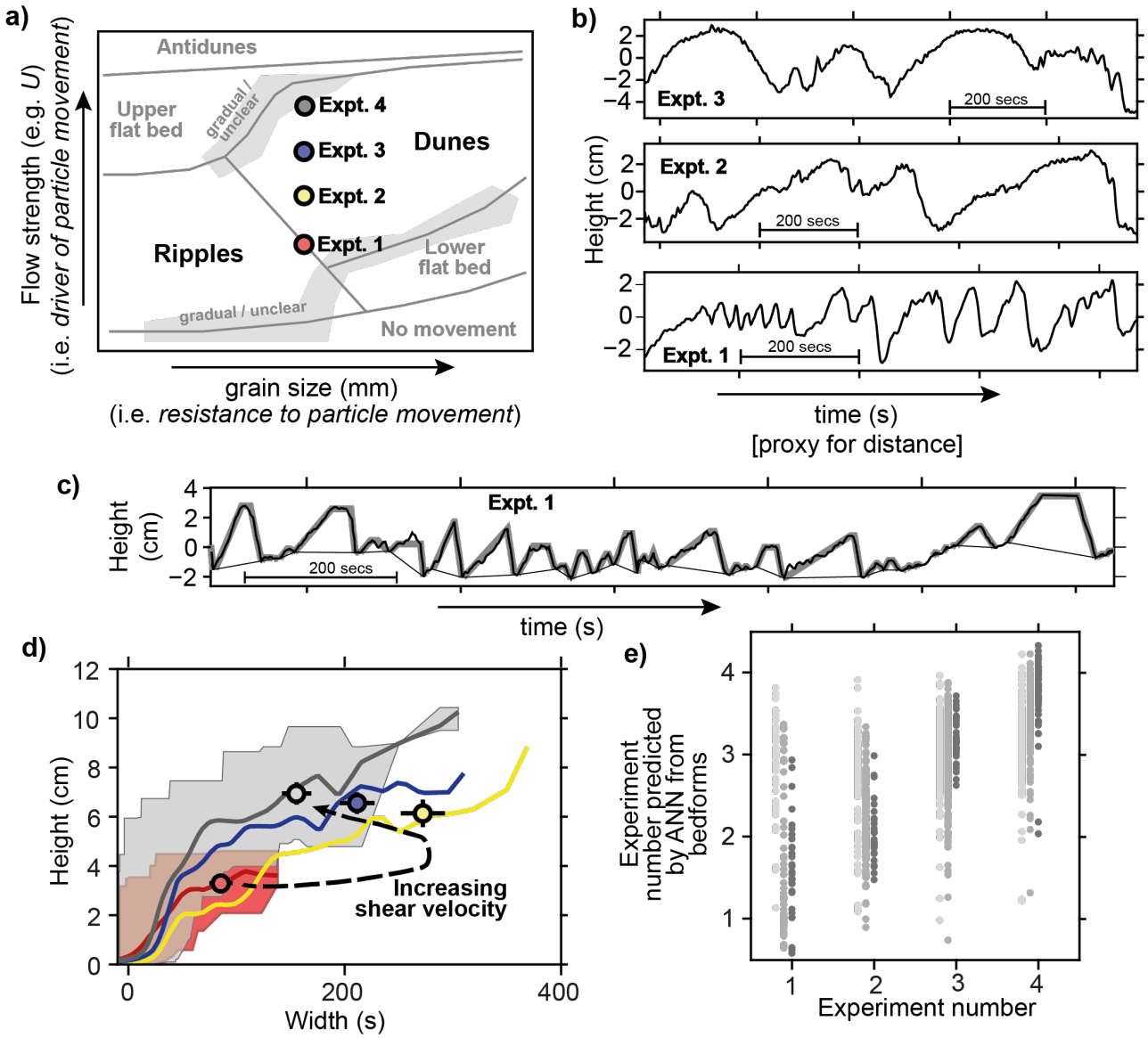
This suggests that participants drew on significant previous learning.

In none of the questions did geoscientists perform better than non-geoscientists! **So**, the prior learning is universal, perhaps the identification of basic idealized shapes when much younger.

Childhood play
(i.e. prior training)

USING AN ANN

1. For 'raw' data, segments of the time series flow regime was predicted poorly (r^2 = 0.03).
2. Fitting a simplified geometry (*H*, *W*) to bedforms (Hillier, 2008) improves results dramatically, up to (r^2 = 0.80).
3. **So,** there is potential in machine learning being useful in identifying flow regime from bedform morphology ..... with a little 'help'.



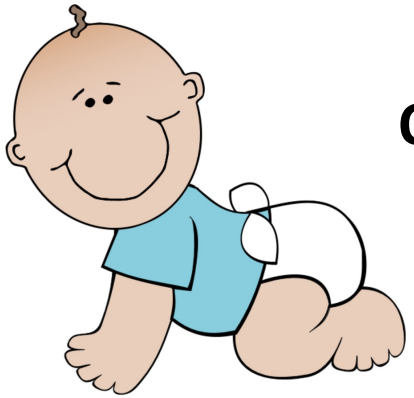
SWT Bedform quantification method:

Hillier, J. K., (2008) Seamount detection and isolation with a modified wavelet transform, *Basin Research* **20**, 555-573, doi:10.1111/j.1365-2117.2008.00382.x

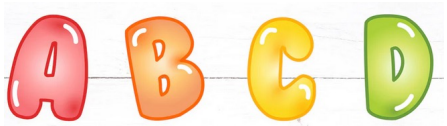
CONCLUSION

Be nice to your 'AI'! ……. give it a bit of help

(particularly with relatively limited real-world data)



OR



Recognising letters

Throw 'Shakespeare' at it - repeatedly

A Computer Science favourite ….

Throw raw profiles at the ANN!

Options

Pre-train to get bedform morphology, e.g. *H, W* via expert algorithm → Use bedform morphology for – your study site to train the AI

Pre-train a first ANN to recognise shapes (could be **any** bedform data) → Use bedform morphology for – your study site to train a second AI