

# What lies beneath?

## Revealing lichen covered surfaces at Stonehenge

G. Leong<sup>1</sup>, M. Brolly<sup>2</sup>

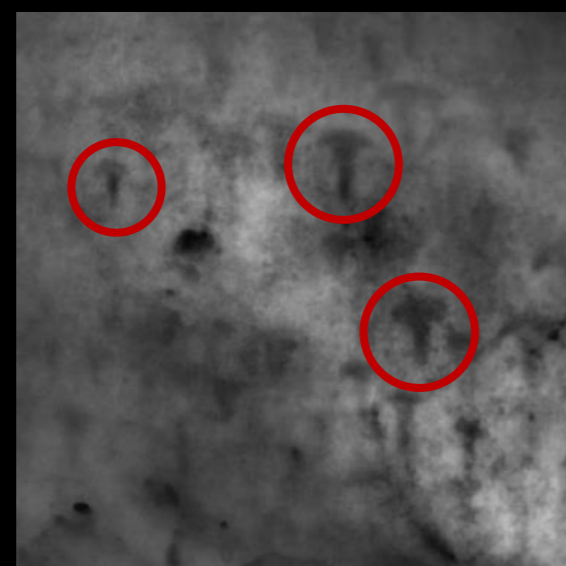
<sup>1</sup> UCL Institute for Sustainable Heritage, University College London, London, UK

<sup>2</sup> Ecosystems and Environmental Management, University of Brighton, UK

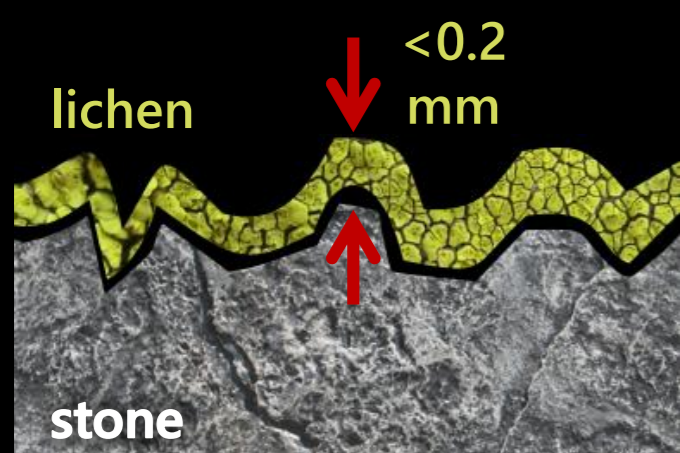
### 1 Lichen and the rock-art



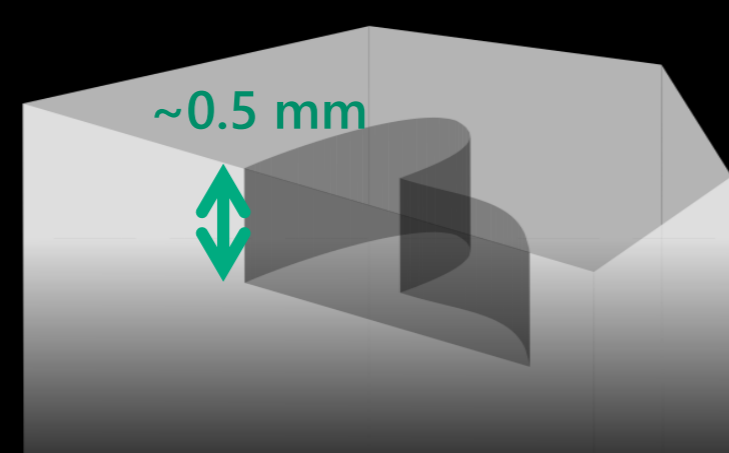
Dense coverage of shrubby fruticose lichen obscures 23% of the stone surface at Stonehenge [1]



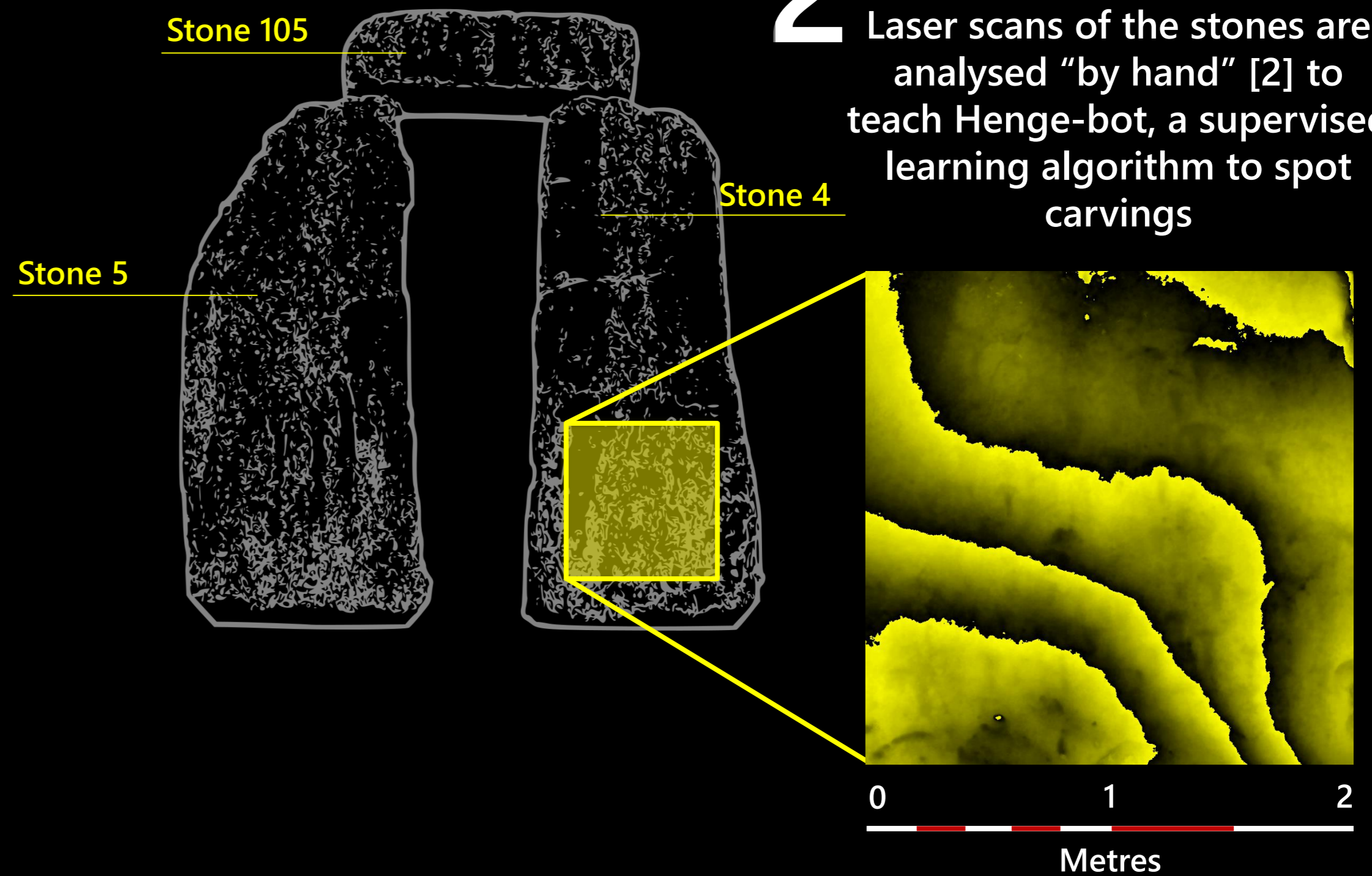
On unobscured surfaces, English Heritage discovered 71 new axe-head carvings [1]



Numerous lichen species adhere to stone surfaces with minimum variation in thickness: <0.2 mm



In contrast, the depth of the carvings is ~0.5 mm. This characteristic of lichen could be exploited to reveal new carvings

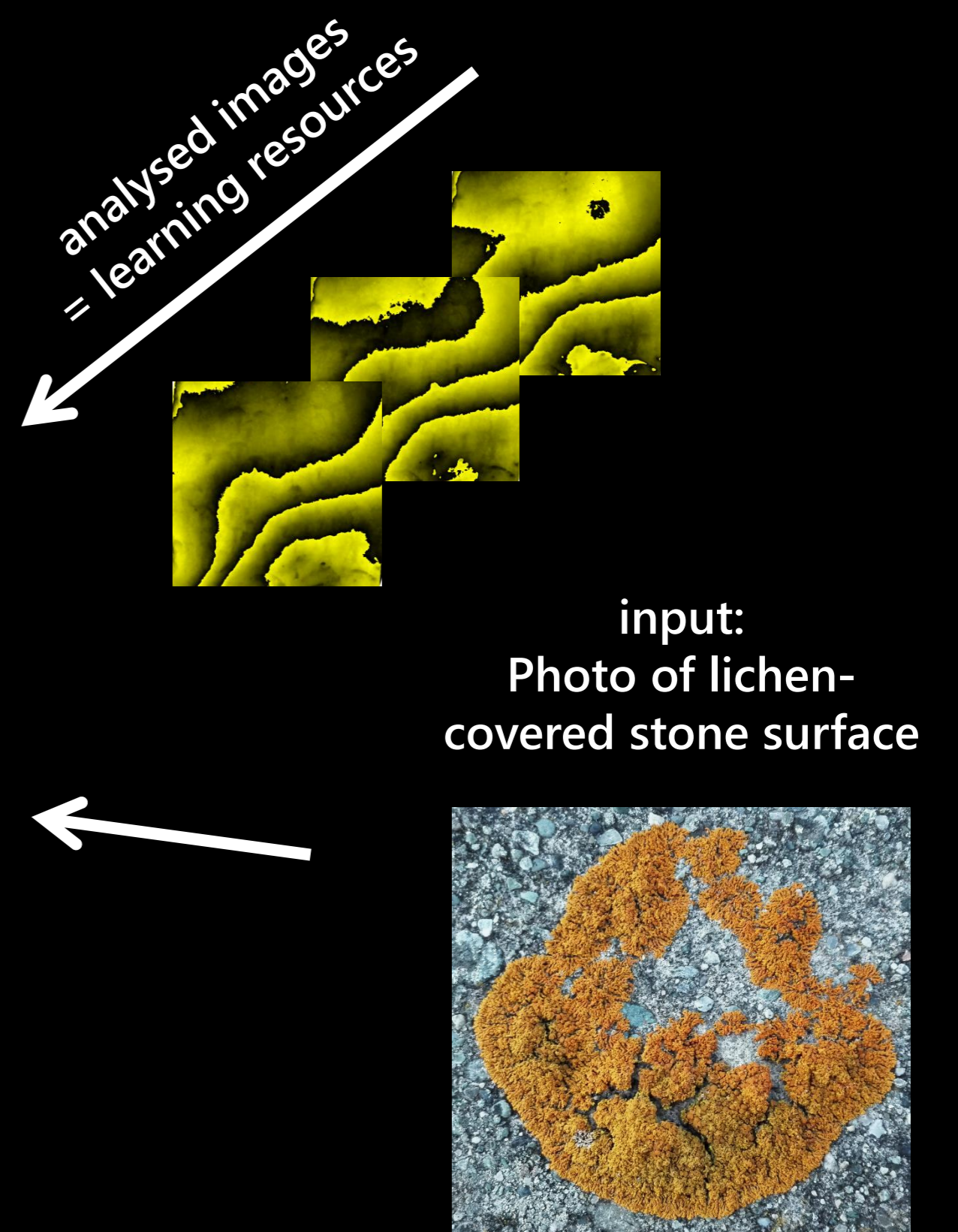
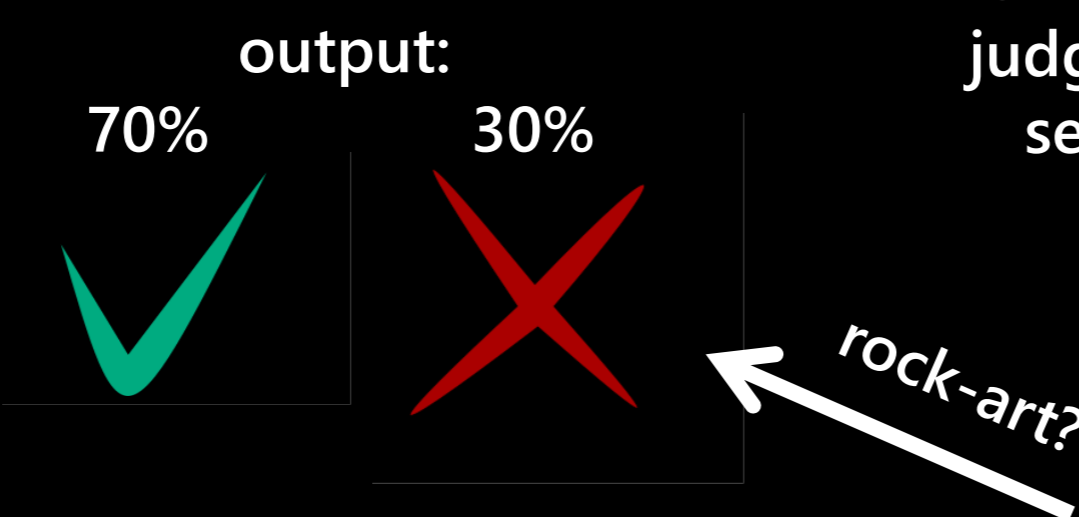


### 2 Image analysis

Laser scans of the stones are analysed "by hand" [2] to teach Henge-bot, a supervised learning algorithm to spot carvings

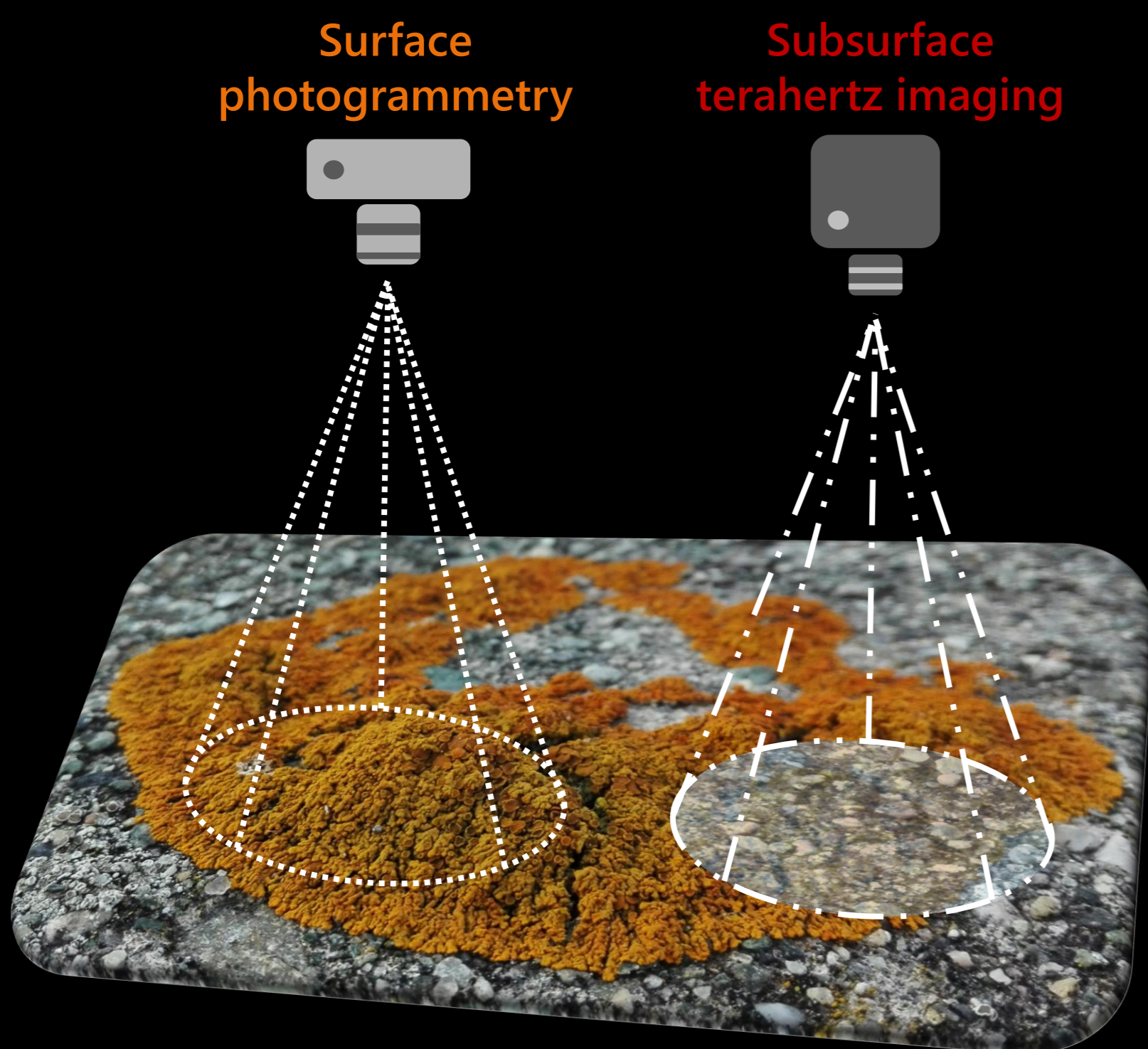
### 3 Machine vision and supervised learning

Once trained, Henge-bot can judge with what confidence it sees carving(s) in a digital image of lichen



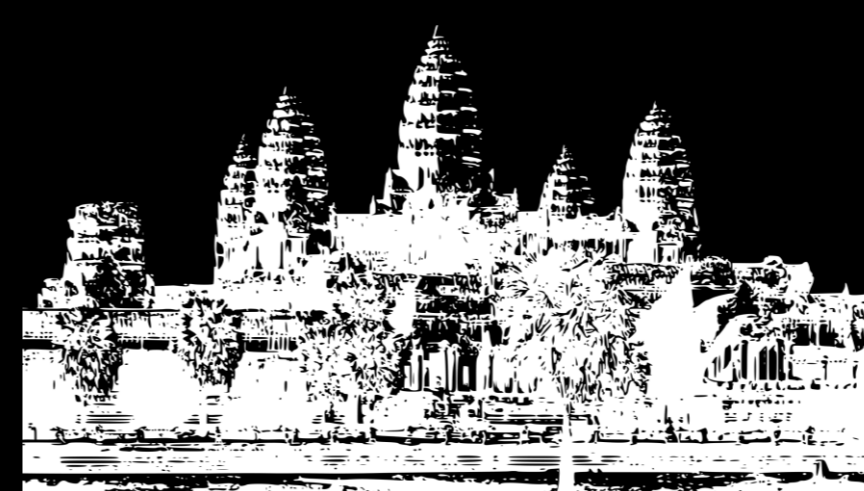
### 4 Imaging techniques

Findings are verified using terahertz imaging, which as opposed to photogrammetry, can reveal sub-surface features

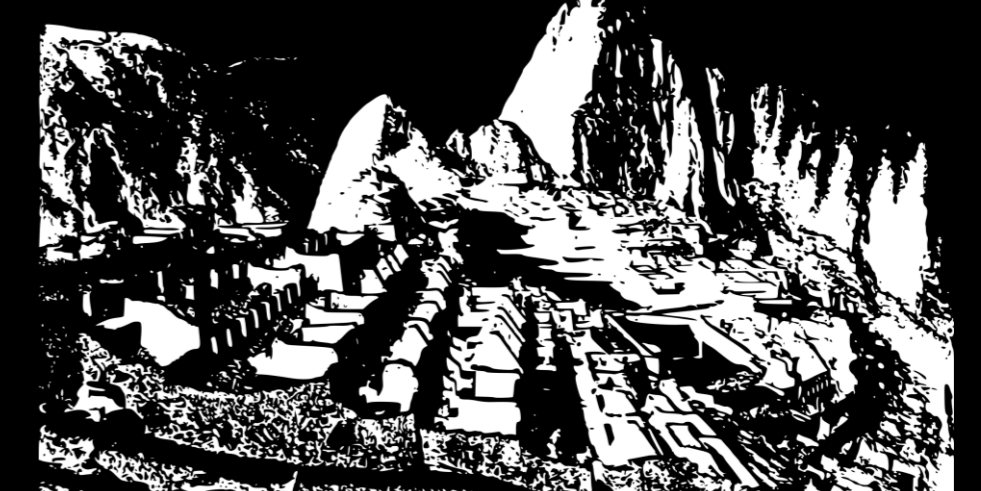


### 5 Outlook

This technique can be generalised to apply on any vegetation-covered built heritage



Angkor Wat



Machu Picchu

### Acknowledgements

This project was supported by SEAHA at UCL's Institute of Sustainable Heritage. We thank Jon Bedford from Historic England for providing the laser scan data of the Stonehenge monument.

### References

- [1] M. Abbott and H. Anderson-Whymark. Stonehenge Laser Scan: Archaeological Analysis Report. Research Report Series, 32, 2012.
- [2] G. E. Mills. Numerical tools for interpreting rock surface roughness. PhD thesis, 2015.