AUTOMATION, AUTOMATION, AUTOMATION:

Approaches to Improving the Pre-Excavation Detection of Inhumations

Bournemouth University

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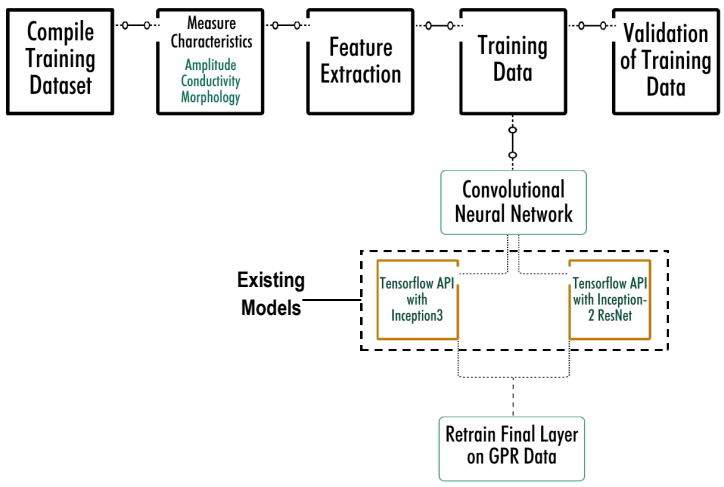
INTRODUCTION

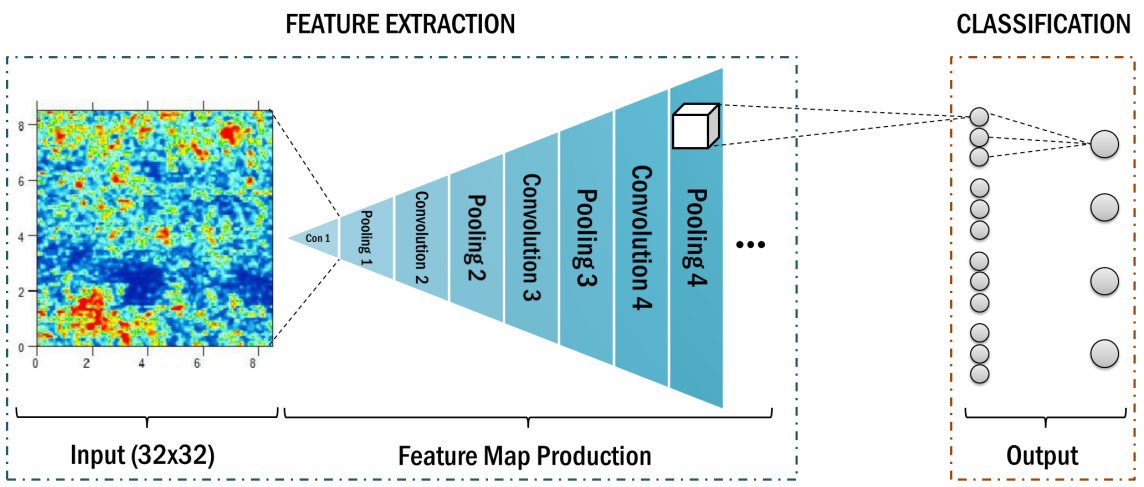
As large scale landscape surveys continue to increase in commercial and research archaeogeophysics, there is still a markedly low ability to geophysically detect and interpret archaeological and forensic inhumations in some instances. The aim of this ongoing research project is to improve data acquisition by implementing an interactive *ad hoc* workflow model for determining appropriate methodologies for ground-penetrating radar (GPR) surveys, to improve data processing speed, and reduce observer error.

Can the confidence of manual interpretations of GPR data be improved by adapting machine learning libraries for automatic object extraction and classification to GPR data based on a training dataset comprised of ground-truthed real GPR data and simulated GPR data?

METHODS



Graphical representation of methodology

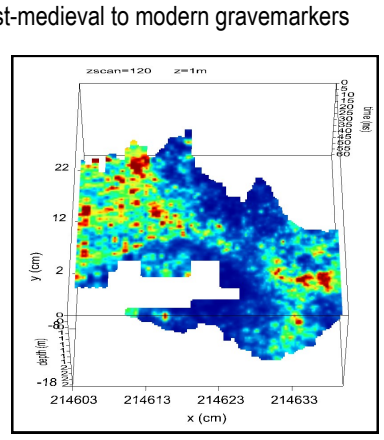


Simplified representation of a convolutional neural network

TEST SITES

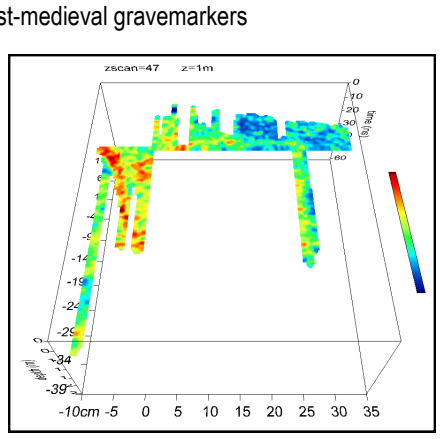
St Catherine's Church, Temple, Cornwall

- Church on site of 12th century Templar chapel once part of the Preceptory of Trebeigh
- Post-medieval to modern gravemarkers



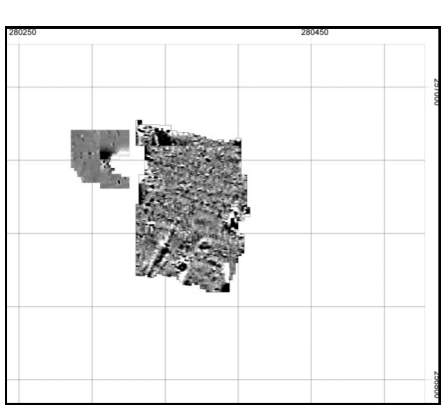
St Brendan's Church, Birr, Co Offaly, Ireland

- 13/14th century square church with 17-19th century additions
- Post-medieval gravemarkers



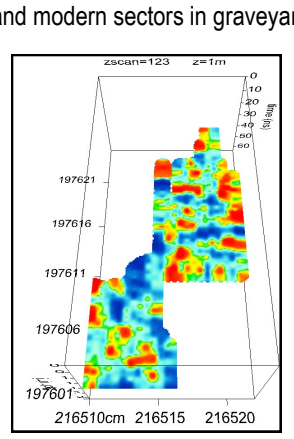
Yellow Steeple, St Mary's Abbey, Trim, Co Meath, Ireland

- Tower associated with the Augustinian abbey dedicated to St Mary
- Built before 1140



Roscomroe Church, Roscrea, The Leap, Co Offaly, Ireland

- Late medieval rectangular church dedicated to St Molua
- Medieval and modern sectors in graveyard



PRELIMINARY RESULTS

```
(C:\Continuum\Anaconda3\envs\tensorflow) C:\Users\agreen>cd models/tutorials/ima
ge/imagenet

(C:\Continuum\Anaconda3\envs\tensorflow) C:\Users\agreen\models\tutorials\image\
imagenet>python classify_image.py
2017-09-07 11:21:25.012539: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
t compiled to use SSE instructions, but these are available on your machine and
could speed up CPU computations.
2017-09-07 11:21:25.012539: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
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could speed up CPU computations.
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1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
t compiled to use SSE3 instructions, but these are available on your machine and
could speed up CPU computations.
2017-09-07 11:21:25.012539: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
t compiled to use SSE4.1 instructions, but these are available on your machine a
nd could speed up CPU computations.
2017-09-07 11:21:25.012539: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
t compiled to use SSE4.2 instructions, but these are available on your machine a
nd could speed up CPU computations.
2017-09-07 11:21:25.012539: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\platform\cpu_feature_guard.cc:45] The TensorFlow library wasn'
t compiled to use AVX instructions, but these are available on your machine and
could speed up CPU computations.
2017-09-07 11:21:26.557088: W c:\l\tensorflow_150190720608 4\work\tensorflow-1.2.
1\tensorflow\core\framework\op_def_util.cc:332] Op BatchNormWithGlobalNormalizat
ion is deprecated. It will cease to work in GraphDef version 9. Use tf.nn.batch_
normalization().
giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca (score = 0.896
32)
indri, indris, Indri indri, Indri brevicaudatus (score = 0.00766)
lesser panda, red panda, panda, bear cat, cat bear, Ailurus fulgens (score = 0.0
0266)
custard apple (score = 0.00138)
earthstar (score = 0.00104)
```
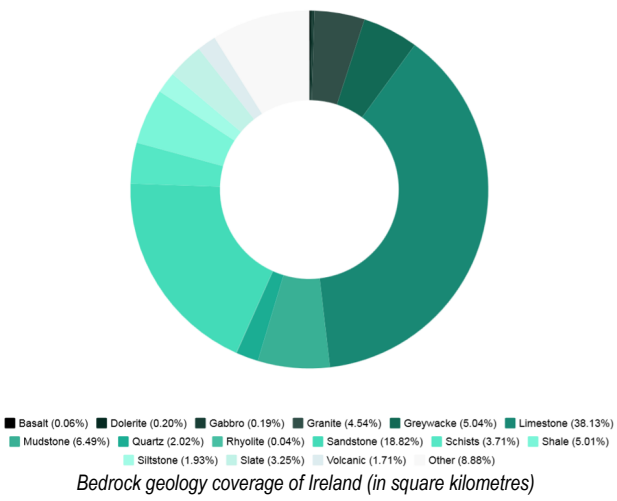

Example of output given by Tensorflow Inception-v3 trained on ImageNet data (Google 2017)

Type	Sample Size	Avg Length	Avg Width	Avg Depth	Soil Types
Lintel	23	1.895m	0.42m	0.295m	Clay, Sandy Clay, Clayey Loam
Cist	5	1.69m	0.40m	0.27m	Clay, Sandy Clay, Clayey Loam, Sand
Unlined	42	1.8m	0.67m	0.27m	Clay, Sandy Clay, Clayey Loam
Slab-lined	3	1.58m	0.88m	0.4m	Clay, Sandy Clay, Clayey Loam, Sand
Pit	6	1.94m	0.87m	0.33m	Clay, Sandy Clay, Clayey Loam
Later Medieval Simple	1	-	-	0.3m	Clay, Sandy Clay, Clayey Loam
Later Medieval Pit	1	0.7m	0.7m	0.3m	Clay, Sandy Clay, Clayey Loam
Later Medieval Coffin	2	1.775m	0.525m	0.45m	Clay, Sandy Clay, Clayey Loam

Measured characteristics used to simulate GPR data and train the networks (after Cahill and Sikora 2011)



Bedrock geology coverage of Ireland (in square kilometres)

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Have data you would like to contribute to the training dataset? Let me know!