9 Conclusions

The goal of this thesis has been to show that the use of change identifiers will reduce the time taken to maintain a footprint over a dynamic dot pattern while introducing an acceptable level of error.

The inquiry began with an investigation of the dot patterns. Our goal was, not merely to provide background to the change identifiers, but to see if measurements on the dot patterns could provide useful information in its own right. This exploration of the dot patterns led to the identification and analysis of the dot pattern descriptors. There is a wealth of information present in the individual patterns and the descriptors are measures of this data. It was found that, not only, could the descriptors provide an stable base for the change identifiers but that they may be able give a classification structure for the dot patterns. A preliminary examination of how this classification might be constructed is demonstrated in Chapter 10.

Footprints have a large scope of operation; appearing in different forms across a range of fields. Before looking at the change identifiers this thesis devoted a chapter (Chapter 4) to the investigation of the types of footprint that are commonly produced by the footprint algorithms in the literature and proposed a classification (as an extension of the work performed in [21]) based on this investigation. The chapter also looked at how the footprint type may be affected as it is updated over a dynamic dot pattern; further discussion on which can be found within the future work chapter.

Having discussed the underlying aspects of the proposed problem the thesis examined the change identifiers in greater detail. Chapter 5 presented the change identifiers used within this thesis and proposed a method with which to combine them into sets measuring mutliple different types of change. It also introduced an assessment approach based on comparing the stored footprint the change identifier set presented at any particular dot pattern phase with the 'true' footprint, i.e. the footprint that would have been created had the algorithm been run for the phase.

With the change identifiers defined and an assessment method in place the experimentation could be performed. The results of these were shown in Chapter 7, which also detailed the range of dynamic dot patterns and algorithms that were used to provide a fair appraisal of the change identifier sets' worth. Chapter 7 showed that it was possible to reduce (greatly in some instances) the number of footprint updates while maintaining a symmetric area difference that was low proportional to the area of the 'true' footprint. The chapter also demonstrated that some identifier sets can out-perform others for specific patterns and that it is possible to create sets to do so using knowledge about the dynamic dot pattern's nature. Finally the results indicated that some identifiers may be generally more applicable than others.

Choosing the appropriate set for any given application is the main difficulty that may arise when using them. For some applications it may be easy to know in advance what type of change is most likely to occur and therefore which identifiers to use, however there are some applications in which the change can occur in different and unpredictable ways. In such erratic cases we need to find a set of identifiers which can identify a mixed range of change types while still making time savings. The chapter on change identifier set selection Chapter 8 undertook this search using Multi-Objective Optimisation techniques which converged on some identifiers that were generally applicable to the test data used. It was noted, however, that this did not indicate that these identifier were superior to others, but that they are useful in many situations. The chapter also compared the generally applicable sets with a set created using knowledge about a dynamic dot pattern to confirm the statement within the results chapter that a human can create effective sets without needing to perform large scale analysis of the dynamic dot pattern.

This thesis has presented the concept of change identifiers and shown that they can be used to reduce the number of footprint updates required to have a suitable representation of a dynamic dot pattern with a user controllable error trade-off. It has provided an initial set of change identifiers and a framework in which they can be used. Further to the use of change identifiers as a way of reducing the number of updates other uses they might have were explored. This exploration led to the conclusion that the information supplied by the change identifiers could well be useful in its own right, perhaps even by-passing the need to produce a footprint in many cases (for example when it only needs to be known if the extent is increasing).

We conclude that the change identifiers are a useful and novel approach to the examination of dynamic dot patterns and that they have scope for use beyond that presented here. We make this statement while aware that there is certainly need for more testing over real world data and note with interest the forthcoming workshop to be chaired by Dr Antony Galton and Dr Zena Wood (Understanding and Modelling Collective Phenomena) which will hopefully provide more examples of such data.

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