Visualising Live Code Study Report

Arrian Purcell

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For most of its history programming code has been displayed as simple text due to the expressiveness of this format and despite its inefficiencies. It is only recently, due to ever increasing programming language complexity and increasing computational power, that code annotations and syntax highlighting have become more commonplace. Nevertheless, these visual enhancements rarely provide information beyond the basic grammar of the language they are intended to augment. The limitations of this approach are becoming ever more apparent as programming languages and interactive programming environments move towards the need for real-time comprehension.

[talk about interactive programming environments and real-time comprehension]

The human brain is highly proficient in pattern recognition (Ware, 2013) and there is evidence to suggest that visualisations can take advantage of this proficiency to enhance understanding (Najjar, 1998). From this, one could potentially conclude that visualisations could be further applied to aid in the process of real-time code comprehension within the space of interactive programming environments [citation needed].

[how can the problem be approached?]

To this end, two code visualisations have been analysed in a live coding context to determine effective presentational and educational features. The two visualisations evaluated included a visualisation targeting aesthetic appeal and a visualisation with a more didactic approach. The goal was to determine differences and desirable aspects of the two visualisation approaches in order to inform future live coding visualisations.

The set of didactic visualisations predominantly focussed on the relationship between the live coding active processes and their behaviour. The visualisations prominently displaying the names of the active functions with visual indication of the number of functions running and their callback time. Bright colours and solid shapes were used to ensure constant visibility and communicate the intention of the underlying code. An example of this approach can be seen in Figure 1b. Overall, four visualisations were presented with each introduced depending on the number of active functions.

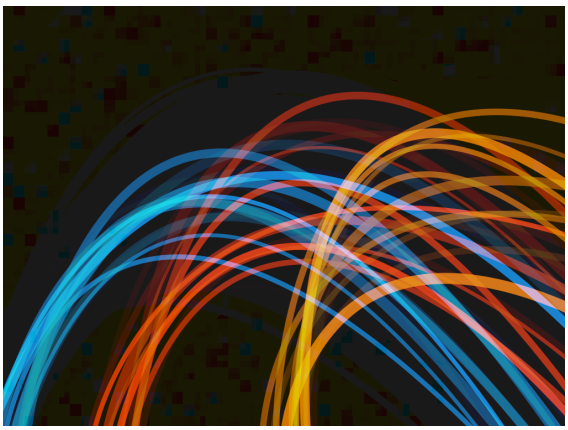
The set of aesthetic visualisations focussed less on the programmatic aspects of the live coding performance, rather intending to provide additional visual interest to the projected code. To this end, more variety was used in visual structure and colour. An example of this approach can be seen in Figure 1a. Again, four visualisations were presented, varying which visualisation was displayed depending on the number of active functions.

[literature supporting the visualisations presented]

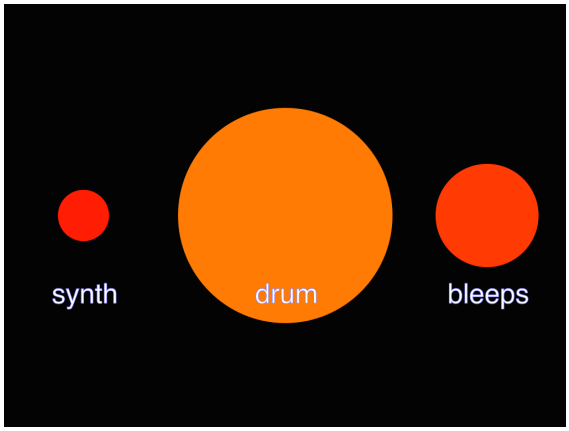
visual variables...

hierarchy of graphical elements...

visualisation analysis model...



(a) Aesthetic Visualisation



(b) Didactic Visualisation

Figure 1: Visualisation Examples

[summary]

[link to study method]

1 Method

Two sets of visualisations were presented during a live coding performance. The performance was run as two ten minute improvised songs with each song demonstrating one of the two experimental visualisations conditions including the didactic condition and the aesthetic condition. The experiment was run twice, with two separate participant groups, rotating the order in which the experimental conditions were administered.

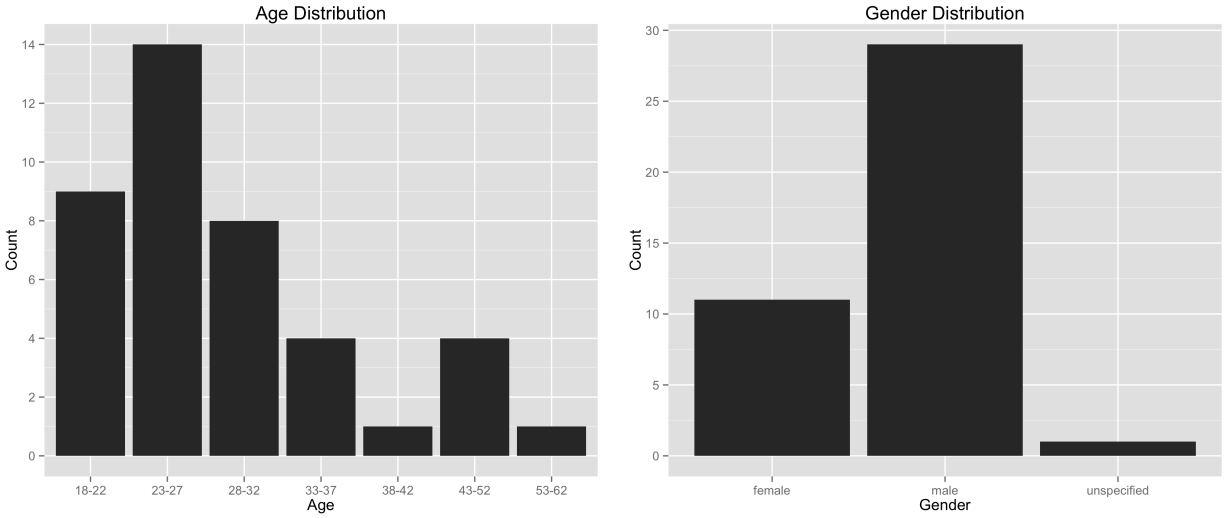
After explaining to the participants the order and the high level intention of the experiment and allowing the participants to complete the initial demographic section of a survey, the live coder began a performance set utilising one type of visualisation with music. Following this first set, some survey questions were administered to the participants asking them specifically about their enjoyment and understanding related to the visualisations. A second set was then played using the alternative visualisation. Following this second set, the same survey questions were administered again, again asking the participants specifics about their enjoyment and understanding related to the specific visualisation demonstrated. A final survey question was then asked relating to their opinion regarding the whole performance and suggested improvements.

2 Participants

A total of 41 participants took part in the study. 66% of the participants stated that they were male (see Figure 2b) and most participants were aged between 18 and 32 (76%, see Figure 2a). As the study was conducted within the Computer Science Department, a large proportion of the participants were experienced with programming with 90% having current or previous experience with it. Nevertheless, only 15% of participants had previous experience with any of the Lisp style languages.

Of the participants, 68% stated that they listened to a large amount of music (see Figure 4a) though only about 15% of participants stated that they played and instrument or sung regularly (see Figure 4b). Only 22% of participants had seen a live coding performance before.

Over the two performances, 19 participants observed the first performance and 22 participants observed the second performance. The demographic makeup of the two performances were very similar.



(a) Age Distribution

(b) Gender Distribution

Figure 2: Basic Demographics

Table 1: Help Understanding by Participant Count

	Yes	No	No Opinion
Aesthetic	5	26	10
Didactic	15	21	5

3 Results

3.1 Aesthetic vs Didactic Visualisation

For the following statistical analysis a significance level of 0.05 will be used with the chi-squared test for independence.

Understanding and enjoyment trends throughout the performance are available in Table 3 and Table 4.

3.1.1 Understanding

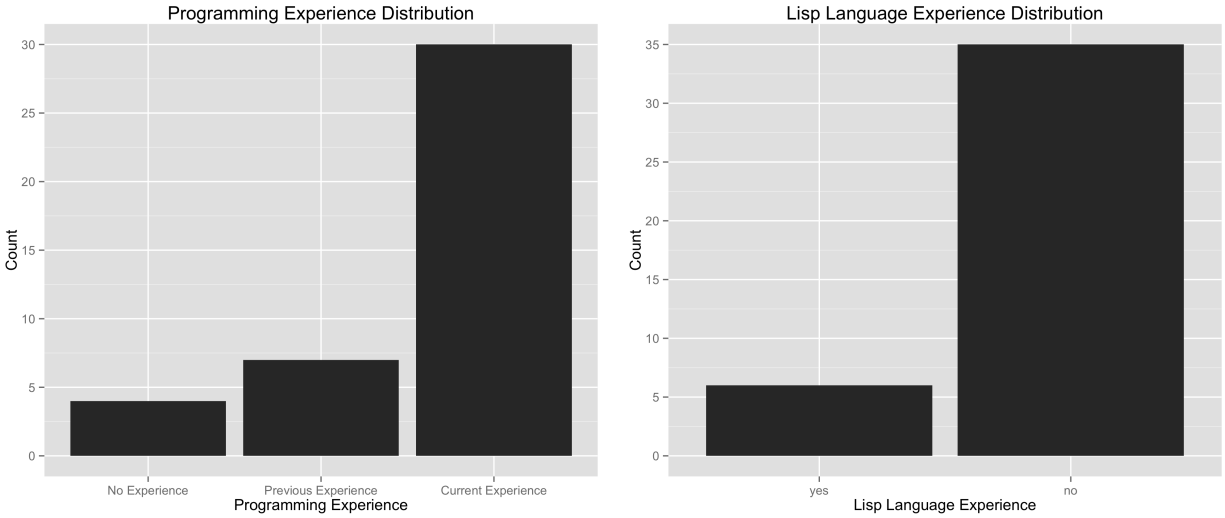
Overall, 15 participants stated specifically that the didactic visualisations helped them to understand the code, whereas 26 participants stated that the aesthetic visualisations did not assist in understanding the code. See Table 1.

H_0: There is no difference between the aesthetic visualisations and didactic visualisations in terms of understanding.
H_1: There is a difference between the two visualisations in terms of understanding.

Significant difference between the visualisations effect on understanding were found ($\chi^2 = 7.1986, df = 2, p = 0.02734$).

3.1.2 Enjoyment

Overall, for both visualisations, a large proportion ($> 50\%$) of the participants stated that the visualisations helped their enjoyment of the performance. See Table 2.



(a) Programming Experience Distribution

(b) Lisp Experience Distribution

Figure 3: Programming Demographics

Table 2: Helped Enjoyment by Participant Count

	Yes	No	No Opinion
Aesthetic	31	5	5
Didactic	24	12	5

H_0: There is no difference between the aesthetic visualisations and didactic visualisations in terms of enjoyment.
H_1: There is a difference between the two visualisations in terms of enjoyment.

No significant difference between the two visualisations effect on enjoyment were found ($\chi^2 = 3.7733, df = 2, p = 0.1516$).

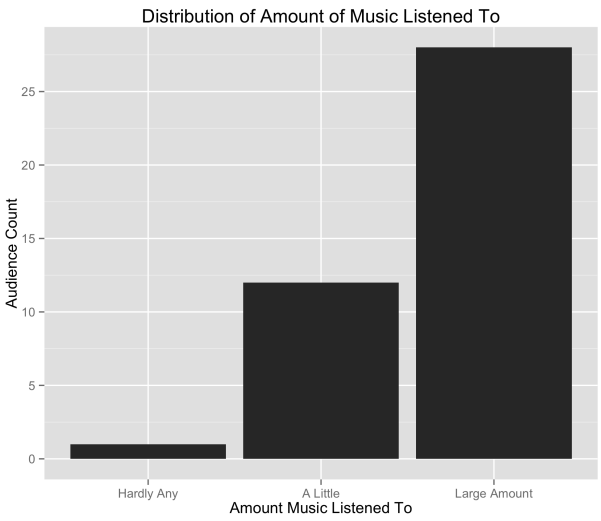
4 Discussion

In general, the visualisations contribution to enjoyment was fairly positive. This was the case for both visualisations. For understanding however, only the didactic visualisation assisted understanding during the performance.

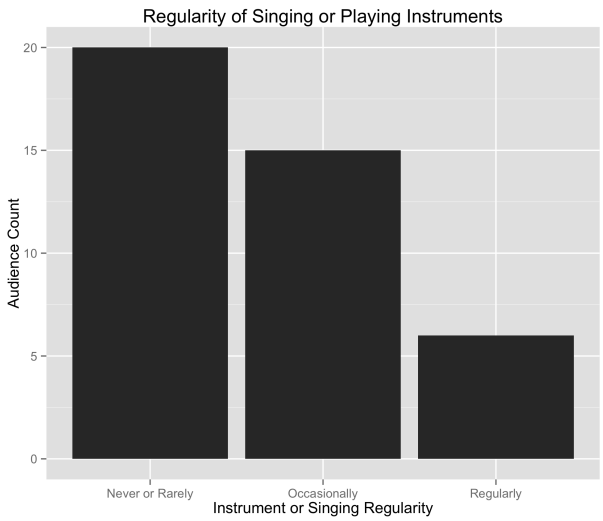
A number of participants stated that the didactic visualisations were distracting, too abrupt or took away from the code in other ways. On the other hand, some said that the didactic visualisations gave the per-

Table 3: Understanding Trend by Participant Count

	Up	Down	Flat	Unspecified
Aesthetic	13	8	18	2
Didactic	15	4	20	2



(a) Listen to Music Regularity Distribution



(b) Playing Instrument or Singing Regularity Distribution

Figure 4: Musical Demographics

Table 4: Enjoyment Trend by Participant Count

	Up	Down	Flat	Unspecified
Aesthetic	15	11	13	1
Didactic	15	12	14	0

formance a sense of being 'too polished'. The general consensus, however, was that the visualisation should either better reflect the code, better reflect the music or have more variety.

The response to the aesthetic visualisation [...more discussion to come]

5 References

@bookware2013information, title=Information visualization: perception for design, author=Ware, Colin, year=2013, publisher=Elsevier
@articlenajjar1998principles, title=Principles of educational multimedia user interface design, author=Najjar, Lawrence J, journal=Human Factors: The Journal of the Human Factors and Ergonomics Society, volume=40, number=2, pages=311–323, year=1998, publisher=SAGE Publications