Combining and Uniting Business Intelligence with Semantic Technologies

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Evaluation of Use Case Prototype

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1 Introduction

This document records the evaluation of the HWU-centric (biological) CUBIST prototype. Contained in this report are:

- a description of the test users who took part in the evaluation;
- an overview of the tasks performed in the evaluation;
- a summary of the evaluation protocol;
- a list of the questions formerly put to the test users; and,
- the responses to the questions.

Please note, this deliverable describes the evaluation and its raw results. It does not provide any substantive analysis or discussion of those results. This is left for the combined deliverable – D1.4.2 – that shall pull together themes from across the separate use cases.

Additionally, this document contains results from the evaluation of the HWU-specific prototype visualisations developed exclusively for this use case.

2 Description of Test Users

Two users will test the HWU version of the CUBIST prototype. Each user will represent a different persona, which was defined in deliverable D7.1.1. This section shall describe those users in more detail.

2.1 Test User 1

Peter Stevenson trained as a geophysicist before undertaking an MSc in Computer Science. Upon graduating he joined the EMAGE team in a role requiring him to provide both IT support and software development to EMAGE's editors. With over ten years of experience in that role, Peter represents the typical software developer depicted in the persona defined in D7.1.1.

Like most software developers, Peter does not interact with EMAGE on a daily basis. Instead he works with the raw data. Occasionally, he uses EMAGE's web interface to check the accuracy of his work and to explore related data. EMAGE does not currently have any analytical tools; accordingly, Peter is not familiar with the concepts of BI nor the tools and their visualisations.

It should be noted that the functionality of CUBIST is targeted more towards expert biological power users rather than the class of occasional users that Peter represents. Therefore, whilst interesting, the responses of this test user are less informative than the second user who is a prime example of our target user group.

2.2 Test User 2

Chris Armit is EMAGE's senior editor. He has both an undergraduate degree in Developmental Biology and a PhD in Pathology. He currently leads a team of editors who have the tasks of ensuring that the experimental data submitted to EMAGE is of sufficient quality to be published. Accordingly, Chris interacts with the EMAGE data, via proprietary tools, on a daily basis.

One of Chris' key roles is customer relations. He interacts with EMAGE users regularly to ensure that they are aware of EMAGE's latest capabilities, and that he is aware of their needs. This knowledge allows Chris to shape the future direction of EMAGE.

Chris will fulfil the role of the biological persona (see D7.1.1.) in this evaluation.

Again, it is worth noting, Chris has no experience of Business Intelligence tools beyond the discussions he has taken part in with respect to the development of CUBIST.

3 Predefined Tasks

Whilst CUBIST enables numerous data-centric tasks to be performed, this evaluation focuses on just three. These tasks are designed to demonstrate the breadth of CUBIST functionality.

3.1 Task 1

The first task is designed to highlight the mechanisms through which the data can be navigated. It uses both the listview and the graph exploration.

The listview element demonstrates the ability to navigate through the dataset using the relationships between entities contained within the underlying use case ontology. The user is provided with a mechanism for exploring the underlying (and hidden) RDF graph on which the prototype is built.

Graph exploration offers the same functionality, but this time the underlying RDF graph is visualised. The user clicks on nodes and sees the graph expand on screen as (s)he does so.

This task helps the user gain an understanding of what subset of the EMAGE data is stored in CUBIST.

3.2 Task 2

Task two has the goal of comparing the gene expression profile of genes *Bmp2*, *Bmp3* and *Bmp4* in Theiler Stage 17.

This task involves generating a query including a filter, and the interpretation of a simple lattice in CUBIX. The lattice is then compared to the Sankey and Icicle diagrams.

The additional views, in particular the “Attribute Inferences”, are discussed.

This task is designed to be a training task that helps familiarise the evaluation test users with the CUBIX interface and FCA visualisations.

3.3 Task 3

The final task is a more complex version of task 2, essentially the first real query that a biological user may ask. The previous two tasks function as training exercises that demonstrate the functionality of CUBIST, while this task illustrates the power of the implemented paradigm.

Task 3 has the goal of showing how CUBIST can be used to compare the expression profiles of similar tissues or genes.

To begin, the task involves comparing the gene expression profile of the heart in TS12 (Theiler Stage 12) with that of the heart in TS13. Initially, the query does *not* feature the

"strength" as an attribute. This provides a lattice in which it is clear that the two tissues have only one gene in common. However, it is not clear what the level of expression is.

In the second half of this task, returning to the home screen, the query is extended to include the "strength" attribute. Once the lattice is visualised, and explored, it becomes evident that the gene has different levels of expression in each stage. This is exactly the kind of result the biological users are interested in. As such, this task is a forceful exemplar of the CUBIST technology.

4 Summary of the Evaluation Plan

A simple protocol governed the evaluation and what the test users did. It shall now be described.

Before the evaluation

1. All potential test users (and their colleagues) saw a presentation explaining CUBIST and providing a brief overview of the prototype[1].
2. When they were invited to take part in the evaluation, the test users were reminded of the presentation.
3. Test users were told that SAP would control the evaluation via teleconference, and that the teleconference would be recorded.

During the evaluation

1. The users were given an introduction to the aim of the project, and this evaluation in particular.
    - It was emphasised that the users should judge the ideas contained within the prototype rather then the actual software.
    - Permission was sought to enable us to record the evaluation session.
2. A local expert user guided the users through a twenty-minute demo using the three tasks described in Section 3.
    - The user was invited to comment and ask questions.
3. The test user was then given the opportunity to play with the prototype, assisted by the expert.
4. SAP asked the interview questions.
5. The test user was thanked for this participation.

Following the evaluation

1. A short questionnaire was emailed to the test user.

[1] This occurred weeks before the actual evaluation, and thus used an older version of the prototype than the evaluation.

5 Interview Questions and Answers

Once the demonstration of the tool had concluded, the user was asked a range of interview questions. This section will list the interview questions as well as the answers given by the two test users. The contents of this section are essentially the remarks noted by SAP during the interview.

Due to time constraints not every question was asked – these questions have a response of *skipped*. Where the user did not, or could not, answer the question the response is documented as *no response given*.

Additional notes provided by the editor are written in *italics*.

5.1 Test User 1 – software developer

Unfortunately, the teleconferencing software malfunctioned and thus the first user was questioned two days after the demo rather than immediately after. This meant that he did not have access to the prototype whilst being questioned and was therefore unable to remember all the elements clearly. Furthermore, due to his own time constraints the user was unable to explore CUBIST as much as he felt was necessary. As such, his comments are brief.

5.1.1 Interview

- Name: Peter Stevenson
- Age: 50
- Gender: male
- Profession: software developer
- Computer Usage per day in hour: 8
- Date of Test: 17/07/2013
- Location of Test: Edinburgh
- Please rate your overall computer skills?

☒ Very good (e.g. programming, security, data modeling, …).

5.1.2 For the tasks as conducted:

1. Please shortly describe the tasks you conducted with CUBIST:

See section 3

What do you expect from a system to fulfill these tasks?

No expectations

2. Did the system offer you the right information to fulfill your analytical tasks?

Very specialized, maybe help expert biologists…

3. Did you discover new facts during your analysis tasks that you had not expected to discover at all before?

No only demonstration, couldn't test it

(*note: the user had to leave because of his own time constraints)*

4**. If the tasks fulfilled are typical for your daily work, do you think the tool can enrich your daily work by offering new ways to analyze your data?**

No because not typical tasks for me

(*note: as mentioned earlier, the system is really aimed at expert biologists not software developers*)

5.1.3 For more tasks:

5. Which analytical systems do you currently use in your daily work?

None.

6. From your point of view …

- Please shortly describe what is missing in current systems to use them effectively for your daily tasks:

  No current system

- Do you think CUBIST fills an analytical gap or provides functionalities that better fit your analytical tasks? Why do you think so?

  Possibly, couldn't understand everything, difficult to understand principles

7. **Next to the data/use case currently implemented in the system, do you see any content from your daily life (private and professional) to be integrated in the system in future?**

No, not routinely doing data analysis

8. For which kind of tasks from you daily work do you believe the system can be especially useful? Please describe the tasks and the possible benefit shortly:

n/a

9. For which kind of tasks from your daily work do you believe the system is annoying / ineffective? Please describe the tasks and the possible drawbacks shortly:

n/a

5.1.4 Comparing the different CUBIST means to access information

Which of CUBIST's analysis components did you find most valuable for your tasks and why?

- "Search and Select" Panel

  Intuitive

- Instance View

  No response given

- "Explore Selection" Panel

  No response given

- "Analyse Selection" Panel

  Difficult, promising, interesting visualization

- Traditional Visualization (e.g. bar charts):

  No response given

- Other – Function:

  No response given

10. For each of the following components, what do you think for what kind of information need it is suited best (e.g. number analysis, …)?

- "Search and Select" Panel

  Straightforward way to get into the data,

- "Navigate in Data" Panel

  Can't remember, alternative view

- "Explore Selection" Panel

  No response given

- "Analyse Selection" Panel

  Discover certain relationships, see differences, unusual things

- Traditional Visualization (e.g. bar charts):

  Presentation in ppt

- Other – Function:

  No response given

11. How easy was it for you to choose the most appropriate analysis approach and visualization for your needs from the overall functionalities offered:

Difficult because, (*he*) have not see the system before, very little time

12. What (functionalities and/or system in general) was the major drawback of CUBIST for you and why?

Complexity, did not understand the visualization

13. Do you think you understood how all the different means offered by CUBIST to access information interact? Comment if necessary.

Yes, ok

14. How did you like the guidance offered by the system to navigate through the available information? Please comment your decision.

Good guidance. Because: filtering understood, explore

15. Did you immediately understand how to read the visualizations and use the analysis functionalities in the tool?

No: too complex

5.1.5 Disliked/Unneeded/Missing Features

In this part, we aim at finding out disliked, unneeded or missing features. We do this per component.

16. For each of the following components, which features do you dislike most? And Why?

- "Search and Select" Panel

  fine

- "Navigate in Data" Panel

  no response given

- "Explore Selection" Panel

  fine

- "Analyse Selection" Panel

  Complexity, not readable, for big datasets not readable

17. For each of the following components, which features are not needed from your point of view?

- "Search and Select" Panel

  No response given

- "Navigate in Data" Panel

  No response given

- "Explore Selection" Panel

  No response given

- "Analyse Selection" Panel

  too many options, too heavy

18. And finally, each of the following components, which features missing?

Nothing missing

5.1.6 Famous last words

Do you have any more comments or remarks?

Well designed

5.2 Test User 2 – biologist persona

5.2.1 Interview

- Name: Chris Armit
- Age: 38
- Gender: male
- Profession: senior editor of EMAGE
- Computer Usage per day in hour: at least 8 h per day
- Date of Test: 21/08/2013
- Location of Test: Edinburgh
- Please rate your overall computer skills?

  Good (e.g. frequently using spreadsheet applications, advanced in office tools, analysis tools,…)

For the tasks as conducted:

1. Please shortly describe the tasks you conducted with CUBIST:

See section 3.

What do you expect from a system to fulfill these tasks?

For the third task, I expected either to see the differences between the two stages, what is the intersection between the two stages. What changed over time? With seeing, I mean a visualization of the data, or a list of genes of genes and the differences between the two stages. I'd like to see more attributes.

2. Did the system offer you the right information to fulfill your analytical tasks?

I think it does! It took me a little while to understand the graphs (the Hasse-diagrams), but I think the graph does answer the question where two genes are co-expressed, either in different tissues or in different Theiler stages. The hasse-diagrams made more sense to me compared to the alternative visualisations.

3. Did you discover new facts during your analysis tasks that you had not expected to discover at all before?

I don't think so. CUBIST provides simply a different way of breaking up the information. I saw what I expected, and that was good.

4. If the tasks fulfilled are typical for your daily work, do you think the tool can enrich your daily work by offering new ways to analyze your data?

Sure! With more experience, it could be more interesting. We are looking at ways to cluster and visualize big sets of graphs. The capability of filtering quickly (in CUBIX) is very good. It would be incredibly useful to have this sort of filtering for larger datasets.

5.2.2 For more tasks:

5. Which analytical systems do you currently use in your daily work?

None

6. From your point of view …

- Please shortly describe what is missing in current systems to use them effectively for your daily tasks:

  Not applicable

- Do you think CUBIST fills an analytical gap or provides functionalities that better fit your analytical tasks? Why do you think so?

  Skipped

7. Next to the data/use case currently implemented in the system, do you see any content from your daily life (private and professional) to be integrated in the system in future?

Skipped

- Why do you think this would be benefit?

  Skipped

8. For which kind of tasks from you daily work do you believe the system can be especially useful? Please describe the tasks and the possible benefit shortly:

Skipped

9. For which kind of tasks from your daily work do you believe the system is annoying / ineffective? Please describe the tasks and the possible drawbacks shortly:

Skipped

5.2.3 Comparing the different CUBIST means to access information

Which of CUBIST's analysis components did you find most valuable for your tasks and why?

- "Search and Select" Panel

  Very neat that queries are stored in the URL That is really nice!.

- "Instance View"

  No response

- "Explore Selection" Panel

  No response

- "Analyse Selection" Panel

  This is the most valuable part. Again, the capability of filtering here is the main strength.

- Traditional Visualization (e.g. bar charts):

  No response

- Other – Function:

  No response

10. For each of the following components, what do you think for what kind of information need it is suited best (e.g. number analysis, …)?

- "Search and Select" Panel

  "What's going on between different tissues" is a question I would ask here. Investigating profiles of different tissues. And, this is the component where I select a subset of data I am interested in.

- "Navigate in Data" Panel

  This is definitely a "nice add-on".

- "Explore Selection" Panel

  This could be useful, but it needs a filter. If this had additional features, it could be incredibly useful.

- "Analyse Selection" Panel

  (Already covered)

- Traditional Visualization (e.g. bar charts):

No response given

- Other – Function:

  No response given

11. How easy was it for you to choose the most appropriate analysis approach and visualization for your needs from the overall functionalities offered:

Easy. Because, the only visualization that made sense to me was the Hasse-diagram.

12. What (functionalities and/or system in general) was the major drawback of CUBIST for you and why?

The tutorial was very useful. The system is not self-explaining. You need a tutorial in order to use CUBIST. It would be ideal if you had a workshop where you can bring your own data and your own questions.

13. Do you think you understood how all the different means offered by CUBIST to access information interact? Comment if necessary.

Yes, I think so. To me, you need to know the data and its structure in order to use it; the system could be confusing if you do not know the dataset.

14. How did you like the guidance offered by the system to navigate through the available information? Please comment your decision.

Ok. Not to mention. Because, Search is quite straight-forward.

15. Did you immediately understand how to read the visualizations and use the analysis functionalities in the tool?

- No: If no, what made it difficult?

  It can be understood after some tutorial, but it cannot be understood immediately. Particularly I did not understand the meaning of the top- and bottom-nodes.

5.2.4 Disliked/Unneeded/Missing Features

In this part, we aim at finding out disliked, unneeded or missing features. We do this per component.

16. For each of the following components, which features do you dislike most? And Why?

- "Search and Select" Panel

  I am puzzled by the two different views (listview / tableview). I'd like to have the capability to get more information about an object in the tableview instead of the listview.

- "Navigate in Data" Panel

  No response given

- "Explore Selection" Panel

  No response given

- "Analyse Selection" Panel

  The popup window is helpful, but its location and size is not good. Would be better if this was, e.g., in the upper corner, and if it was bigger.

17. For each of the following components, which features are not needed from your point of view?

- "Search and Select" Panel

  No response given

- "Navigate in Data" Panel

  Not sure this is part of the same task. A useful feature, but not needed in CUBIST

- "Explore Selection" Panel

  Not sure this is part of the same task. A useful feature, but not needed in CUBIST

- "Analyse Selection" Panel

  I like the filters

18. And finally, each of the following components, which features missing?

- "Search and Select" Panel

  A "select All" in the filter part is missing. Total number of results e.g. in filter parts is missing. Would be nice if one could per use case customize the default objects.

- "Navigate in Data" Panel

  No response given

- "Explore Selection" Panel

  No response given

- "Analyse Selection" Panel

  No. Again, I like the filters.

5.2.5 Famous last words

Do you have any more comments or remarks?

I like to see more, this is fantastic! Particularly the ability to handle a large dataset.

6 The results of the post evaluation questionnaire

Following the evaluation session, the user was emailed a questionnaire to fill in at their convenience. This section records their responses.

6.1 Test User 1 – software developer persona

6.1.1 For the overall prototype

	strongly agree		neutral		strongly disagree		n/a
The CUBIST software was easy to use and work with.	☐	☐	☒	☐	☐	☐	☐
Neglecting the currently prototypic character, I would like to use the CUBIST software in future again.	☐	☐	☐	☐	☐	☐	☒
In future, I would prefer CUBIST to other analytical tools I currently use.	☐	☐	☐	☐	☐	☐	☒
Using CUBIST software could make my work more effective and efficient.	☐	☐	☐	☐	☐	☐	☒
The integration of different components (used to access, explore and visualize information) was helpful for fulfilling my tasks.	☐	☐	☒	☐	☐	☐	☐
The different components and the visualizations in CUBIST are well integrated.	☐	☐	☒	☐	☐	☐	☐
It is clear how the different components interact.	☐	☐	☐	☒	☐	☐	☐
The navigation/interaction functionalities were easy to understand and apply.	☐	☐	☒	☐	☐	☐	☐
It was easy to follow the steps performed by the system when using the interaction functionalities.	☐	☐	☐	☐	☐	☐	☒

6.1.2 For the "Search and Select" component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☐	☐	☒	☐	☐	☐	☐
The component is easy to understand and use.	☐	☐	☒	☐	☐	☐	☐
The interface is appealing and attractive.	☐	☒	☐	☐	☐	☐	☐
The component is useful.	☐	☐	☒	☐	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☐	☐	☒	☐	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☐	☒

6.1.3 For the "Navigate in Data" component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☐	☐	☒	☐	☐	☐	☐
The component is easy to understand and use.	☐	☐	☒	☐	☐	☐	☐
The interface is appealing and attractive.	☐	☐	☒	☐	☐	☐	☐
The component is useful.	☐	☐	☒	☐	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☐	☐	☒	☐	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☐	☒

6.1.4 For the "Explore Selection" component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☐	☐	☒	☐	☐	☐	☐
The component is easy to understand and use.	☐	☐	☒	☐	☐	☐	☐
The interface is appealing and attractive.	☐	☐	☒	☐	☐	☐	☐
The component is useful.	☐	☐	☒	☐	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☐	☐	☒	☐	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☐	☒

6.1.5 For the "Analyse Selection" component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☐	☐	☐	☒	☐	☐	☐
The component is easy to understand and use.	☐	☐	☐	☐	☒	☐	☐
The interface is appealing and attractive.	☐	☐	☐	☒	☐	☐	☐
The component is useful.	☐	☐	☐	☒	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☐	☐	☐	☒	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☐	☐
The visualizations were easy to understand.	☐	☐	☐	☐	☒	☐	☐
There are visualizations available that did fit my tasks very well.	☐	☐	☐	☐	☐	☐	☒
The integration of different visualizations was helpful for fulfilling my task.	☐	☐	☐	☐	☐	☐	☒
It is clear how the different visualization interact.	☐	☐	☐	☐	☒	☐	☐

6.2 Test User 2 – biologist persona

6.2.1 For the overall prototype

	strongly agree		neutral		strongly disagree		n/a
The CUBIST software was easy to use and work with.	☐	☑	☐	☐	☐	☐	☐
Neglecting the currently prototypic character, I would like to use the CUBIST software in future again.	☑	☐	☐	☐	☐	☐	☐
In future, I would prefer CUBIST to other analytical tools I currently use.	☑	☐	☐	☐	☐	☐	☐
Using CUBIST software could make my work more effective and efficient.	☑	☐	☐	☐	☐	☐	☐
The integration of different components (used to access, explore and visualize information) was helpful for fulfilling my tasks.	☑	☐	☐	☐	☐	☐	☐
The different components and the visualizations in CUBIST are well integrated.	☑	☐	☐	☐	☐	☐	☐
It is clear how the different components interact.	☐	☑	☐	☐	☐	☐	☐
The navigation/interaction functionalities were easy to understand and apply.	☐	☑	☐	☐	☐	☐	☐
It was easy to follow the steps performed by the system when using the interaction functionalities.	☐	☑	☐	☐	☐	☐	☐

6.2.2 For the "Search and Select" component

The purpose and function of the component is clear.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐
The component is easy to understand and use.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐
The interface is appealing and attractive.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐
The component is useful.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐
I have similar functionalities in the tools I usually use.	strongly agree	☐	☐	neutral	☐	strongly disagree	☐	n/a ☐

6.2.3 For the "Navigate in Data" component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☐	☐	☐	☐	☐	☐	☐
The component is easy to understand and use.	☐	☐	☐	☐	☐	☐	☐
The interface is appealing and attractive.	☐	☐	☐	☐	☐	☐	☐
The component is useful.	☐	☐	☐	☐	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☐	☐	☐	☐	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☐	☐

6.2.4 For the "Explore Selection" component

	strongly agree			neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☒	☐	☐	☐	☐	☐		☐
The component is easy to understand and use.	☒	☐	☐	☐	☐	☐		☐
The interface is appealing and attractive.	☒	☐	☐	☐	☐	☐		☐
The component is useful.	☒	☐	☐	☐	☐	☐		☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☒	☐	☐	☐	☐	☐		☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☒		☐

6.2.5 For the "Analyse Selection" Component

	strongly agree		neutral		strongly disagree		n/a
The purpose and function of the component is clear.	☒	☐	☐	☐	☐	☐	☐
The component is easy to understand and use.	☐	☒	☐	☐	☐	☐	☐
The interface is appealing and attractive.	☒	☐	☐	☐	☐	☐	☐
The component is useful.	☒	☐	☐	☐	☐	☐	☐
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	☒	☐	☐	☐	☐	☐	☐
I have similar functionalities in the tools I usually use.	☐	☐	☐	☐	☐	☒	☐
The visualizations were easy to understand.	☐	☒	☐	☐	☐	☐	☐
There are visualizations available that did fit my tasks very well.	☒	☐	☐	☐	☐	☐	☐
The integration of different visualizations was helpful for fulfilling my task.	☒	☐	☐	☐	☐	☐	☐
It is clear how the different visualization interact.	☐	☒	☐	☐	☐	☐	☐

7 MousePy evaluation

In addition to the standard CUBIST evaluation, HWU performed an evaluation of the specialised visualisations they generated as part of the CUBIST project. This was wrapped into a prototype code-named MousePy (MP).

MP provides the ability to visually generate a gene expression query and then view the results in the context of the anatomy using either a sunburst or icicle visualisation.

Initially, MP provides a visual means of generating a gene expression query. Once the user selects a Theiler Stage in which they are interested, MP displays all the textual annotations (at that stage) as a cloud of nodes within a Cluster Diagram – see Figure 1. Each node represents a gene, the larger the node the greater the number of textual annotations in which that gene features. By clicking on a node, the user can select a gene. Once the user has selected the gene(s) (s)he is interested in, (s)he can visualise the textual annotations as a sunburst or icicle diagram.

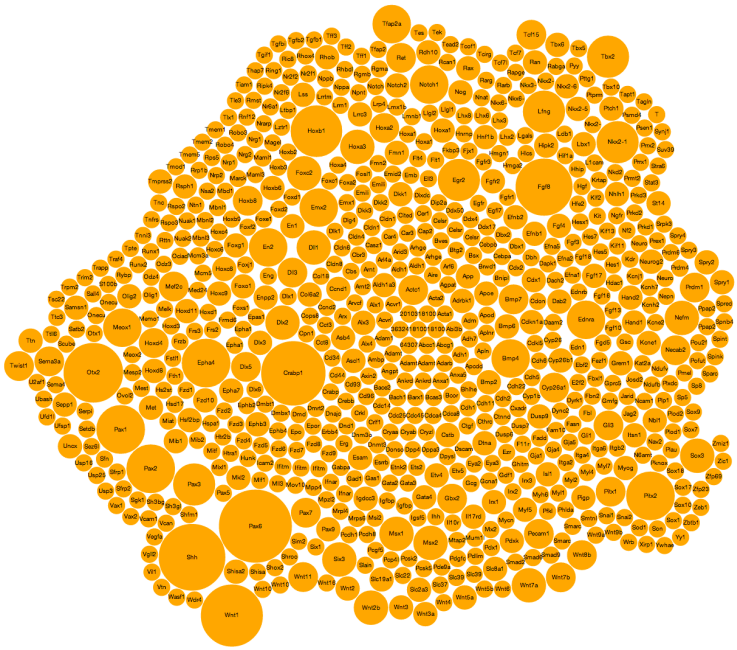


Figure 1: Node cloud representing textual annotations at TS15. Every node is a gene, the larger the node the more textual annotations that gene has.

A typical sunburst can be seen in Figure 2. The nodes in the sunburst represent the anatomical structures in the mouse anatomy. The anatomy has a tree organisation that is carried across to the layout of nodes in the sunburst. Colours are used to indicate the selected gene's level of expression.

The icicle diagram (Figure 3) is essentially a stretched out sunburst. It conveys exactly the same information in exactly the same way, the only difference is the layout: radial versus linear. The reason for including both the sunburst and icicle is simple: different monitor sizes. The sunburst is a compact space saving design that works well on laptop monitors; however, the icicle takes advantage of the extra real estate available on the wide screen monitors that are becoming increasingly prevalent.

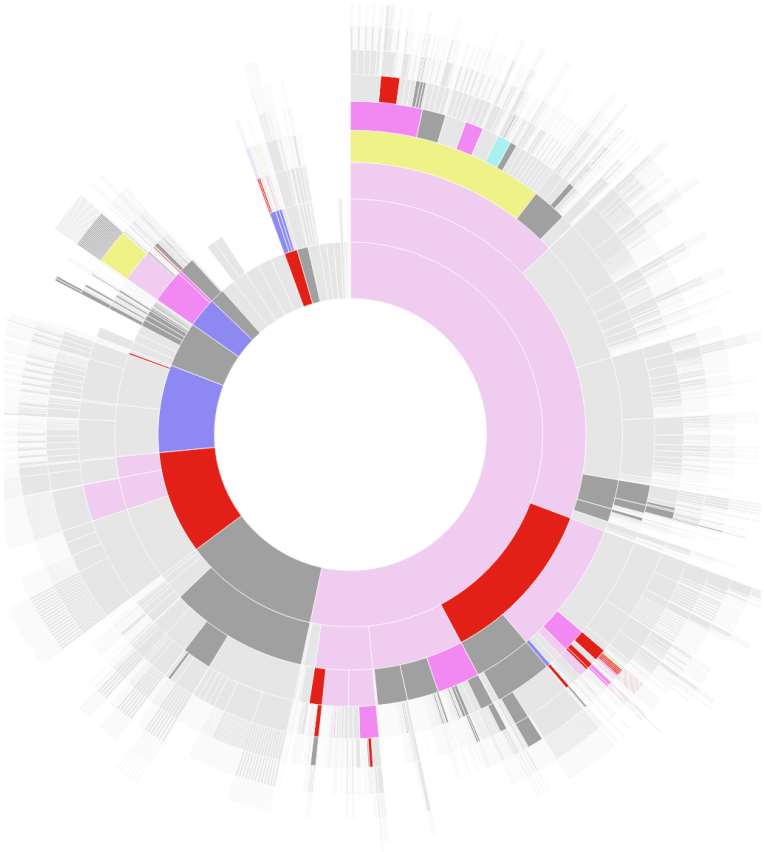


Figure 2: Sunburst diagram showing gene expression in TS15. Nodes represent anatomical structures, and colours indicate a gene's level of expression.

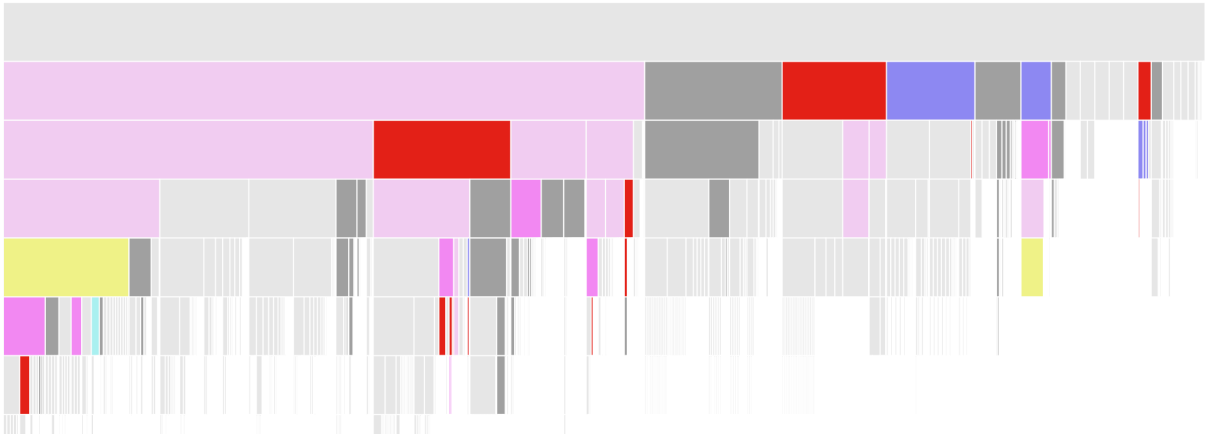


Figure 3: Icicle diagram showing the same information as Figure 2

As MousePy was targeted at expert biological users, instead of having one user from that persona and another from the second persona, both test users came from the biological persona.

7.1 Test Users

The first test user was *Chris Armit* (test user 2 in the main CUBIST evaluation), and the second user was his colleague Shanmugasundaram Venkataraman (normally known as Venkat).

Venkat completed both an undergraduate degree and doctorate in BioChemistry. He has worked at EMAGE, as an editor, for over ten years. His role comprises hands on inspection of the data submitted to EMAGE and supporting those (for example CUBIST) that want to work with EMAGE.

There is a noticeable difference between the responses of the two test users. Chris is very positive, whilst Venkat is more neutral. It is believed this is because of the different criteria used by the testers to evaluate MousePy. Chris decided that as MousePy was a prototype he should evaluate the "idea" rather than the actual tool. In contrast, Venkat evaluated the prototype as though it were a real world tool. Regardless, both users like the principle of using sunburst/icicle diagrams to visualise gene expression data in the context of the mouse anatomy.

7.2 Evaluation protocol

During the evaluation the user was given a brief introduction to the tool and then presented with a collection of paper:

- The first sheet provided a brief outline of the evaluation and asked them for their consent.
- The second sheet collected background information.
- The third sheet presented a walkthrough of the system.
- The remaining sheets were standard SUS[2] and QUIS[3] questionnaires, apart from one that asked the user to compare and contrast the sunburst with the icicle.

The users were encouraged to ask questions, raise issues and provide feedback at all stages of this exercise.

[2] J. Brooke. *The System Usability Sutdy (SUS) – a quick and dirty usability scale.* RedHatch Consulting Ltd., UK, 1986.

[3] B. Shneiderman. *Designing the user interface: strategies for effective human-computer interaction.* Addison-Wesly, Reading, MA, 2nd edition, 1992.

7.3 Walkthrough

This section documents the walkthrough of the system that the users were given. The aim was simply to guide them through the main aspects of the system and prompt them to communicate their opinions to the evaluator.

Walk through

Please follow these instructions carefully; they will guide you through the visualisations that are being evaluated. Please feel free to ask any questions or comment at any stage of the evaluation.

1. You see a sunburst diagram showing the mouse anatomy at TS15. Each node, or radial block, represents a tissue. The box on the right hand side of the screen presents information about the nodes (tissues) in the sunburst. Move the mouse over the central node. On the right you see this is the "Mouse TS15". If you move the mouse around the central node you will see the "Organ System", "Mesenchyme", et cetera. Below "Organ System" we see "Visceral organ", "Nervous System" et cetera.

2. The box on the left hand side of the screen allows us to change the sunburst. Click on the "Select Anatomy Type" listbox and choose "Abstract Anatomy". Now click "Generate Sunburst". After a moment you see TS15 represented using the abstract anatomy. When nodes are light grey in colour it indicates that the tissue does not exist at the current Theiler Stage.

3. Click on the "Select Gene" list box, type "bmp" and then click on "Bmp4". Now click "Generate Sunburst". Now you see where Bmp4 is expressed in TS15. Different colours indicate different levels of expression, click "Show Legend" (right hand side box) to see the mapping between colours and levels of expression.

4. Using the same procedure as step 3, add the genes *Hoxb13*, *Shh* and *Wnt1*. Now click "Generate Sunburst".

5. There is a large yellow tissue at the top of the screen, move the mouse over it. Looking at the right hand side box, we see that this is the "Gut" and that the gene Shh has three textual annotations for this tissue. What are the three levels of expression?
   ANSWER: _____ _____ _____

6. Click on the "Select Theiler Stage" listbox, and choose TS16 then click on "Generate Sunburst". Which genes are now expressed in the gut? ANSWER: _____

7. Change to TS17. In the bottom right of the sunburst, what is the name of the large green tissue? ANSWER: _____

8. Click on "Generate Icicle" button. An icicle diagram is essentially a flattened, straightened, sunburst. It features all of the same information.

9. Double click on the tissue called "Central Nervous System" (large green tissue). The diagram will zoom into the tissue you clicked on so that you can more clearly see the smaller nodes below it. To go back up the hierarchy repeatedly click on the top tissue until the diagram no longer changes.

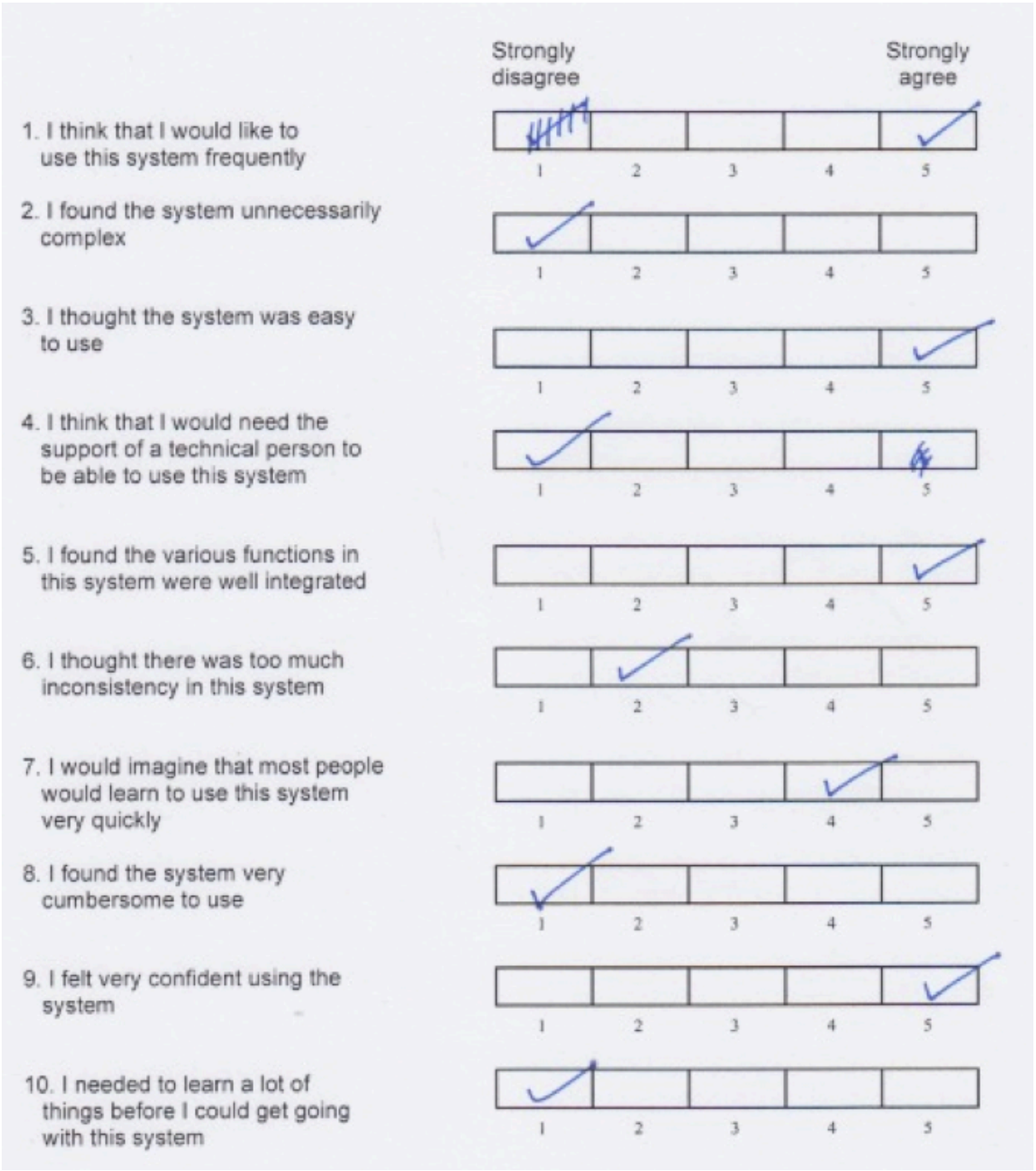
10. Click on the "Advanced Search" button at the top of the screen. You are presented with a page that helps you develop gene expression queries. The nodes in the centre of the screen represent genes that are expressed at the current stage (TS17). The bigger the node, the more textual annotations are present. The genes that feature in the current query are highlighted (*Bmp4*, *Hoxb13*, *Shh* and *Wnt1*).

11. You can add genes by clicking on them or by using the "Select Gene" listbox on the left. Add the genes *Dlx5*, *Foxf1a* and *Fgf8*. Now click "generate sunburst".

If you wish, you may now experiment with the tool further. Once you are satisfied you understand what the tool does and how it works, please answer the questions over the page.

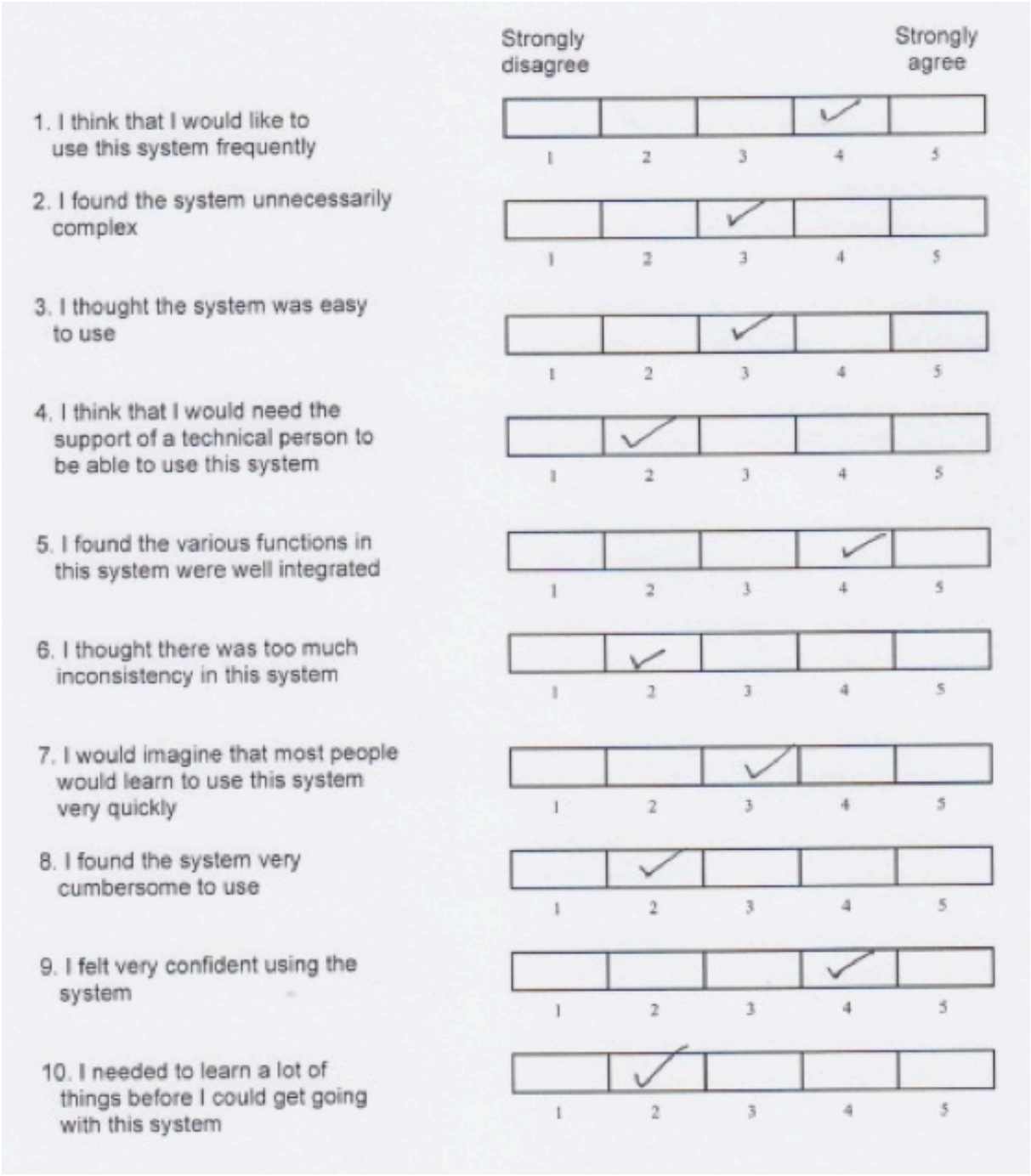
7.4 SUS questionnaire for sunburst visualisation

7.4.1 Chris



SUS score = 95 (out of 100).

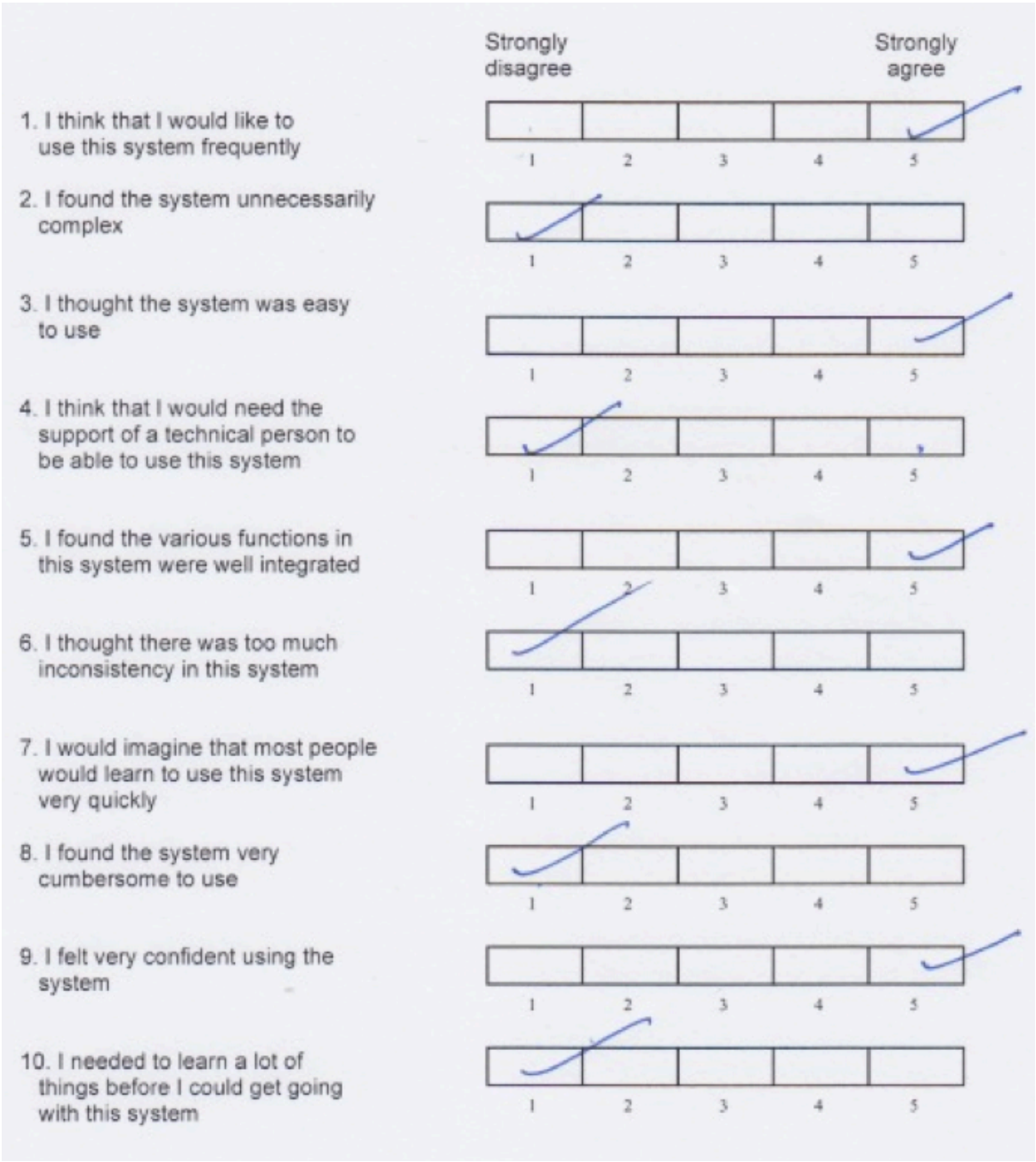
7.4.2 Venkat



SUS score = 60.

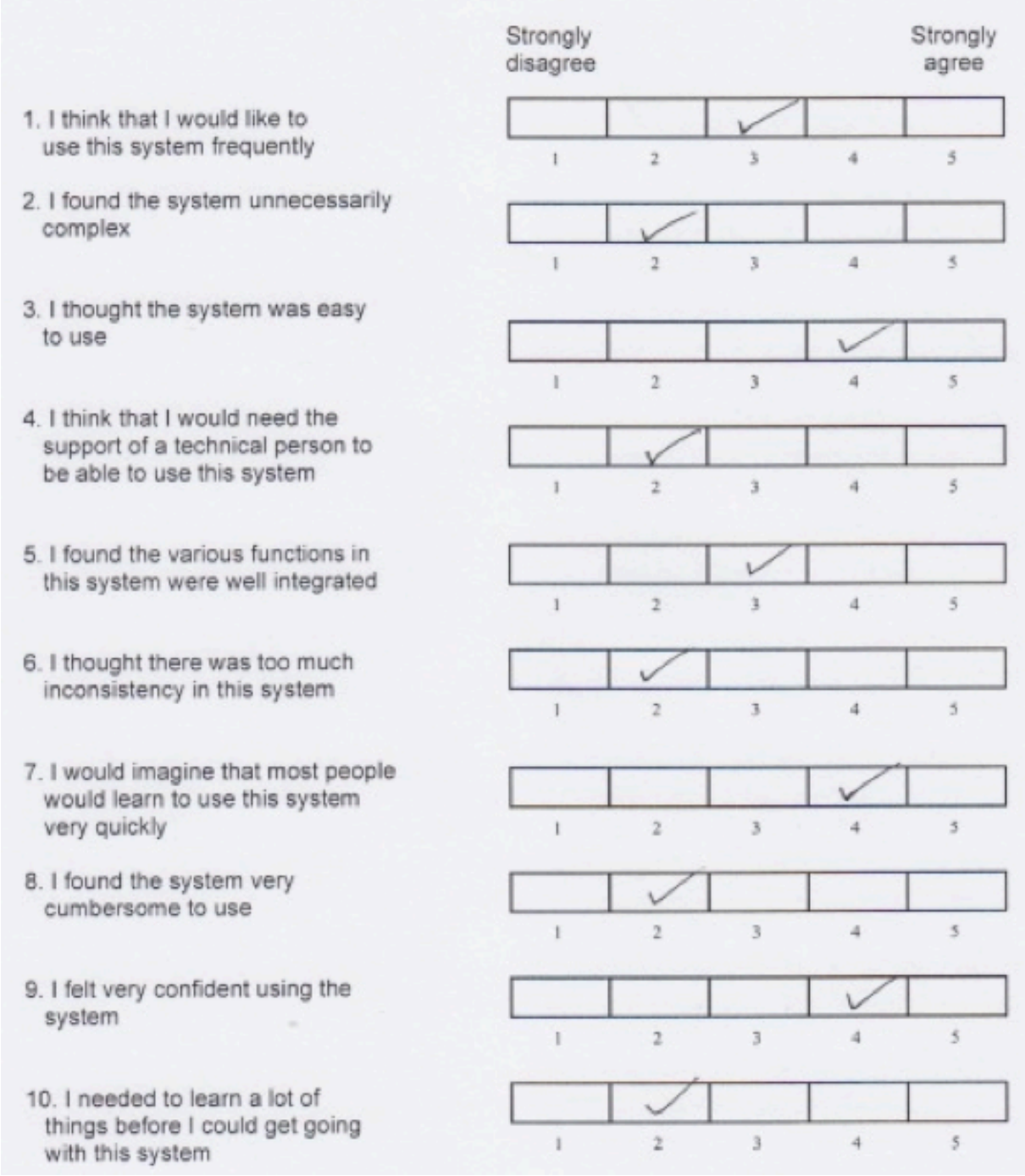
7.5 SUS questionnaire for icicle visualisation

7.5.1 Chris



SUS score = 100 (i.e., a perfect score).

7.5.2 Venkat



SUS score = 70

7.6 Comparison between icicle and sunburst diagrams

7.6.1 Chris

What task(s) might you use the sunburst for?
I would use the sunburst to display all text annotations per gene. I would display the profiles of different genes in different sunburst diagrams and compare between them.

Could you use the icicle for the same task(s)?

(YES) NO Do not know

If NO, what task(s) would you use the icicle for?

Which visualisation did you prefer?

Sunburst (Icicle) No preference Do not know

Why?
The icicle has the advantage that - when I zoom in or out - I am not disoriented.

Which visualisation do you think you will use most often?

Sunburst (Icicle) Do not know

Can you think of any extra functionality you would like to see?
I would like to see, where possible text annotation of ontology components (e.g. gut, CNS, PNS) printed on each of the nodes.

7.6.2 Venkat

What task(s) might you use the sunburst for?

Gene expression and anatomy queries.

Could you use the icicle for the same task(s)?

(YES) NO Do not know

If NO, what task(s) would you use the icicle for?

Which visualisation did you prefer?

(Sunburst) Icicle No preference Do not know

Why?

Preference for radical layout

Which visualisation do you think you will use most often?

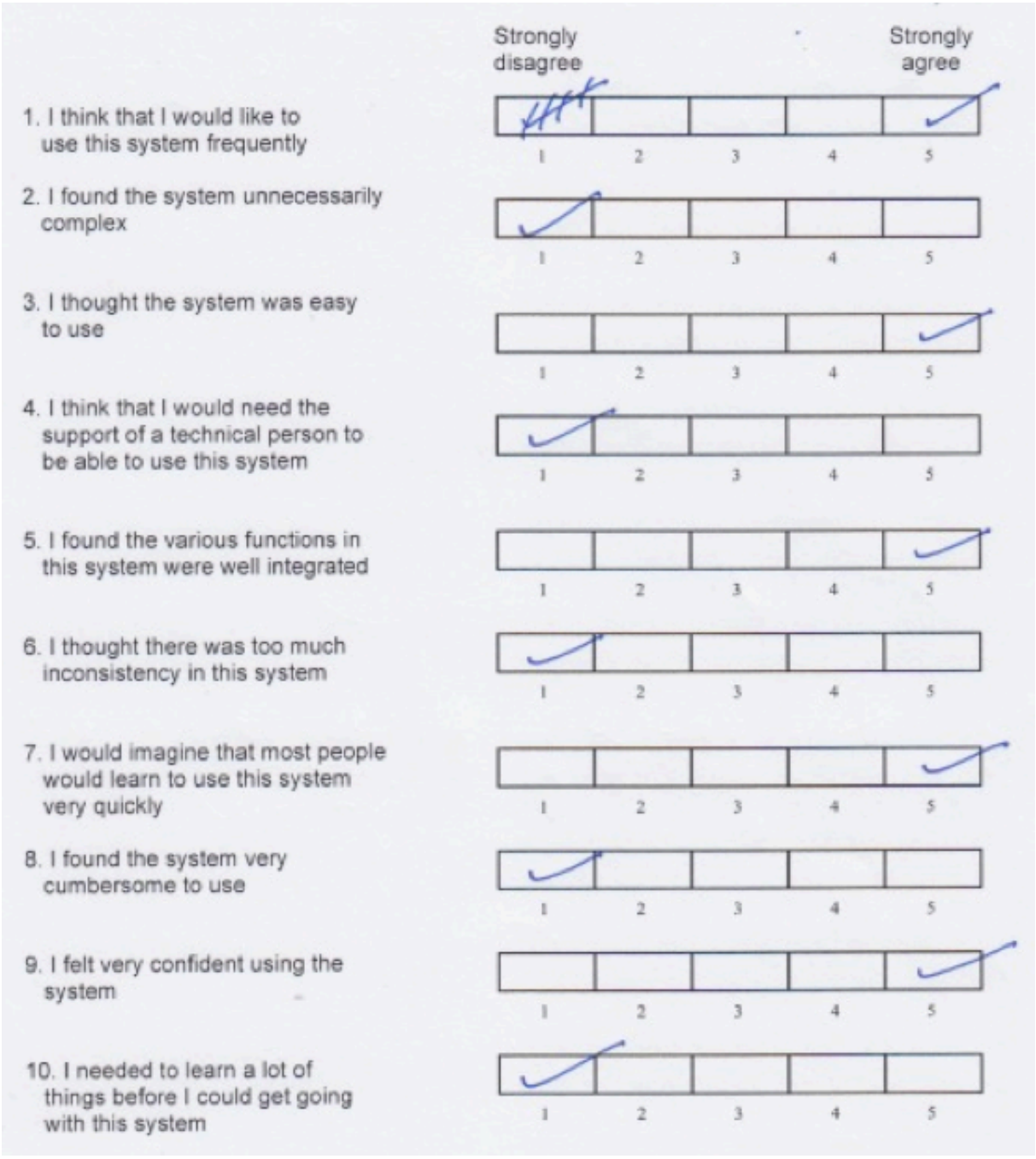
(Sunburst) Icicle Do not know

Can you think of any extra functionality you would like to see?

Interestingly, Venkat has a preference for the sunburst despite scoring the icicle higher in the usability questionnaire.

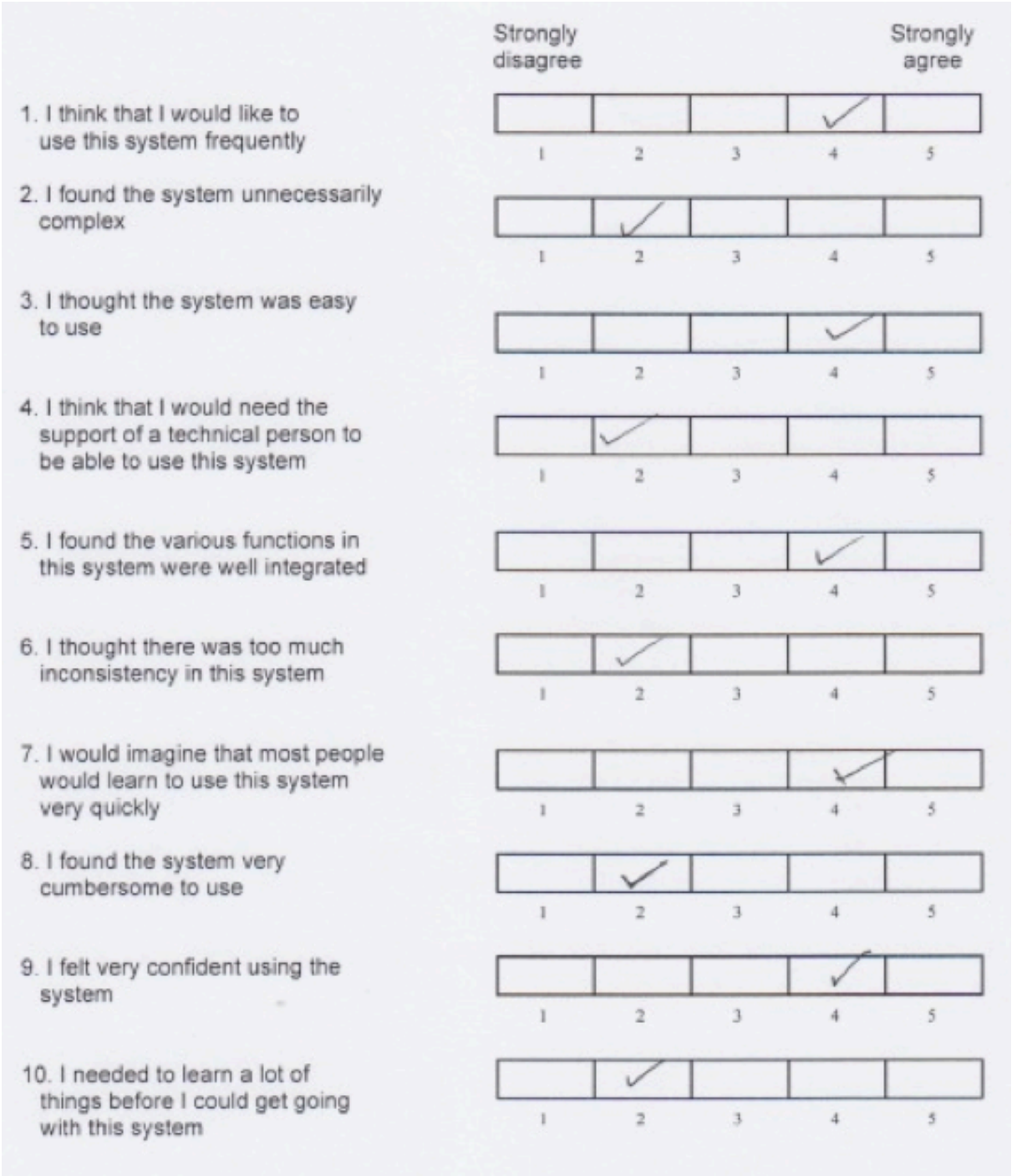
7.7 SUS questionnaire for the visual query builder

7.7.1 Chris



SUS score = 100 (i.e., perfect)

7.7.2 Venkat

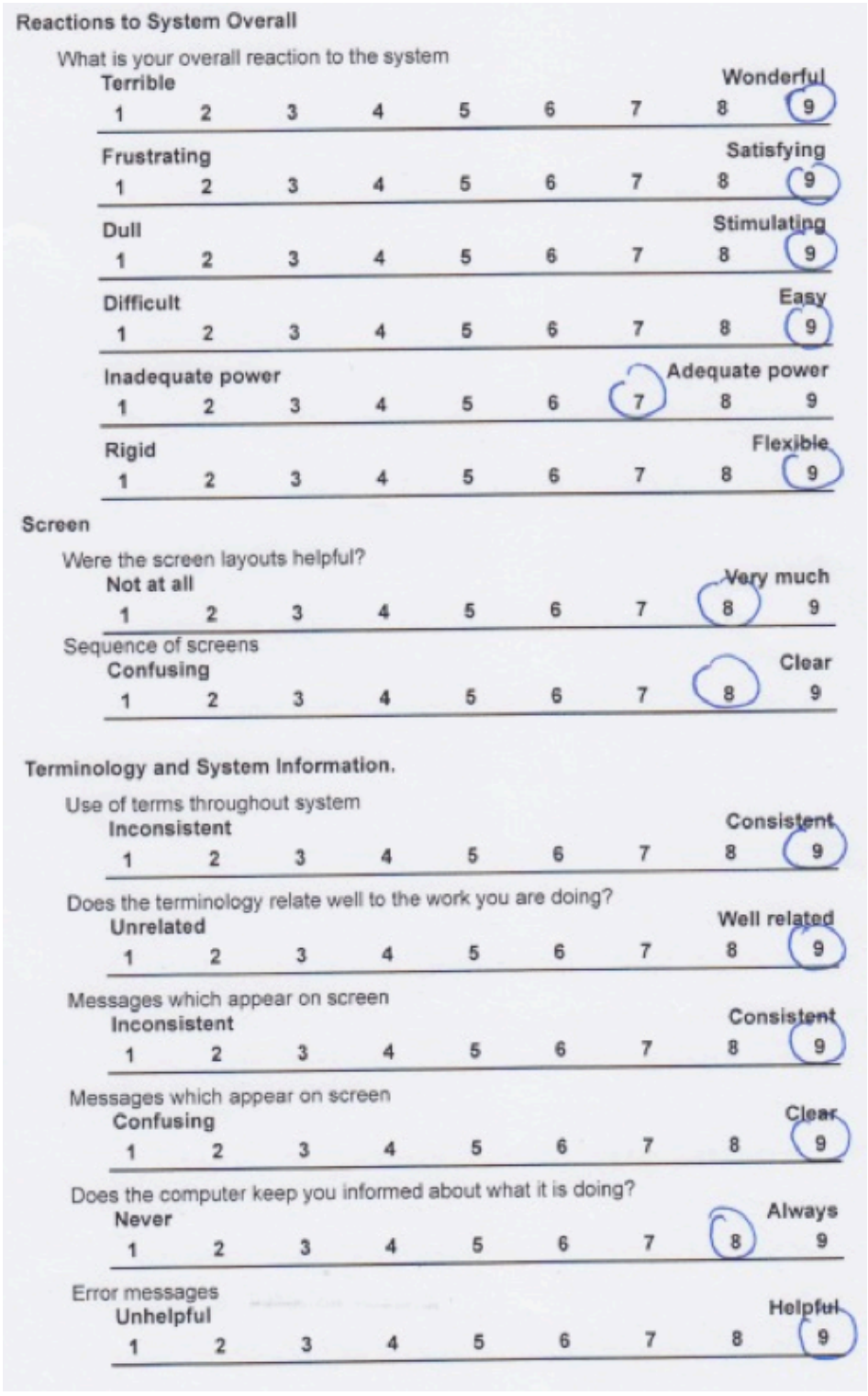


	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently				✓	
	1	2	3	4	5
2. I found the system unnecessarily complex		✓			
	1	2	3	4	5
3. I thought the system was easy to use				✓	
	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system		✓			
	1	2	3	4	5
5. I found the various functions in this system were well integrated				✓	
	1	2	3	4	5
6. I thought there was too much inconsistency in this system		✓			
	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly				✓	
	1	2	3	4	5
8. I found the system very cumbersome to use		✓			
	1	2	3	4	5
9. I felt very confident using the system				✓	
	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system		✓			
	1	2	3	4	5

SUS score = 75

7.8 QUIS questionnaire for the whole system

7.8.1 Chris



Reactions to System Overall

What is your overall reaction to the system

Terrible — 1 2 3 4 5 6 7 8 **9** — Wonderful

Frustrating — 1 2 3 4 5 6 7 8 **9** — Satisfying

Dull — 1 2 3 4 5 6 7 8 **9** — Stimulating

Difficult — 1 2 3 4 5 6 7 8 **9** — Easy

Inadequate power — 1 2 3 4 5 6 **7** 8 9 — Adequate power

Rigid — 1 2 3 4 5 6 7 8 **9** — Flexible

Screen

Were the screen layouts helpful?

Not at all — 1 2 3 4 5 6 7 **8** 9 — Very much

Sequence of screens

Confusing — 1 2 3 4 5 6 7 **8** 9 — Clear

Terminology and System Information.

Use of terms throughout system

Inconsistent — 1 2 3 4 5 6 7 8 **9** — Consistent

Does the terminology relate well to the work you are doing?

Unrelated — 1 2 3 4 5 6 7 8 **9** — Well related

Messages which appear on screen

Inconsistent — 1 2 3 4 5 6 7 8 **9** — Consistent

Messages which appear on screen

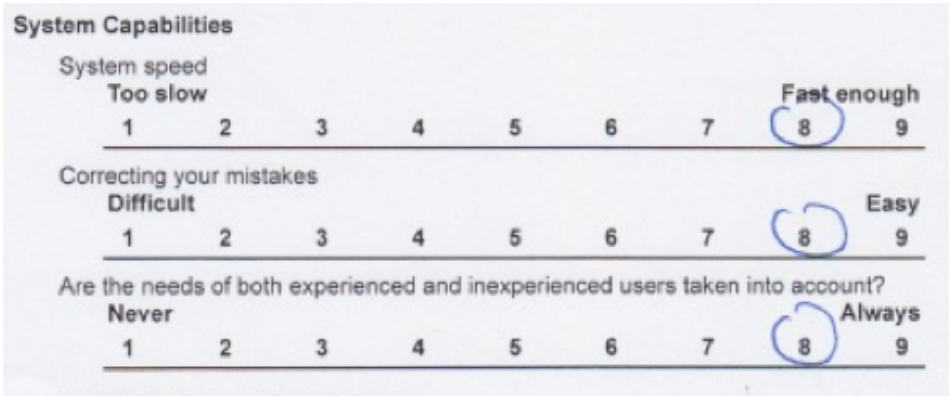
Confusing — 1 2 3 4 5 6 7 8 **9** — Clear

Does the computer keep you informed about what it is doing?

Never — 1 2 3 4 5 6 7 **8** 9 — Always

Error messages

Unhelpful — 1 2 3 4 5 6 7 8 **9** — Helpful



System Capabilities

System speed

Too slow — Fast enough

1 2 3 4 5 6 7 8 9

Correcting your mistakes

Difficult — Easy

1 2 3 4 5 6 7 8 9

Are the needs of both experienced and inexperienced users taken into account?

Never — Always

1 2 3 4 5 6 7 8 9

7.8.2 Venkat

Reactions to System Overall

What is your overall reaction to the system

	1	2	3	4	5	6	7	8	9	N/A
Terrible ... Wonderful									(9)	
Frustrating ... Satisfying								(8)		
Dull ... Stimulating								(8)		
Difficult ... Easy							(7)			
Inadequate power ... Adequate power							(7)			
Rigid ... Flexible							(7)			

Screen

Were the screen layouts helpful?

	1	2	3	4	5	6	7	8	9	N/A
Not at all ... Very much								(8)		

Sequence of screens

	1	2	3	4	5	6	7	8	9	N/A
Confusing ... Clear							(7)			

Terminology and System Information.

Use of terms throughout system

	1	2	3	4	5	6	7	8	9	N/A
Inconsistent ... Consistent							(7)			

Does the terminology relate well to the work you are doing?

	1	2	3	4	5	6	7	8	9	N/A
Unrelated ... Well related									(9)	

Messages which appear on screen

	1	2	3	4	5	6	7	8	9	N/A
Inconsistent ... Consistent							(7)			

Messages which appear on screen

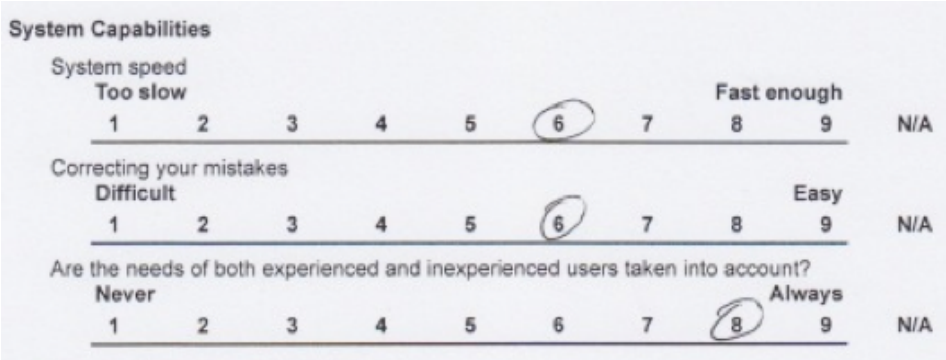
	1	2	3	4	5	6	7	8	9	N/A
Confusing ... Clear								(8)		

Does the computer keep you informed about what it is doing?

	1	2	3	4	5	6	7	8	9	N/A
Never ... Always								(8)		

Error messages

	1	2	3	4	5	6	7	8	9	N/A
Unhelpful ... Helpful										(N/A)



System Capabilities

System speed

Too slow — Fast enough

1	2	3	4	5	6	7	8	9	N/A

Correcting your mistakes

Difficult — Easy

1	2	3	4	5	6	7	8	9	N/A

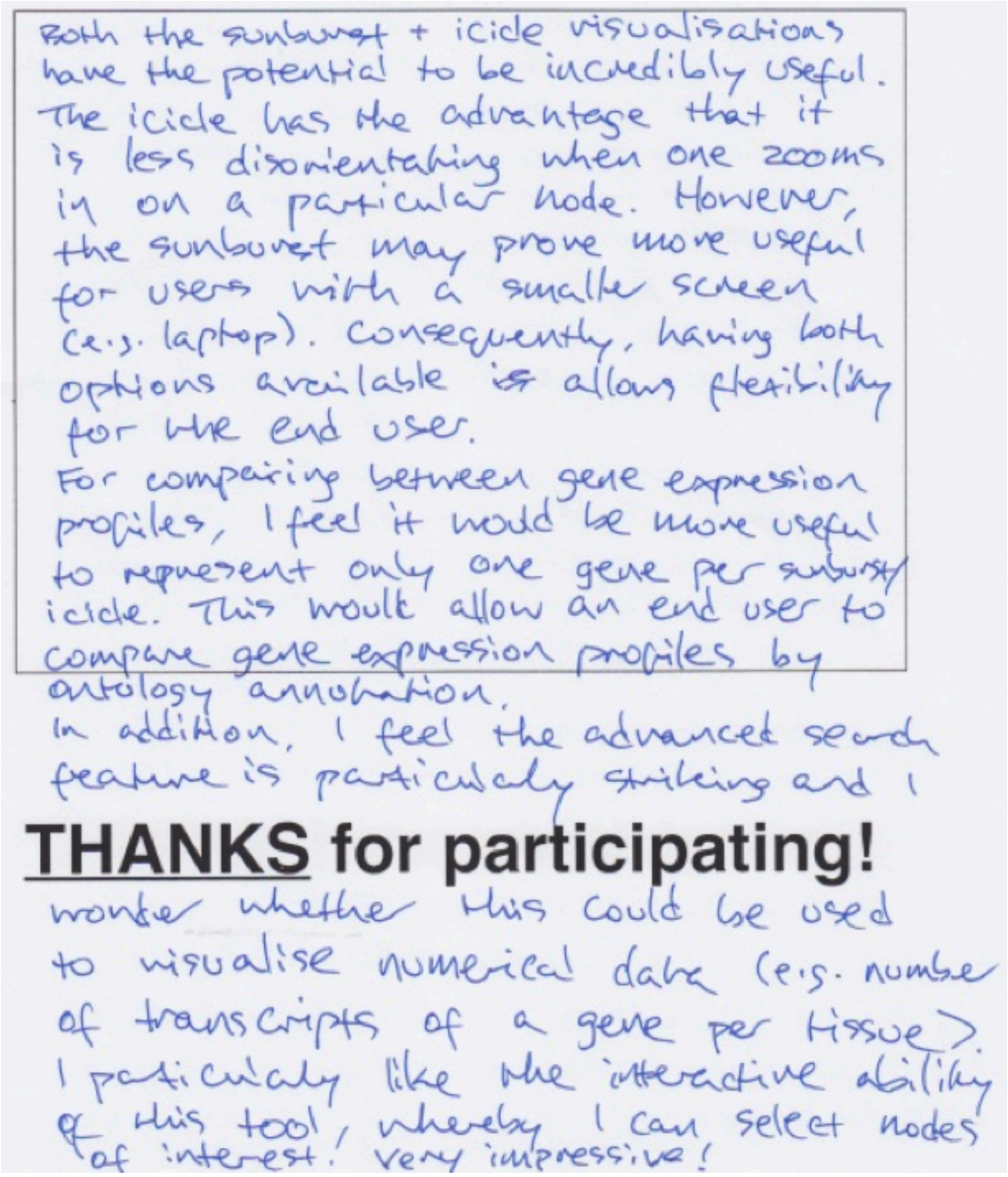
Are the needs of both experienced and inexperienced users taken into account?

Never — Always

1	2	3	4	5	6	7	8	9	N/A

7.9 Additional comments

7.9.1 Chris



7.9.2 Venkat

Venkat did not write any comments, but instead said, “an interesting idea that needs work, but looks very promising.”