

# Visualisation of human-computer interaction within an interactive web-based learning environment

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## 1 Introduction

In this paper we use visualisation techniques to study the human-computer interaction (HCI) of nursing students using an interactive web-based environment for learning clinical skills. Evaluation of IT and HCI systems traditionally involves paper and pen interviewing or self-administered questionnaires, usually data collected before and after use of a given system. Sometimes rudimentary computer-assisted data collection is used, e.g. to measure time to complete a given task (de Leeuw and Nicols, 1996). Psychologists have often conducted computer-based experiments and used the computer to automatically log the experimental information of interest, e.g. reaction times and whether tasks were successfully completed or not. It is now time to fully explore the potential of computer-assisted data collection for the study of the interaction of users with the computer. We now have the required skills for the implementation of computer-assisted data capture of each user's actions in real time, along with the state of the system when action was taken, e.g. which windows were open and which event occurred, etc. Few computer scientists have collected and analysed such audit trails (Henry et al, 1990; Hutchings, 1993).

The School of Nursing and Midwifery at the University of Southampton has developed Virtual Interactive Practice (VIP®) to augment student placement capacity and provide new opportunities to address the quality, nature and type of student learning experiences.

VIP is a designated period of assigned practice where web-based and/or simulation-based clinical scenarios are integrated to provide coherent learning experiences with which students can interact. These scenarios are constructed with real patient data so as to mimic real practice contexts and responses. The School of Nursing and Midwifery has two skills laboratories resembling hospital wards separated by a central control room. Each ward contains a nurses station and 6 beds viewable from the central control room via 6 audio-equipped ceiling mounted cameras, each controllable with a 360 degree viewing angle. Each ward is equipped with computerised and interactive SimMan mannequins which are used to simulate interactions with real patients.

This paper explores the potential of computer-assisted data collection for the study of the interaction of users with the VIP scenario-based learning package. Grid-enabled technologies have the potential to be used in powerful ways to support data collection and analysis which could provide new and richer insights into understanding educational processes (Conole and Dyke, 2003; Conole, 2004; Chen and Hinton, 1999, de Roure et al, 2003). For visualisation, we use directed mathematical graphs and event history charts available within a grid-enabled R service, based on the open source R package for statistical analysis.

## **2 VIP web-based clinical scenario learning package**

In collaboration with academic and practice staff from the appropriate branches of nursing, web-based resources were designed for both first-year and second-year nursing students. The web-based resources were available via computer labs with dedicated headphones at the university/hospital or elsewhere, e.g. home, if the student used a virtual private network (VPN) connection. To use these online resources, students had to login with their username and password. The session web access log files, weblogs for short, were saved for analysis. As a secure HTTP connection was used, the username was recorded in the weblogs and, therefore, it is possible to track students who access these web-based resources on separate occasions and to link their multiple session weblogs. Note that informed consent for the collection, storage and use and analysis of video, weblogs and other student data was obtained using written consent forms, following submission to the Local NHS Research Ethics Committee

and the approval of the University of Southampton School of Nursing and Midwifery Ethics Committee.

Figure 1 presents a screenshot of the Clinical Skills Home webpage. Five options (links) are presented, one for first-year students and four for second-year students. Second-year students would normally choose to use the scenarios corresponding to the branch of nursing that they are studying, e.g. Adult Branch students would normally access the Adult Simulation scenarios, but they could access the Child Simulation or Mental Health Simulation scenarios if they wished (the Learning Disabilities web-based scenarios had not been developed and clicking on this link returns the user to the Clinical Skills Home page).

The Techniques for Nursing Care scenarios are studied by all first-year students. Clicking on the Techniques for Nursing Care link takes the student to the Techniques for Nursing Care information page which provides the student with the basic information they need before they access the Techniques for Nursing Care home page; see Figure 2. This information page tells the student that some of the following webpages contain a playlist of 3 videos, and it is suggested that the student chooses the video that they think is most appropriate for their chosen branch of nursing. The student can, however, view them all the videos if they wish. The skills to be learned are broken down into seven areas. The navigational pathway in this learning resource is not linear. At a given webpage, the student can access any learning resources available, e.g. links to other webpages, videos, audiofiles, Word documents, Powerpoint slides and even a crossword. Students can (re)visit any webpage by using various mechanisms: (1) the browser forward or back buttons or the browser history, (2) the previous and next buttons on a given the webpage, (3) links to the start page or (4) selecting a (new) webpage from the list on the left hand side of the screen (if available). Users can exit the web-based resource at any time, e.g. by closing the browser, and revisit the resource as many times as they wish. Once the student has explored all the resource, they must take a quiz on the material covered by clicking on the link at the bottom of the start (home) webpage. Note it was intended that each student must have attempted the quiz at least 24 hours before the Techniques for Nursing Care session, otherwise they would not be allowed into the skills session, but this was not implemented due to technical difficulties at one off-site computer centre.

Note that the weblogs saved on the dedicated server distinguish the first visit to a webpage and a revisit. For example, the URL for the first access of the Techniques for Nursing Care start page is `.../clinical_skills/tnc.asp?section=0` and the URL for a revisit is `.../clinical_skills/tnc.asp?id=1`. Each URL is given an unique integer code, e.g. code 110 corresponds to `.../clinical_skills/tnc.asp`, i.e. the Techniques for Nursing Care information page (Figure 2) and codes 169 and 117 correspond to a first visit and a revisit to the Hygiene >> Student Nurses' Responsibilities page (Figure 3).

Consider the start of the Techniques for Nursing Care material; see Figure 3. The student is instructed to watch one of three videos, then continue with each of the following areas: (1) Hygiene, (2) Infection Prevention, (3) Moving & Handling, (4) Nutritional Care: Eating & Drinking, (5) Observations, (6) Therapeutic Skills and (7) Environment. The student can explore the different areas in any order by clicking on the boxes with these labels and there is no linear structure to the placement of these boxes. Note that the boxes with the instructions, e.g. play video 'interaction\_mh' contain patient photos that have not been reproduced in the screenshot of the webpage. The 'subscripts' mh, ad and ch on the video names correspond to the Mental Health (mh), Adult (ad) and Child (ch) branches of nursing. When the students were finished, they were instructed to take the quiz via the link at the bottom of the start page.

Note that playing the video inline does not generate an entry in the weblog as the video is streamed from a server. The student is presented with the option of playing the video with an external player, e.g. Windows Media player. As the external player provides a larger video image, some students may prefer to play the videos using the external player rather than play them inline. The request for the external player is recorded in the weblog. If the student did not request the use of an external player, we can only infer whether the student watched the video by the length of time the student visited this URL.

We will illustrate the weblog analysis by considering a single day's weblogs of first year students using the VIP package. On this day 45 students accessed the package 64 times, 34 students used the package once, 7 students used it twice and 2 students used it 3 times., We will focus on the Hygiene area in the Techniques for Nursing Care section. The analysis of the weblogs starts with visualization of the visits to each URL using directed mathematical

graphs.

### 3 Weblog visualisation via directed mathematical graphs

Consider Figure 4, which is a screenshot of the start/home page of the Hygiene material. The left hand side of the page contains a list of pages under the Hygiene heading and ‘ $\gg$  Student Nurses’ Responsibilities’ is in boldface to highlight the current location. Students can (re)visit the Techniques for Nursing Care start page by clicking on the ‘ $\ll$  Techniques for Nursing Care’ link at the bottom of the list or on the ‘Back to Techniques for Nursing Care’ link just below the horizontal line. They can move to the ‘Privacy & Dignity’ page by clicking the link just below the highlighted ‘ $\gg$  Student Nurses’ Responsibilities’ or by using the next page button ‘next  $\Rightarrow$ ’ coloured green.

Consider Figure 5, which is a screenshot of the start/home page of the Hygiene material. The left hand side of the page contains a list of pages under the Hygiene heading and ‘ $\gg$  Student Nurses’ Responsibilities’ is in boldface to highlight the current location. Students can (re)visit the Techniques for Nursing Care start page by clicking on the ‘ $\ll$  Techniques for Nursing Care’ link at the bottom of the list or on the ‘Back to Techniques for Nursing Care’ link just below the horizontal line. They can move to the ‘Privacy & Dignity’ page by clicking the link just below the highlighted ‘ $\gg$  Student Nurses’ Responsibilities’ or by using the next page button ‘next  $\Rightarrow$ ’ coloured green.

The number of visits and revisits can be visualized using Rgraphviz, which interfaces R with the AT & T GraphViz library for drawing mathematical graphs. Figure 8 presents a directed graph representation of the weblogs for one day of sessions using Rgraphviz. The nodes (circles) represent URLs of learning resources. The first number is the URL code and the second number in square brackets is the number of visits to the node. The directed edges (arrows) represent the number of movements from one node to another, with the arrowhead showing the direction. Note that it is possible for an arrow to start at a given node and end at the same node. This may occur with a page refresh in the browser or by clicking on the link to the current page. On the bottom left of Figure 8, the codes 1 and 2 refer to URLs ‘.../clinical\_skills’ and ‘https://skills.soton.ac.uk/clinical\_skills/’, both correspond to

the Clinical Skills home page (the first without the ending forward slash on the URL). Code 110 corresponds to ‘.../clinical\_skills/tnc.asp’, the first visit to the Techniques for Nursing Care information page. Code 168 corresponds to ‘.../clinical\_skills/tnc.asp?section=0’, the start page for the Techniques for Nursing Care. One problem with using directed mathematical graphs for visualisation is it is hard to ‘see the forest for the trees’ if there are a large number of nodes and many directed arrows. The full graph including all possible nodes typically looks like a ‘plate of spaghetti (edges) with meatballs (nodes)’ and is not easily interpreted.

Figure 9 presents a subgraph consisting only of nodes 169, 117, 142, 140, 177, 183 and 141. The subgraph focuses on the ‘Hygiene >> Student Nurses’ Responsibilities’ page and related nodes. The codes are:

169 - first visits to ‘Hygiene >> Student Nurses’ Responsibilities’ page

117 - revisits to ‘Hygiene >> Student Nurses’ Responsibilities’ page

142 - Privacy & Dignity page

140 - Principles of Bed Bath page

177 - Do the crossword: Things you need for a bed bath

183 - Play video ‘bedbath2’

141 - Principles of Baby Bathing

Note that the size of the circles representing the nodes is related to the number of visits in order to help the analyst see which nodes were accessed most frequently. The minimum node size is set to 1 (node 183 had only 9 visits) and maximum node size set to 2 (node 169 had 64 visits). The size of the node is given by the formula:  $1 + (n / \max n)$ , where  $n$  is the number of visits to the node and  $\max n$  is the number of visits to the node with the largest number of visits, here 64. Hence, the node sizes vary from 1 to 2. We can immediately see that the bedbath video was accessed only 9 times by an external media player and the crossword was accessed only 28 times. One conclusion is that fewer than two-thirds of the students accessed the Crossword, so either the students were not fully engaging with the online material or they decided to access these learning resources another day. Note that even for students who accessed the URLs corresponding to the Crossword and media player to watch the video, the directed subgraph cannot tell us if they completed the Crossword or

completely watched the video.

## 4 Weblog visualisation via event history charts

Visualisation of event histories is still in its infancy (Francis and Fuller, 1996). Event history charts/graphs can be used to display the relative timing of different types of events (Goldman, 1992; Lee et al., 2000). The horizontal axis represents the elapsed time since a given time origin (which typically the occurrence of a given event). The timing and the occurrence of events of interest are presented for each session, with one horizontal line for each session. Different plotting symbols are used to represent the different events. Figure 10 is an event chart which focuses on nodes:

140 - Principles of Bed Bath page (solid circle)

183 - Play video 'bedbath2' (solid triangle)

177 - Do the crossword: Things you need for a bed bath (upside down triangle)

The rest of the nodes are represented by unfilled circles.

The time origin starts with a visit to node 140 - Principles of Bed Bath page. Note that this visit can be the last node of the session as in the case of sessions 1-3. Session 14 consists of visiting node 140 for approximately 12 seconds then exiting to a node other than nodes 183 or 177. Session 4 is a very short session with the overplotting of a solid circle with an unfilled circle. In 4 sessions the student requested access to the external media player (solid triangles) and these failed every time (http error code not found according to the weblogs), possibly due to the media player not being installed on a home computer. The total time it takes the video 'bedbath2' to play is 22 minutes and 21 seconds or 1,341 seconds. Only 10 of the event chart lines are long enough for the student to have watched the entire video, so one conclusion is that either few of the students fully engaged with the video or they decided to access these learning resources another day or they already had these clinical skills.

## 5 Acknowledgements

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Figure 1 - Clinical Skills Home Page (screenshot)

## Clinical Skills Home

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Techniques  
for Nursing  
Care

(for First  
Year  
students)

Adult  
Simulation

(for Second  
Year, Adult  
Branch  
students)

Child  
Simulation

(for Second  
Year, Child  
Branch  
students)

Learning  
Disabilities  
Simulation

(for Second Year,  
Learning  
Disabilities Branch  
students)

Mental Health  
Simulation

(for Second Year,  
Mental Health  
Branch students)

Figure 2 - Information page for Techniques for Nursing Care (screenshot)



## Techniques for Nursing Care

This provides you with the information you need BEFORE you access the Techniques for Nursing Care Skills session.

In the skills session you will practice the skills shown in the videos on the next page, the home page. There are 3 versions of the video, choose the one you think is most appropriate for your chosen branch of nursing. You can of course watch them all if you wish.

The skills you see are then broken down, and you can explore the different aspects by clicking on the boxes, and then navigating down the menu on the following pages

Once you have explored the resource, please take the quiz by clicking on the link at the bottom of the home page. This is not marked, but you need to have ATTEMPTED the quiz at least 24 hours before your session, we get an electronic report to let us know that you have done this, if we do not receive this you will not be allowed in to the skills session.

You will be able to continue to access the resource even after you have taken the quiz, and it is planned to add some additional information later in the semester – we will email you to let you know when this is available.

Figure 3 - Start » Techniques for Nursing Care (screenshot)

Start

## Techniques for Nursing Care

These skills have been developed in conjunction with the clinical experts and skills facilitators in Southampton University Hospitals (NHS), Southampton City Primary Care and Portsmouth NHS Trusts

The session requires each student to undertake the following techniques:

- 1 - Correct Hand Hygiene - washing, drying and use of alcohol gel throughout the session.
- 2 - Personal Hygiene, and hygiene needs for patients confined to bed.
- 3 - Bed Making & Safe Operation of Hospital Beds.
- 4 - Taking and Recording Blood Pressure, temperature, pulse and respiration rate.
- 5 - Correct and accurate documentation for procedures/care given.

N.B. - you will need to bring a small towel, face flannel and soap/skin cleanser, to complete skill 2 and a watch with a second hand for skill 4. [Click here](#) to access the full lesson plan for this session.

**Watch one of the videos, then continue with each of the following sections.**

**When you're finished, take the quiz via the link at the bottom of this page.**

play video 'interaction_mh'	play video 'interaction_ad'
play video 'interaction_ch'	If the videos are not playing properly, click here to choose to play them in an external player.

**Pick an Area**

Hygiene

Environment

Infection Prevention

Therapeutic Skills

Moving & Handling

Nutritional Care: Eating & Drinking

Observations

**Take the Quiz**

**Please note that you may see an error / warning message about security certificates when accessing the quiz as ISS have a server issue they need to resolve. Just proceed through the warnings to access the quiz.**

Figure 4 - Hygiene » Student Nurses' Responsibilities (screenshot)

Hygiene

## Student Nurses' Responsibilities

**Hygiene**

» **Student Nurses' Responsibilities**

- Privacy & Dignity
- Principles of Bed Bath
- Principles of Baby Bathing
- Principles of Eye Care
- Oral Hygiene

Effect of Handwashing

Shaving

Washing hair

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« Techniques for Nursing Care

- Always gain consent and assess your patient before starting any aspect of hygiene needs.
- Explain what you are doing to your patient throughout each procedure, this will help them co-operate where possible and alleviate any fears/anxieties they have.
- Accurately document all care given and any significant changes in your patient's condition ensuring that if necessary you report this to a trained member of staff.
- Whether you are fully completing all hygiene needs or just assisting your patient with aspects of their hygiene requirements, use this time to assess them.
- Be aware of local policies e.g. infection control, correct disposal of waste and soiled linen etc.

[Back to Techniques for Nursing Care](#)

**next**

Figure 5 - Hygiene » Privacy & Dignity (screenshot)

**Professional Studies**

**Hygiene**  
**Privacy & Dignity**

**Hygiene**  
Student Nurses' Responsibilities  
» **Privacy & Dignity**  
• Principles of Bed Bath  
• Principles of Baby Bathing  
• Principles of Eye Care  
• Oral Hygiene  
Effect of Handwashing  
Shaving  
Washing hair  
« Techniques for Nursing Care

You may not be able to see through a curtain, but you can still hear!!!



← previous

[Back to Techniques for Nursing Care](#)

next →

Figure 6 - Hygiene » Principles of Bed Bath (screenshot)

**Nursing Practice**

**Hygiene**

## Principles of Bed Bath

**Hygiene**

Student Nurses' Responsibilities

- Privacy & Dignity
- » **Principles of Bed Bath**
- Principles of Baby Bathing
- Principles of Eye Care
- Oral Hygiene

Effect of Handwashing

Shaving

Washing hair

---

« Techniques for Nursing Care

- Before starting always assess each patient's ability to perform basic hygiene requirements
- Be aware of cultural needs and the patients "normal" routine.
- Where appropriate always use patients own toiletries.
- Prepare the environment (close windows etc) and bed area (bed correct height) and ensure the area is free from hazards.
- Collect the necessary equipment and supplies prior to starting

Watch the video and think about the items needed for your patients.

Do the crossword: [Things you need for a bed bath](#)

[play video 'bedbath2'](#)

If the videos are not playing properly, click here to choose to play them in an external player.

[Back to Techniques for Nursing Care](#)

[previous](#) [next](#)

Figure 7 - Crossword (screenshot)

## Things needed for a bed bath

Revert  
Check

**Across**

- 1 Use this twice a day (10)
- 4 A child may call these Jim-Jams (7)
- 5 Found on a chicken's head (4)
- 8 Boxers sometimes throw this in (5)
- 9 Can also be a way of talking (7)
- 11 Usually comes in a can (7,4)
- 12 Can be flat or fitted (6)
- 13 Carefull you don't slip on this (4)

**Down**

- 2 A fox's tail (5)
- 3 Also known as H2O (5)
- 6 Used to knock down 10 pins! (4)
- 7 Fine fragrant dust (6,6)
- 8 Give's that 'ring of confidence' (10)
- 10 Common name for female night attire (7)
- 11 Bald men don't need this! (7)

[Crossword Compiler](#) Software © 2003 x-word.com

Web page created by [Crossword Compiler](#).



Figure 8 - Directed mathematical graph of URL visits

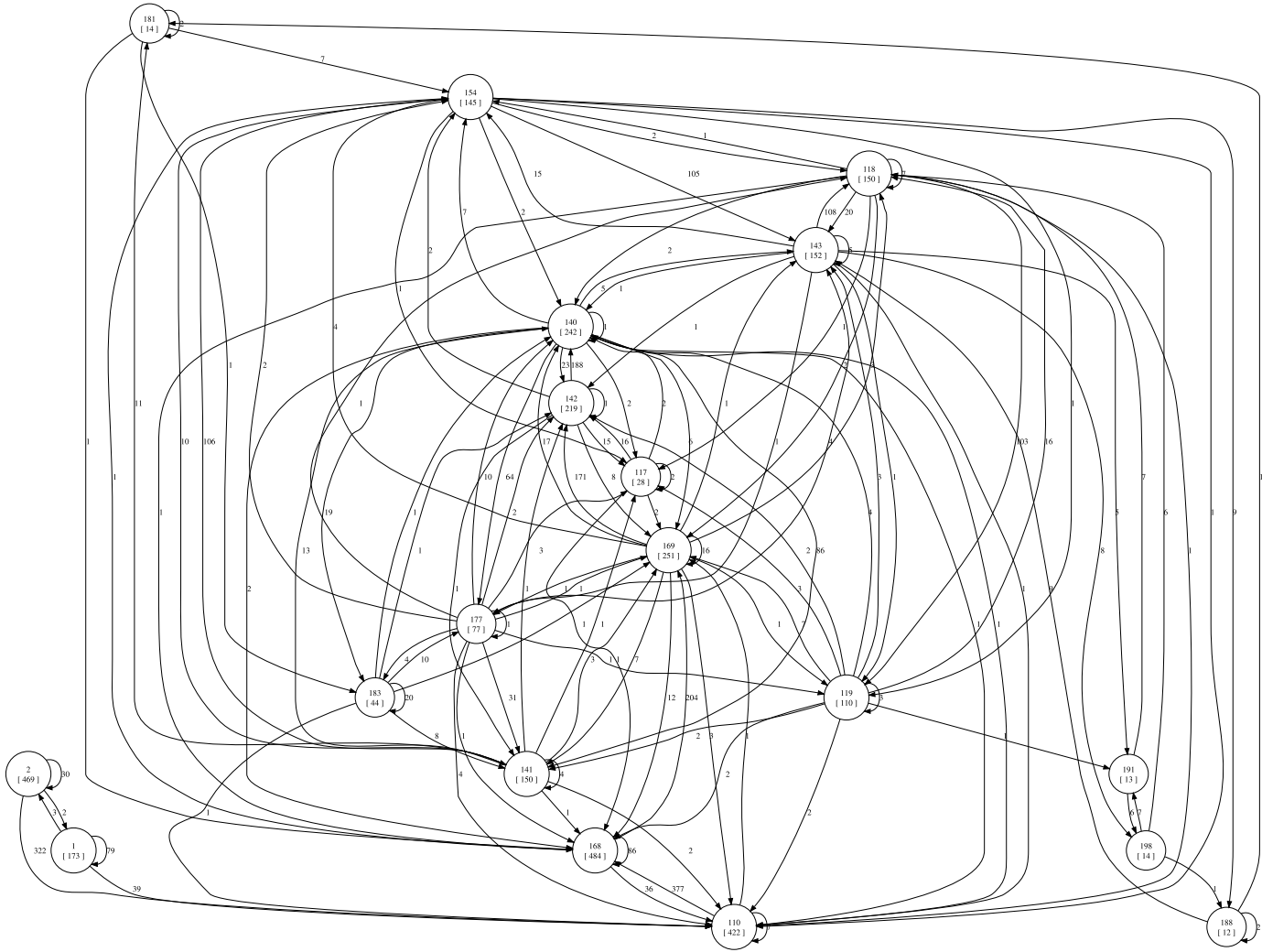


Figure 9 - Directed mathematical graph of selected URL visits

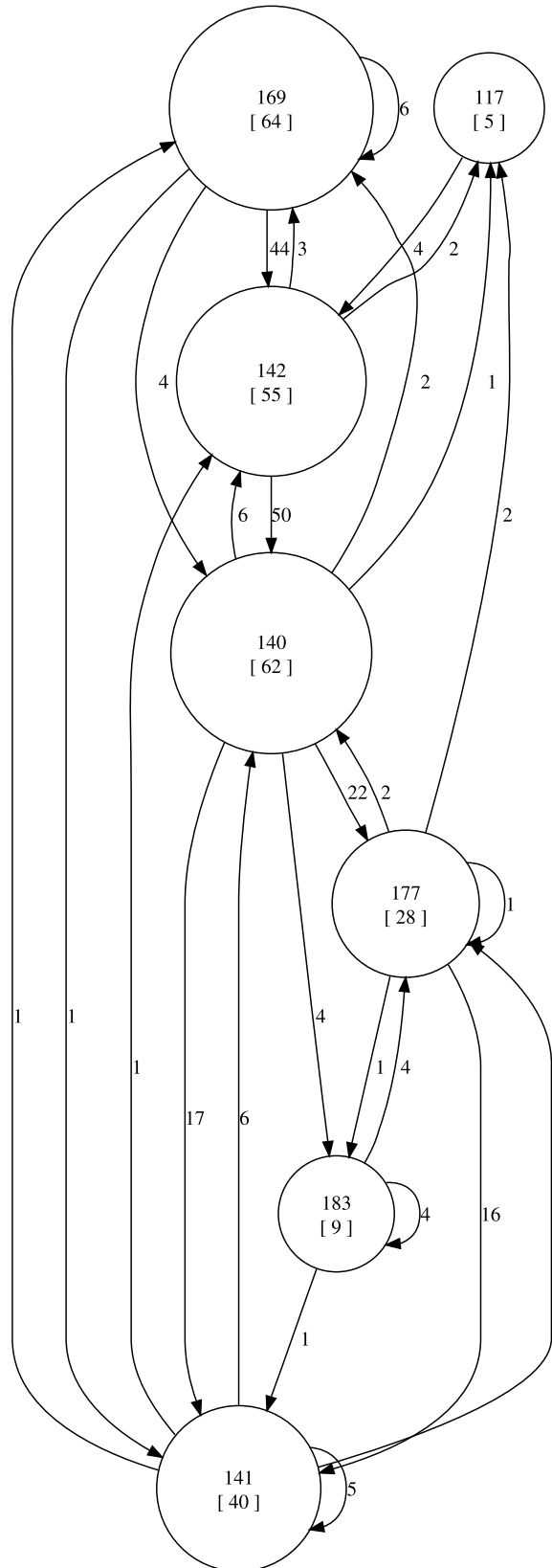


Figure 10 - Event chart

### Event Chart

