

# MarkUs: An On-line Marking Tool

Report on a Pilot Project in CS135 Winter 2010

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## Abstract

Karen Reid and others at the University of Toronto are developing a paperless tool for marking text-based files (i.e. computer programs) submitted by students. It was used in the delivery of CS135 at University of Waterloo in Winter, 2010. Overall, the results were very positive and its continued, and expanded, use is recommended.

## 1. Introduction

Marking programs has been a laborious procedure, particularly in our large introductory CS courses. The following steps are typical:

1. Students submit their assignments electronically using an arcane (from their perspective) command-line tool or a failure-prone but somewhat more friendly web-based tool.
2. A considerable number of resources (time, paper, hardware) is spent printing the assignments out and distributing them to markers.
3. Markers mark the assignments. After some period of days, in which course staff has no feedback on the progress of marking, the marked assignments are (hopefully) returned by the markers.
4. Assignments are grouped by tutorial section and taken to the tutorials. Some are picked up by the students; many are not.
5. Assignments are taken to the Tutorial Centre, just in case a student comes by to pick it up; most don't.

To be explicit, the problems with this process are:

- The resources used to print the assignments.
- The time demands to shuffle paper to markers and students.
- The inability to monitor marker progress and the limited window in which to monitor their actual work.
- The low return rate of assignments to students.
- Collecting, remarking, and returning remarking requests.

### 1.1. Description of MarkUs

MarkUs addresses many of these issues by eliminating the need for paper. Students submit via a reliable web-based interface.<sup>1</sup> When the due date/time is

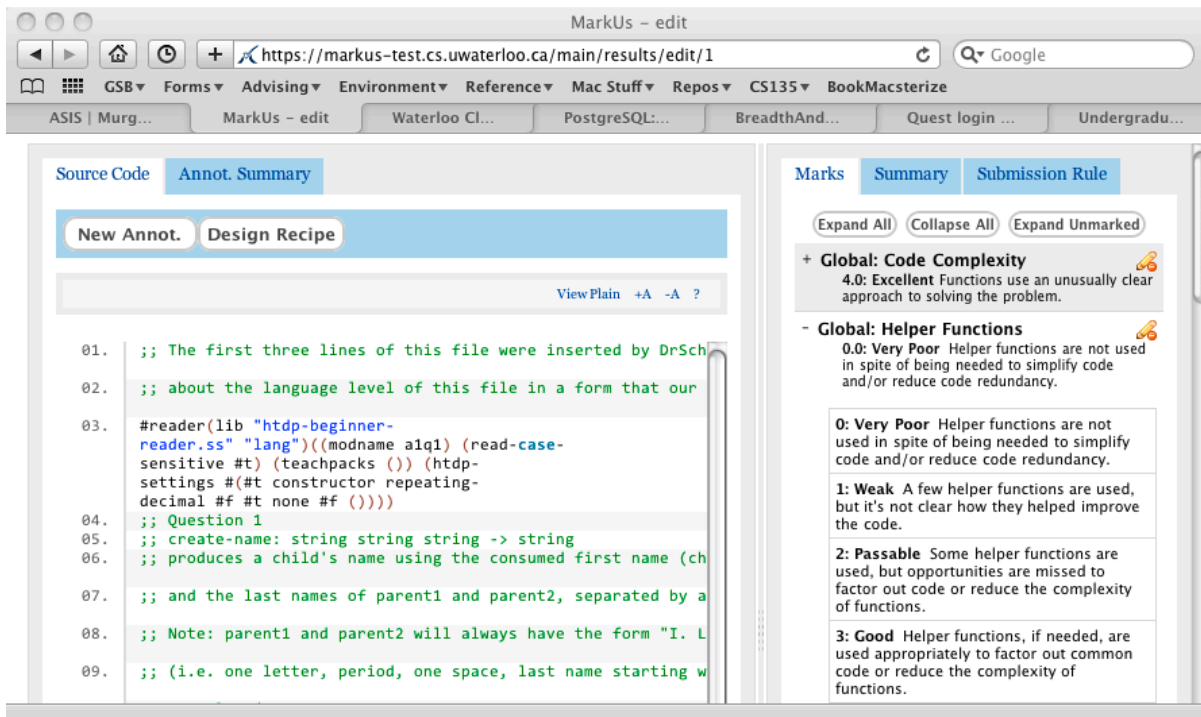
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<sup>1</sup> Command-line options are also available, but have not yet been tested.

reached, assignments are assigned to markers. Markers mark the assignments using a web-based application. The two basic activities they perform are a) assigning marks according to a marking scheme or rubric, and b) adding annotations to the text of the assignment. Annotations can be either prepared ahead of time for multiple use or a one-off annotation.

The following image shows the main part of the marking interface. A student file is shown in the left pane with syntax highlighting. The marking scheme or rubric is shown on the right. To assign a mark for one element of the marking scheme, the marker simply clicks on the appropriate description. This has already been done for “Global: Code Complexity” but not for “Global: Helper Functions.” The total of all the marks assigned can be seen in the “Summary” tab.

The marker can also highlight a section of the student’s code and annotate it, either with a canned annotation selected from one or more drop-down menus (such as “Design Recipe”) or a new annotation. New annotations can be kept for future use. The “Annotation Summary” tab shows a list of all the annotations assigned for this student.



MarkUs also has administrative functions for creating assignments, assigning assignments to markers, releasing marks to students, etc.

MarkUs has provisions for forming student groups and implementing various late policies. Neither of these were used in CS135.

Students submissions are kept in a source code repository (Subversion, by default). Thus past submissions can be viewed (useful when cheating is suspected). Annotations, marks, and related data are kept in a database.

This summer the development team is implementing features for testing student code. They hope to have a workable system in time for the Fall offering.

More information about MarkUs can be found on its web site, <http://www.markusproject.org/>.

## **1.2. Local Adaptations**

Two adaptations were required for use at Waterloo. First, the login security model used by MarkUs wasn't obviously compatible with the standard approaches we use. Omar Nafees modified the login page to redirect to our CAS authentication server. Unfortunately, the user must then click on a "continue" button. Considerably worse is that the CAS authentication gets in the way of a crucial administrative operation (more, below). We're looking into alternatives.

The second adaptation concerns testing student code. Our marking assumes that markers have the results of running student code through a test suite. We have also provided students with a "public test" option which puts their submitted code through a trivial test to ensure that it meets some minimal correctness standards (e.g. saved in the correct format, has correct function names).

MarkUs currently has no provision for running such tests, so a hook was added to call an external program each time code is submitted. The external program copies the student submission from MarkUs to a Subversion working copy in the location expected by our testing software. After the tests are run, the output is simply checked in to the MarkUs repository. But there is one stumbling block: only files present at the due date and time are shown to markers. The tests are done after the due date. The work-around has been to reset the due date to just after the tests are run and updated. Unfortunately, students could continue to work on their assignment beyond the due date. MarkUs has a facility to load such files without changing the due date, but the changes to the security model we introduced prevent it from working.

## **1.3. Use in CS135**

MarkUs was used in CS135 in the Winter, 2010, term. The course had about 150 students, four markers, and one full-time tutor. Ten assignments were collected, marked, and returned via MarkUs.

A typical weekly schedule had the assignment due on Monday evening at 10:00. An exceptionally dedicated tutor ran the marking scripts, updated the repositories with the marking results, and adjusted the due date (a required work-around, as noted above) as soon as possible on Monday evening. On Tuesday, the tutor reviewed some of the submissions and prepared a collection of relevant annotations for the markers to use. The instructor, tutor, and markers met on Wednesday afternoon to review the intent of the assignment, the marking scheme, and pre-written annotations. Markers had until Sunday at 6:00pm to mark their share of the assignments. The tutor then released the marks so that students could see their results via MarkUs. In every case we were able to return one set of assignment results before the next assignment was due; something we were never able to accomplish under the paper-based system.

An email to the course account was sufficient for a student to request remarking an assignment. The tutor could view the assignment on-line (along with the annotations

and marks, of course), update the marks, and release it back to the student -- all without handling any paper.

The remainder of this paper outlines the advantages and disadvantages of using MarkUs, the response of the students and the markers, and recommendations.

## **2. Advantages of MarkUs**

Many of the advantages of using MarkUs, relative to our existing “system”, are probably already apparent. Discussions among myself (the instructor), markers, the tutor, and the Instructional Support Coordinator (Karen Anderson) identified the following advantages:

### **2.1. Eliminating Paper Handling; Cost Savings**

Eliminating paper was a huge advantage in many ways, including:

- In the Fall term we spent \$1,925 for printing assignments. If we had been using MarkUs, that would have been \$1,925 we could have used for other purposes. Other courses may not be as dramatic, but would still present savings. Besides benefiting the School’s budget, avoiding printing also obviously benefits the Earth’s environment.
- Printing takes a substantial amount of time and often introduces a delay of a day or longer in marking the assignments. We allowed about 36 hours between due date and marking meeting, but that could have been cut substantially. All that’s really needed is enough time to look at actual submissions and prepare canned annotations.
- Tutors often spend a lot of time shuffling paper assignments into piles for markers, into piles based on tutorials, from their office to tutorials or office hours and back again, etc. Most of that time can now be used for other tasks.
- Tutor offices have often been cluttered with assignments that haven’t been picked up (sometimes from previous terms!). MarkUs eliminates that clutter.
- Markers appreciated not having to carry paper assignments home with them. Some said they were more likely to mark “in the cracks” because all they needed was an Internet connection. They also appreciated not needing to make a trip to the University just to return marked assignments.
- Assignments can’t be misplaced.

### **2.2. Better Student Feedback**

No formal study was done, but we believe that we provided better feedback to students via MarkUs than if we had used paper-based methods. There are two feedback components; we believe both improved.

The first component is the marking scheme. The marking schemes we used tended to have longer, more qualitative descriptions of the marking criteria. These descriptions did a better job of communicating expectations to students.

The second component are the annotations. Choosing an appropriate annotation from a menu is much faster than writing one out long-hand. Even if you create a new annotation, it’s faster than writing it out. Furthermore, the annotations could be crafted to include some teaching about how to do better next time. For example,

*Better Names: Function and parameter names don't have to be long, but they should be descriptive. One should be able to look at the name and have a pretty good idea what the function does or what the value in the parameter represents. Sometimes names are context-dependent. For example, writing a mathematical function with a parameter named "x" is fine, but for most functions that wouldn't be acceptable. Please pay more attention to naming in the future.*

I don't think anyone would expect a marker to write this much by hand, but using MarkUs it's easy to apply a detailed, teaching-oriented, annotation. It does take time to prepare for the first use, however.

In a survey taken roughly two-thirds through the course, students did complain that more annotations -- and more detailed annotations -- would be useful. The above sample is from after that survey and is more detailed than those first used. In spite of the survey, however, it's fair to say that students received more annotations and more detailed annotations than they would have with the old system.

### **2.3. Easier Marking Procedures**

With all of the marks and annotations on-line and accessible at all times to course staff, remarking becomes much easier. Instead of needing to coordinate the hand-off of the physical assignment, the tutor or instructor can simply log on to MarkUs, review the marks, and adjust as necessary.

### **2.4. Easier and More Robust Student Web Submission**

It's clear that students in our introductory courses are uncomfortable with command-line submission mechanisms and use Web-based submission even if it's slow and unreliable. Fortunately, MarkUs proved to be very reliable. We had no complaints about the system being down and only a few about slowness at peak times. This is a significant contrast to the Fall term where many students felt "burned" by Odyssey crashing or being overwhelmed as the deadline approached.

To be fair, the Fall term had about four times as many students; MarkUs has not yet faced the heavy demands of a Fall term. However, MarkUs uses load balancing techniques that I don't believe Odyssey uses giving hope that it will stand up well under heavier usage. It's also worth pointing out that MarkUs has been running on an older PC rather than a more substantial server. If load becomes a problem, hopefully the hardware can be upgraded.

### **2.5. Automatic Mark Handling**

The system automatically totals all the part marks, eliminating an error-prone step in the procedure. It also can export the marks for inclusion in a spreadsheet, eliminating mark entry.

### **2.6. Monitoring Marking**

On-line marking allows instructors to monitor marking, both the progress and the quality. It's a simple matter to log on and see a list of all student submissions along with the state of their marking. It's also easy to see the marks and annotations assigned to an individual student.

## **2.7. Marking Speed**

One of the markers observed that “using MarkUs ... may be marginally slower than marking by hand, assuming no annotations are added.” However, that last qualification is an important one, indicating that we’re not really comparing apples to apples. Given the standard of marking we desire, it seems that marking with MarkUs is at least as fast (although this hasn’t been tested).

## **2.8. More Consistent Marking**

The markers stated that they thought their marking was more consistent because “we are reminded of the marking scheme by the rubric at all times”. In contrast, at least some markers report that with the paper-based system they could mark many papers with only minimal reference back to the marking scheme.

## **3. Disadvantages of MarkUs**

The disadvantages we identified are remarkably few. The most significant focus on things we wish MarkUs would do but doesn’t (yet).

### **3.1. Required Internet Connection**

Markers observed that in some ways MarkUs is more portable than the paper-based approach because markers do not have to carry the assignments with them -- all they need is an internet connection. But there are some times that the internet is not available; a road trip was one example they cited. Overall, however, markers did not view this as a significant issue.

### **3.2. Difficult to Use Without a Large Screen**

The MarkUs marking display requires space for the student code, the rubric, and annotation menus. All this is larger than will comfortably fit on most lap-top screens, further restricting the environments in which MarkUs can be used for marking.

### **3.3. Difficult to Mark Samples as a Group**

With paper-based marking, it’s relatively easy for everyone to mark a few papers as part of the marking meeting. It’s difficult to do that with MarkUs. Some may not have laptops and even for those that do the screen size makes it more difficult. Holding the marking meeting in a lab is one option, but adds one more (difficult) constraint to the scheduling problem.

### **3.4. Limited Feature Set**

MarkUs is still in its infancy. The core functionality works -- and works quite well -- but there are many places where one could imagine doing better. The following is a partial list of limitations and suggestions that was discussed with the core implementors at a meeting on April 9, 2010.

#### **3.4.1. Integrated Testing System**

An integrated way to test student programs -- and include the resulting marks in the overall total -- is an obvious omission. Fortunately, several people have been hired to work on MarkUs over the summer, including putting a testing framework in place.

Fortunately, their vision seems to be very similar to ours (same basic ideas as Marmoset).

### 3.4.2. Performance

From a student perspective, performance seems to be quite good. From an administrative perspective the story is quite different. Two views in particular are very slow: building a list of submissions and building a list of assignments to mark. Hopefully, this will be addressed over the summer.

### 3.4.3. Miscellaneous

- Better reporting on graders (average mark given, annotations applied, etc), grades (mean, mode, median, distribution, by rubric component, etc), submissions (students not submitting current assignment, students not submitting multiple assignments), etc.
- MarkUs should be able to reject files early in the submission process based on file name, size, attributes of the contents, etc.
- MarkUs should permit command-line submission and web-based submission. Both are currently available, but only one at a time.
- Rubrics should allow zero and negative weights (penalties for doing something you weren't supposed to). One should be able to designate a rubric criteria as a bonus. Both of these can be addressed with an explicit bonus/penalty mechanism, but it's not part of the rubric and can thus be overlooked and it's more difficult to apply than making it part of the rubric.
- MarkUs should allow students to see the entire rubric rather than just the descriptions of the mark they received.
- Annotations are up/downloaded as a CSV file; this probably isn't the best format.
- Support for CAS authentication.
- Standardized hooks for pre- and post-submission processes would give more flexibility. I added my own post-submission hook to integrate with our testing system, but that requires maintenance with every new MarkUs release.
- Several entities (assignments, graders, administrators) can't be deleted once created.
- It would be great if we could mark up PDFs as well as text files.

## 4. Marker Response

The markers for the pilot offering were asked three questions:

1. What's good about using MarkUs?
2. What's bad about using MarkUs?
3. How could MarkUs be improved?

Much of the previous sections was based upon their replies. Overall, the markers were positive throughout the pilot project and listed relatively few disadvantages for using MarkUs (required internet connection and need for a large screen; the majority of the section on *Limited Feature Set* was from me). From the few disadvantages they cited, I believe it was a positive experience for the markers.

## 5. Student Response

About two-thirds of the way through the term students repeating CS135 were asked the following three questions:

1. Compare the hand-in process:

Submit is better	1	2	3	4	5	6	7	MarkUs is better
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2. Compare the grading:

Paper is better	1	2	3	4	5	6	7	Online is better
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3. Compare the hand-back process:

Paper is better	1	2	3	4	5	6	7	Online is better
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Their responses are summarized in the following table:

	Hand-in	Grading	Hand-back
<b>Mean</b>	6.79	5.79	6.44
<b>Median</b>	7	7	7
<b>Min</b>	1	1	1
<b>Max</b>	7	7	7
<b>StDev</b>	0.81	1.63	1.11
<b>Distributions</b>			
<b>7</b>	53	32	43
<b>6</b>	7	8	9
<b>5</b>	0	10	6
<b>4</b>	0	3	1
<b>3</b>	0	5	1
<b>2</b>	0	1	0
<b>1</b>	1	2	1

With very few exceptions, students with experience using our existing systems and MarkUs strongly preferred MarkUs.

In addition, all students were asked two more questions:

4. What are the best parts about using MarkUs?

5. What are the worst parts about using MarkUs?

Student responses to the best parts about using MarkUs are shown in Appendix 1. To summarize, students appreciated better feedback. They appreciated the annotations, break down of marks, and the timeliness of the feedback. Several appreciated having access to the class average. Students appreciated the stability and

ease of use of MarkUs, especially compared to the old systems. Convenience was cited often -- convenience in submitting assignments, getting them back, and accessing their marks.

Student responses to the worst parts about using MarkUs are shown in Appendix 2. Students wished the quality of the annotations themselves was higher (we put renewed emphasis on that after the survey). They cited some issues about the system, including a few performance problems, overly aggressive time-outs, and some usability concerns. Students suggested several feature enhancements, including better handling of bonus marks and integrating public test requests. Six responses indicated they preferred paper-based marking, although some of these seem to be related to the quality of the feedback we provided rather than inherent to the system. Some students expressed frustration with our automatic testing (really outside the scope of MarkUs). Finally, even in the “what’s the worst part” question, some students gave responses like “It’s so good it’s bad” and “I really don’t think there are any worst parts...”.

## 6. Recommendations

I am very encouraged by our pilot project. I’m optimistic that the MarkUs developers will extend it to include Marmoset-like testing tools so that eventually we can replace Marmoset and Odyssey/Submit with MarkUs. For the short-term, I recommend:

Spring 2010: Use MarkUs in CS115 to develop experience in another course and to prepare for using MarkUs with the Dubai version of CS115 in Fall. (This is happening.)

Fall 2010: Use MarkUs in CS135 (I will be on the teaching team) to test it with a large number of students. MarkUs developers are hoping to have a new version with testing capabilities released by Fall, but I suggest that we stick with the current version (0.7).

Use MarkUs with the Dubai version of CS115 to enable using Canadian-based markers.

If we use MarkUs with part of CS115, I think it would also make sense to use it for the local sections as well. Whether we do so depends on whether CS115 instructors are prepared to accept some risk that problems occur with higher volumes of students.

Winter 2011: Pilot the new version of MarkUs, with provision for testing student code, in either CS135 or CS136. The advantage of CS136 is that I will be teaching it and can do the work for the pilot. The disadvantage is that it’s bringing new techniques and a new course on board at the same time.

Continue using version 0.7 in the courses that used it in Fall 2010.

Spring 2011: Encourage instructors throughout the School to adopt MarkUs.

## 7. Summary

MarkUs represents an opportunity for us to improve the feedback we give students on their programs, give them the feedback faster, save costs, and reduce work for tutors and staff. Given the few disadvantages, we should make extensive use of this tool.

## Appendix 1: The Best Parts (Student Perspective)

All of the student answers to the question “What are the best parts about using MarkUs?” were entered into a spreadsheet. Comments with two or more ideas were split. The results were then placed in categories.

### 1. Better Feedback

#### 1.1. Annotations

- Explanation of problems with code are better
- Feedback is included.
- The interactive process of knowing where to improve by looking at the marker’s comments.
- You can view TA feedback easily.

#### 1.2. Marks

- All the marks were broken down well.
- Marks on assignments are more clear
- The overall mark is broken down and is displayed clearly.
- We can see the marking scheme.

#### 1.3. Timeliness

- As the results come out, we can see them immediately.
- Get feedback, grades, public tests as soon as possible.
- Get marks soon.
- Get OUTPUT.txt just after the program is tested.
- Output file (test results) can be scanned early on.
- Quick return and easy to review marks for the term since paper usually means someone has to update ACE.
- Quick return of marks.

#### 1.4. Class Average

- It allows students to see the average mark easily.
- Knowing the average.
- Nice to see class average
- It tells you what files you’re missing.

#### 1.5. General

- Assignment rubrics.
- Assignment summary.
- Better feedback
- Clear.
- Clearer grades
- Easy to understand feedback.
- Feedback was very easy to find.

- I can easily see my mark on it and the parts where I lost marks.
- I can know exactly what goes wrong in my program.
- Mark breakdown is clear
- MarkUs makes an output text file (actually, the result of our marking scripts); easier to check marks.
- Testing output always provided before hand-back time.
- The ability to see your submission and having a live look at the mistake.
- The comments on assignments can be easier to recognize compared to handwriting
- The feedback is clearer.
- The feedback is much better because they elaborate on what they are looking for, for instance if a code is too lengthy.
- The marking detail is quite clear.

### 2. Better Stability

- Old one was impossible to access if traffic was high
- Does not crash like Odyssey did when everyone submits last minute. Easy to miss deadlines when Odyssey crashed. MarkUs is always stable.
- Doesn’t crash like Odyssey.
- Don’t have to worry about system crashing when you want to hand it in on-line. So, you can complete the assignment and hand it in on a personal computer.
- Fairly reliable when servers are at high traffic.
- Hasn’t crashed.
- Hasn’t crashed.
- Haven’t experienced down-time.
- It doesn’t crash as often as before.
- It works.
- Never crash like submit.
- Never crashes
- No crashing servers.
- No lag towards the deadline of an assignment.
- Odyssey crashed and was very slow.

- Server does not shut down as much as last term.
- So far it has not yet crashed before the deadline of the assignment.
- System does not crash at all.
- The system also does not crash.
- There are no crashes to the system when you submit your assignment at the last minute.

### **3. Convenience**

#### **3.1. Accessing Marks**

- Can check marks on-line.
- Can check marks on-line.
- Check grades in same location as submit.
- Check marks easily.
- It's very easy to view my marks and view the comments on my assignments.
- You can look at your marks easily.

#### **3.2. Submitting Assignments**

- Assignments can be returned on-line.
- Can submit and receive electronically (ie: don't have to come to a dropbox).
- Convenience. Easy to hand in my assignment.
- Convenient submit
- Don't need to leave the house to submit your work.
- Easier to submit assignments.
- Easy to submit my work. I can submit it whenever I want and replace it by my new work any time I want.
- Hand in the assignment on-line.
- Handin assignments from home.
- I can submit it from my computer.
- I don't need to come to school to hand in my assignments. I can do it from home.
- I like that you can submit multiple times.
- You can submit it right before the deadline so that you don't need to go to school to submit. Therefore, we have more time doing the question.
- You don't need to rush to the dropboxes to handin your assignment.
- I don't need to print my assignment. I can just submit my work at home.

#### **3.3. Picking up Assignments**

- Don't have to go to tutorial to get it back.
- Hand-back is better.
- I don't have to go to tutorials to learn what grade I got.

- It's easy to get the result of the assignment and figure out what part I'm lacking on.
- WE don't have to go to get our assignment.
- We don't need to go to MC to pick up our assignments.

#### **3.4. General**

- A lot more convenient than Odyssey.
- Any idiotic typo or other error can be quickly corrected via a simple file resubmission as opposed to having to reprint an assignment because of said idiotic typo/error.
- Can check and submit re-mark requests on-line.
- Convenience
- Convenient
- Convenient
- Convenient resubmission process.
- Do not have to go to get assignment.
- Easy to use (submitting, checking submission, etc).
- I can submit or make modifications up to the last second.
- I don't have to pick (through a) bunch of papers
- It is more convenient to use and to update changes in the assignments.
- Save some time for us.
- Student can access their account at any time and view their assignments.

### **4. Ease of Use**

#### **4.1. Submit**

- Easier to submit.
- Easy to hand in assignments
- Easy to hand in.
- Easy to submit
- Easy to submit assignments (just like uploading attachments).
- Easy to submit assignments.
- I find it a lot simpler than using Odyssey. You do not have to keep re-uploading all your files and click so many links to get into the submission process.
- I find it easy to hand in, and easy to get some form of initial feedback using the request public test.
- It's easier and faster to hand in assignments.
- It's easy to submit and revise when the public test fails.
- It's easy to submit the homework.
- It's easy to submit.

- Much simpler way to submit than previous system.
- Very easy to submit.
- Very simple method of submission.
- We can submit our assignment easily.

#### 4.2. Check Marks

- Easier to see current marks.
- Easy to check marks
- Easy to look for the marks.
- We can check our marks easily.

#### 4.3. General Ease of Use

- Ease of use.
- Easier
- Easier to use.
- Easy
- Easy to understand.
- Easy to understand.
- Easy to use (x7)
- Easy. No need for extra software or set-up.
- Interface is easy to use.
- Intuitive to use.
- It's a lot easier to use than Odyssey.
- It's simple to use.
- MarkUs is easier and more efficient to use than the previous method last term.
- Much easier than the old system
- Resubmitting a question is easy.
- Simple to use.
- Simple.
- The interface is way easier to handle compared to submit.
- We can see the summary and comment easily.

### 5. General Comments

#### 5.1. Archiving Past Assignments

- Able to check the mark and the previous work at any time.
- Easier to check previous assignments and their comments.
- It can store the assignments.
- Paperless. Can always get assignment back even (if) I don't go to tutorials.
- There are records of every assignment.
- You don't have to worry about losing your assignment feedback.

#### 5.2. Speed

- A lot faster than Odyssey, especially during peak-times right before assignments are due.

- Does not slow down/crash like Odyssey
- Doesn't seem to lag.
- There hasn't been a single slow load time of the website, unlike last term with Odyssey.
- Uploads quicker and less traffic (compared to Odyssey).
- Fast, compared to paper hand-back.
- Less steps to submit assignments.
- Fast submission.
- Fast/Faster (x5)
- Hand in fast.
- It's quick and comfortable.
- Much quicker

#### 5.3. Better User Interface

- A lot more organized.
- Concise website space
- Easy, intuitive interface.
- Easy and understandable user interface.
- Everything from submission to handling is great.
- Everything on one site.
- Good interface.
- Good interface.
- Great to see all online marks at once in the same place.
- Nice layout.
- Tells you what you're still missing.

#### 5.4. Appreciate Public Tests

Note: This isn't a part of MarkUs.

- I like the parts where I can utilize public-test that can see whether my code works fine before it is to be marked.
- Public tests; I always make those "silly mistakes."

#### 5.5. Other

- Submitting it!
- We can submit assignments after due time.
- Excellent prototype.
- Gives exact time left.
- It's safe.
- It's the best thing that's ever happened in my life.
- Keep MarkUs!
- Less paper (works? marks?) and troubles
- Pretty much every function is much improved and more easily trackable. Especially the grading functions.
- Reduces the possibility of handing in the wrong section.
- Smooth

## Appendix 2: The Worst Parts (Student Perspective)

All of the student answers to the question “What are the worst parts about using MarkUs?” were entered into a spreadsheet. Comments with two or more ideas were split. The results were then placed in categories.

### 1. Feedback

#### 1.1. Poor Quality

- Annotations aren't as good as when assignments were marked on paper.
- Comments and feedback are still inadequate to determine what needs to be improved.
- Comments from markers lack clarity.
- Comments on marked assignments are not understandable.
- Comments on marked assignments are very vague.
- Comments on where you went wrong are limited.
- Did not see enough comments.
- Hard to read the comments from the TAs on my work.
- I think the people marking have gotten lazy.
- It does not contain a lot of feedback coming from the markers.
- Lack of individualized comments. It's almost there, though.
- Less explanation about marking problem code.
- Not a lot of comments.
- Not as much feedback.
- Often little to no explanation of deducted marks given (this does not seem to be a technical restriction, however).
- Some comments are not clear enough.
- Tendency to get non-instructive, generic comments on assignments.
- The comment from the marker is enough. [?]
- The comment graders give is some how ambiguous.
- The comment is not clear. (eg: Purpose is not clear; don't know why).
- The comments are usually a little vague upon hand-back. A more complete rubric for the non-code elements would be much appreciated post-hand-back.
- Too few comments on where the marks are deducted.

#### 1.2. Other Feedback Concerns

- Returning marks are harder to see where I went wrong.
- Seems like it takes a while to get feedback for assignments, but that is probably due to so many students rather than MarkUs itself.
- The way assignments are marked. The system just runs tests (check-expects) on your program and grades on the correctness when the marks should be awarded on that and the amount of effort allocated to the task.

### 2. System Issues

#### 2.1. Performance

- Connection speed is slow.
- Sometimes slow.
- The system does not work well sometimes and sometimes cannot login when near the peak time.

#### 2.2. Timeouts

- Have to re-submit file if the login time expired.
- Login timeouts are too frequent.

#### 2.3. Usability

- Difficult to read comments; sometimes the comments get messed up on the browser.
- Grading window could be made simpler so it's easier to read comments.
- No command-like submit, like Odyssey
- Reading on-line marked assignments is a bit of a hassle in terms of clarity.
- Sometimes MarkUs doesn't work fluently.
- The current login process is inane.
- The feedback is a bit confusing to read.
- The session expires too soon.
- Viewing results are somewhat confusing, since the summary and the comments cannot be viewed at the same time.

## 2.4. Feature Requests

### 2.4.1. Handling of Bonus Marks

- Bonus marks problem.
- Cannot handle bonus questions correctly so the mark displayed is not exact.
- It can't show bonus and clicker marks as well as total grades.
- The bonus marks are also included in the total marks.
- The bonus marks are also included in the total marks.
- The grading part. Since bonus appears on the grading, if we do not do the bonus, it doesn't display our actual mark.

### 2.4.2. Integration of Other Course Marks

- No midterm or clicker marks

### 2.4.3. Integration of Public Tests; Solutions

- I think it should include public test in the MarkUs that is more convenient.
- Must sign into a different place to request a public test.
- Can we integrate solution requests, sample papers into Markus?

## 2.5. Other Concerns

- Besides MarkUs crashing once in a while, it hasn't posed a huge problem for me.
- Cannot connect to the system sometimes.
- Crashed that one time (assignment 1) but hasn't since [Note: this was actually an upgrade that affected students negatively]
- Sometimes I get a page that cannot be displayed. Rare, however.
- Sometimes the Internet breaks or there's something wrong with the website.
- Sometimes the system may have an error when I submit files.
- Sometimes we cannot do "replace" (for resubmitting). I have to delete the old one, then submit the new one. I don't know if it is a general problem or if it is just for me.
- The due dates on MarkUs are inconsistent with those on the website (specifically the exact times).
- There are some bugs while submitting the assignments.
- There is always a bug that happens when I check my solutions. It lags, and then I need to switch to other solution...

- There's nothing much that I can say as a bad part of MarkUs but to state one thing, I don't know why when I'm replacing a file and click "Browse" it shows like ".../fakepath/...", but I think this is just Windows 7's problem or my computer's problem.
- When it logs/times out I can select a new file to upload only to be logged out when I press submit.

## 3. Prefer Paper

- Easily neglect little mistakes I made because I can't take notes;
- Feedback not as nice [as paper?].
- Hard to discuss my assignments when they are handed back.
- I don't really like how it is graded. I would prefer if it were on paper because I find that the comments are too general and don't exactly point out where your mistakes are. But I like getting the hand-back online; it is quicker than getting back on paper.
- No physical copy to see.
- Really think that feedback via MarkUs is a bad idea. It's really minimal and I'd rather get an actual paper returned to me.

## 4. Testing

- Cannot tell where you went wrong in the check-expects.
- It's harder to get marks because you get a grade based on how many tests your function passes. For the paper process, the markers actually read all your code.
- Not always easy to know what errors occurred.
- One mistake somewhere can harm your submission disproportionately, when compared to what you have learned, and the work produced.
- Sometimes it does not update the new files that I submit again.
- Sometimes there are files on MarkUs however my public test cannot be run successfully.
- Synchronization issues.

## 5. Other

### 5.1. Ambiguous Answers

- Not easy to ask (?).
- Unfinished assignment or program marking.

## 5.2. Positive Answers

- Actually, comparing to Odyssey, everything is better comparatively.
- Blank (9)
- Do not have any bad comments about MarkUs.
- Haven't found any, no complaints.
- I really don't think there are any worst parts to markus; it's clean and efficient...
- It is better overall.
- It's good.
- It's so good it's bad.
- N/A (2)
- No bad part for me.
- No complaints.
- None. I cannot imagine how it could fulfill its function in a substantially better way.
- None. It's better in every way.
- Nothing so far.
- Nothing thus far
- Nothing/No/None/Not Really (12)
- So far so good.

## 5.3. Unrelated to MarkUs

- I can not talk to the professor face to face.
- Must have exact file name (not really an issue)
- Some of the automatic marking are not reasonable in my opinion.
- Sometimes I forget to check my MarkUs homepage, so I don't get information on time.
- Sometimes I lose marks for just small mistakes.
- The assignment clock is off by a minute as compared with the one my computer keeps time by