CSC 840

Project 6

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1.0 Abstract

The LSP method is an abstract way of evaluating software, which relies on logical aggregators to get values and add them together. This is a good way of evaluating software because it tries to take away the bias that one might get when trying to evaluate software on their own. The criterion are the leaves of the LSP tree, while the aggregators are leading to the leaves. It's important to note that the LSP method has a stake holder that the tree should revolve around. When the stake holder changes that could change the values going into all the aggregators, as well as the values given to the leaves. The LSP method also has an expert. The expert is the one responsible for telling the evaluator which fields are important. For example in video games the system requirements are very important, because if you can't run the game you can't play; therefore, you are not very satisfied. In this paper I'm going to be going talking about why I selected each aggregator for video games, and why I selected each of my criterion.

2.0 Attribute tree for project: Modern_PC_Games

1 Modern_PC_Games
- **11 Game Play**
  - 111 Multiplayer
    - 1111 Ranking System
    - 1112 Chat system
    - 1113 Friends list
    - 1114 Multiple game modes
  - 112 Campaign
    - 1121 Multiple paths
    - 1122 Difficulty options
    - 1123 Levels
  - 113 Variety of Strategy
  - 114 Mechanics
- **12 User Interface**
  - 121 Main Menu
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- **13 Graphics**
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  - 132 Screen Resolution Options
  - 133 Frames Per Second (units - FPS)
  - 134 Additional art/object details
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    - 1512 GPU
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2.0 Aggregators

When talking about the aggregators for this project, I'll be numbering them with their node number from the LSP tree. It's also important to talk about what the aggregators do. The purpose of the aggregators is to allow multiple criterion to add into one attribute. For example in my LSP tree I have the Multiplayer aggregator that takes in four criterion. From that aggregator there is the Game Play aggregator that takes in four more criterion. Finally you get to the root aggregator of the project that takes in 5 criterion to sum up your evaluation. So their important in making sure your tree has enough depth to be useful in the summation of large systems that would be troubling to do by hand. Before I would create a new aggregator I would ask myself "what children should it have"? With this I tried to make the most logical tree as I could fitting the aggregators more or less where they belong. Aggregators can also be conjunctive and disjunctive, and in this section of the paper I'll be talking about my decision for each aggregator. Starting with the Multiplayer aggregator.

11 Game Play - The game play aggregator is split up into 4 criterion 2 of which are aggregators which go deeper into the tree. The multiplayer and campaign aggregators are essential for breaking up the games into experiences that cover multiple games, and not just a set genre. Therefore, these aggregators will cater to a wider span of games allowing the LSP tree to be more diverse in games we can evaluate with it. The other two criterion are Variety of strategy, and mechanics. These two are essential as they depict how hard the game will be to pick up and learn. Without these there would be no way of telling if there is one strategy that always works, or is there a eco system of strategies that will work but you have to pick the right one. Mechanics are the controls the game uses to interface with the user. These can very on a range from easy (you can pick up the game in a day), to hard (it takes years to master). Although my favorite is when a games mechanics are easy to learn, and takes years to master. This usually means the game is user friendly and can bring in new gamers easily, but still cater to a crowd of people who desire a gap in skill between them (Starcraft 2 is an excellent example of this). To make this aggregator account for games that don't have a multiplayer but have a campaign, and the opposite as well; I made the aggregator disjunctive with a D+- rating. Therefore doing it this way it can have a campaign or a multiplayer for gameplay and a game that has either won't be punished severely for not having the other game mode. The weights for this aggregator are as follows Multiplayer – 20, Campaign – 20, Variety of Strategy – 20, Mechanics – 40.

111 Multiplayer – The multiplayer aggregator I made with the C+- soft conjunction aggregator. I chose this aggregator because all of the criterion it's aggregating are somewhat needed. For example in the multiplayer experience it's very important to have a ranking system, the ability to chat and add to a friend's list, and multiple game modes. The friends list directly relates to the ability to make friends and have a good time with people you know, so you are not playing always with random people. I tended to give more weight to the ranking system involved, and the multiple game modes. The weights for the criterion are as follows: Ranking system – 50, Chat system – 10, Friends list – 10, Multiple game modes – 30. The reason the ranking system is worth 50 points is because if you are paired against people of unequal skill frequently you will not have fun; therefore, your satisfaction will decrease because of it. The other way around is also true, if you continue to beat people of significantly less skill you will lose interest in the game, and lose satisfaction in it. However, if you are paired against people of equal skill consistently winning games, and losing games at a good rate you will stay hooked to the game.

112 Campaign – While some games may be more multiplayer intensive they may also have a campaign, or not have a multiplayer and just have a campaign for players to play. For this reason I needed to break these up into two separate aggregators. The Campaign aggregator contains criterion such as: Multiple paths, difficulty options, and levels. When playing a campaign you are going to want lots of variety. That's where multiple paths through the campaign, and varying creativity for levels will be very useful. While difficulty options will change the experience to fit the user's ability with the game. The aggregator I used for this is C-+ which is a soft conjunctive aggregator. I picked this one because it has some optional components; such as, difficulty options which are not required but add good flavor to a game. When you're able to pick which difficulty option you would like to play at you can better cater the game to your level of skill.

12 User Interface – The user interface is an important part of any game. Being able to navigate to the appropriate page is a huge deal in satisfaction of a game. If you have to take even a couple of minutes to figure out the user interface you could lose interest and have your satisfaction in the game drop. With the newest generation the millennials they are accustomed to getting what they want from technology fast, so if your user interface has a bad design you will most likely have a very dissatisfied user. Therefore, for the aggregator I chose C+ because the user interface for both the main menu, and the options menu should both be mandatory. The weights for these two criterion are as follows: Main Menu – 60, and Options Menu – 40. I swayed towards giving the main menu more weight because it's the first thing a user will be interacting with. It is also the piece of the game the gamer will be interacting with second to most other than the game itself. Whenever there is a game mode to change it all revolves around the main menu. Therefore, the main menu is a very critical point to the games overall user interface granting it an additional 20% more to its weight. However, the options menu is still

important because having played games where the options menu was confusing really took away from the game. I would say it's the part of the game that's usually most neglected, but one of the criterion that is a definite must for any game that wants to be successful. Since the options menu is the screen that users are going to look at to customize their personal experience, it's very important to get this piece of the game right.

13 Graphics – Graphics are another large piece of whether a game will be satisfying or not. If a game is not visually pleasing it may discourage people from playing it, and they may try out more visually appealing games. The criterion for this aggregator are weighted as follows: low, med, high options – 20, screen resolution options – 10,
frames per second - 60, additional art/object details – 10. The reason why frames per second is rated the highest out of all these criteria is because you need the game play to be as smooth as possible. If it's not smooth people will stop playing your game. I've seen this time and time again, people barely meet the minimum requirements for a game there game is choppy and they stop playing weeks after buying the game. After they switch to a game more suitable to them where they can get a decent frames per second and have their game be smooth. Other criterion in this section such as screen resolution play into it, because with higher resolutions you can fit more pixels on the screen. Therefore, when you fit more pixels on the screen it increases visual clarity and sharpness allowing a more satisfied experience. Low, medium, and high options play a crucial role in the graphics section, because it allows gamers to alter how GPU intensive the game will be on their computer. A person with a lacking GPU may want to lower the settings to increase their FPS and hence increase how satisfied they are with the game. So these options to modify how much detail is in the game are very important that's why they are weighted higher than the other two. Finally the additional art/object detail refers to the small details developers will add to games that if you take the time to notice will put a smile on your face. For example in Hearth Stone there are items for you to click on unrelated to the game play while you wait for your opponent to make his move. This serves two purposes, keep the user interested in the game while nothing is happening, and create an enjoyable experience where if this wasn't there, there wouldn't be one. The aggregator for graphic is half way disjunctive, because it has some things that are kind of optional; such as, the additional art/object details. All games don't need to have these, but if they do they should be rewarded for it, while games that don't shouldn't exactly be punished. While also having it disjunctive will give the appropriate score to the frames per second which is the most important part of the graphics aggregator.

14 Audio – Audio is another large piece of what makes a game enjoyable. Without audio, the games lose personality, and become rather bleak to play. There needs to be sound effects, and music, as well as have it all be appealing to the ear. I rated the audio aggregator a C-+ because I felt it should be more conjunctive to punish attributes a game doesn't have. For example if a game doesn't have very good sound effects it should lose points, as well as if the sound effects and music is not timed well with the game. The aggregator weights for this are as follows: Fits game genre – 15, Plays on a queue from the game – 15, Appealing – 50, sound effects – 20. I weighted appealing with 50% due to the fact that if the music that is played in the game, and the sound effects are not appealing to the ear you will hate the game. For example you wouldn't listen to a genre of music you hated, why would you? But a genre of music you like, you would listen to all the time. Therefore, if the music appeals to you, you are more likely to play the game, and are therefore more satisfied with the end result of it. Sound effects have a 20% rating because they are the icing on the cake for video games. When you click on items on the menu, click on items in the game, activate things in the game, sound effects are there to add flavor and diversity to the sound you hear in the game. While playing the music at appropriate times at a certain queue from the game will tell the user more about what's happening and will help envelope them into the world of the game they are currently playing in. Now the last criterion is somewhat key to all of these features, and that is the music must fit the genre of game. If you are playing a first person shooter game that's fully of blood and gore, such as Doom 2. You wouldn't want a happy sound track to be playing in the back ground, you would want something more intense. A more intense song or sound track would help the user get more into the game than a happy sound track, and would therefore increase satisfaction the game provides.

15 Computer Requirements – Computer requirements are going to one of the most pivotal aggregator, as if your computer can't run the game your satisfaction should result in zero. Why is this? Well no matter how well the game is made let's say the game scores 100's on every category it is really awesome; however, your computer cannot run the game. Are you going to be satisfied with this game? I would hope not, because you are not going to be playing a game your computer can't run. Therefore the evaluation should result in a score of zero, and other games your computer can run will result in a better score. For this reason I made this aggregator C++ so that it is a hard conjunctive aggregator. The weight for the criterion are as follows: RAM – 30, GPU – 40, CPU – 20, OS available – 10. RAM and the GPU are the most important so I weighted them heavier. Without sufficient RAM the game may not run as intended causing crashing and errors, as your computer searches for more memory that is not there. While if you have an insufficient GPU your games FPS and graphics will be bad and choppy, therefore this is crucial when it comes to system requirements. The CPU being the thing that has to process all the information comes next, and finally after that the operating systems the game is available on. A game that runs on multiple operating system is sufficiently more desirable

as your friends may have different operating systems than you, but you would still want to play with them. So finding a game that runs on both Windows and Mac OS is a very desirable feature to have in a game.

1 Modern_PC_Games – This is the aggregator that ties everything together, it takes all of the previous aggregators and criterion, and merges them all together to get one final score for the evaluation. This is a very conjunctive aggregator, because it should contain all of the previous aggregators and criterion in it. All of them should be important to some extent, therefore conjunctive is the right choice. The weights are split up as follows: Computer requirements – 30, Audio – 15, Graphics – 20, User interface – 10, Game play - 25. This was probably the hardest aggregator to decide the weights, because all of them are so important I wish I could give them all higher weights but you can't since they have to add up to 100. Therefore, I gave 30% to the most important of the 5 which is the computer requirements as I talked about before why it's important I will reiterate. If you cannot play the game in the first place you will not be satisfied in the slightest. Therefore I feel it's fair to say that if you are able to play the game, you will probably be at least 30% satisfied with it. As playing a new game is a thrilling experience in the first place. Game play comes next adding in 25% of the score. I gave it a quarter of the weight, because the game play is how you interact and experience the game. It's the objectives, and story that brings in the user to play more and more. Therefore I feel it's fair to give this a quarter of the score. Next is the graphics which will closely relate to how smooth the gameplay is. I've made it so that without this it's impossible to get above an 80% overall rating if the gameplay is not smooth, with a high frames per second. Next is the audio which has a 15% stake in the final score, as it's one of the smaller factors that will add on to the game, but adds a very nice touch. And last is user interface which has a small 10% stake in the overall rating of the game, but cannot got an A+ (90%) without having an excellent user interface. Overall this should give well balanced scores, and have a well-rounded set of traits for the aggregators to sum up.

3.0 Criterion

1111		Ranking System
Value	%	0 - No ranking system 1 - Ranking system exists, but is not very large 2 - Ranking system exists, and is very large, but is not used match you against proper opponents of equal skill 3 - Ranking system exists, and is very large, and is used to match you against proper opponents of equal skill
0	0	
1	50	
2	75	
3	100	

1112		Chat System
Value	%	0 - No chat system 1 - Has chat system, but no ability to mute/filter toxic people 2 - Has chat system, ability to mute/filter toxic people. Definition toxic - Other people curse, or use vulgar language frequently. Making it an unpleasant experience.
0	0	
1	40	
2	100	

1113		Friends List
Value	%	0 - Cannot add friends to a friend's list. 1 - Can add friends to a friend's list.
0	0	
1	100	

1114		Multiple game modes
Value	%	0 - 0 to 1 game mode 1 - 2 to 3 game modes 2 - 3+ game modes Definition game modes - Game modes are things such as Competitive, casual, when the objective of the game changes I.E (Capture the flag, detonation, hostage rescue, ect...).
0	50	
1	80	
2	100	

1121		Multiple paths
Value	%	0 - no additional paths through the campaign you must follow it exactly till the campaign completes. 1 - 1 path through the campaign. Feels like you are on a train track and are pushed along the path. 2 - 2 paths through the campaign. Feels less like you are on a train track being pushed along a path. 3 - 3 to 4 paths through the campaign, not limited to a singular path allowed to complete side quests/missions at will 5 - 5+ paths through the campaign, Completely unrestricted to which missions you complete first.
0	0	
1	30	
2	50	
3	75	
5	100	

1122		Difficulty options
Value	%	0 - No options to change difficulty 1 - easy, normal, hard options for difficulty 2 - beginner, easy, normal, hard, (brutal/impossible/unbeatable) options for difficulty
0	0	
1	85	
2	100	

1123		Levels
Value	%	0 - Campaign levels are unoriginal and repeat the same design, there are also only a few to levels (Short campaign) 1 - Campaign levels are unoriginal, but do not repeat the same design, still to few levels (Short campaign) 2 - Campaign levels are original, do not repeat the same design, but there is still to few levels (short campaign) 3 - campaign levels are original, do not repeat the same design, and there are lots of levels (med/long campaign length)
0	0	
1	40	
2	80	
3	100	

113		Variety of Strategy
Value	%	0 - only 1 viable strategy to use, no creativity involved. 1 - 2 - 5 viable strategies to use, no creativity involved. 2 - 6 - 15 viable strategies to use, some creativity involved. 3 - N viable strategies to use, lots of creativity involved.
0	10	
1	40	
2	80	
3	100	

114		Mechanics
Value	%	0 - mechanics are hard to use, takes time to learn, skill cap and gap is skewed greatly due to this. 1 - Mechanics are easy to use, can learn quickly, skill gap doesn't exist now because the game is too easy but playable. 2 - Mechanics are easy to use, takes time to learn, skill cap and gap is now linear.
0	20	
1	50	
2	100	

121		Main Menu
Value	%	0 - Main menu is confusing, don't understand what the buttons do, hard to navigate. 1 - Main menu is navigable, buttons are somewhat obscure but can be reasoned about, medium difficult to navigate. 2 - Main menu is easy to use, button names are clear and understandable, and you never get lost.
0	10	
1	50	
2	100	

122		Options menu
Value	%	0 - The options menu is difficult to navigate, hard to find the options you want to modify, not organized well. 1 - The options menu is okay to navigate, reasonable to find the options you want to modify, and organized decently 2 - The options menu is easy to navigate, very good at being able to find the options you want to modify, and organized very well.
0	25	
1	75	
2	100	

131		Low, Med, High Options
Value	%	0 - no options to modify what graphics settings your game runs at. 1 - Low, med, high options for graphic settings. 2 - very low, low, med, high, very high (ultra)
0	15	
1	80	
2	100	

132		Screen Resolution Options
Value	%	0 - No options to change screen resolution. 1 - has options between the range of 600x800 to 1920x1080 2 - Has options that are less than 600x800 or greater than 1920x1080 in addition to the 600x800 to 1920x1080 range. Can also run full screen or window mode.
0	0	
1	85	
2	100	

133		133
Value	%	40 FPS - gets a 0 score because play ability will be greatly decreased hence, decreasing satisfaction. 60 FPS - gets a score of 50 because it meets the bare minimum refresh rate of a monitor. 80 FPS - gets a score of 75 because it is still less than 144. 100 FPS - gets a score of 90 because for most games this is still very good and the last 44 FPS is less noticeable by the eye if you have not use a 144Hz monitor before. 144 FPS - gets a score of 100 because it hits the max hertz refresh rate of current gaming monitors. Most monitors are 60hz refreh rate which means 60fps is max usually, although for gaming monitors you can get 144hz refresh rate. This means that you can get a max of 144 FPS and still be able to notice the difference in frame rate. Therefore 144 FPS is the max satisfaction for this category.
40	0	
60	50	
80	75	
100	90	
144	100	

134		Additional art/object details
Value	%	0 - No additional small details that the design team took time to implement, that add flavor and uniqueness to the game. 1 - Some additional small details that the design team took time to implement, that add flavor and uniqueness to the game. 2 - Lots of additional small details that the design team took time to implement, that add flavor and uniqueness to the game.
0	30	
1	70	
2	100	

141		Fits game genre
Value	%	0 - if the music does not fit the genre of the game I will not be satisfied. 1 - The music sort of fits the genre of the game, but there is probably a better choice they could have gone with. 2 - The music fits the game perfectly, no corrections needed.
0	0	
1	50	
2	100	

142		Plays on a queue from the game
Value	%	Definition (plays on queue from the game) - What I mean by this is that when you enter the main menu maybe they have a different sound track. When you get to the final boss a different more intense sound track plays, when you beat the final boss a different sound track plays ect. 0 - music is constant throughout the game, hardly any changes. 1 - Music is changing sometimes on a queue from the game, but the developers could still do more. 2 - The music changes seamlessly when a different scene starts.
0	20	
1	60	
2	100	

143		Appealing
Value	%	0 - music is not appealing and hurts ears. 1 - Music fits your taste, and does not hurt ears. 2 - Music is fantastic and, is pleasant to your ears.
0	5	
1	60	
2	100	

144		Sound effects
Value	%	0 - no sound effects. 1 - Very little sound effects. 2 - An average amount of sound effects. 3 - above average amount of sound effects. 4 - Above and beyond the amount of sound effects needed.
0	0	
1	15	
2	50	
3	70	
4	100	

151		RAM
Value	%	0 - Doesn't meet Recommended RAM requirements. 1 - Meets RAM requirements. 2 - Exceeds recommended RAM requirements.
0	0	
1	60	
2	100	

152		GPU
Value	%	0 - Doesn't meet recommended GPU requirements. 1 - Meets recommended GPU requirements. 2 - Exceeds recommended GPU requirements.
0	0	
1	60	
2	100	

153		CPU
Value	%	0 - Doesn't meet recommended CPU requirements. 1 - Meets recommended CPU requirements. 2 - Exceeds recommended CPU requirements.
0	0	
1	60	
2	100	

154		OS Available
Value	%	0 - Only implements the game for 1 operating system 1 - Implements the game for more than 1 operating system
0	70	
1	100	

5.0 Results

Id	Attribute	Counter_Strike_Global_Offensive	Hearth_Stone	League_Of_Legends
1	PC_Games	89.86	92.36	89.77
11	Game Play	87.45	79.87	84.88
12	User Interface	87.47	92.44	74.97
13	Graphics	86.37	92.36	84.87
14	Audio	69.93	87.97	89.86
15	Computer Requirements	89.99	84.87	84.87
111	Multiplayer	79.94	79.94	84.95
154	OS Available	85	85	85
153	CPU	90	84	80
152	GPU	90	84	80
151	RAM	90	84	80
144	Sound effects	70	70	15
143	Appealing	60	88	80
142	Plays on a queue from the game	60	76	90

141	Fits game genre	0	67	50
134	Additional art/object details	70	92.5	70
133	Frames Per Second (units - FPS)	50	50	50
132	Screen Resolution Options	86.5	42.5	85
131	Low, Med, High Options	80	80	60.25
122	Options Menu	47.5	92.5	58.75
121	Main Menu	87.5	75	75
113	Mechanics	87.5	65	62.5
112	Variety of Strategy	70	60	60
1114	Multiple game modes	80	80	85
1113	Friends list	75	0	70
1112	Chat system	40	0	85

1111	Ranking System	75	50	75

5.1 Cost Preference Analysis

System	Cost	Relative importance of high score (w)											Overall score [%]
		0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100%	
Counter_Strike_Global_Offensive	20	5	6.73	9.05	12.18	16.39	22.06	29.68	39.93	53.73	72.3	97.29	89.86
Hearth_Stone	1	100	100	100	100	100	100	100	100	100	100	100	92.36
League_Of_Legends	1	100	99.72	99.43	99.15	98.87	98.59	98.31	98.03	97.75	97.47	97.19	89.77

6.0 Conclusion

In conclusion I believe the LSP method is a very tricky way to evaluate software. My experience working with a LSP tree is that the smallest of things can send it in the wrong direction. Therefore, you need a lot of careful planning to get the values you want. For example if you make it easy to get 100 in 1 or 2 fields, this can skew all your data into being 99.99% satisfied in a game that barely satisfies you except for two criteria. On the other hand if you give out 1 or 2 zero's those could propagate through the LSP tree as well, and skew your data the other way. The take away is that careful planning is 100% needed when using the LSP method. An expert is also needed to know which fields are important, and how to give scores out accordingly. It's also extremely important to define your stake holder or else you'll be shooting in the dark with respect to selecting the right criterion, and giving the right weights and values to them. Selecting the right aggregator is also key, if you pick conjunction you better have a reason, as well as if you pick conjunction you better have a reason. If you don't have any reason or don't put thought into it, makes your tree illogical, and you can and probably will have bad results. My final take away is even after developing a tree with criteria, and aggregators you still need to fine tune your tree. It's very hard to do correct the first time through, therefore you need to take your time and understand how the values propagate through your tree, and make adjustments accordingly.

7.0 Appendix

a.) Evaluation report of PC GAMES

EVALUATION REPORT FOR THE PC_Games PROJECT

This report presents the evaluation results for the following 3 competitive systems:

1. Counter_Strike_Global_Offensive
2. Hearth_Stone
3. League_Of_Legends

The evaluation is based on 20 elementary criteria grouped in the following 5 major groups:

1. Game Play
2. User Interface
3. Graphics
4. Audio
5. Computer Requirements

This summary includes two parts: (1) System Comparison and Ranking, and (2) Survey of Individual Systems. Deatailed numerical results can be found in the report entitled "Detailed Evaluation Results of the PC_Games Project".

(1) System Comparison and Ranking

The global preference of a system indicates the global percentage of satisfied
requirements. Therefore, the best system has the highest global preference. The
ranking of competitive systems is based on decreasing global preferences, as follows:

1. 92.36% Hearth_Stone
2. 89.86% Counter_Strike_Global_Offensive
3. 89.77% League_Of_Legends

Therefore, the best system is Hearth_Stone.
This system satisfies 92.36% of the requirements specified by evaluation criteria.
The absolute value of global preference depends both on the quality of each system
and the level of demand imposed by the evaluation criterion function. So, low global

preferences may sometimes reflect too demanding criteria. The relative ranking of
competitive systems is based on normalized preferences so that the best system has
the normalized global preference of 100%. Following is the ranking according to
normalized preferences:

1. 100.00% Hearth_Stone
2. 97.29% Counter_Strike_Global_Offensive
3. 97.19% League_Of_Legends

The relative differences between systems can be interpreted as follows:

System Hearth_Stone dominates system Counter_Strike_Global_Offensive in 37.50% of inputs
System Hearth_Stone dominates system League_Of_Legends in 60.00% of inputs
System Counter_Strike_Global_Offensive domantes system League_Of_Legends in 60.00% of inputs

The reasons for a specific value of global preference can be explained by investigating the quality of all major components of the evaluated systems. Following is the survey of preferences of 5 major system components: Game Play, User Interface, Graphics, Audio, and Computer Requirements.

Systems	Game Play	User Interfac	Graphics	Audio	Computer Requ
Counter	87.45	87.47	86.37	69.93	89.99
Hearth_	79.87	92.44	92.36	87.97	84.87
League_	84.88	74.97	84.87	89.86	84.87

COST/PREFERENCE ANALYSIS

Cost/preference analysis is the analysis of relations between the global cost and the global preference of evaluated systems. The cost/preference analysis can be performed assuming equal importance of cost and preference, or assuming different levels of importance. In the case of different levels of importance it is necessary to specify the relative level of importance of cost and the relative level of importance of preference. These levels are specified as two complementary values: p is the relative importance of cost and 1-p is the relative importance of preference. Both p and 1-p can be expressed as percentages.

The goal of cost/preference analysis is to compute the aggregated quality

indicator Q that combines the global cost and the global preference in a single numerical indicator suitable for expressing the global quality of the evaluated system taking into account all relevant components, both cost elements and performance variables. Following are two cost preference reports.
The first report shows the results of cost/preference analysis for equal importance of cost and preference, and the second report shows a spectrum of results corresponding to various levels of relative importance of cost. In both cases the results are normalized, so that the best system is assigned the global quality value Q=100%, and other systems have smaller values. This enables ranking and justifiable selection of the most appropriate system

COST/PREFERENCE ANALYSIS FOR EQUAL IMPORTANCE OF COST AND PREFERENCE

N o r m a l i z e d v a l u e s : Emax = Qmax = Cmin = 100%

Competitive Systems	Global Preference[%]	Global Cost[%]	Q=ECmin/C[%]
Hearth_Stone	100.00	100.00	100.00
Counter_Strike_Global_O	97.29	2000.00	4.86
League_Of_Legends	97.19	100.00	97.19

COST/PREFERENCE ANALYSIS FOR INCREASING RELATIVE IMPORTANCE OF COST

Table of Q = (Cmin/C)^p * (E/Emax)^(1-p), for p = 0, 10%, ..., 100%

N o r m a l i z e d r e s u l t s : Qmax = 100%

Systems	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Hearth_	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Counter	97.3	72.3	53.7	39.9	29.7	22.1	16.4	12.2	9.1	6.7	5.0
League_	97.2	97.5	97.7	98.0	98.3	98.6	98.9	99.1	99.4	99.7	100.0

(2) Survey of Individual Systems

This survey highlights the strongest and the waekest components of all evaluated systems. In particular, the survey includes lists of the weakest components that are primary candidates for improvements. This is an analysis of relative performance and for high quality systems the weakest component can still satisfy a substantial percentage of user's requiremenmts. Therefore, improvements are not equally urgent for all systems. They are primariliy needed for systems having a relatively low global preference.

Counter_Strike_Global_Offensive

This system satisfies 89.86% of user's requirements. The best subsystem of Counter_Strike_Global_Offensive is Computer Requirements.
The best subsystem satisfies 89.99% of specified requirements.
The weakest subsystem of Counter_Strike_Global_Offensive is Audio.
The weakest subsystem satisfies 69.93% of specified requirements.

Weak components of this system are components that are rated below the global preference. These are components that primarily need improvement. Following is the sorted list of weak components, starting with the weakest component:

ID	X	E[%]	Elementary criterion
141	0.00	0.00	Fits game genre
1112	1.00	40.00	Chat system
122	0.50	47.50	Options Menu
133	60.00	50.00	Frames Per Second (units - FPS)
142	1.00	60.00	Plays on a queue from the game
143	1.00	60.00	Appealing
134	1.00	70.00	Additional art/object details
112	1.75	70.00	Variety of Strategy
144	3.00	70.00	Sound effects
1111	2.00	75.00	Ranking System
1113	0.75	75.00	Friends list
1114	1.00	80.00	Multiple game modes
131	1.00	80.00	Low, Med, High Options
154	0.50	85.00	OS Available
132	1.10	86.50	Screen Resolution Options
113	1.75	87.50	Mechanics
121	1.75	87.50	Main Menu

Hearth_Stone

This system satisfies 92.36% of user's requirements. The best subsystem of Hearth_Stone is User Interface.
The best subsystem satisfies 92.44% of specified requirements.
The weakest subsystem of Hearth_Stone is Game Play.
The weakest subsystem satisfies 79.87% of specified requirements.

Weak components of this system are components that are rated below the global preference. These are components that primarily need improvement. Following is the sorted list of weak components, starting with the weakest component:

ID	X	E[%]	Elementary criterion
1112	0.00	0.00	Chat system
1113	0.00	0.00	Friends list
132	0.50	42.50	Screen Resolution Options
1111	1.00	50.00	Ranking System
133	60.00	50.00	Frames Per Second (units - FPS)

112	1.50	60.00	Variety of Strategy
113	1.30	65.00	Mechanics
141	1.34	67.00	Fits game genre
144	3.00	70.00	Sound effects
121	1.50	75.00	Main Menu
142	1.40	76.00	Plays on a queue from the game
131	1.00	80.00	Low, Med, High Options
1114	1.00	80.00	Multiple game modes
151	1.60	84.00	RAM
152	1.60	84.00	GPU
153	1.60	84.00	CPU
154	0.50	85.00	OS Available
143	1.70	88.00	Appealing

League_Of_Legends

This system satisfies 89.77% of user's requirements. The best subsystem of League_Of_Legends is Audio.
The best subsystem satisfies 89.86% of specified requirements.
The weakest subsystem of League_Of_Legends is User Interface.
The weakest subsystem satisfies 74.97% of specified requirements.

Weak components of this system are components that are rated below the global preference. These are components that primarily need improvement. Following is the sorted list of weak components, starting with the weakest component:

ID	X	E[%]	Elementary criterion
144	1.00	15.00	Sound effects
141	1.00	50.00	Fits game genre
133	60.00	50.00	Frames Per Second (units - FPS)
122	0.75	58.75	Options Menu
112	1.50	60.00	Variety of Strategy
131	0.75	60.25	Low, Med, High Options
113	1.25	62.50	Mechanics
1113	0.70	70.00	Friends list
134	1.00	70.00	Additional art/object details
1111	2.00	75.00	Ranking System
121	1.50	75.00	Main Menu
143	1.50	80.00	Appealing
151	1.50	80.00	RAM
152	1.50	80.00	GPU
153	1.50	80.00	CPU
132	1.00	85.00	Screen Resolution Options
1114	1.25	85.00	Multiple game modes
1112	1.75	85.00	Chat system
154	0.50	85.00	OS Available

B.) Detailed evaluation results for PC Games project

DETAILED EVALUATION RESULTS FOR THE PC_Games PROJECT

Competitive System(s):

1. Counter_Strike_Global_Offensive
2. Hearth_Stone
3. League_Of_Legends

COST/PREFERENCE ANALYSIS FOR EQUAL IMPORTANCE OF COST AND PREFERENCE

Competitive Systems	Global Preference E[%]	Global Cost C	Q=ECmin/C
Hearth_Stone	92.36	1.00	92.36
Counter_Strike_Global_O	89.86	20.00	4.49
League_Of_Legends	89.77	1.00	89.77

COST/PREFERENCE ANALYSIS FOR EQUAL IMPORTANCE OF COST AND PREFERENCE

N o r m a l i z e d v a l u e s : Emax = Qmax = Cmin = 100%

Competitive Systems	Global Preference[%]	Global Cost[%]	Q=ECmin/C[%]
Hearth_Stone	100.00	100.00	100.00
Counter_Strike_Global_O	97.29	2000.00	4.86
League_Of_Legends	97.19	100.00	97.19

COST/PREFERENCE ANALYSIS FOR INCREASING RELATIVE IMPORTANCE OF COST

Table of Q = (Cmin/C)^p * (E/Emax)^(1-p), for p = 0, 10%, ..., 100%

Systems	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Hearth_	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Counter	0.973	0.723	0.537	0.399	0.297	0.221	0.164	0.122	0.091	0.067	0.050
League_	0.972	0.975	0.977	0.980	0.983	0.986	0.989	0.991	0.994	0.997	1.000

COST/PREFERENCE ANALYSIS FOR INCREASING RELATIVE IMPORTANCE OF COST

Table of Q = (Cmin/C)^p * (E/Emax)^(1-p), for p = 0, 10%, ..., 100%

N o r m a l i z e d r e s u l t s : Qmax = 100%

Systems	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Hearth_	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Counter	97.3	72.3	53.7	39.9	29.7	22.1	16.4	12.2	9.1	6.7	5.0
League_	97.2	97.5	97.7	98.0	98.3	98.6	98.9	99.1	99.4	99.7	100.0

PERFORMANCE VARIABLES:

1111. Ranking System
1112. Chat system
1113. Friends list
1114. Multiple game modes
112. Variety of Strategy
113. Mechanics
121. Main Menu
122. Options Menu
131. Low, Med, High Options
132. Screen Resolution Options
133. Frames Per Second (units - FPS)
134. Additional art/object details
141. Fits game genre
142. Plays on a queue from the game
143. Appealing
144. Sound effects
151. RAM
152. GPU
153. CPU
154. OS Available

PERFORMANCE VARIABLES (INPUT ATTRIBUTES)

#	ID	Counter_S	Hearth_St	League_Of
1	1111	2.000	1.000	2.000
2	1112	1.000	0.000	1.750
3	1113	0.750	0.000	0.700
4	1114	1.000	1.000	1.250
5	112	1.750	1.500	1.500
6	113	1.750	1.300	1.250
7	121	1.750	1.500	1.500
8	122	0.500	1.750	0.750
9	131	1.000	1.000	0.750
10	132	1.100	0.500	1.000
11	133	60.000	60.000	60.000
12	134	1.000	1.750	1.000
13	141	0.000	1.340	1.000

14	142	1.000	1.400	1.750
15	143	1.000	1.700	1.500
16	144	3.000	3.000	1.000
17	151	1.750	1.600	1.500
18	152	1.750	1.600	1.500
19	153	1.750	1.600	1.500
20	154	0.500	0.500	0.500

ELEMENTARY PREFERENCES [%]

#	ID	Counter_S	Hearth_St	League_Of
1	1111	75.00	50.00	75.00
2	1112	40.00	0.00	85.00
3	1113	75.00	0.00	70.00
4	1114	80.00	80.00	85.00
5	112	70.00	60.00	60.00
6	113	87.50	65.00	62.50
7	121	87.50	75.00	75.00
8	122	47.50	92.50	58.75
9	131	80.00	80.00	60.25
10	132	86.50	42.50	85.00
11	133	50.00	50.00	50.00
12	134	70.00	92.50	70.00
13	141	0.00	67.00	50.00
14	142	60.00	76.00	90.00
15	143	60.00	88.00	80.00
16	144	70.00	70.00	15.00
17	151	90.00	84.00	80.00
18	152	90.00	84.00	80.00
19	153	90.00	84.00	80.00
20	154	85.00	85.00	85.00

ALL PREFERENCES [%]

#	ID	Counter_S	Hearth_St	League_Of
1	1111	75.00	50.00	75.00
2	1112	40.00	0.00	85.00
3	1113	75.00	0.00	70.00
4	1114	80.00	80.00	85.00
5	112	70.00	60.00	60.00
6	113	87.50	65.00	62.50
7	121	87.50	75.00	75.00
8	122	47.50	92.50	58.75
9	131	80.00	80.00	60.25
10	132	86.50	42.50	85.00
11	133	50.00	50.00	50.00
12	134	70.00	92.50	70.00
13	141	0.00	67.00	50.00
14	142	60.00	76.00	90.00
15	143	60.00	88.00	80.00
16	144	70.00	70.00	15.00

17	151	90.00	84.00	80.00
18	152	90.00	84.00	80.00
19	153	90.00	84.00	80.00
20	154	85.00	85.00	85.00
21	111	79.94	79.94	84.95
22	15	89.99	84.87	84.87
23	14	69.93	87.97	89.86
24	13	86.37	92.36	84.87
25	12	87.47	92.44	74.97
26	11	87.45	79.87	84.88
27	1	89.86	92.36	89.77

Elementary Preferences for System = Counter_Strike_Global_Offensive

ID	X	E[%]	Elementary criterion
1111	2.00	75.00	Ranking System
1112	1.00	40.00	Chat system
1113	0.75	75.00	Friends list
1114	1.00	80.00	Multiple game modes
112	1.75	70.00	Variety of Strategy
113	1.75	87.50	Mechanics
121	1.75	87.50	Main Menu
122	0.50	47.50	Options Menu
131	1.00	80.00	Low, Med, High Options
132	1.10	86.50	Screen Resolution Options
133	60.00	50.00	Frames Per Second (units - FPS)
134	1.00	70.00	Additional art/object details
141	0.00	0.00	Fits game genre
142	1.00	60.00	Plays on a queue from the game
143	1.00	60.00	Appealing
144	3.00	70.00	Sound effects
151	1.75	90.00	RAM
152	1.75	90.00	GPU
153	1.75	90.00	CPU
154	0.50	85.00	OS Available

Sorted Elementary Preferences for System = Counter_Strike_Global_Offensive

ID	X	E[%]	Elementary criterion
141	0.00	0.00	Fits game genre
1112	1.00	40.00	Chat system
122	0.50	47.50	Options Menu
133	60.00	50.00	Frames Per Second (units - FPS)
142	1.00	60.00	Plays on a queue from the game
143	1.00	60.00	Appealing
134	1.00	70.00	Additional art/object details
112	1.75	70.00	Variety of Strategy
144	3.00	70.00	Sound effects
1111	2.00	75.00	Ranking System
1113	0.75	75.00	Friends list
1114	1.00	80.00	Multiple game modes
131	1.00	80.00	Low, Med, High Options
154	0.50	85.00	OS Available

132	1.10	86.50	Screen Resolution Options
113	1.75	87.50	Mechanics
121	1.75	87.50	Main Menu
152	1.75	90.00	GPU
153	1.75	90.00	CPU
151	1.75	90.00	RAM

Elementary Preferences for System = Hearth_Stone

ID	X	E[%]	Elementary criterion
1111	1.00	50.00	Ranking System
1112	0.00	0.00	Chat system
1113	0.00	0.00	Friends list
1114	1.00	80.00	Multiple game modes
112	1.50	60.00	Variety of Strategy
113	1.30	65.00	Mechanics
121	1.50	75.00	Main Menu
122	1.75	92.50	Options Menu
131	1.00	80.00	Low, Med, High Options
132	0.50	42.50	Screen Resolution Options
133	60.00	50.00	Frames Per Second (units - FPS)
134	1.75	92.50	Additional art/object details
141	1.34	67.00	Fits game genre
142	1.40	76.00	Plays on a queue from the game
143	1.70	88.00	Appealing
144	3.00	70.00	Sound effects
151	1.60	84.00	RAM
152	1.60	84.00	GPU
153	1.60	84.00	CPU
154	0.50	85.00	OS Available

Sorted Elementary Preferences for System = Hearth_Stone

ID	X	E[%]	Elementary criterion
1112	0.00	0.00	Chat system
1113	0.00	0.00	Friends list
132	0.50	42.50	Screen Resolution Options
1111	1.00	50.00	Ranking System
133	60.00	50.00	Frames Per Second (units - FPS)
112	1.50	60.00	Variety of Strategy
113	1.30	65.00	Mechanics
141	1.34	67.00	Fits game genre
144	3.00	70.00	Sound effects
121	1.50	75.00	Main Menu
142	1.40	76.00	Plays on a queue from the game
131	1.00	80.00	Low, Med, High Options
1114	1.00	80.00	Multiple game modes
151	1.60	84.00	RAM
152	1.60	84.00	GPU
153	1.60	84.00	CPU
154	0.50	85.00	OS Available
143	1.70	88.00	Appealing

122	1.75	92.50	Options Menu
134	1.75	92.50	Additional art/object details

Elementary Preferences for System = League_Of_Legends

ID	X	E[%]	Elementary criterion
1111	2.00	75.00	Ranking System
1112	1.75	85.00	Chat system
1113	0.70	70.00	Friends list
1114	1.25	85.00	Multiple game modes
112	1.50	60.00	Variety of Strategy
113	1.25	62.50	Mechanics
121	1.50	75.00	Main Menu
122	0.75	58.75	Options Menu
131	0.75	60.25	Low, Med, High Options
132	1.00	85.00	Screen Resolution Options
133	60.00	50.00	Frames Per Second (units - FPS)
134	1.00	70.00	Additional art/object details
141	1.00	50.00	Fits game genre
142	1.75	90.00	Plays on a queue from the game
143	1.50	80.00	Appealing
144	1.00	15.00	Sound effects
151	1.50	80.00	RAM
152	1.50	80.00	GPU
153	1.50	80.00	CPU
154	0.50	85.00	OS Available

Sorted Elementary Preferences for System = League_Of_Legends

ID	X	E[%]	Elementary criterion
144	1.00	15.00	Sound effects
141	1.00	50.00	Fits game genre
133	60.00	50.00	Frames Per Second (units - FPS)
122	0.75	58.75	Options Menu
112	1.50	60.00	Variety of Strategy
131	0.75	60.25	Low, Med, High Options
113	1.25	62.50	Mechanics
1113	0.70	70.00	Friends list
134	1.00	70.00	Additional art/object details
1111	2.00	75.00	Ranking System
121	1.50	75.00	Main Menu
143	1.50	80.00	Appealing
151	1.50	80.00	RAM
152	1.50	80.00	GPU
153	1.50	80.00	CPU
132	1.00	85.00	Screen Resolution Options
1114	1.25	85.00	Multiple game modes
1112	1.75	85.00	Chat system
154	0.50	85.00	OS Available

142	1.75	90.00	Plays on a queue from the game

Subsystem Preferences for System = Counter_Strike_Global_Offensive

ID	E[%]	Subsystem
111	79.94	Multiplayer
15	89.99	Computer Requirements
14	69.93	Audio
13	86.37	Graphics
12	87.47	User Interface
11	87.45	Game Play
1	89.86	PC_Games

Sorted Subsystem Preferences for System = Counter_Strike_Global_Offensive

ID	E[%]	Subsystem
14	69.93	Audio
111	79.94	Multiplayer
13	86.37	Graphics
11	87.45	Game Play
12	87.47	User Interface
1	89.86	PC_Games
15	89.99	Computer Requirements

Subsystem Preferences for System = Hearth_Stone

ID	E[%]	Subsystem
111	79.94	Multiplayer
15	84.87	Computer Requirements
14	87.97	Audio
13	92.36	Graphics
12	92.44	User Interface
11	79.87	Game Play
1	92.36	PC_Games

Sorted Subsystem Preferences for System = Hearth_Stone

ID	E[%]	Subsystem
11	79.87	Game Play
111	79.94	Multiplayer
15	84.87	Computer Requirements
14	87.97	Audio
13	92.36	Graphics
1	92.36	PC_Games
12	92.44	User Interface

Subsystem Preferences for System = League_Of_Legends

ID	E[%]	Subsystem
111	84.95	Multiplayer
15	84.87	Computer Requirements
14	89.86	Audio
13	84.87	Graphics
12	74.97	User Interface
11	84.88	Game Play
1	89.77	PC_Games

Sorted Subsystem Preferences for System = League_Of_Legends

ID	E[%]	Subsystem
12	74.97	User Interface
13	84.87	Graphics
15	84.87	Computer Requirements
11	84.88	Game Play
111	84.95	Multiplayer
1	89.77	PC_Games
14	89.86	Audio

Note: All sorted reports are divided in two parts: the first part contains components that are below the average quality level for the analyzed system and the second part contains those components that are above the average quality level