Name: _____ **Student ID Number:** _____

Signature: _____

CPSC 444 2009-10 (T2) Midterm Exam

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Exam Instructions (read carefully):

1. Sign the first page of the exam with your **signature** in the space provided on the upper left **immediately**.
2. Continue reading the instructions, but **do not open the exam booklet** until you are told to do so by a proctor.
3. Cheating is an academic offense. Your signature on the exam indicates that you **understand** and **agree to** the University's policies regarding cheating on exams.
4. The exam is **closed book**. There are **no aids permitted**, except for a **simple non-programmable calculator**.
5. There are 5 questions on this exam, each worth the indicated number of points. **Answer as many questions as you can**.
6. **Keep your answers short and to the point (i.e., avoid any unnecessary details).**
7. Write **all** of your answers on these pages. If you need more space, there is blank space at the end of the exam. Be sure to indicate when a question is continued, **both** on the page for that question and on the continuation page. **Do not write on the back of any page.**
8. Interpret the exam questions as written. **No questions** will be answered by the proctor(s) during the exam period. **State your assumptions if you are unsure about a question.**
9. You have **60 minutes** in which to work. **Budget your time wisely**.
10. No one will be permitted to enter the exam room after one half-hour from the start time, or to leave during the first half-hour of the exam. In addition, no one can leave the exam room during the **last ten minutes** of the exam.

Question	Points Possible	Mark
1	8	
2	7	
3	7	
4	8	
5	10	
Total	40	

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Question #1 [8 points total]: True/False

For each question, circle **one** of either true or false. You do **not** have to provide a justification for the answer you have given. [1 pt each]

(a) The 7 ± 2 rule refers to the chunks of information that can be moved at any one time from short-term memory to long-term memory.

True False *False* (this is the amount of information that can be stored in short-term memory)

(b) The Model Human Processor is a model of perception, memory, and cognition that is based on empirical findings.

True False *True*

(c) In terms of effective colour use, large areas should use highly saturated colours, and small areas should use low saturation colours.

True False *False* (it is the opposite)

(d) The core theory of colour vision (Opponent Process Theory) describes that the human's receptor signals are processed into two separate opponent channels in the early stages of neural processing.

True False *False* (it is 3 channels)

(e) Of all types of validity, experimental studies *best* preserve ecological validity.

True False *False* (if anything, they least preserve ecological validity, tasks are usually artificial)

(f) In the paper on the Acquisition of Expanding Targets, the authors found that performance can be predicted by the final expanded target size rather than the initial target size.

True False *True*

(g) In a Fitts' Law model, the index of performance can be calculated two different ways (through a direct division of mean scores and through linear regression), which both yield the same result.

True False *False* (they don't yield the same result)

(h) For an experiment trying to show that graffiti text input on a mobile device is faster for novices, but unistroke text input is faster for experts, a paired t-test will be sufficient for the statistical analysis.

True False *False* (two independent variables therefore ANOVA best)

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Question #2 [7 points total]: Human Abilities – Visual Processing & Memory

(a) In tutorial #2, you analyzed Google Earth in terms of its visual perceptual properties. Provide **one strength** *or* **one weakness** in the Google Earth design with respect to **each** of the following: (i) perceptual grouping (ii) colour (iii) attention. [3 pts]

Lots of possible answers, here are some strengths:

Perceptual grouping:

Strength: with balloons, use of "connectedness" to display more information on a specific result

Strength: "balanced" arrangement of icons and buttons in navigation tool bar below the main display

Colour:

Strength: green and red cars indicating start and end of the route – reflective of the universal traffic light convention

Strength: colors for icons and labels are made easily distinguishable by having a thin black border around those

Attention:

Strength: when adding a new placemark, blinking effect attracts users of the location of the placemark

Strength: attention coercion done by higher resolution in the central region and lower resolution in peripheral region

(b) **Define** what it means to process information pre-attentively and **list one primitive** that is processed pre-attentively. [2 pts]

To process information very quickly, in 10 msec or less per item. Another way to describe it is when the time taken to find a target is independent of the number of distracters.[1 pt]

Lots of things are processed preattentively: color, orientation, motion, size, simple shading (there are other examples) [1 pt]

(c) When displaying a coloured object (such as text) on a coloured background, **why is it important to vary the luminance level** between the object and the background? [2 pts]

It can be difficult for the eye to detect the edges of the letters when colour alone is used to differentiate the letters from the background. [1 pt]

According to the Opponent Process Theory, luminance contrast is one of the ways that our receptors differentiate between objects. For people with full colour blindness, this is the only way of differentiating objects. [1 pt]

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Question #3 [7 points total]: Human Abilities – Motor Processing & Empirical Laws

(a) Explain with reference to an empirical law discussed in class why it often makes sense to allow a subject a small number of unrecorded practice sessions with an interface before an experiment that measures the subject's speed performing a series of tasks on the same interface. [3 pts]

Name the relevant empirical law [1 pt]: _____

Power Law of Practice. – 1 pt

Describe the law in plain language (you may provide the formula, but it is not necessary and this does not negate your need to describe the law in plain language) [1 pt]:

You get faster, the more times you do it, until you become an expert at which point you plateau. - 1 pt

Explain why the practice sessions will help. [1 pts]:

The learning curve is based on a power law, which means the subject is quite slow at first. These trials are not representative of real performance, and so it is best not to count them and treat them only as practice sessions – 1 pt

(b) Which **term** in the movement time equation using the Shannon formulation ($MT = a + b \log_2(A/W + 1)$) best explains the performance benefit of using a Macintosh menu bar (located at the top of the screen) over a Windows menu bar (located inside each application window)? **Explain** your answer. [2 pts]

W – 1 pt

By placing the menu bar at the edge, you essentially given the menus (targets) infinite width. According to Fitts Law this makes the target easier to acquire. – 1 pt

(c) In plain language, **explain** how the Steering Law is related to Fitts' Law, and **state one example** of where the Steering Law can be applied to interface design. [2 pts]

Fitts' Law is about the time it takes to reach a target. Users are not constrained in the trajectory of their motion. The Steering Law extends Fitts' Law such the user's trajectory must be maintained within a constrained area (a tunnel). [1 pt]

It can be applied to menu design given that the user must keep the trajectory of motion within the constraints of the menu. [1 pt]

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Question #4 [8 points total]: Experiment Design and Analysis

A company that develops 3D modeling software for the film industry wants to test two prototype interfaces for a new quick-sketch application they are developing. One of the prototypes relies on a traditional mouse-and-keyboard interface while the other relies on a stylus (pen)-based interface. The company's HCI specialists suspect that the stylus interface will be faster than the mouse-and-keyboard interface, but perhaps only for expert stylus users, and perhaps only for certain kinds of tasks (input intensive ones rather than non-input intensive ones).

Assume that you are designing an experiment to evaluate the prototypes. You want to see if the company's suspicions in terms of the comparative performance between the two prototypes is in fact true.

(a) Name the **factors** (independent variables) of the experiment, and name the **levels** for each factor. [3 pts]

Prototype: traditional mouse & keyboard + stylus

Expertise: expert + novice

Task type: input-intensive tasks + non-input intensive

(b) Explain the **difference** between a within-subjects and between-subjects comparison. [2 pt]

Within-subjects comparison is where a user sees all levels of a given factor. For between-subjects, a subject only sees one level of a factor.

(c) For each of the independent variables in part (a) above, **identify** whether it should be a within- or between-subjects factor. **Explain** your answer. [3 pts]

Prototype and task type are within, because there is no reason not to expose the subjects to both, and within subjects designs are more powerful. (But they must be properly counterbalanced.) Expertise is between because without extraordinary effort, it is not possible for a subject to be both an expert and a novice in the same experiment.

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Question #5 [10 points total]: Statistical Analysis

For this question, you will carry out a simple t-test on the provided data and make an experimental conclusion.

> Sam hypothesizes that Tablet PC users will perform significantly differently than Desktop PC users when interacting with NewCAD software. She brings 14 participants into her lab and randomly assigns them to one of two groups. In one group she has participants use the Tablet PC and in the other group they use the Desktop PC. A standardized set of tasks are completed.

The data provided on the following page are subject performances on the standardized set of tasks. They range from 1-9 with high scores representing better performance.

In computing your t-statistic,

- **Show all intermediate steps,** making use of blank columns in the data table as needed to show the intermediate results from applying a formula (be sure to label any column used).
- For this particular problem, choose appropriately from among the following formulas and use the table of t-values that follows:

$$s^2 = \frac{SS}{N-1}$$

$$t = \frac{\left|\bar{X}_1 - \bar{X}_2\right|}{s_{ed}}$$

$$s_{ed} = \sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}$$

$$SS = \sum (X_i - \bar{X})^2$$

$$sd = \sqrt{s^2}$$

Provide answer and show all work on following page.

NO CREDIT GIVEN FOR ANYTHING WRITTEN ON THIS PAGE.

Question #5 (continued)

Tablet PC (Group A)				**Desktop PC (Group B)**			
Data				**Data**			
5				4			
7				6			
5				9			
3				5			
5				6			
4				9			
3				8			

(a) What is the value of t? [5 pts] _____

(b) How many degrees of freedom does this t-statistic have? [1 pts] _____

(c) Can Sam accept her hypothesis? Use the table on next page, and **justify your answer quantitatively**. [4 pts]

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Question #5 (solution)

Tablet PC (Group A)				Desktop PC (Group B)			
Data	$r-M_A$	$(r-M_A)^2$		**Data**	$r- M_B$	$(r-M_B)^2$	
5	*0.43*	*0.18*		4	*-2.71*	*7.37*	
7	*2.43*	*5.90*		6	*-0.71*	*0.51*	
5	*0.43*	*0.18*		9	*2.29*	*5.22*	
3	*-1.57*	*2.47*		5	*-1.71*	*2.94*	
5	*0.43*	*0.18*		6	*-.071*	*0.51*	
4	*-0.57*	*0.33*		9	*2.29*	*5.22*	
3	*-1.57*	*2.47*		8	*1.29*	*1.65*	
M_A=4.57		*SS_A=11.71*		*M_B=6.71*		*SS_B=23.43*	
df=6		*s^2= SS_A / df =*	*1.95*	*df=6*		*s^2= SS_B / df=*	*3.9*

t = |4.57 – 6.71| / (sqrt (1.95/7 + 3.9/7))

½ pt for each mean

1 pt for each s^2

1 pt for s_{ed}

1 pt for t

(a) What is the value of t? [5 pts] _____*2.34*_____

(b) How many degrees of freedom does this t-statistic have? [1 pts] _____*12*_____

(c) Can Sam accept her hypothesis? Use the table on next page, and **justify your answer quantitatively**. [4 pts]

Yes, can reject the null hypothesis, therefore can accept the alternate hypothesis. They are different

Looking here for numerical values for the following:

what's the largest value of p that permits rejection? 0.05 (1 pts)

Critical value of t at that p and type of test? 2.179 (1 pts)

–> 2.34 > 2.179 –> can reject null hypothesis (2 pts)

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df	Critical Values of Student's t (2-tailed)					
p ->	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.683	2.353	3.182	4.542	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	4.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
35	1.31	1.69	2.030	2.438	2.724	3.591
40	1.303	1.684	2.021	2.423	2.704	3.551
45	1.301	1.679	2.014	2.412	2.69	3.520
50	1.299	1.676	2.009	2.403	2.678	3.496
55	1.297	1.673	2.004	2.396	2.668	3.476
60	1.296	1.671	2.000	2.390	2.660	3.460
65	1.295	1.669	1.997	2.385	2.654	3.447
70	1.294	1.667	1.994	2.381	2.648	3.435
75	1.293	1.665	1.992	2.377	2.643	3.425
80	1.292	1.664	1.990	2.374	2.639	3.416

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