

Contents

Abstract	ii
Acknowledgments	iv
1 Introduction	9
1.1 Chapter Introduction	9
1.2 Historical Overview of Game and Game Psychology	10
1.2.1 Game Psychology	12
1.3 Operant Conditioning Chamber and the Principle of Reinforcement	13
1.4 Game Refinement Theory and Motion in Mind Model	15
1.5 Problem Statement	16
1.6 Structure of The Thesis	18
2 Literature Review	22
2.1 Chapter Introduction	22
2.2 Game and Game Entertainment	22
2.2.1 The concept of game play	23
2.2.2 Game entertainment	23
2.3 Player Psychology and its Basis Behaviourist Psychology	26
2.3.1 Player Psychology Research	26
2.3.2 The basis of behaviourism	27
2.3.3 Summary	33
2.4 Uncertainty in Entertainment: Game Refinement Theory	34
2.4.1 Motion in Mind	35
2.5 An Overview of the Featured Games	37

2.6	Chapter Summary	39
3	Player Satisfaction Model and Its Implication to Cultural Change	40
3.1	Chapter Introduction	40
3.2	Background	41
3.3	Player Satisfaction Model in Games	42
3.3.1	Game Refinement Theory	42
3.3.2	Variable ratio schedule (N) and winning hardness (m) in games . . .	43
3.3.3	Motions in Mind	43
3.3.4	Force in Mind and player satisfaction	44
3.4	Physics in Mind and Cultural Change	46
3.4.1	First phase from Go evolution	47
3.4.2	Second phase from Chess evolution	47
3.4.3	Third phase from Mah Jong evolution	48
3.4.4	Evolution of sports games	49
3.4.5	Evolution of action video games	52
3.5	Discussion and Implications	52
3.5.1	Development and current trends of game and history	52
3.5.2	Game - playing landscapes	56
3.6	Chapter Summary	58
4	The Correlation between Player and Game	59
4.1	Introduction	60
4.2	Theoretical framework	62
4.2.1	Multi armed Bandit	62
4.2.2	Reward Mechanism in Games	63
4.2.3	Motions in Mind and Internal Energy Change in Games	64
4.3	Methodology	66
4.3.1	Energy Difference in Games	66
4.3.2	Upper Confidence Bound Method	67
4.3.3	Methodology Introduction	67
4.3.4	Experiment Setup	68

4.3.5	Results and Analysis	71
4.3.6	Psychological Gap Expressed by Energy Difference	72
4.3.7	Link between Satisfaction and Competitive in Game Playing	74
4.4	Discussion	75
4.4.1	Application with player fairness domain	75
4.4.2	Why is the Multi-armed Bandit Addictive?	75
4.4.3	Limitation	76
4.5	Chapter Summary	77
5	Analysis of Driving Comfort through Steering Wheel Information with a Focus on Motion-in-mind	79
5.1	Introduction	80
5.2	Literature Review and Methodology	82
5.2.1	Driving comfort	82
5.2.2	Game refinement theory	84
5.2.3	Variable ratio schedule (N) and winning hardness (m) in Games	85
5.2.4	Motions in Mind	85
5.2.5	Motion-in-mind in driving	88
5.2.6	Simulation based on End-to-End Deep Learning	89
5.3	Experiment Setting	90
5.3.1	Experiment with human players	90
5.3.2	Experiment with AI players	91
5.3.3	The validity of N	92
5.4	Discussion	94
5.4.1	Discussion of E_d	96
5.4.2	Discussion of Motion in mind measure in driving comfort	97
5.4.3	Evaluation experiment	99
5.5	Chapter Summary	101
6	Conclusion	102
6.1	Concluding Remarks	102
6.2	Answer to RQ1, RQ2	105

6.3 Future Works	106
Bibliography	108
Publications	122

List of Figures

1.6.1 Overview of research content	19
2.2.1 The basic elements of a game from Bernard Suits [124]	25
2.2.2 A model of three masters [59]	26
2.3.1 Types of simple reinforcement schedules	29
2.3.2 A chart demonstrating the different response rates of the simple schedules of reinforcement, each hatch mark designates a reinforcer being given [55].	30
2.3.3 Fixed schedules [40]	31
2.3.4 Variable Schedules [40]	32
3.3.1 The F measures with other physics in mind measure	45
3.3.2 The F measures of various board games and its cross points ($F = \vec{p}$) relative to other physics in mind measure	46
3.4.1 The Go developmental history based on various physics in mind measures	48
3.4.2 The Chess developmental history based on various physics in mind mea- sures [143, 27, 62]	49
3.4.3 The Mah Jong developmental history based on various physics in mind measures [143]	50
3.4.4 The developmental history of Basketball and Soccer games based on various physics in mind measures	51
3.4.5 The evolution of different versions (1985–2017) of action video games rela- tive to various physics in mind measures	53
3.5.1 The historical development trends of Go, Chess, and Mah Jong variants. The gray-shaded region is where the occurrence of the symmetry-like trends between Go and Chess games.	55

3.5.2 The convergence of p-sports, m-sports, and e-sports based on the a indicators, relative to the physics in mind measures	56
4.3.1 Comparison of predicted reward and actual reward with a game length of 300 steps with $m \in [0, 1]$ (m is mass in game).	71
4.3.2 Changes of energy difference measures.	73
4.3.3 Changes of energy difference measures.	74
4.4.1 Application with player fairness domain.	75
5.2.1 Motion in mind measures with $m \in [0, 1]$	87
5.2.2 Simulator from Udacity's self-driving car nanodegree	89
5.3.1 Flow chart	90
5.3.2 Learning approaches for self-driving; (A) traditional model; (B)End-to-End model	91
5.3.3 Fitting function of player growth	93
5.3.4 N changes and shaking turns during 85 turns	93
5.3.5 An example of the change in steering wheel angle(x-axis: times, y-axis: $1/r$)	95
5.4.1 E_d curve with various k	98
5.4.2 Objective and subjective reinforcement when $k = 3$	99
5.5.1 Comparison of E_d and cosine similarity	101
6.1.1 A historical perspective on the evolution of the rules	104

List of Tables

2.1	A brief overview of the definition of play	24
2.2	Measures of game refinement for various games	35
2.3	Analogical Link Between Motion in Mind and Motion in Physics.	36
2.4	An Overview of the Featured Games	37
3.1	Analogical link between game and physics [60]	43
3.2	Data of some major board games and Mah Jong	45
3.3	Data of the Go variants [144]	47
3.4	Data of the Chess variants [62, 27]	48
3.5	Data of the Mah Jong variants [61, 143]	49
3.6	Results on basketball games	51
3.7	Results on action video games	53
3.8	Classification of activities according to the interplay of physics in mind measures (\vec{p} , E_p , and F) and reward frequencies (N)	57
4.1	Analogical link between game and physics [60]	65
4.2	Two potential energies compared.	66
4.3	Experiment setting for 3-armed bandit.	70
4.4	Experiment setting for 10-armed bandit	70
4.5	Results of energy difference in 3-arm bandit.	73
4.6	Results of energy difference in 10-arm bandit.	73
5.1	Analogical link between motion in game and driving	87
5.2	Motions in the experiment for human players	95
5.3	Max reinforcement points when $k = 0, 1, 2, 3 \dots (0 < m < 1)$	97

5.4 Comparison of the objective and subjective difference based on motion in mind	100
--	-----