

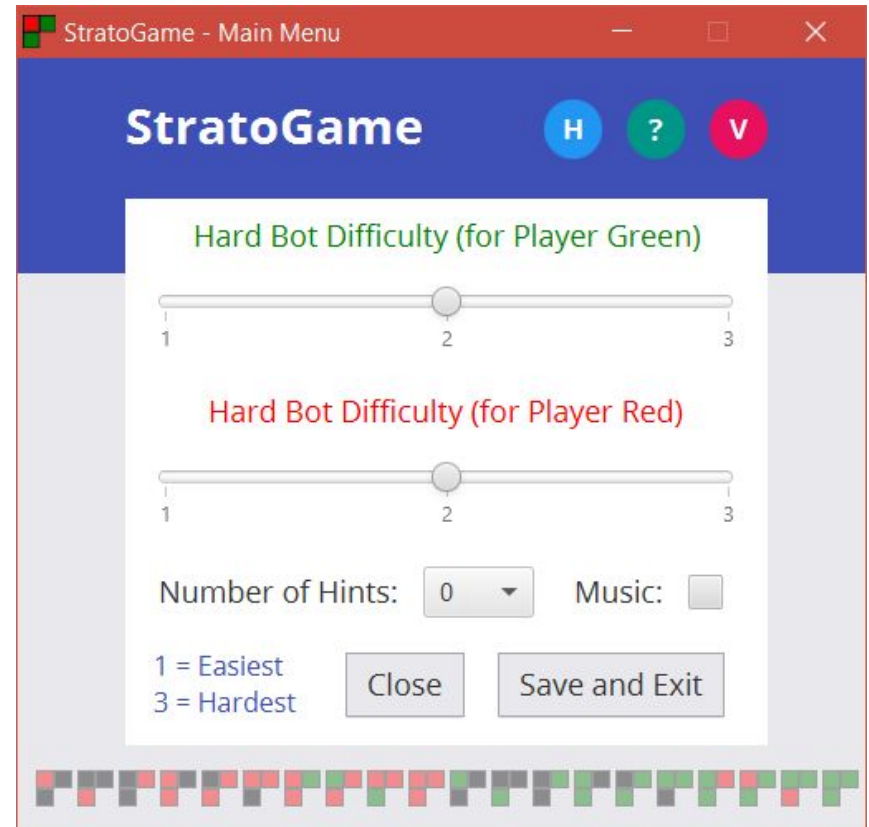
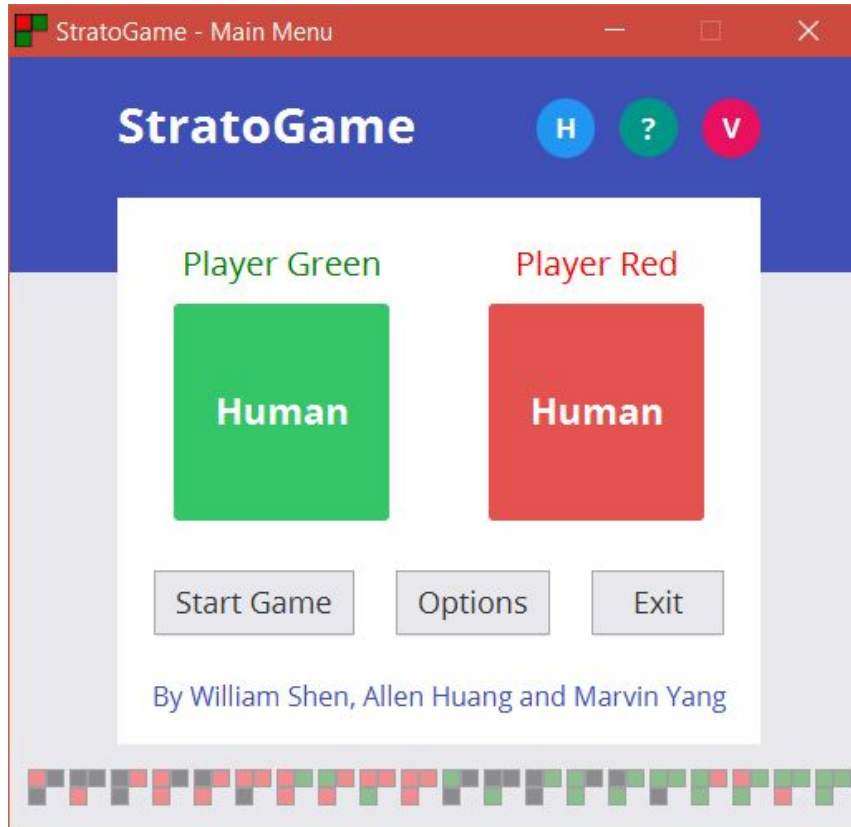
COMP1140 Group Assignment

By William Shen, Allen Huang, and Marvin Yang (tue13s)

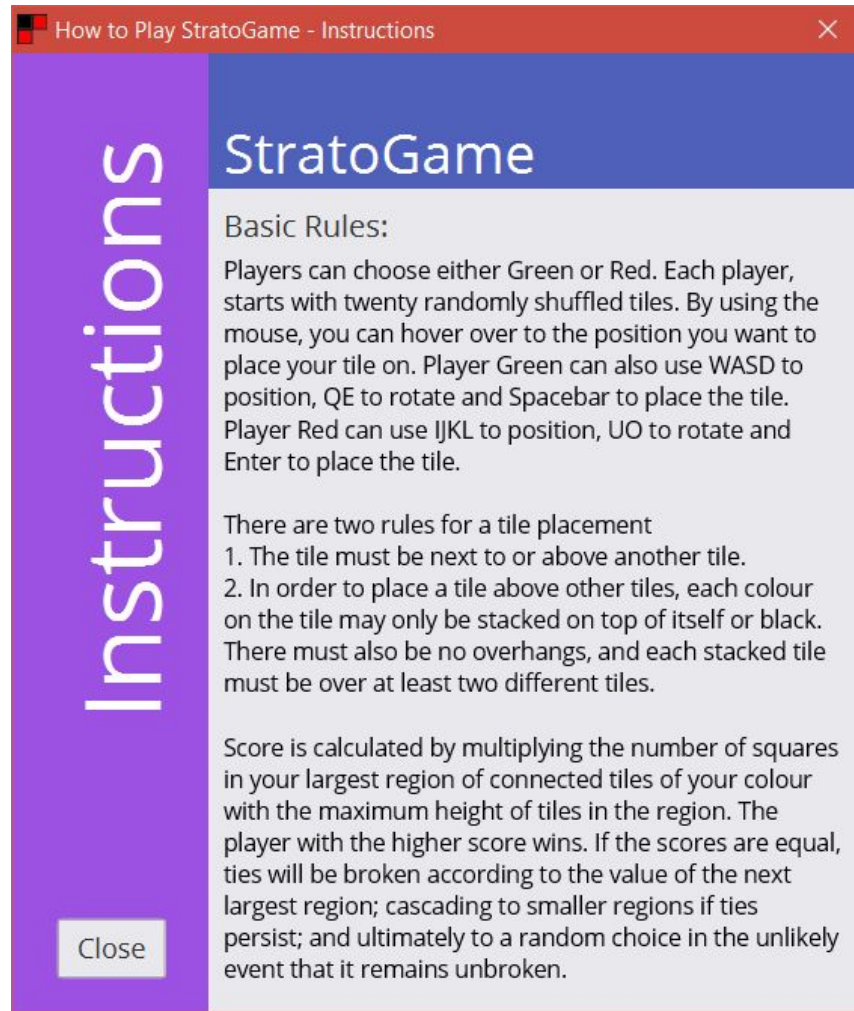
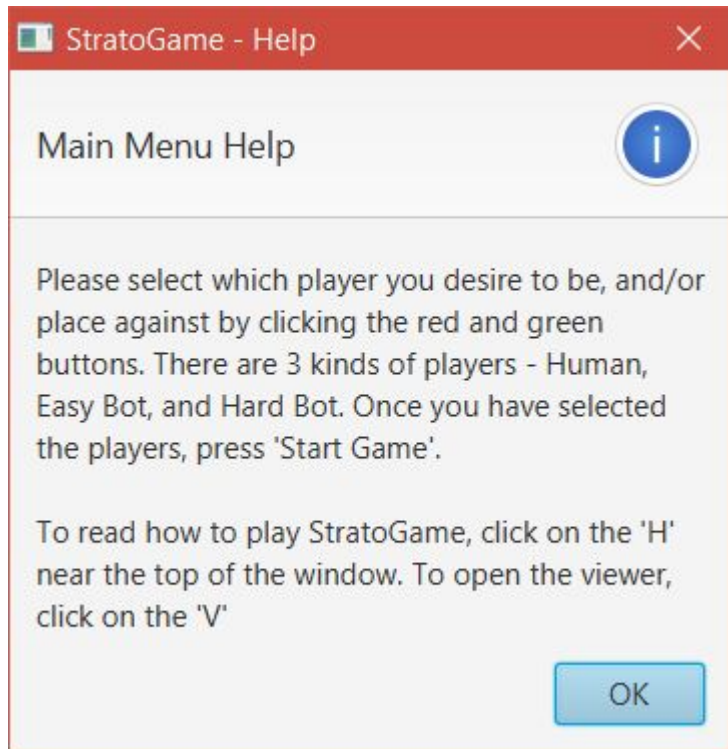
General Summary and Design Approach

- **Modern and intuitive UI and UX design** - easy to use, aesthetically pleasing
- **Package Organisation** - easy to make changes if game rules are altered.
- **Abstraction** - breaking things down into smaller segments (e.g. Tiles have been broken down into Position, Shape (which is broken down into Colour), and Orientation. Making use of the object-oriented paradigm.
- **Features** - hints for human players, bot vs bot (including helpful console messages), HardBot difficulty, music, options menu, keyboard support, instructions, and tile placement viewer.

Menu



Instructions and Help



Viewer

Viewer

Viewer

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA	KA	LA	MA	NA	OA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	ZA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB	KB	LB	MB	NB	OB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	ZB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC	KC	LC	MC	NC	OC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	ZC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD	KD	LD	MD	ND	OD	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	ZD
AE	BE	CE	DE	EE	FE	GE	HE	IE	JE	KE	LE	ME	NE	OE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	ZE
AF	BF	CF	DF	EF	FF	GF	HF	IF	JF	KF	LF	MF	NF	OF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	ZF
AG	BG	CG	DG	EG	FG	GG	HG	IG	JG	KG	LG	MG	NG	OG	PG	QG	RG	SG	TG	UG	VG	WG	XG	YG	ZG
AH	BH	CH	DH	EH	FH	GH	HH	IH	JH	KH	LH	MH	NH	OH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	ZH
AI	BI	CI	DI	EI	FI	GI	HI	II	JI	KI	LI	MI	NI	OI	PI	QI	RI	SI	TI	UI	VI	WI	XI	YI	ZI
AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	IJ	JJ	KJ	LJ	MJ	NJ	OJ	PJ	QJ	RJ	SJ	TJ	UJ	VJ	WJ	XJ	YJ	ZJ
AK	BK	CK	DK	EK	FK	2	HK	IK	JK	KK	LK	MK	NK	OK	PK	QK	RK	SK	TK	UK	VK	WK	XK	YK	ZK
AL	BL	CL	DL	EL	2	2	2	2	JL	KL	2	2	NL	OL	PL	QL	RL	SL	TL	UL	VL	WL	XL	YL	ZL
AM	BM	CM	2	3	2	2	3	3	3	3	3	3	NM	OM	PM	QM	RM	SM	TM	UM	VM	WM	XM	YM	ZM
AN	BN	2	3	3	3	3	3	3	3	3	2	3	3	NN	ON	PN	QN	RN	SN	TN	UN	VN	WN	XN	ZN
AO	BO	2	3	3	2	2	HO	3	3	2	3	3	NO	OO	PO	QO	RO	SO	TO	UO	VO	WO	XO	YO	ZO
AP	BP	CP	3	2	2	3	HP	3	3	3	3	3	NP	OP	PP	QP	RP	SP	TP	UP	VP	WP	XP	YP	ZP
AQ	BQ	CQ	DQ	3	2	3	3	3	3	2	3	3	3	OQ	PQ	QQ	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ
AR	BR	CR	DR	ER	FR	2	2	3	3	3	3	3	3	OR	PR	QR	RR	SR	TR	UR	VR	WR	XR	YR	ZR
AS	BS	CS	DS	ES	FS	GS	2	3	3	3	3	3	3	OS	PS	QS	RS	SS	TS	US	VS	WS	XS	YS	ZS
AT	BT	CT	DT	ET	FT	2	2	3	3	2	3	3	3	OT	PT	QT	RT	ST	TT	UT	VT	WT	XT	YT	ZT
AU	BU	CU	DU	EU	FU	3	3	2	2	3	3	3	3	OU	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	ZU
AV	BV	CV	DV	EV	FV	GV	HV	IV	JV	KV	LV	MV	NV	OV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	ZV
AW	BW	CW	DW	EW	FW	GW	HW	IW	JW	KW	LW	MW	NW	OW	PW	QW	RW	SW	TW	UW	VW	WW	XW	YW	ZW
AX	BX	CX	DX	EX	FX	GX	HX	IX	JX	KX	LX	MX	NX	OX	PX	QX	RX	SX	TX	UX	VX	WX	XX	YX	ZX
AY	BY	CY	DY	EY	FY	GY	HY	IY	JY	KY	LY	MY	NY	OY	PY	QY	RY	SY	TY	UY	VY	WY	XY	YY	ZY
AZ	BZ	CZ	DZ	EZ	FZ	GZ	HZ	IZ	JZ	KZ	LZ	MZ	NZ	OZ	PZ	QZ	RZ	SZ	TZ	UZ	VZ	WZ	XZ	YZ	ZZ

Close

Placement:



Refresh

Board

Initial Board State

StratoGame

Player Green






20 piece(s) left
Score = 1


Hints Left: 7

Hint

Green Player's Turn

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA	KA	LA	MA	NA	OA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	ZA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB	KB	LB	MB	NB	OB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	ZB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC	KC	LC	MC	NC	OC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	ZC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD	KD	LD	MD	ND	OD	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	ZD
AE	BE	CE	DE	EE	FE	GE	HE	IE	JE	KE	LE	ME	NE	OE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	ZE
AF	BF	CF	DF	EF	FF	GF	HF	IF	JF	KF	LF	MF	NF	OF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	ZF
AG	BG	CG	DG	EG	FG	GG	HG	IG	JG	KG	LG	MG	NG	OG	PG	QG	RG	SG	TG	UG	VG	WG	XG	YG	ZG
AH	BH	CH	DH	EH	FH	GH	HH	IH	JH	KH	LH	MH	NH	OH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	ZH
AI	BI	CI	DI	EI	FI	GI	HI	II	JI	KI	LI	MI	NI	OI	PI	QI	RI	SI	TI	UI	VI	WI	XI	YI	ZI
AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	IJ	JJ	KJ	LJ	MJ	NJ	OJ	PJ	QJ	RJ	SJ	TJ	UJ	VJ	WJ	XJ	YJ	ZJ
AK	BK	CK	DK	EK	FK	GK	HK	IK	JK	KK	LK	MK	NK	OK	PK	QK	RK	SK	TK	UK	VK	WK	XK	YK	ZK
AL	BL	CL	DL	EL	FL	GL	HL	IL	JL	KL	LL	ML	NL	OL	PL	QL	RL	SL	TL	UL	VL	WL	XL	YL	ZL
AM	BM	CM	DM	EM	FM	GM	HM	IM	JM	KM	LM		NM	OM	PM	QM	RM	SM	TM	UM	VM	WM	XM	YM	ZM
AN	BN	CN	DN	EN	FN	GN	HN	IN	JN	KN	LN		NN	ON	PN	QN	RN	SN	TN	UN	VN	WN	XN	YN	ZN
AO	BO	CO	DO	EO	FO	GO	HO	IO	JO	KO	LO	MO	NO	OO	PO	QO	RO	SO	TO	UO	VO	WO	XO	YO	ZO
AP	BP	CP	DP	EP	FP	GP	HP	IP	JP	KP	LP	MP	NP	OP	PP	QP	RP	SP	TP	UP	VP	WP	XP	YP	ZP
AQ	BQ	CQ	DQ	EQ	FQ	GQ	HQ	IQ	JQ	KQ	LQ	MQ	NQ	OQ	PQ	QQ	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ
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AT	BT	CT	DT	ET	FT	GT	HT	IT	JT	KT	LT	MT	NT	OT	PT	QT	RT	ST	TT	UT	VT	WT	XT	YT	ZT
AU	BU	CU	DU	EU	FU	GU	HU	IU	JU	KU	LU	MU	NU	OU	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	ZU
AV	BV	CV	DV	EV	FV	GV	HV	IV	JV	KV	LV	MV	NV	OV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	ZV
AW	BW	CW	DW	EW	FW	GW	HW	IW	JW	KW	LW	MW	NW	OW	PW	QW	RW	SW	TW	UW	VW	WW	XW	YW	ZW
AX	BX	CX	DX	EX	FX	GX	HX	IX	JX	KX	LX	MX	NX	OX	PX	QX	RX	SX	TX	UX	VX	WX	XX	YX	ZX
AY	BY	CY	DY	EY	FY	GY	HY	IY	JY	KY	LY	MY	NY	OY	PY	QY	RY	SY	TY	UY	VY	WY	XY	YY	ZY
AZ	BZ	CZ	DZ	EZ	FZ	GZ	HZ	IZ	JZ	KZ	LZ	MZ	NZ	OZ	PZ	QZ	RZ	SZ	TZ	UZ	VZ	WZ	XZ	YZ	ZZ

Player Red



20 piece(s) left
Score = 1

Hints Left: 7

Hint

Board


Human vs Human

Hovering

Hints on

StratoGame

Player Green



19 piece(s) left
Score = 1


Hints Left: 6

Hint

Green Player's Turn

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA	KA	LA	MA	NA	OA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	ZA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB	KB	LB	MB	NB	OB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	ZB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC	KC	LC	MC	NC	OC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	ZC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD	KD	LD	MD	ND	OD	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	ZD
AE	BE	CE	DE	EE	FE	GE	HE	IE	JE	KE	LE	ME	NE	OE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	ZE
AF	BF	CF	DF	EF	FF	GF	HF	IF	JF	KF	LF	MF	NF	OF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	ZF
AG	BG	CG	DG	EG	FG	GG	HG	IG	JG	KG	LG	MG	NG	OG	PG	QG	RG	SG	TG	UG	VG	WG	XG	YG	ZG
AH	BH	CH	DH	EH	FH	GH	HH	IH	JH	KH	LH	MH	NH	OH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	ZH
AI	BI	CI	DI	EI	FI	GI	HI	II	JI	KI	LI	MI	NI	OI	PI	QI	RI	SI	TI	UI	VI	WI	XI	YI	ZI
AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	IJ	JJ	KJ	LJ	MJ	NJ	OJ	PJ	QJ	RJ	SJ	TJ	UJ	VJ	WJ	XJ	YJ	ZJ
AK	BK	CK	DK	EK	FK	GK	HK	IK	JK	KK	LK	MK	NK	OK	PK	QK	RK	SK	TK	UK	VK	WK	XK	YK	ZK
AL	BL	CL	DL	EL	FL	GL	HL	IL	KL	LL	ML	NL	OL	PL	QL	RL	SL	TL	UL	VL	WL	XL	YL	ZL	
AM	BM	CM	DM	EM	FM	GM	HM	IM	JM	KM	LM	MM	NM	OM	PM	QM	RM	SM	TM	UM	VM	WM	XM	YM	ZM
AN	BN	CN	DN	EN	FN	GN	HN	IN	JN	KN	LN	MN	NN	ON	PN	QN	RN	SN	TN	UN	VN	WN	XN	YN	ZN
AO	BO	CO	DO	EO	FO	GO	HO	IO	JO	KO	LO	MO	NO	OO	PO	QO	RO	SO	TO	UO	VO	WO	XO	YO	ZO
AP	BP	CP	DP	EP	FP	GP	HP	IP	JP	KP	LP	MP	NP	OP	PP	QP	RP	SP	TP	UP	VP	WP	XP	YP	ZP
AQ	BQ	CQ	DQ	EQ	FQ	GQ	HQ	IQ	JQ	KQ	LQ	MQ	NQ	OQ	PQ	QQ	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ
AR	BR	CR	DR	ER	FR	GR	HR	IR	JR	KR	LR	MR	NR	OR	PR	QR	RR	SR	TR	UR	VR	WR	XR	YR	ZR
AS	BS	CS	DS	ES	FS	GS	HS	IS	JS	KS	LS	MS	NS	OS	PS	QS	RS	SS	TS	US	VS	WS	XS	YS	ZS
AT	BT	CT	DT	ET	FT	GT	HT	IT	JT	KT	LT	MT	NT	OT	PT	QT	RT	ST	TT	UT	VT	WT	XT	YT	ZT
AU	BU	CU	DU	EU	FU	GU	HU	IU	JU	KU	LU	MU	NU	OU	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	ZU
AV	BV	CV	DV	EV	FV	GV	HV	IV	JV	KV	LV	MV	NV	OV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	ZV
AW	BW	CW	DW	EW	FW	GW	HW	IW	JW	KW	LW	MW	NW	OW	PW	QW	RW	SW	TW	UW	VW	WW	XW	YW	ZW
AX	BX	CX	DX	EX	FX	GX	HX	IX	JX	KX	LX	MX	NX	OX	PX	QX	RX	SX	TX	UX	VX	WX	XX	YX	ZX
AY	BY	CY	DY	EY	FY	GY	HY	IY	JY	KY	LY	MY	NY	OY	PY	QY	RY	SY	TY	UY	VY	WY	XY	YY	ZY
AZ	BZ	CZ	DZ	EZ	FZ	GZ	HZ	IZ	JZ	KZ	LZ	MZ	NZ	OZ	PZ	QZ	RZ	SZ	TZ	UZ	VZ	WZ	XZ	YZ	ZZ

Player Red



19 piece(s) left
Score = 2

Hints Left: 7


Hint

Board

Bot vs Bot

StratoGame

Easy Bot

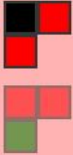


9 piece(s) left
Score = 40

Red Player's Turn. Bot thinking...

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA	KA	LA	MA	NA	OA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	ZA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB	KB	LB	MB	NB	OB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	ZB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC	KC	LC	MC	NC	OC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	ZC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD	KD	LD	MD	ND	OD	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	ZD
AE	BE	CE	DE	EE	FE	GE	HE	IE	JE	KE	LE	ME	NE	OE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	ZE
AF	BF	CF	DF	EF	FF	GF	HF	IF	JF	KF	LF	MF	NF	OF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	ZF
AG	BG	CG	DG	EG	FG	GG	HG	IG	JG	KG	LG	MG	NG	OG	PG	QG	RG	SG	TG	UG	VG	WG	XG	YG	ZG
AH	BH	CH	DH	EH	FH	GH	HH	IH	JH	KH	LH	MH	NH	OH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	ZH
AI	BI	CI	DI	EI	FI	GI	HI	II	JI	KI	LI	MI	NI	OI	PI	QI	RI	SI	TI	UI	VI	WI	XI	YI	ZI
AJ	BJ	CJ	DJ	EJ	FJ																				
AK	BK	CK	DK																						
AL	BL	CL	DL																						
AM	BM	CM	DM	EM	FM																				
AN	BN	CN	DN	EN	FN																				
AO	BO	CO	DO	EO	FO																				
AP	BP	CP	DP	EP	FP																				
AQ	BQ	CQ	DQ	EQ	FQ																				
AR	BR	CR	DR	ER	FR																				
AS	BS	CS	DS	ES	FS																				
AT	BT	CT	DT	ET	FT																				
AU	BU	CU	DU	EU	FU																				
AV	BV	CV	DV	EV	FV																				
AW	BW	CW	DW	EW	FW																				
AX	BX	CX	DX	EX	FX																				
AY	BY	CY	DY	EY	FY																				
AZ	BZ	CZ	DZ	EZ	FZ																				

Hard Bot



10 piece(s) left
Score = 20

Board

End Game

StratoGame

Easy Bot

0 piece(s) left
Score = 40

Play Again

Menu

Exit

Player Red wins! Green = 40, Red = 95

AA	BA	CA	DA	EA	FA	GA	HA	IA	JA	KA	LA	MA	NA	OA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	ZA
AB	BB	CB	DB	EB	FB	GB	HB	IB	JB	KB	LB	MB	NB	OB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	ZB
AC	BC	CC	DC	EC	FC	GC	HC	IC	JC	KC	LC	MC	NC	OC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	ZC
AD	BD	CD	DD	ED	FD	GD	HD	ID	JD	KD	LD	MD	ND	OD	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	ZD
AE	BE	CE	DE	EE	FE	GE	HE	IE	JE	KE	LE	ME	NE	OE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	ZE
AF	BF	CF	DF	EF	FF	GF	HF	IF	JF	KF	LF	MF	NF	OF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	ZF
AG	BG	CG	DG	EG	FG	GG	HG	IG	JG	KG	LG	MG	NG	OG	PG	QG	RG	SG	TG	UG	VG	WG	XG	YG	ZG
AH	BH	CH	DH	EH	FH	GH	HH	IH	JH	KH	LH	MH	NH	OH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	ZH
AI	BI	CI	DI	EI	FI	GI	HI	II	JI	KI	LI	MI	NI	OI	PI	QI	RI	SI	TI	UI	VI	WI	XI	YI	ZI
AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	IJ																	
AK	BK	CK	DK	EK	FK																				
AL	BL	CL	DL																						
AM	BM	CM	DM	EM																					
AN	BN	CN	DN	EN	FN	GN	HN																		
AO	BO	CO	DO	EO	FO																				
AP	BP	CP	DP	EP	FP																				
AQ	BQ	CQ	DQ	EQ	FQ																				
AR	BR	CR	DR	ER																					
AS	BS	CS	DS																						
AT	BT	CT																							
AU	BU	CU	DU	EU	FU	GU	HU	IU	JU																
AV	BV	CV	DV	EV	FV	GV	HV	IV	JV	KV	LV	MV	NV	OV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	ZV
AW	BW	CW	DW	EW	FW	GW	HW	IW	JW	KW	LW	MW	NW	OW	PW	QW	RW	SW	TW	UW	VW	WW	XW	YW	ZW
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AZ	BZ	CZ	DZ	EZ	FZ	GZ	HZ	IZ	JZ	KZ	LZ	MZ	NZ	OZ	PZ	QZ	RZ	SZ	TZ	UZ	VZ	WZ	XZ	YZ	ZZ

Hard Bot

0 piece(s) left
Score = 95

UI and UX Design Approach

- **Easy to Use**

- You can hover tiles around the board (green/red outlines)
- Helpful messages - if anything needs confirmation or goes wrong
- Play game with keyboard (2-player, laptop trackpads, etc.)

- **Intuitive and Aesthetic Interface**

- Subtle changes on controls using CSS - e.g. hover over button
- Colours to easily identify which controls for each player.
- Large and easily accessible buttons
- Helpful console messages (if launched from command line)

Package Organisation

comp1110.ass2

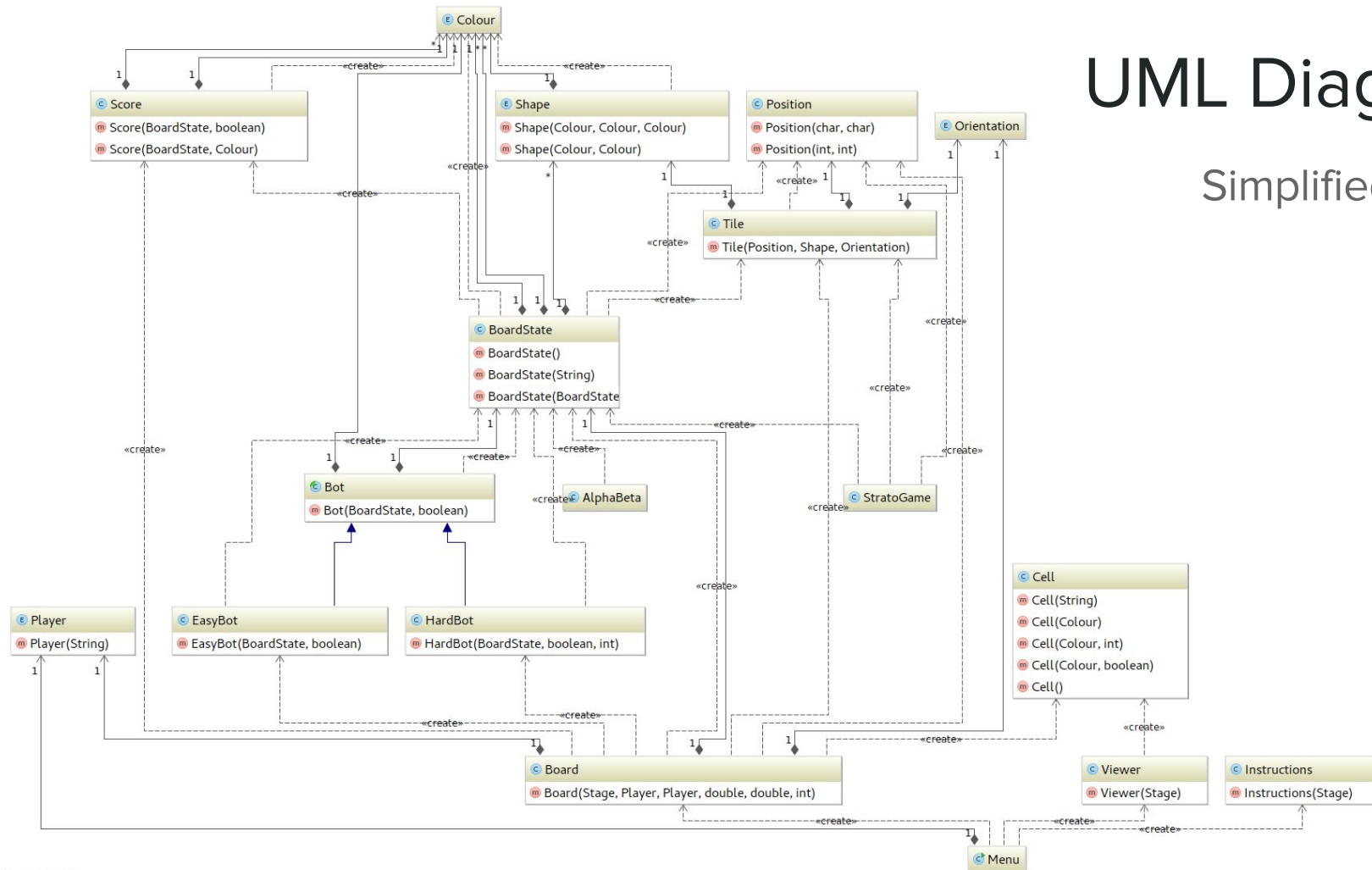
bots

gui

logic

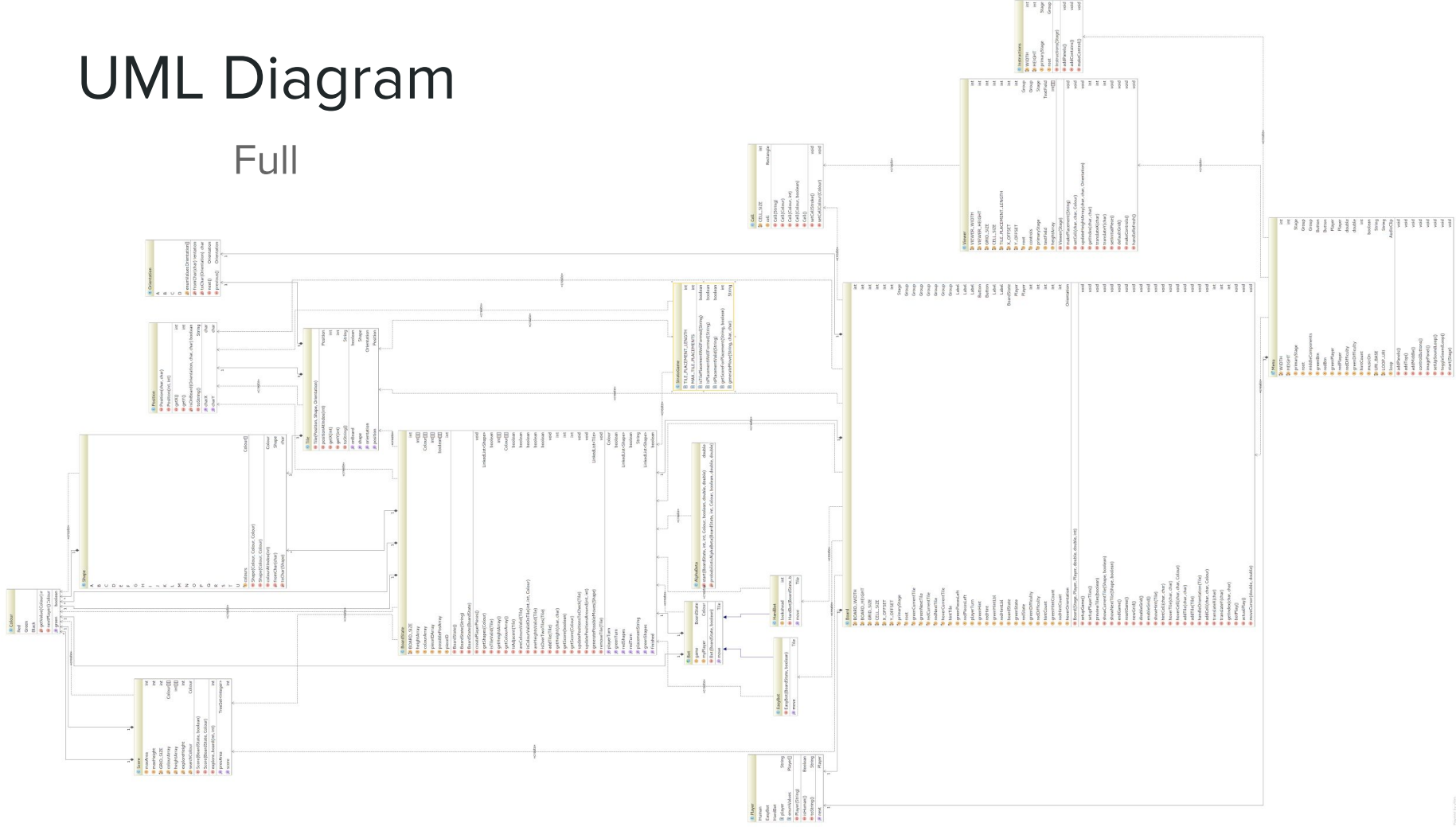
UML Diagram

Simplified



UML Diagram

Full



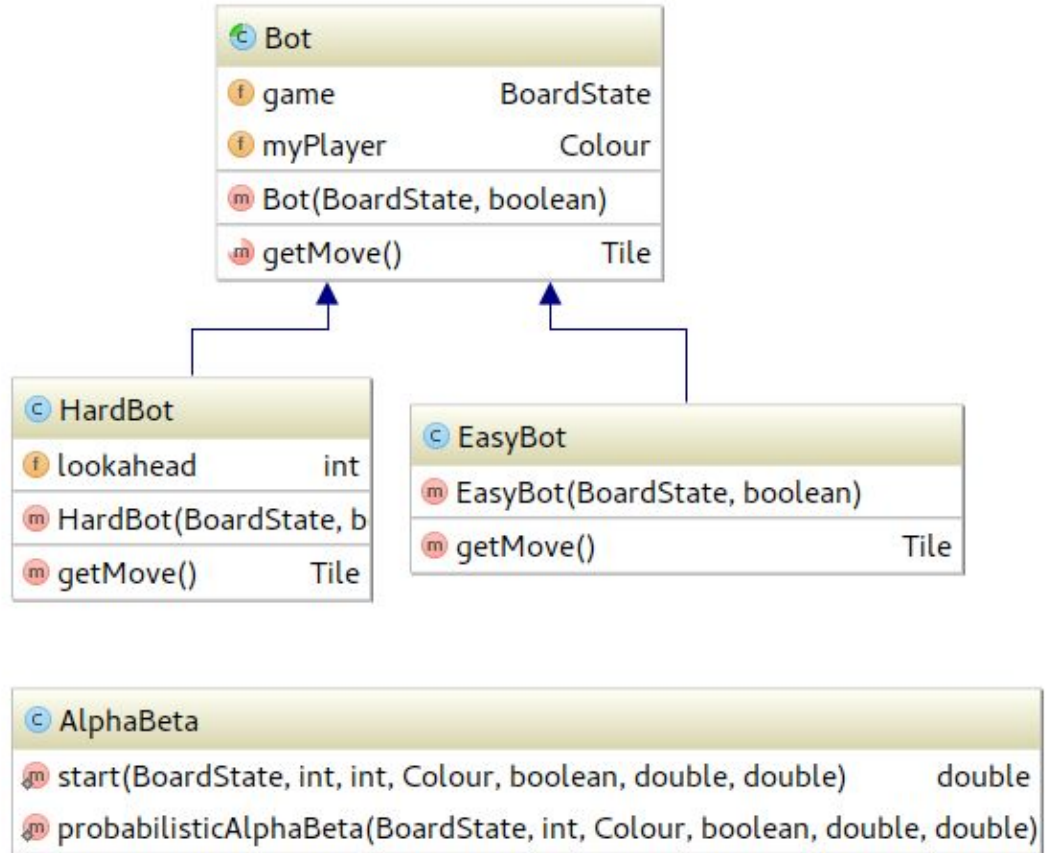
Bots Package

AlphaBeta

Bot

EasyBot

HardBot



Bots

Bot: abstract class used to define what EasyBot and HardBot should implement

EasyBot: extends and implements Bot

HardBot: extends and implements Bot

AlphaBeta: statically called from HardBot

Bots

Heuristic is just *My Score – Opponent's Score*

EasyBot has a search depth of one, and just chooses the highest scoring move of the possible moves

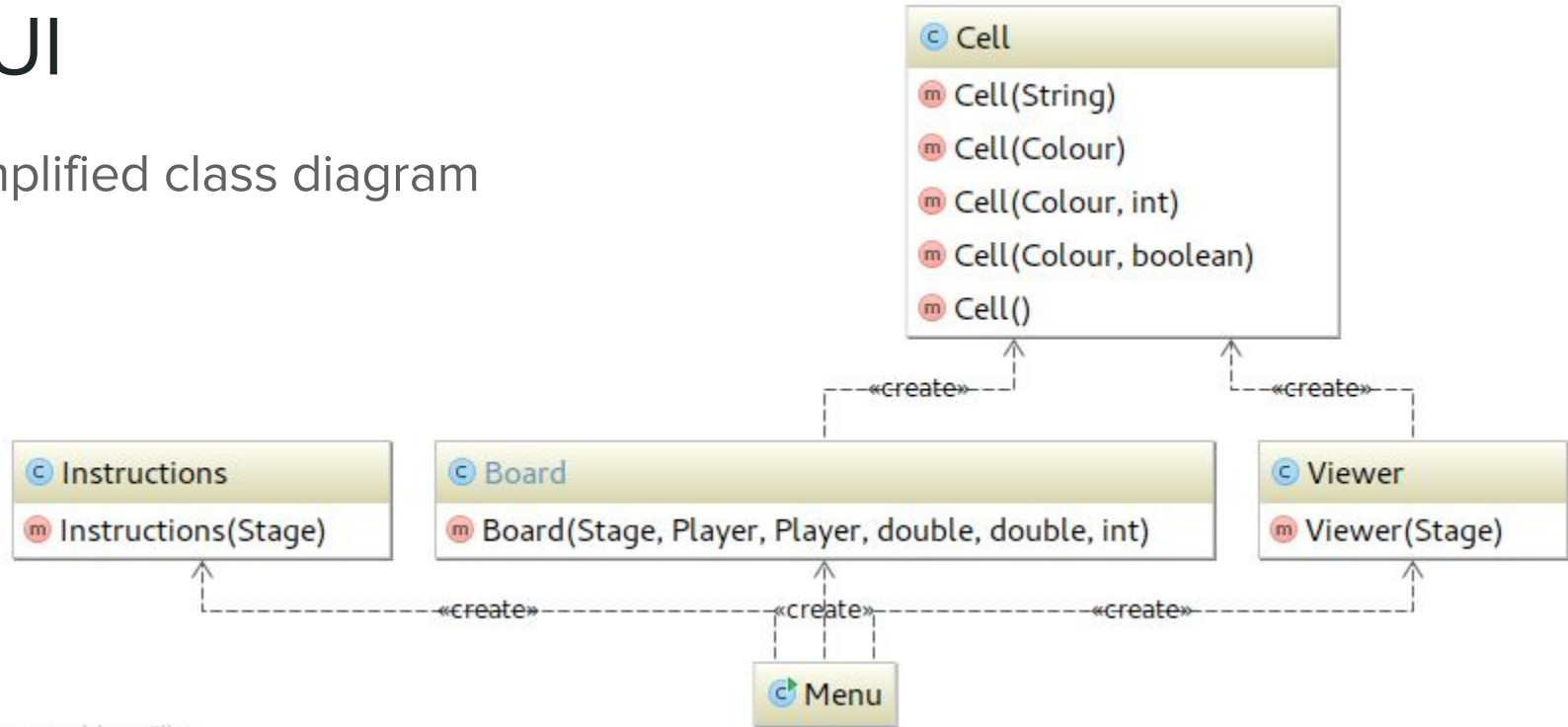
HardBot for the first two depths is just normal minimax with alpha beta pruning. After two depths it no longer has information and returns a weighted score.

GUI Package

- **assets** - font files, music, tile images, and CSS file (for styling)
- **Board** - main stage on which games are played
- **Cell** - for creating a cell of a tile, or a cell-grid identifier
- **Instructions** - help for the user
- **Menu** - where the game is initialised, for choosing game options
- **Viewer** - for viewing tile placements

GUI

Simplified class diagram



GUI

- **Menu** passes the relevant option parameters to board
 - HardBot difficulties
 - Hints
- **Board, Instructions, and Viewer** extend Stage.
 - Opened from Menu
 - This allows us to seamlessly open and close them.
 - Opened as blocking dialogs.
- All logic has been outsourced to the classes in **logic package**.

Board

- **Most of the code here is related to JavaFX.** For example,
 - Displaying preview tiles and hover tiles
 - Preparing grid and showing pieces
 - Updating score labels
- **All logic has been outsourced to other classes.** For example,
 - Checking if tile placement/hover is legal (BoardState, Tile)
 - Handling each player's pieces (BoardState)
 - Getting game result and breaking ties (Score)
 - Generating Hints (EasyBot)

Cell

- **Extends StackPane**

- Allows us to create a 'cell' to display on the grid.
- StackPane allows us to group text, colour fill and border together

- **Different Cells can be created using the constructors**

- Grid Identifier Cells (e.g. 'AB', 'MM', 'GZ')
- Normal Coloured Cells (filled with black, green or red)
- Normal Coloured Cells with height identifier
- Coloured Cell for Hovering (decreased opacity, outline)
- Yellow Coloured Cell for showing hints

Logic Package

BoardState - stores ALL information about the board

Colour - colours on a tile, and colour of the player (enum)

Orientation - orientation of a tile on the board (enum)

Player - Human, EasyBot, or HardBot - used for Menu and Board

Position - position of a tile on the board in character coordinates

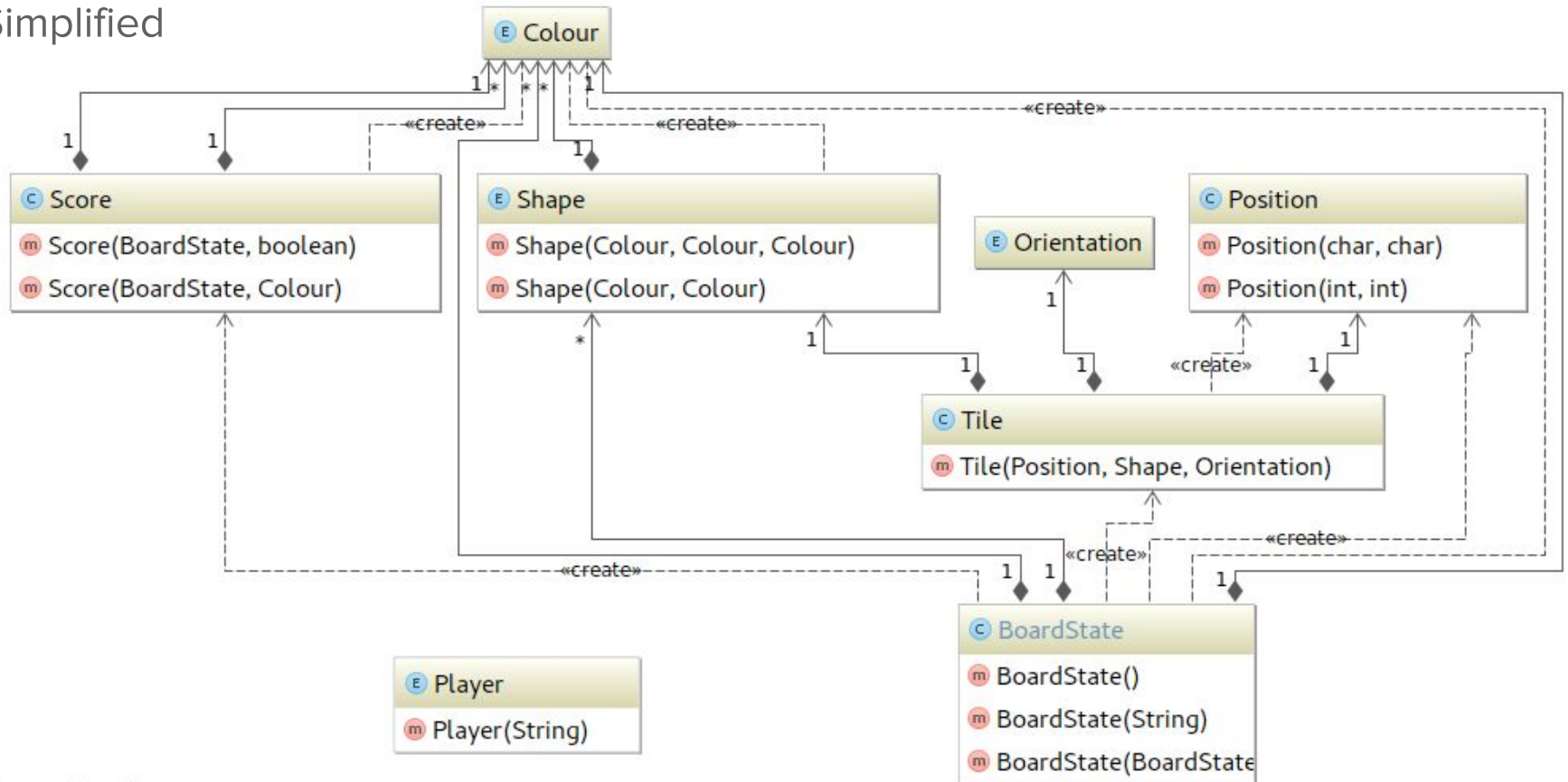
Score - calculating score for BoardState and determine winner

Shape - storing shapes and their colours (enum)

Tile - Position, Shape and Orientation combined

Logic

Simplified



BoardState

- **Stores all information about a game**
 - Board represented as 2D arrays: colour, height and piece ID array.
 - Keep track of Player Green and Red's remaining pieces
 - Whose turn it is, placement string, etc.
 - We keep an array of possible positions for the bots (and hints)
- **Constructors.** We can either:
 1. Create a blank board - i.e. with MMUA
 2. Create a BoardState from a placement string (for StratoGame)
 3. Create a new copy of a BoardState (mainly for bots)

BoardState

- **Useful Functions**

- Retrieve data about a BoardState - e.g. height at a given cell
- Generate pieces for the players
- Generate possible moves for a given shape on the board
- Easy access to the scoring interface
- Check whether Tile placements are legal, and adding them

Tile

- **Tile** is made of **Position**, **Shape**, and **Orientation**
 - **Position** represents the coordinates of the tile
 - **Shape** is an enum class representing each Shape ID with its relevant colours at their indexes.
 - **Orientation** is an enum class of either *A*, *B*, *C*, *D*
- Each of these classes have functions which help us
 1. Retrieve relevant data
 2. Check if additions are legal
 3. Make general changes to a Tile

Score - determining winner

- **When scoring at end-game, each area is added into a TreeSet**
 - TreeSet ensures uniqueness and order
 - Elements are sorted in descending order using compareTo
- **If the maximum scores are equal, then we:**
 1. Loop through the TreeSet each element at a time, until empty
 2. Compare green and red's areas accordingly
 3. Continue or return the appropriate value
 4. End of Loop: generate random int that is either 0 or 1 (coin toss)
 5. 0 = Green, 1 = Red. Return accordingly

Limitations

- **Bot vs. Bot game cannot be terminated until end game**
 - **Why?** Threads are continuously created and killed for the bots
 - Board calls botPlay which is ultimately recursive
- **More research could go into finding a better heuristic**
 - *My Score — Opponent's Score* is very basic
 - A better heuristic would weigh different areas of the board differently
 - Move preference is to top-left right now - Possible position array is 2D and read left-to-right, row-by-row from the top.