Technical Report: NBA GM Project
EECE 2560: Fundamentals of Engineering Algorithms

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1 Project Scope

The aim of the NBA GM project is to simulate the role of an NBA General Manager during the draft, allowing users to make strategic player selections based on algorithmic sorting. This project leverages efficient algorithms and data structures to create a realistic draft experience focused on optimization and user interactivity.

The main objectives of this project are:

- To apply algorithmic techniques, such as the Greedy Algorithm, in the context of player selection.

- To design a user-friendly system allowing interactive draft selection based on player attributes.

- To analyze the time and space complexity of sorting and selection algorithms.

- To provide comprehensive documentation and testing of the codebase.

Expected outcomes include a fully functional draft simulation, a detailed technical report, and a final presentation.

2 Project Plan

2.1 Timeline

The project was organized into phases, each with specific deliverables:

- **Week 1**: Defined project scope and outlined technical requirements.

- **Week 2**: Developed the core draft simulation algorithms in C++ and set up the repository.

- **Week 3**: Completed algorithmic optimization, complexity analysis, and initial testing.

- **Week 4**: Finalized the GUI, conducted testing, debugged, and completed the report and presentation.

2.2 Milestones

Key milestones achieved:

- Scope definition and project plan finalized by the end of Week 1.

- Development of draft simulation core completed by Week 2.

- Completion of core algorithms and complexity analysis by Week 3.

- Final testing, debugging, and report writing by Week 4.

3 Team Roles

- **Cesar De Oleo**: Developed core algorithms, GUI design, and prepared the final presentation.

- **Aryash Jain**: Developed core algorithms, debugging, and prepared the final presentation.

- **Abhinav Yarlagadda**: Managed documentation, wrote the report, and handled Overleaf.

4 Methodology

4.1 Pseudocode and Complexity Analysis

Below is the pseudocode for the Greedy Algorithm used for team assignment during the draft. Each team selects the top-ranked player based on its preferred attribute, optimizing team selections efficiently.

Pseudocode for Greedy Algorithm:

```
for each draft pick in draftOrder:
    if team == user's team:
        let user choose attribute and player
    else:
        assign best available player based on team's preferred attribute
    update available players by removing selected player
```

Complexity Analysis:

- The sorting algorithm (insertion sort) has a time complexity of $O(n^2)$, which is manageable due to the relatively small dataset.

- The Greedy Algorithm operates in $O(n)$ time for each selection, making it efficient within the draft's scope.

4.2 Data Collection and Preprocessing

Data was sourced from `NBA_Data.csv`, containing player attributes like height, shooting accuracy, and speed. Data preprocessing involved reading player attributes into custom-made structured data objects and compiling them in vectors and hash maps, enabling quick access during the draft simulation.

5 Results

The NBA GM simulation achieved the following:

- **Key Findings**: The Greedy Algorithm effectively optimized selections, with each team maximizing player potential based on attribute preferences.

- **Visualization**: See Figure 3 in Appendix C for a sample draft order outcome.

6   Discussion

6.1   Implications of Findings

This simulation highlights the value of algorithmic decision-making in sports management, showing how a GM could make data-driven draft decisions. Having the ability to sort an entire draft class by a given attribute allows for much more efficient draft planning and analysis. The project can serve as a foundation for educational tools in sports analytics.

6.2   Project Limitations

While the NBA GM project effectively simulates a draft scenario, there are several areas for potential improvement. Firstly, the insertion sort algorithm used for player ranking, though functional for smaller datasets, has a time complexity of $O(n^2)$, which may become inefficient with larger player pools. Implementing a more efficient sorting algorithm, such as quicksort or mergesort, could improve performance.

Secondly, the Greedy Algorithm used for team selection ensures that each team picks the most optimal available player based on a single attribute preference. However, this approach has limitations, as it does not account for the overall team balance or synergy between selected players. This limitation reflects a common drawback of greedy algorithms: optimizing locally (per draft pick) does not always result in a globally optimal team composition. A more comprehensive algorithm, such as one considering multiple player attributes or weighted factors, could enhance decision-making accuracy and team-building strategy.

7   Conclusion

The NBA GM project successfully simulated the NBA draft process using algorithms for optimal player selection. Key achievements include a Greedy Algorithm for team assignments, a user-friendly GUI, and comprehensive draft results. Future work could improve the sorting time complexity, enhance algorithm efficiency, and introduce additional features like trade options, including trading players within the draft or trading draft picks for future drafts.

8 References

References

[1] NBA Data, retrieved from u/dagtrix `https://docs.google.com/spreadsheets/d/1g4E2so_T8u_C4R-_keF2cJnejyQULyBb5KKEABIKLP0/edit?gid=0#gid=0`.

A   Appendix A: Link to Github Repository

Link to Repository

B   Appendix B: Code

```
) { .\NBAGM }
Welcome to the NBA GM program!
Available NBA Teams:
- ATLANTA HAWKS
- BOSTON CELTICS
- BROOKLYN NETS
- CHARLOTTE HORNETS
- CHICAGO BULLS
- CLEVELAND CAVALIERS
- DALLAS MAVERICKS
- DENVER NUGGETS
- DETROIT PISTONS
- GOLDEN STATE WARRIORS
- HOUSTON ROCKETS
- INDIANA PACERS
- LOS ANGELES CLIPPERS
- LOS ANGELES LAKERS
- MEMPHIS GRIZZLIES
- MIAMI HEAT
- MILWAUKEE BUCKS
- MINNESOTA TIMBERWOLVES
- NEW ORLEANS PELICANS
- NEW YORK KNICKS
- OKLAHOMA CITY THUNDER
- ORLANDO MAGIC
- PHILADELPHIA 76ERS
- PHOENIX SUNS
- PORTLAND TRAIL BLAZERS
- SACRAMENTO KINGS
- SAN ANTONIO SPURS
- TORONTO RAPTORS
- UTAH JAZZ
- WASHINGTON WIZARDS

Choose your team to become the GM of:
Boston Celtics

Starting the NBA Draft!
Pick 1: MILWAUKEE BUCKS selects Kevin Durant from Texas based on top attribute: mid_Range_Shot
Pick 2: CHICAGO BULLS selects Chris Paul from Wake Forest based on top attribute: mid_Range_Shot
Pick 3: CHARLOTTE HORNETS selects Khris Middleton from Texas A&M based on top attribute: mid_Range_Shot
Pick 4: SAN ANTONIO SPURS selects Andre Drummond from Connecticut based on top attribute: rebounding
Pick 5: PHOENIX SUNS selects Tacko Fall from Central Florid based on top attribute: height
Pick 6: WASHINGTON WIZARDS selects Stephen Curry from Davidson based on top attribute: three_Point_Shot
Pick 7: TORONTO RAPTORS selects DeΓÇÖAaron Fox from Kentucky based on top attribute: speed
```

Figure 1: Initial welcome message and team selection

```
Starting the NBA Draft!
Pick 1: MILWAUKEE BUCKS selects Kevin Durant from Texas based on top attribute: mid_Range_Shot
Pick 2: CHICAGO BULLS selects Chris Paul from Wake Forest based on top attribute: mid_Range_Shot
Pick 3: CHARLOTTE HORNETS selects Khris Middleton from Texas A&M based on top attribute: mid_Range_Shot
Pick 4: SAN ANTONIO SPURS selects Andre Drummond from Connecticut based on top attribute: rebounding
Pick 5: PHOENIX SUNS selects Tacko Fall from Central Florid based on top attribute: height
Pick 6: WASHINGTON WIZARDS selects Stephen Curry from Davidson based on top attribute: three_Point_Shot
Pick 7: TORONTO RAPTORS selects DeГÇÖAaron Fox from Kentucky based on top attribute: speed
Pick 8: MIAMI HEAT selects Boban Marjanovic from Serbia based on top attribute: weight
Pick 9: INDIANA PACERS selects Enes Kanter from Turkey based on top attribute: rebounding
Pick 10: CHARLOTTE HORNETS selects Russell Westbrook from UCLA based on top attribute: speed
Pick 11: LOS ANGELES LAKERS selects Kawhi Leonard from San Diego State based on top attribute: defending
Pick 12: TORONTO RAPTORS selects Zion Williamson from Duke based on top attribute: weight
Pick 13: BROOKLYN NETS selects Kristaps Porzingis from Latvia based on top attribute: height
Pick 14: SAN ANTONIO SPURS selects Clint Capela from Switzerland based on top attribute: rebounding
Pick 15: UTAH JAZZ selects Kevin Love from UCLA based on top attribute: mid_Range_Shot
Pick 16: ATLANTA HAWKS selects Jonathan Isaac from Florida State based on top attribute: defending
Pick 17: CHICAGO BULLS selects Derrick Favors from Georgia Tech based on top attribute: rebounding
Pick 18: MINNESOTA TIMBERWOLVES selects Klay Thompson from Washington State based on top attribute: three_Point_Shot
Pick 19: OKLAHOMA CITY THUNDER selects Bogdan Bogdanovic from Serbia based on top attribute: mid_Range_Shot
Pick 20: NEW YORK KNICKS selects Luke Kornet from Vanderbilt based on top attribute: height

It's your turn to pick for BOSTON CELTICS!
Enter an attribute to sort players by (e.g., height, weight, mid_Range_Shot, three_Point_Shot, speed, passing, defending, rebounding):
speed

Top 15 players based on speed:
1. Josh Okogie - 96 (Georgia Tech)
2. Donovan Mitchell - 96 (Louisville)
3. Zhaire Smith - 95 (Texas Tech)
4. Derrick White - 94 (Colorado)
5. Lonnie Walker IV - 94 (Miami (FL))
6. Jared Harper - 93 (Auburn)
7. Melvin Frazier Jr. - 93 (Tulane)
8. Ben Simmons - 93 (LSU)
9. Ja Morant - 92 (Murray State)
10. Tremont Waters - 91 (LSU)
11. Jordan Bone - 91 (Tennessee)
12. Giannis Antetokounmpo - 90 (Greece)
13. John Wall - 90 (Kentucky)
14. Collin Sexton - 89 (Alabama)
15. James Harden - 89 (Arizona State)
Enter the number of the player you want to draft: 2

You selected Donovan Mitchell from Louisville!
```

Figure 2: Draft simulation and draft picking functionalities

C   Appendix C: Additional Figures

Pick	Team	Name	College	Attribute Used
1	MILWAUKEE BUCKS	Kevin Durant	Texas	mid_Range_Shot
2	CHICAGO BULLS	Chris Paul	Wake Forest	mid_Range_Shot
3	CHARLOTTE HORNETS	Khris Middleton	Texas A&M	mid_Range_Shot
4	SAN ANTONIO SPURS	Andre Drummond	Connecticut	rebounding
5	PHOENIX SUNS	Tacko Fall	Central Florid	height
6	WASHINGTON WIZARDS	Stephen Curry	Davidson	three_Point_Shot
7	TORONTO RAPTORS	De'Aaron Fox	Kentucky	speed
8	MIAMI HEAT	Boban Marjanovic	Serbia	weight
9	INDIANA PACERS	Enes Kanter	Turkey	rebounding
10	CHARLOTTE HORNETS	Russell Westbrook	UCLA	speed
11	LOS ANGELES LAKERS	Kawhi Leonard	San Diego State	defending
12	TORONTO RAPTORS	Zion Williamson	Duke	weight
13	BROOKLYN NETS	Kristaps Porzingis	Latvia	height
14	SAN ANTONIO SPURS	Clint Capela	Switzerland	rebounding
15	UTAH JAZZ	Kevin Love	UCLA	mid_Range_Shot
16	ATLANTA HAWKS	Jonathan Isaac	Florida State	defending
17	CHICAGO BULLS	Derrick Favors	Georgia Tech	rebounding
18	MINNESOTA TIMBERWOLVES	Klay Thompson	Washington State	three_Point_Shot
19	OKLAHOMA CITY THUNDER	Bogdan Bogdanovic	Serbia	mid_Range_Shot
20	NEW YORK KNICKS	Luke Kornet	Vanderbilt	height
21	BOSTON CELTICS	Donovan Mitchell	Louisville	speed
22	MINNESOTA TIMBERWOLVES	Robin Lopez	Stanford	weight
23	MILWAUKEE BUCKS	Jusuf Nurkic	Bosnia and Herzegovina	rebounding
24	DENVER NUGGETS	Anthony Davis	Kentucky	defending
25	OKLAHOMA CITY THUNDER	Seth Curry	Duke	mid_Range_Shot
26	PHILADELPHIA 76ERS	Josh Okogie	Georgia Tech	speed
27	UTAH JAZZ	Duncan Robinson	Michigan	three_Point_Shot
28	NEW YORK KNICKS	Monte Morris	Iowa State	passing
29	PHOENIX SUNS	Jahlil Okafor	Duke	weight
30	ATLANTA HAWKS	Bol Bol	Oregon	height
31	INDIANA PACERS	Moses Brown	UCLA	height
32	GOLDEN STATE WARRIORS	JaVale McGee	Nevada	weight
33	LOS ANGELES LAKERS	Zhaire Smith	Texas Tech	speed
34	BOSTON CELTICS	Giannis Antetokounmpo	Greece	defending
35	BROOKLYN NETS	T.J. Warren	North Carolina State	mid_Range_Shot
36	MEMPHIS GRIZZLIES	Brook Lopez	Stanford	weight
37	CLEVELAND CAVALIERS	Derrick White	Colorado	speed
38	SACRAMENTO KINGS	DeAndre Jordan	Texas A&M	rebounding

Figure 3: Draft order sample output

NAME	Position	Height (cm)	Weight (lb)	Prior to NBA	Mid-Range Shot	Three Point Shot	Speed	Pass Accuracy	Defending	Rebounding
De'Andre Hunter	SF / PF	201	225	Virginia	82	79	76	67	65	47
Trae Young	PG	185	180	Oklahoma	92	86	84	80	48	43
Cam Reddish	SF / SG	203	208	Duke	70	76	85	68	66	47
Kevin Huerter	SG / SF	201	190	Maryland	74	82	84	74	55	45
Bruno Fernando	C	206	237	Maryland	70	42	78	52	54	73
Damian Jones	C	211	245	Vanderbilt	66	57	63	34	58	67
DeAndre' Bembry	SG / PG	196	210	Saint Joseph's	55	59	70	75	70	53
John Collins	PF / C	206	235	Wake Forest	80	83	71	37	59	76
Brandon Goodwin	PG	183	180	Florida Gulf Coast	72	73	84	75	52	52
Jeff Teague	PG	191	196	Wake Forest	72	80	81	81	63	40
Treveon Graham	SF / PF	196	225	Virginia Commonweal	79	68	66	60	57	54
Dewayne Dedmon	C	213	245	Southern California	73	51	44	25	65	78
Charlie Brown (TW)	SG / SF	198	199	Saint Joseph's	76	79	76	62	51	34
Clint Capela	C	208	240	Switzerland	60	25	58	34	70	90
Skal Labissière	PF / C	208	235	Kentucky	85	70	63	37	55	76
Jayson Tatum	PF / SF	203	208	Duke	80	85	79	74	80	56
Jaylen Brown	SG / SF	198	220	California	88	82	77	75	74	54
Kemba Walker	PG	183	184	Connecticut	91	82	85	89	61	45
Gordon Hayward	SF / PF	201	225	Butler	85	83	80	75	61	55
Marcus Smart	SG / PG	191	220	Oklahoma State	74	79	75	65	83	44
Daniel Theis	C	203	243	Germany	83	76	57	69	65	72
Enes Kanter	C	208	250	Turkey	72	55	62	40	41	91
Robert Williams III	C	203	240	Texas A&M	44	25	75	37	72	81
Brad Wanamaker	PG / SG	191	210	Pittsburgh	72	80	79	79	50	40
Vincent Poirier	C	213	255	France	71	55	50	54	54	81
Javonte Green	SF / SG	193	220	Radford	72	65	72	60	65	57
Grant Williams	PF / C	198	240	Tennessee	70	64	58	69	63	56
Semi Ojeleye	SF / PF	198	241	SMU	54	80	82	54	52	47
Romeo Langford	SG / SF	193	215	Indiana	72	65	84	70	55	46
Tacko Fall	C	226	289	Central Florid	48	30	25	44	53	79
Carsen Edwards	PG	180	199	Purdue	82	73	81	75	48	46
Tremont Waters	PG	178	172	LSU	69	75	91	76	62	39
Kevin Durant	SF / PF	208	240	Texas	98	86	80	75	73	51
Kyrie Irving	PG	188	193	Duke	94	83	85	88	64	49
Caris LeVert	SG / SF	198	204	Michigan	75	82	72	75	61	47
Spencer Dinwiddie	PG / SG	196	210	Colorado	66	76	82	88	59	41
Jarrett Allen	C	211	237	Texas	54	39	75	25	66	84
DeAndre Jordan	C	211	265	Texas A&M	25	25	65	25	66	89

Figure 4: All NBA Players and Attributes