

Exploring Gender & Ethnic Differences in Autism Diagnosis

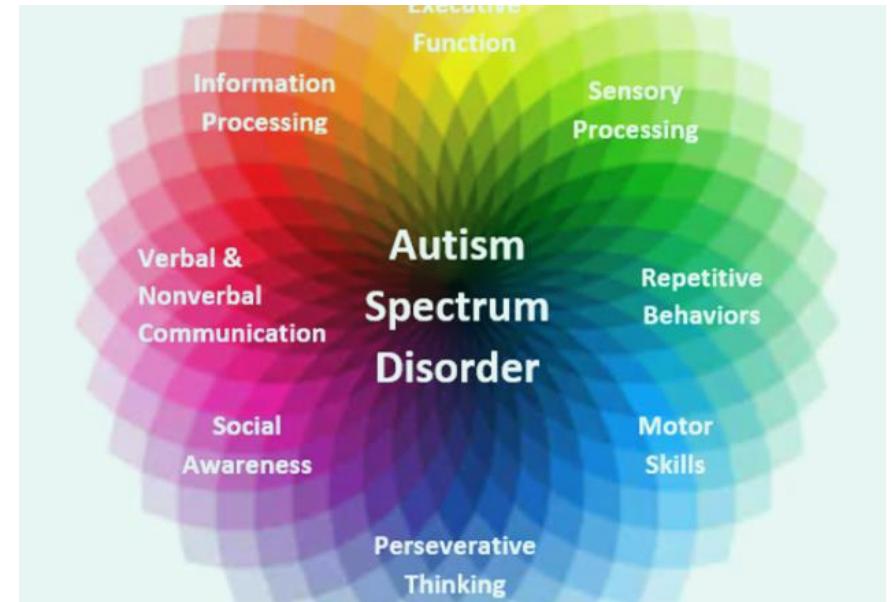
By: Chana Sherrington

Executive Summary:

Autism (ASD) is a neurological disorder that affects 1% of the world's population. Research on this disorder has not taken gender differences into account when creating screening assessments for autism. The purpose of this analysis is to determine whether ASD assessment responses differ between males and females, as well as ethnic groups, and whether we need to create curated assessments for autism diagnosis. The output of our analytical models showed that there are significant differences between male and female responses to autism assessments and further differences between ethnic groups. Clinical experts should therefore create specialized screening assessments that take these differences into account to improve diagnosis accuracy.

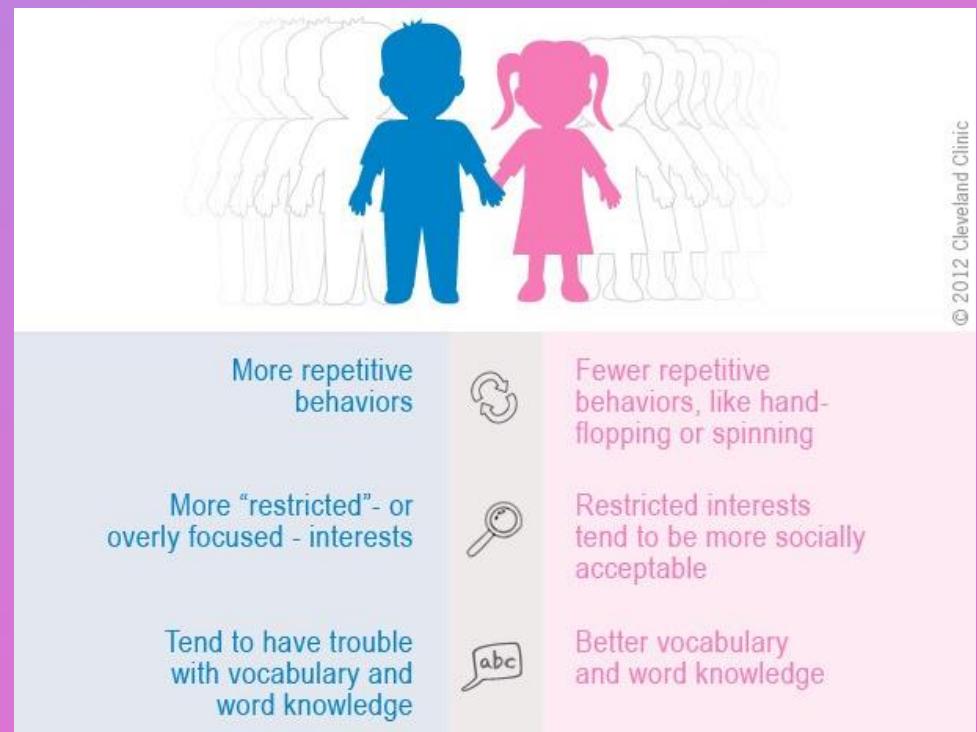
ASD is a neurological and Developmental Disorder:

Autism Spectrum Disorder (ASD) is characterized by difficulties in communication, learning, and social interaction, making it challenging for these individuals to navigate society. These difficulties are exacerbated if the individual is unaware of their disorder.



Women have been overlooked in ASD research:

Since 1938, clinical studies of autism have focused primarily on men. Recently it has been discovered that autism manifests differently in men and women and that many women with autism have been incorrectly diagnosed with depression, anxiety, or ADHD.



Analytical Objective:

This analysis aims to look for key differences between male and female responses to the AQ-10-Adult screening to determine whether it is necessary to develop more nuanced metrics for diagnosing autism that takes gender differences and ethnic differences into account. To this end we asked three questions:

- Which behaviors measured by the AQ-10-Adult are most indicative of ASD?
- Do females display different combinations of behaviors than males?
- If there are gender differences, can they be further differentiated by ethnicity?

The data for
this analysis
has been
collected from
the AQ-10

NHS
National Institute for
Health Research

AQ-10
Autism Spectrum Quotient (AQ)

A quick referral guide for adults with suspected autism who do not have a learning disability.

Please tick one option per question only:

		Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
1	I often notice small sounds when others do not				
2	I usually concentrate more on the whole picture, rather than the small details				
3	I find it easy to do more than one thing at once				
4	If there is an interruption, I can switch back to what I was doing very quickly				
5	I find it easy to 'read between the lines' when someone is talking to me				
6	I know how to tell if someone listening to me is getting bored				
7	When I'm reading a story I find it difficult to work out the characters' intentions				
8	I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant etc)				
9	I find it easy to work out what someone is thinking or feeling just by looking at their face				
10	I find it difficult to work out people's intentions				

This analysis uses the Autism Screening Dataset for Adults:

Attribute	Type	Role	Description
age	Number	Input	Age in years
age_desc	String	Rejected	Description of age category (18 and above)
gender	String	Input	Male or Female
ethnicity	String	Input	List of common ethnicities in text format
austim	Boolean (yes or no)	Input	Whether there is a history of ASD diagnosis in the family.
jundice	Boolean (yes or no)	Input	Whether the case was born with jaundice
Relation	String	Input	Who is competing the test (Parent, self, caregiver, medical staff, clinician ,etc.)
contry_of_residence	String	Input	List of countries in text format
Used_app_before	Boolean (yes or no)	Input	Whether the user has used a screening app
Question 1 Answer (A1_Score)	Binary (0, 1)	Input	I often notice small sounds when others do not
Question 2 Answer (A2_Score)	Binary (0, 1)	Input	I usually concentrate more on the whole picture, rather than the small details
Question 3 Answer (A3_Score)	Binary (0, 1)	Input	I find it easy to do more than one thing at once
Question 4 Answer (A4_Score)	Binary (0, 1)	Input	If there is an interruption, I can switch back to what I was doing very quickly
Question 5 Answer (A5_Score)	Binary (0, 1)	Input	I find it easy to 'read between the lines' when someone is talking to me
Question 6 Answer (A6_Score)	Binary (0, 1)	Input	I know how to tell if someone listening to me is getting bored
Question 7 Answer (A7_Score)	Binary (0, 1)	Input	When I'm reading a story I find it difficult to work out the characters' intentions
Question 8 Answer (A8_Score)	Binary (0, 1)	Input	I like to collect information about categories of things
Question 9 Answer (A9_Score)	Binary (0, 1)	Input	I find it easy to work out what someone is thinking or feeling just by looking at their face
Question 10 Answer (A10_Score)	Binary (0, 1)	Input	I find it difficult to work out people's intentions
Screening Score (Result)	Integer	Rejected	The final score obtained based on the scoring algorithm of the screening method used. This was computed in an automated manner. Score of 7+ generates 'YES' for target variable.
Class/ASD	String	Target	'YES' or 'NO' ASD Classification

This dataset is limited:

- Because the data has been collected from a mobile application it may not be representative of the whole population, since only those with the app are included in the dataset.
- We must also assume that all records in the dataset are unique, as there are no identification variables (e.g. name, email address).

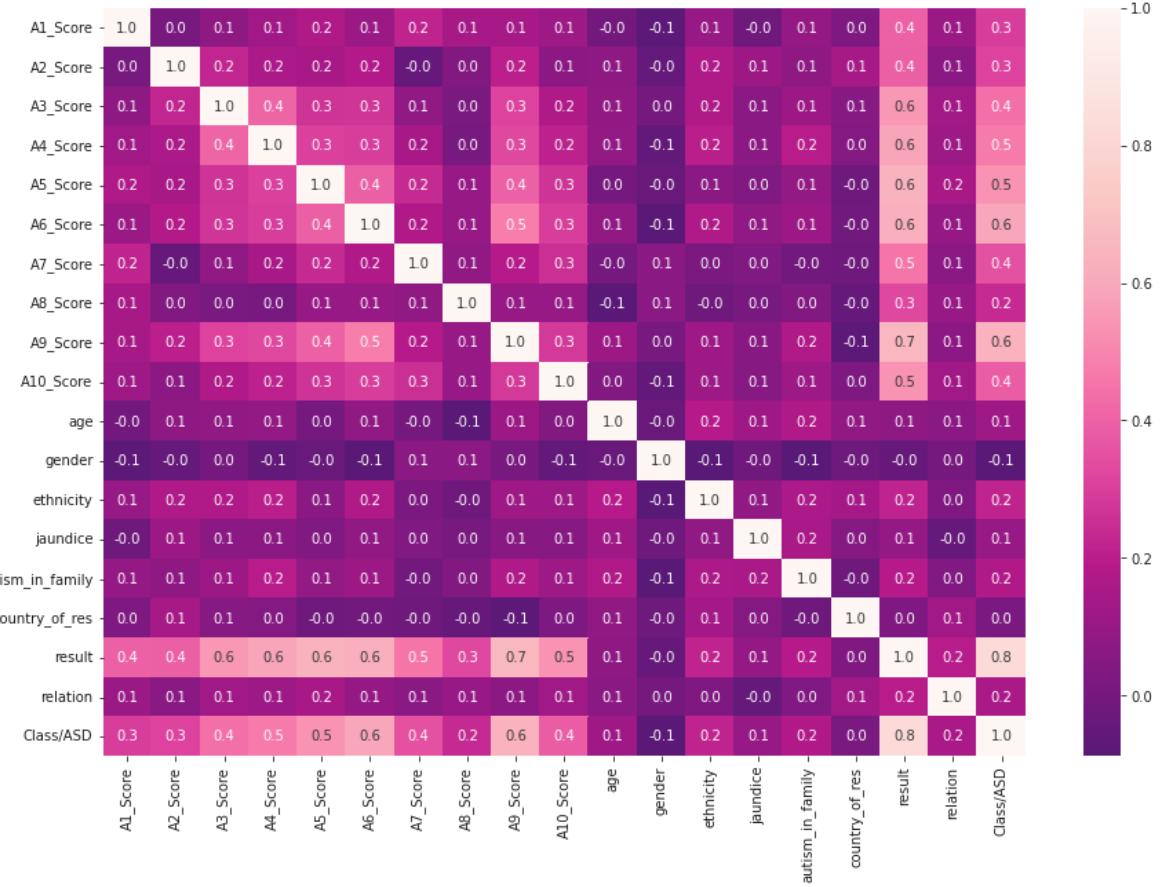
Analytical Process:

- Exploratory Data Analysis
- Analyze Male and Female subgroups
- Analyze Ethnic subgroups for Females
- Analyze Ethnic Subgroups for Males



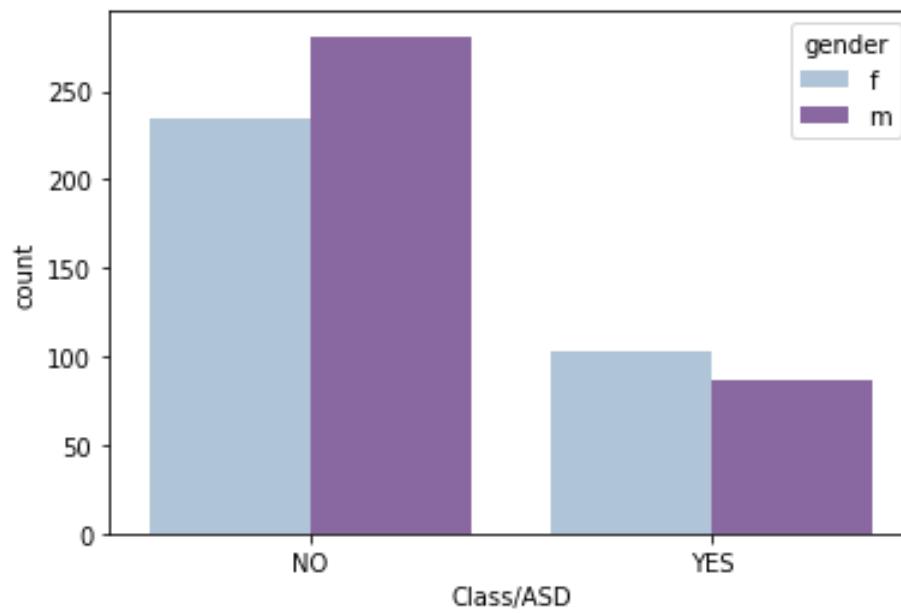
Exploratory Data Analysis:

As you would expect, _Score variables have the strongest correlation with the target. We can predict that A9_Score and A6_Score will appear as significant in our models.

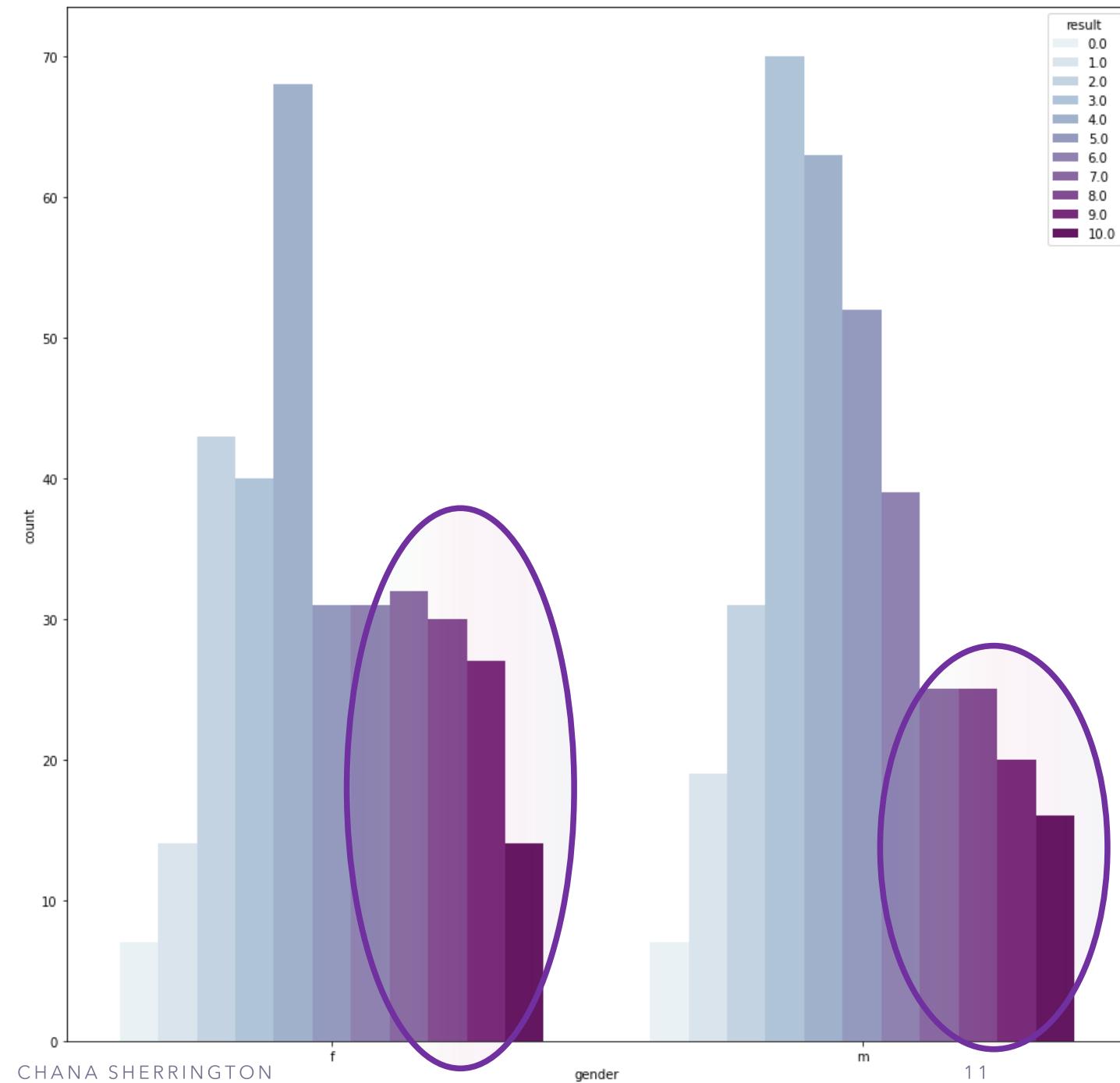


Exploratory Data Analysis of Gender Differences:

Out of the dataset records, 367 were Male and 337 were Female.

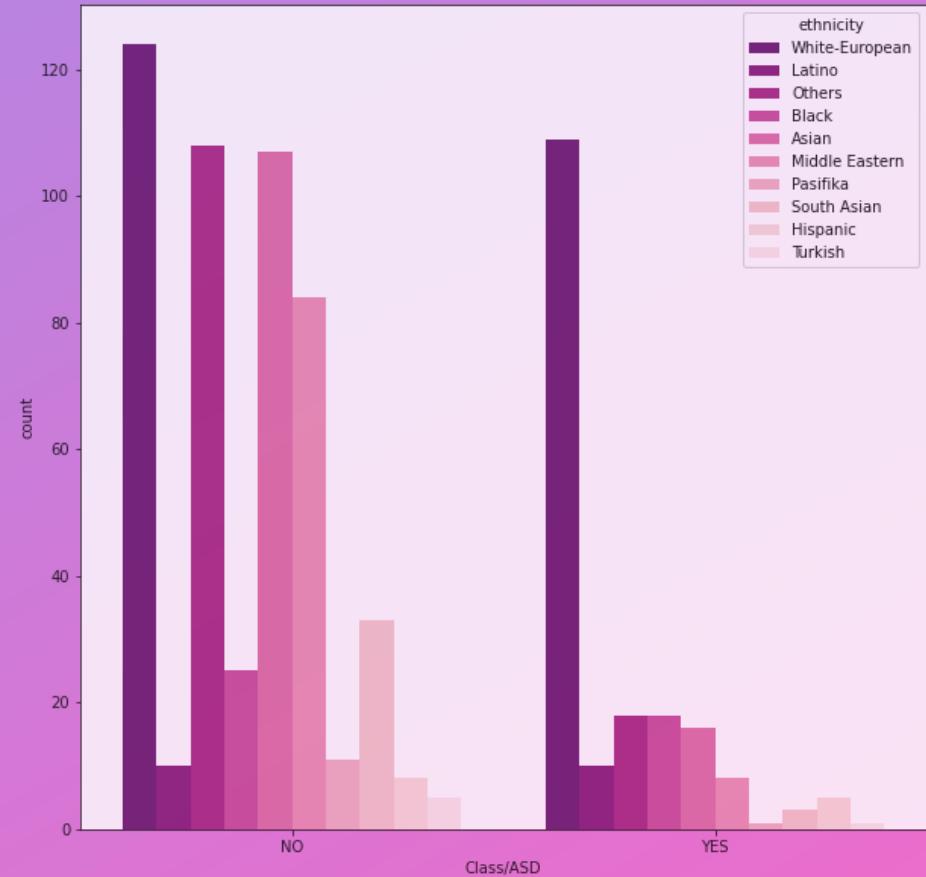


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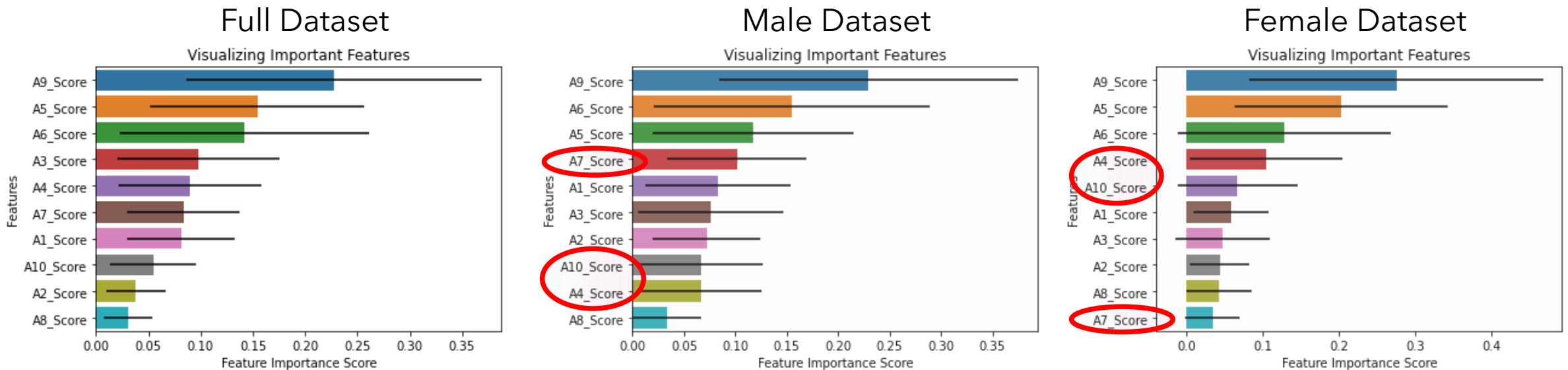
Exploratory Data Analysis of Ethnicity:

- Already we can see a discrepancy in ethnic representation in the dataset, with White-Europeans largely outnumbering the other groups.
- The 'Other' category may prove to have significant differences from the reported ethnic groups, requiring further investigation.



Neural Network is the best model for the Full Dataset and Male & Female Subgroups:

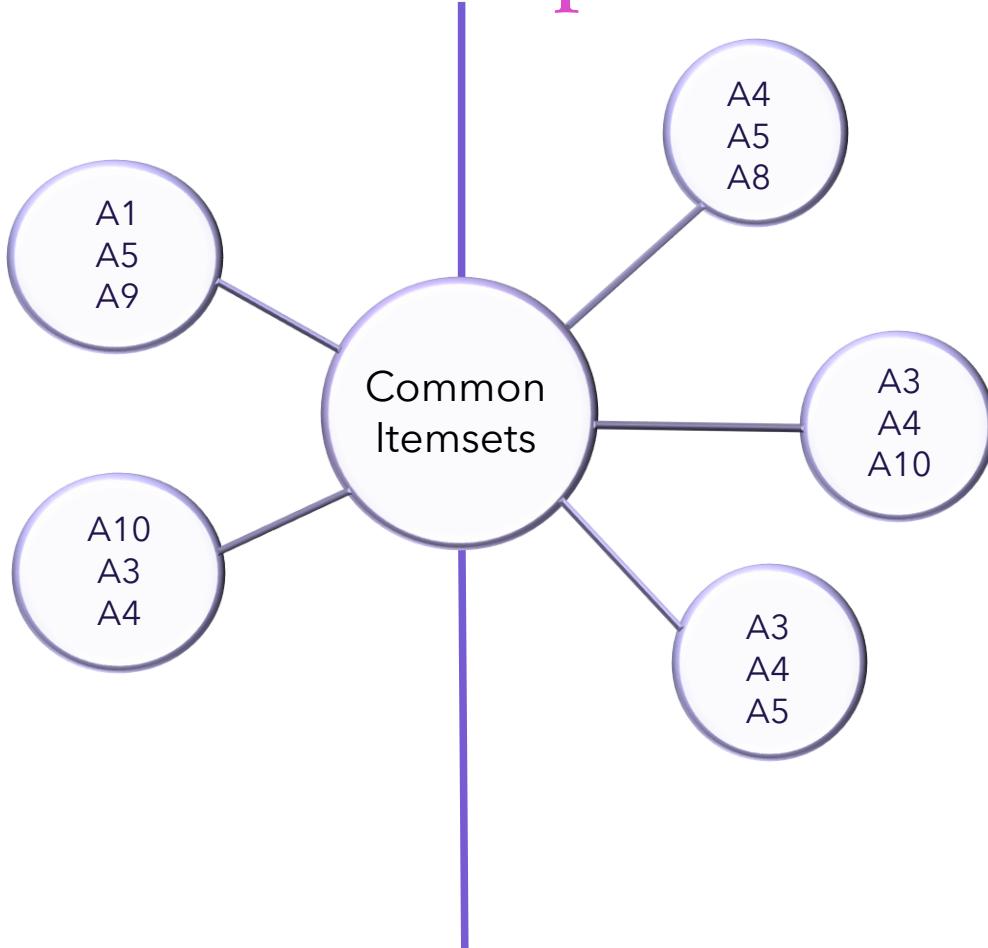
Datasets	Maximal Trees	Optimized Trees	Random Forest	Logistic Regression	Neural Network
Full Dataset	93.9%	93.2%	96.1%	96.8%	99.6%
Full Female	91.8%	85.2%	94.0%	93.3%	100.0%
Full Male	91.8%	91.8%	98.0%	98.6%	100.0%



There are key differences between Males and Female feature importance:

Common Groupings for Male and Female Questionnaire Responses:

Males



Females

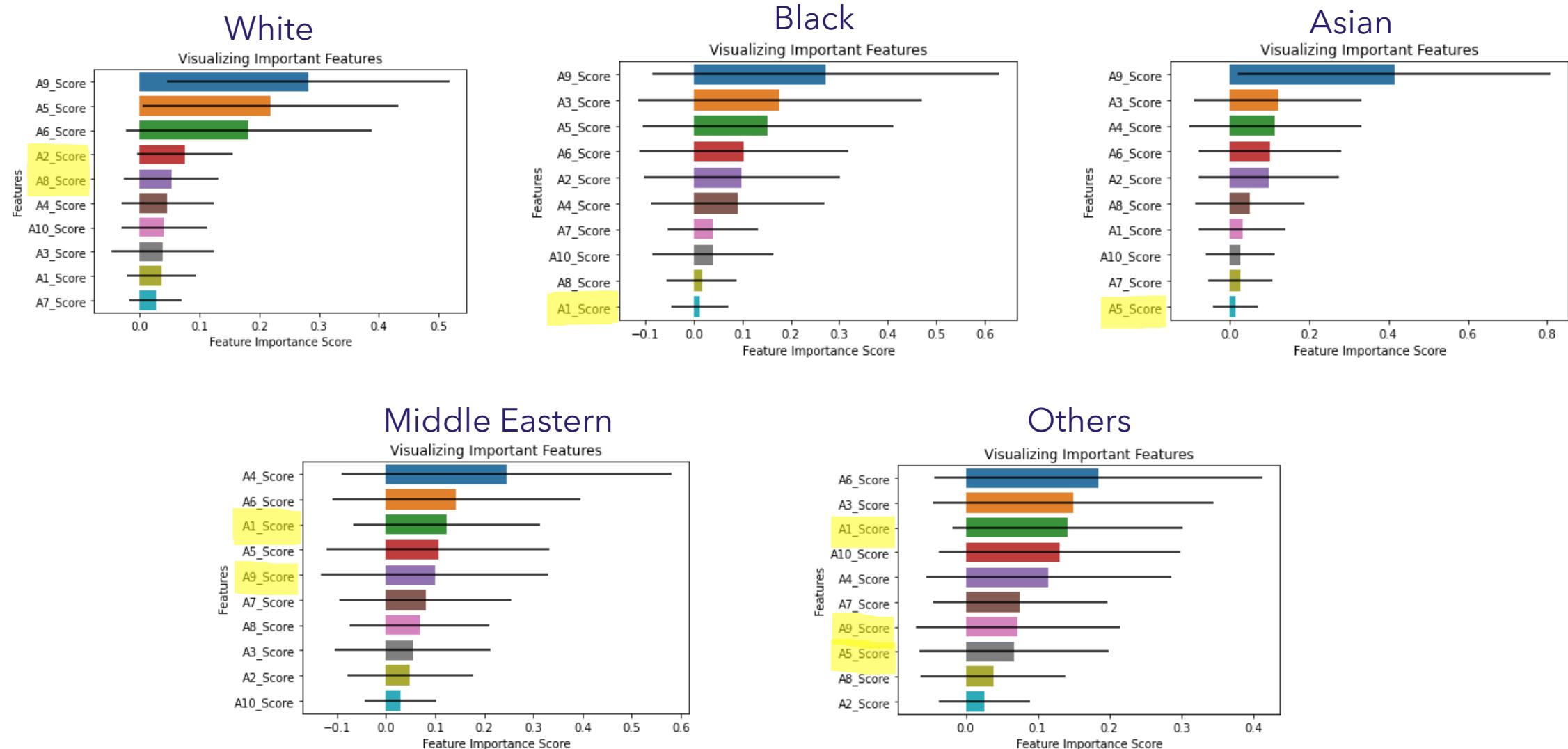
Response Key:

A1	Sensitivity to sounds
A2	Highly detail-oriented
A3	Inability to multitask
A4	Inability to handle interruptions
A5	Can't 'read between the lines'
A6	Inability to read moods
A7	Inability to understand the intentions of story characters
A8	Obsessed with collecting facts
A9	Inability to read facial expressions
A10	Difficulty understanding people's intentions

Random Forest is the best model for female ethnicity subgroups:

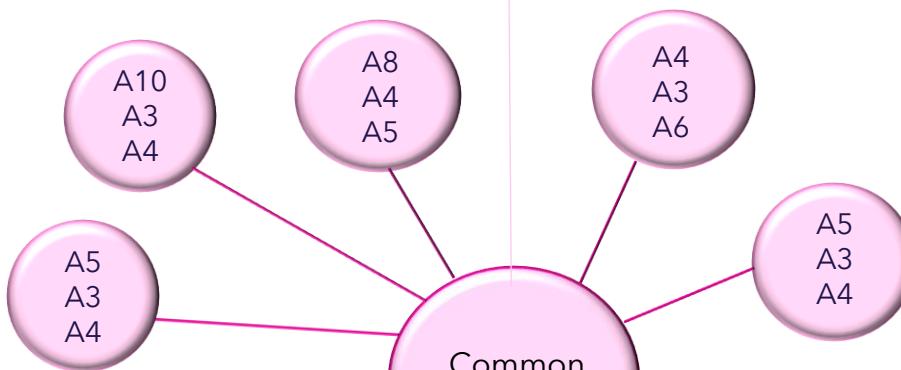
Datasets	Maximal Trees	Optimized Trees	Random Forest	Logistic Regression	Neural Network	Column2
White Female	88.0%	84.0%	92.0%	92.0%	92.0%	92.0%
Black Female	70.0%	70.0%	80.0%	80.0%	80.0%	80.0%
Asian Female	81.0%	81.0%	95.0%	81.0%	85.7%	95.0%
Middle Eastern Female	81.3%		100.0%	93.8%	93.8%	100.0%
Others Female	92.3%	88.0%	96.2%	96.2%	96.2%	96.2%

Important features for ethnic subgroups differ from the full female dataset and each other:

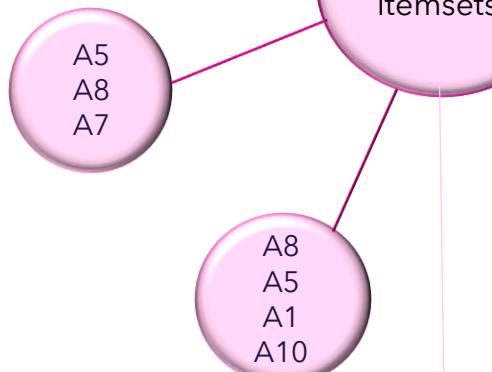


Common Groupings for Female Ethnic Groups Responses:

White & Black Females



Asian Females



Others

Middle Eastern Females



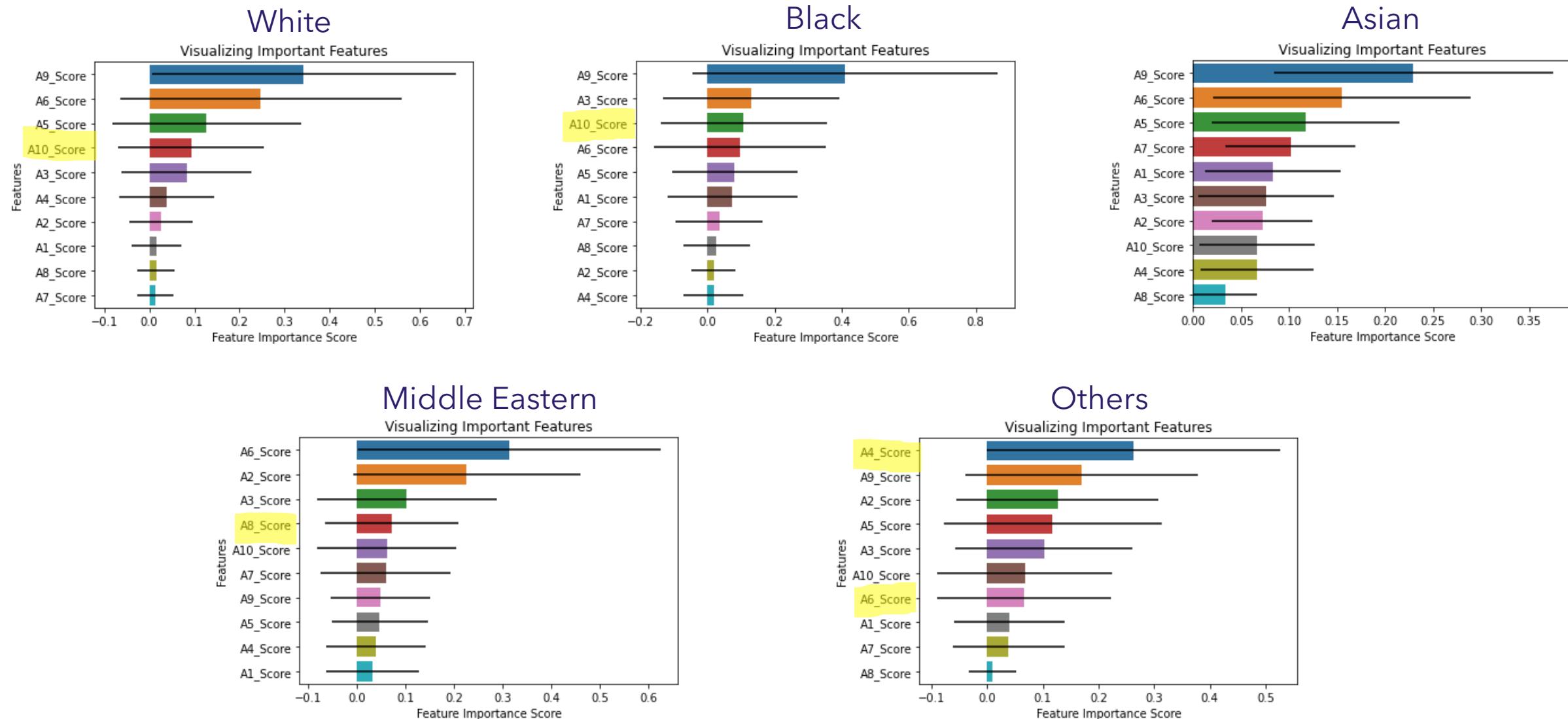
Response Key:

A1	Sensitivity to sounds
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Random Forest & Maximal Trees are the best models for Male ethnic subgroups:

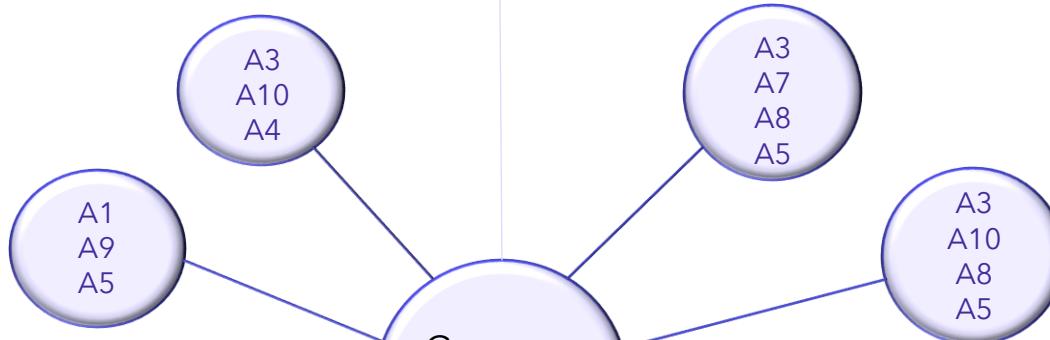
Column1	Maximal Trees	Optimized Trees	Random Forest	Logistic Regression	Neural Network
White Male	86.4%	84.0%	88.5%	84.1%	86.4%
Black Male	100.0%		100.0%	87.5%	87.5%
Asian Male	93.1%	89.7%	96.6%	93.1%	89.7%
Middle Eastern Male	95.5%	N/A	95.5%	95.5%	95.5%
Others Male	92.3%	N/A	84.6%	84.6%	88.5%

Important features for ethnic subgroups differ from the full male dataset and each other:



Common Groupings for Male Ethnic Groups Responses:

White & Black
Males



Others

Asian Males

Middle Eastern
Males

Response Key:

A1	Sensitivity to sounds
A2	Highly detail-oriented
A3	Inability to multitask
A4	Inability to handle interruptions
A5	Can't 'read between the lines'
A6	Inability to read moods
A7	Inability to understand the intentions of story characters
A8	Obsessed with collecting facts
A9	Inability to read facial expressions
A10	Difficulty understanding people's intentions

Summary of Findings:

The purpose of this analysis was to determine whether we can improve ASD screening by accounting for gender and ethnic differences in autistic behaviors. We have found that:

- Model accuracy improved when subgrouping the data by gender.
- Model accuracy for males tends to be higher than model accuracy for females.
- Feature importance differs between males and females.
- Questionnaire response itemsets differ for males and females.
- Feature importance differs between ethnic groups for both genders.
- Questionnaire response itemsets differ by ethnic group except for Black & White participants who share the same response associations.
- The 'Others' subgroup differs significantly from the other ethnic subgroups.

Recommendations:

- We recommend that clinical experts:
 - Expand their research on female manifestations of ASD.
 - Research the differences in ASD symptoms and behaviors for ethnic groups.
 - Create more nuanced screening assessments for ASD that are specialized for gender and ethnic groups.

Thank you

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