

Data Science Project: CryptoPunks

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1. Introduction

1.2 What are CryptoPunks?

CryptoPunks are 10,000 unique collectible characters with proof of ownership stored on the Ethereum blockchain created in June 2017.

They have created a digital art revolution and set a new standard for the collectibles industry for people that want to stand out and for investors since CryptoPunks are characterized by their rarity and non-fungible.

Originally anyone with an Ethereum account could claim them for free, but the 10,000 were quickly claimed. They must now be purchased from someone through the marketplace which is also integrated into the blockchain. Through this market you can buy, bid and offer punks for sale [1].

CryptoPunks are one of the first NFTs (non-fungible tokens) [2] in history, both outside and inside the Ethereum network. They symbolize the beginning of NFTs, and are therefore highly valued by some collectors (especially within the crypto world). They even have been auctioned at Christies, for example, which have made them very popular. Many celebrities, influencers, angel investors, key opinion leaders, poker stars and business leaders joined the bandwagon, driving prices up considerably [3].

1.2 Price evolution

Like all NFT's the value of CryptoPunks is very volatile and prone to speculative movements. Since November 2021, Ethereum has lost value against the dollar in a downward spiral and it's future evolution is uncertain.

The live Unicly CryptoPunks Collection price was on January 25, 2022 \$ 0.0326464 USD with a 24-hour trading volume of \$ 50,649.81 USD. Unicly CryptoPunks Collection was -4.03% in the last 24 hours. Unicly CryptoPunks Collection has a market cap of \$ 8,161,598.75 USD. It has a circulating supply of \$ 250,000,000.00 UPUNK coins and a max supply of \$ 250,000,000.00 UPUNK coins [4].



Figure 1. Year evolution CryptoPunks price [4].

Although this market has experienced a reduction of its value, it is still active and there are around 20 transactions every day.



Figure 2. CryptoPunk activity during the last 90 days [5].

Currently overall statistics are as follow [1]:

- Current Lowest Price Punk Available 79.95 ETH (\$191,596.17 USD)
- Number of Sales (Last 12 Months) 12,111
- Total Value of All Sales (Lifetime) 668.39KΞ (\$1.97B)
- Value of Sales (24 Hours) 1.96KΞ (\$4.74M)
- Value of Sales (Week) 20.44KΞ (\$50.26M)
- Value of Sales (4 Weeks) 36.24KΞ (\$103.51M)

In many cases, the interest of the investor is not purely as a financial investment but collectionist, because CryptoPunks has been the first market of this kind.

1.3 Objectives of this study and tasks done

The **objective** of this study requested by the client is to analyze the CryptoPunks market to identify possible investment opportunities.

The following **tasks** have been carried out in the study:

- Obtaining data by scraping the web [2]. The following data has been obtained:
 - Number, characteristics, current owner, if it is for sale or not, and if there are any purchase bids, as well as the transaction history of each Cryptopunk. After cleaning, the data was loaded into a database for further analysis.
 - Tables on types and attributes of the CryptoPunks with the summary information of attributes, number of CryptoPunks with the attribute, their availability, the average sale price in the last 90 days, the price of the cheapest one for sale. The data has been loaded into an Excel. In addition to the usefulness of having the summary information, it has served us as a qualitative control of the results obtained from the database.
- Data analysis: a descriptive exploration analysis (means, variances, standard deviations, distributions, outlier analysis, etc.) has been carried out, emphasizing the observed trends.
- Application of Machine Learning methods through which one or more algorithms learn from existing data to perform CryptoPunks clustering tasks, as well as for regressions to determine trends in sales and purchases.
- Drafting of conclusions and recommendations for the client.

1.4 Conclusions

CryptoPunks are 10,000 unique collectible characters with proof of ownership stored on the Ethereum blockchain and are therefore highly valued by some collectors and investors.

The value of CryptoPunks is very volatile and prone to speculative movements. Since November 2021, Ethereum has lost value against the dollar in a downward spiral and its future evolution is uncertain, but it's an active market.

The objective of this study is to analyze the CryptoPunks market to identify possible investment opportunities. For this, we obtained data by scraping the web, realized a descriptive exploration analysis of the data, applied Machine Learning methods and other statistical analysis to draw conclusions and recommendations for the client.

2. Data gathering

2.1 Data gathering methods

The data of the web has been obtained with web scraping techniques through an ad hoc program retrieving information of interest and saving it into a MySQL database. We have used: Pandas, Beautiful Soup, Selenium, MySQL and Excel.

The structure of the database is as follows:

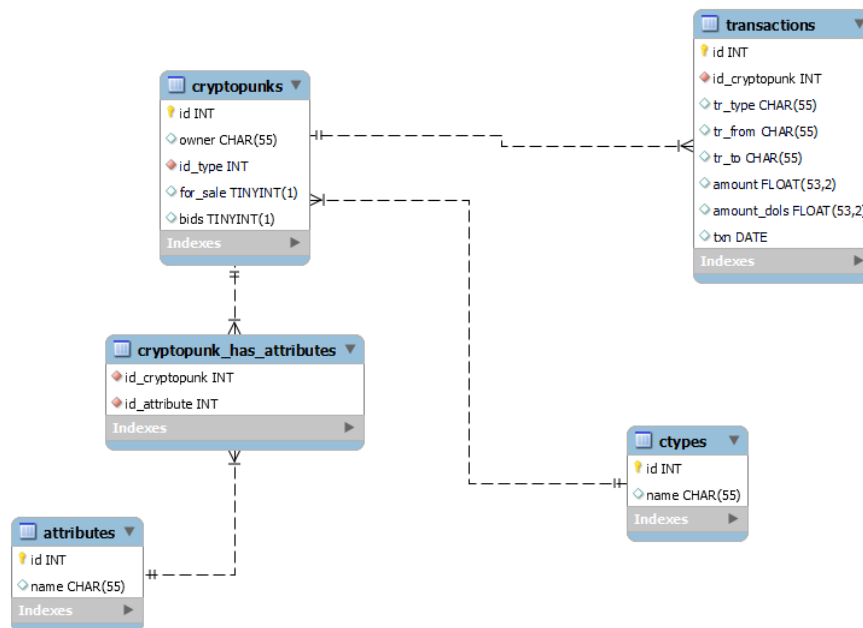


Figure 3. Database ERD Diagram

An Excel created by scraping summarizes part of the information of interest (sample):

Tipos					
	Attribute	#	Avail	Avg Sale	Cheapest
0	Alien	9	3	0	23000
1	Ape	24	3	2500	4160
2	Zombie	88	4	900	1380
3	Female	3840	510	403	68
4	Male	6039	851	88	73
Atributos					
	Attribute	#	Avail	Avg Sale	Cheapest
0	Beanie	44	9	349	350
1	Choker	48	11	121	140
2	Pilot Helmet	54	11	143	225
3	Tiara	55	5	120	170
4	Orange Side	68	15	116	109

Figure 4. Excel sample. Data summary.

2.2 Data processing

Data was taken out from the database in multiple formats, depending on the task at hand. We roughly had a dataframe for CryptoPunks and another for transactions, and we were constantly merging the tables and adding new columns.

For general statistics we used whole tables, but for the regressions and clusterings we left out outliers. There are very few sales for very big amounts, and this data distorted the results.

Many CryptoPunks were never sold after the first claim. We didn't take them into account in the machine learning algorithms. We believe they don't add any information.

2.3 Conclusions

We gathered more information that we finally used, as for example the owner of the cryptopunk or the bid transactions. At this point we weren't sure if they would prove useful.

The gathering process was checked in different ways because wrong data would have ruined our work. The final database schema was proven useful because we could get all the information needed in the analysis.

3. Data analysis

3.1 Distribution of CryptoPunks by type, attributes and number of attributes

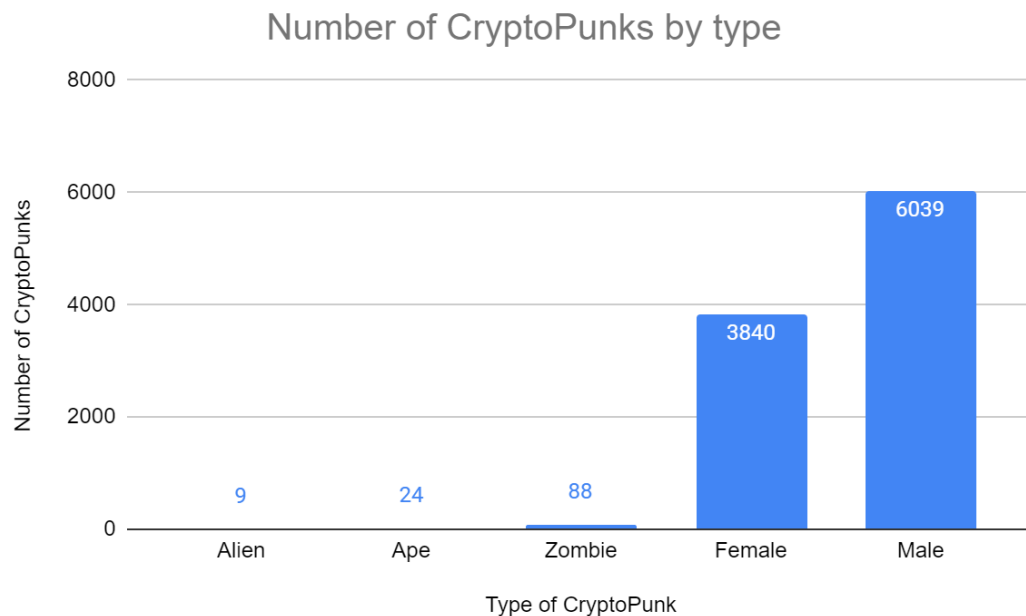


Figure 5. Number of CryptoPunks by type.

There are 10.000 CryptoPunks and the most frequent types are Male and Female. The less frequent are Alien, Ape and Zombie, which make them more desired, and thus, more valuable.

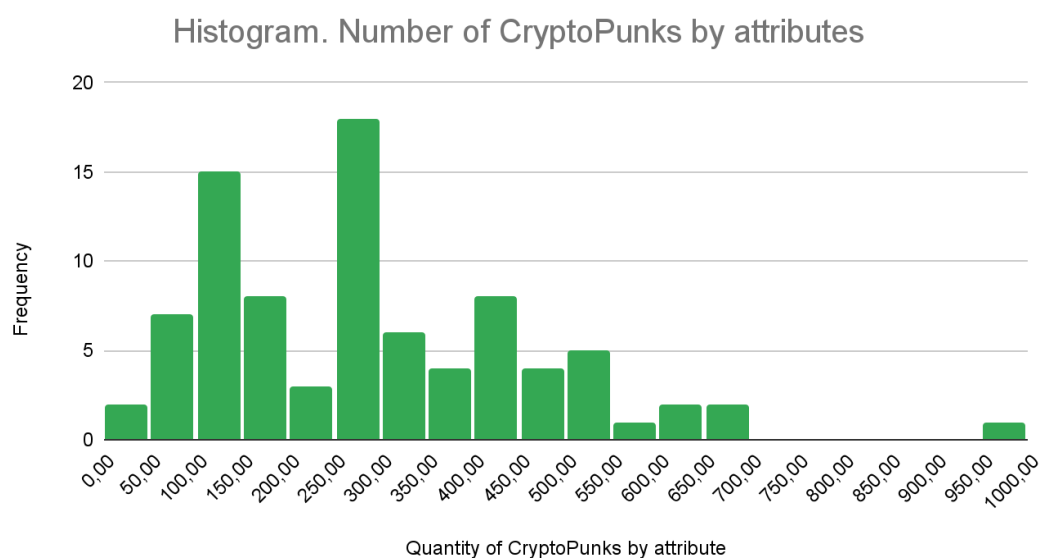


Figure 6. Histogram. Number of CryptoPunks by attribute.

There are 87 different attributes which are not evenly distributed among different CryptoPunks. For example, the attribute Beany is only present in 44 of the punks, but Earring is in 2459 of them. The most frequent distribution is an attribute that is in 250-300 punks.

There are also a few CryptoPunks with no attributes.

Table 1. Attributes present in less number of CryptoPunks (sample)

Nº	Attribute	Quantity	Availability for sale	Average sale price (90 days)	Cheapest for sale	% Availability for sale over total
1	Beanie	44	9	349	350	20%
2	Choker	48	11	121	140	23%
3	Pilot Helmet	54	11	143	225	20%
4	Tiara	55	5	120	170	9%
5	Orange Side	68	15	116	109	22%
6	Buck Teeth	78	18	97	89	23%
7	Welding Goggles	86	13	95	88	15%
8	Pigtails	94	20	115	90	21%
9	Pink With Hat	95	13	154	139	14%
10	Top Hat	115	31	228	140	27%

As a general rule, the lower the number of CryptoPunks an attribute has, the higher the sale price, according to the rule of offer and demand. There are significant exceptions, like Black Lipstick, for example, with much higher prices than expected. This is because when an owner offers a punk for sale the logic of the offer many times is not recognisable or it is purely arbitrary.

Table 2. Attributes with a higher number of CryptoPunks

Nº	Attribute	Quantity	Availability for sale	Average sale price (90 days)	Cheapest for sale	% Availability for sale over total
77	Shadow Beard	526	63	92	90	12%
78	Regular Shades	527	86	87	72	16%

79	Horned Rim Glasses	535	72	83	72	13%
80	Big Shades	535	74	92	69	14%
81	Nerd Glasses	572	61	90	77	11%
82	Black Lipstick	617	82	1620	68	13%
83	Mole	644	89	79	69	14%
84	Purple Lipstick	655	87	81	70	13%
85	Hot Lipstick	696	89	66	69	13%
86	Cigarette	961	144	90	73	15%
87	Earring	2459	338	81	69	14%

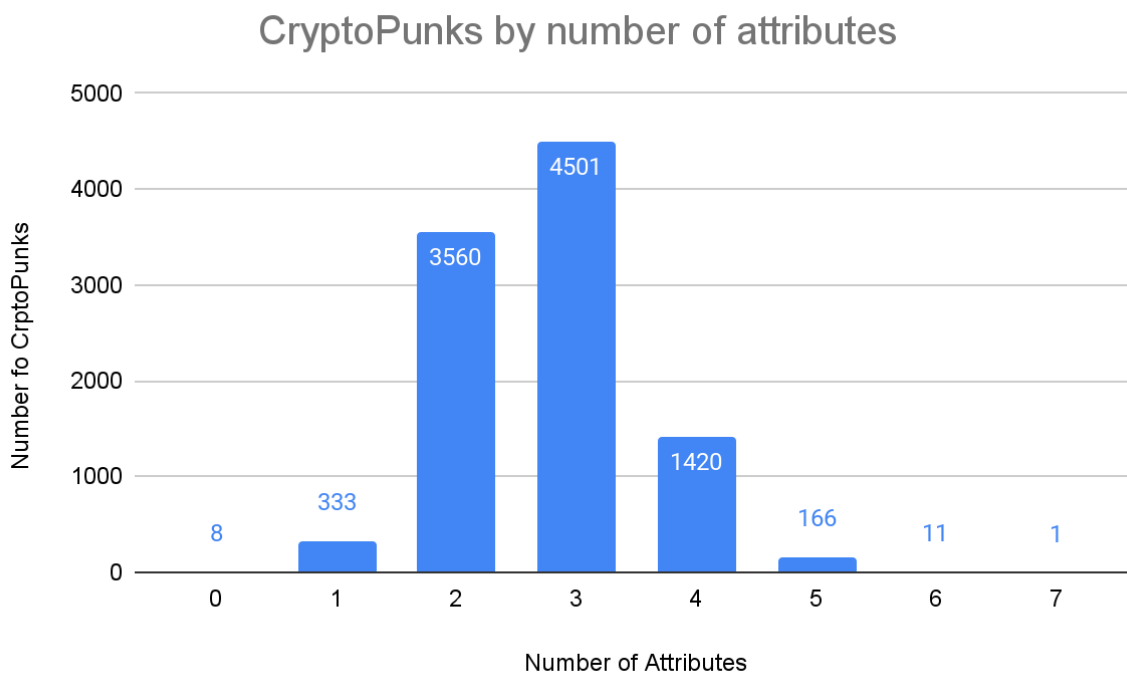


Figure 7. Number of CryptoPunks by number of attributes.

Most of the CryptoPunks have 2 or 3 attributes. There is only one punk with 7 attributes and 8 with none.

3.2 Availability for sale of CryptoPunks by type, attributes and number of attributes

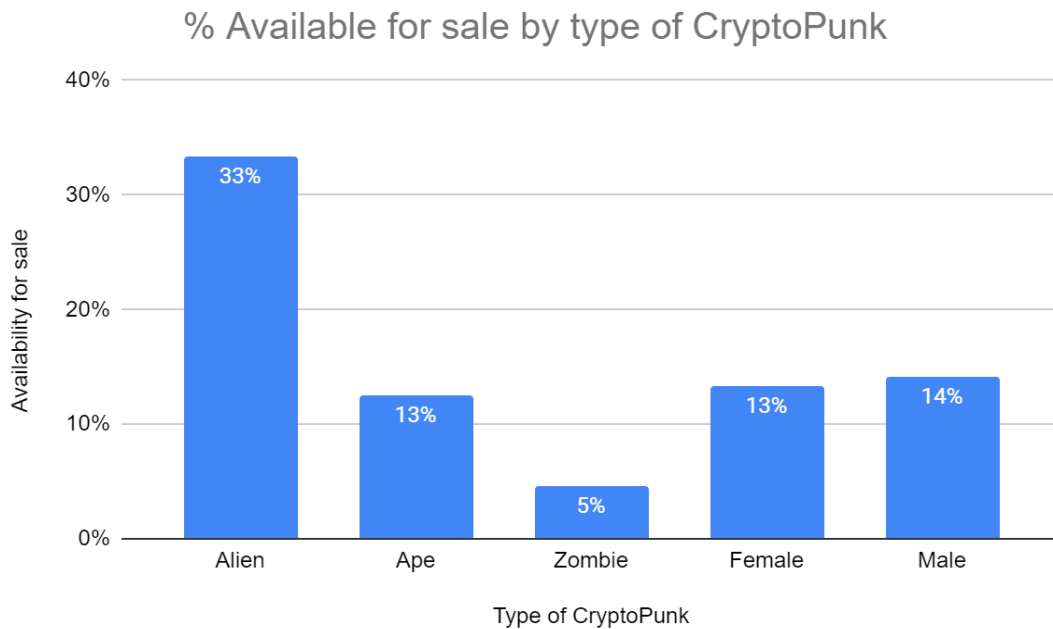


Figure 8. % Availability for sale by type of CryptoPunk.

On average, 14% of CkryptoPunks are on sale, but only 5% of Zombie type, which is a sign of popularity, and 33% of Alien, due to their high price.

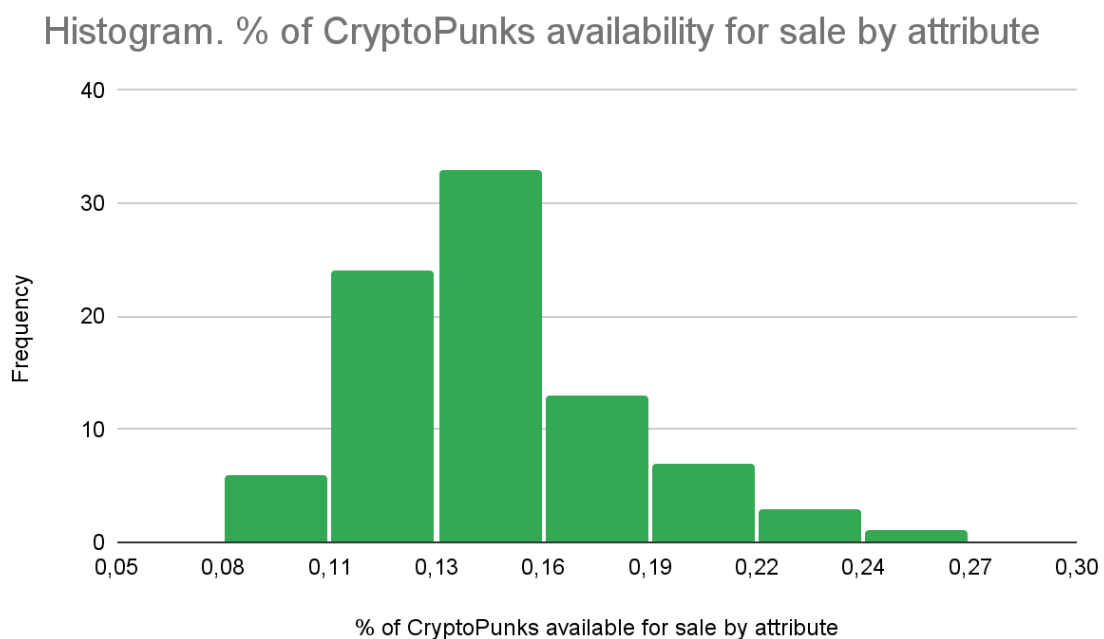


Figure 9. Histogram. % of CryptoPunks availability for sale by attribute.

As we can see in the histogram in Figure 9, most of the CryptoPunks with attributes are available for sale between 11% and 19% of the total. Thus, some CryptoPunks with certain attributes are not available for sale.

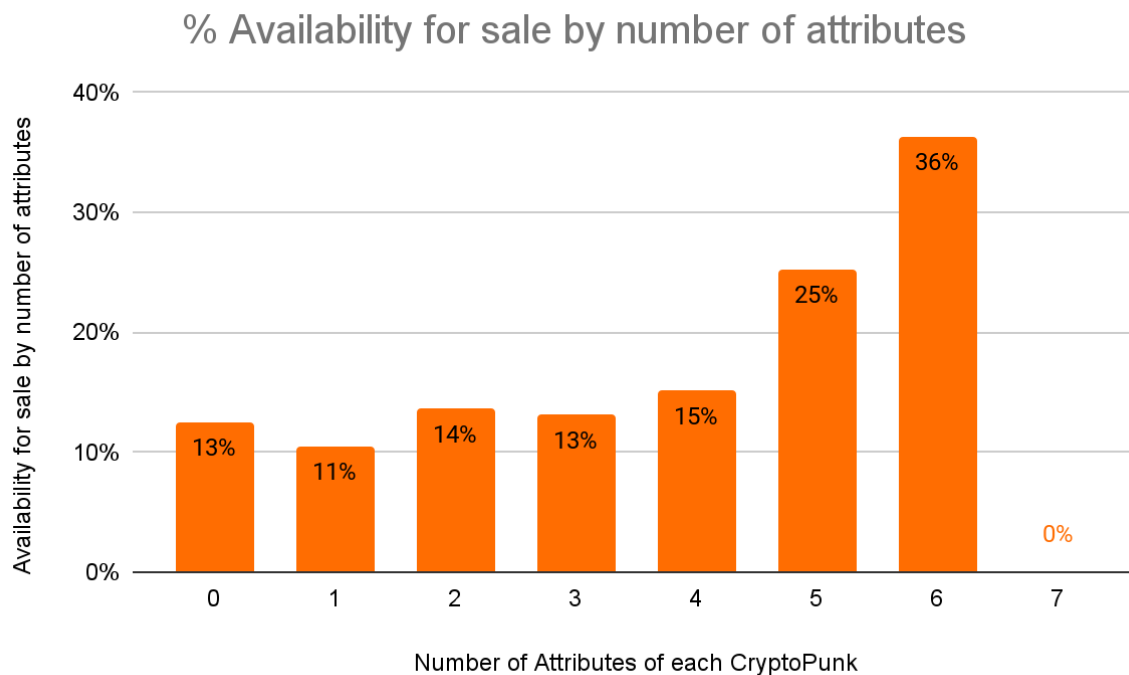


Figure 10. % Availability for sale by number of attributes.

The number of attributes also affect the availability for sale. The only punks with 7 attributes are not available and only 11% of the total punks with 1 attribute.

3.3 Average sale price over the last 90 days and cheapest CryptoPunk by type, attributes and number of attributes

We've noticed that, especially in the last months, there are a number of offers and sales for a value of 0 Ethers. We understand this is an activity going on outside the standard market, and we decided not to take this operations into account.

This kind of operations have started in the last months and are mostly concentrated in a few dates, as we can see in the figure:

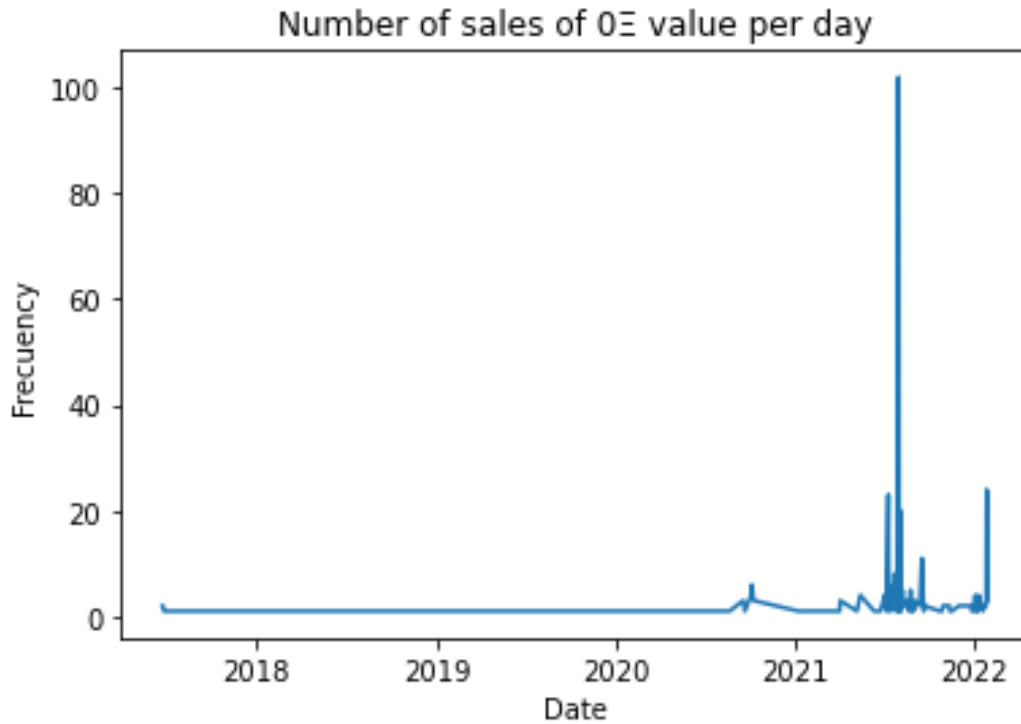


Figure 11. Number of sales of 0 Ethereum per day.

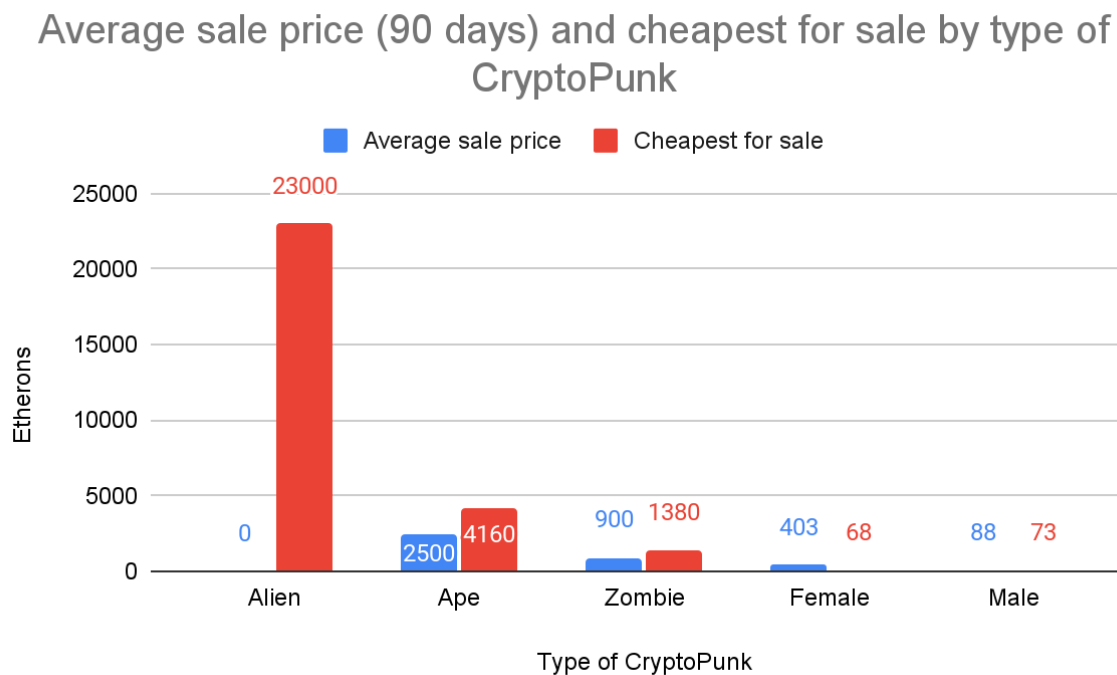


Figure 11. Average sale price (90 days) and cheapest for sale by type of CryptoPunk.

If the average sale price in the last 90 days is superior to the cheapest for sale by type could be a signal of an opportunity for a good investment.

The most frequent sale price by attribute is between 75 and 100 Etherons.

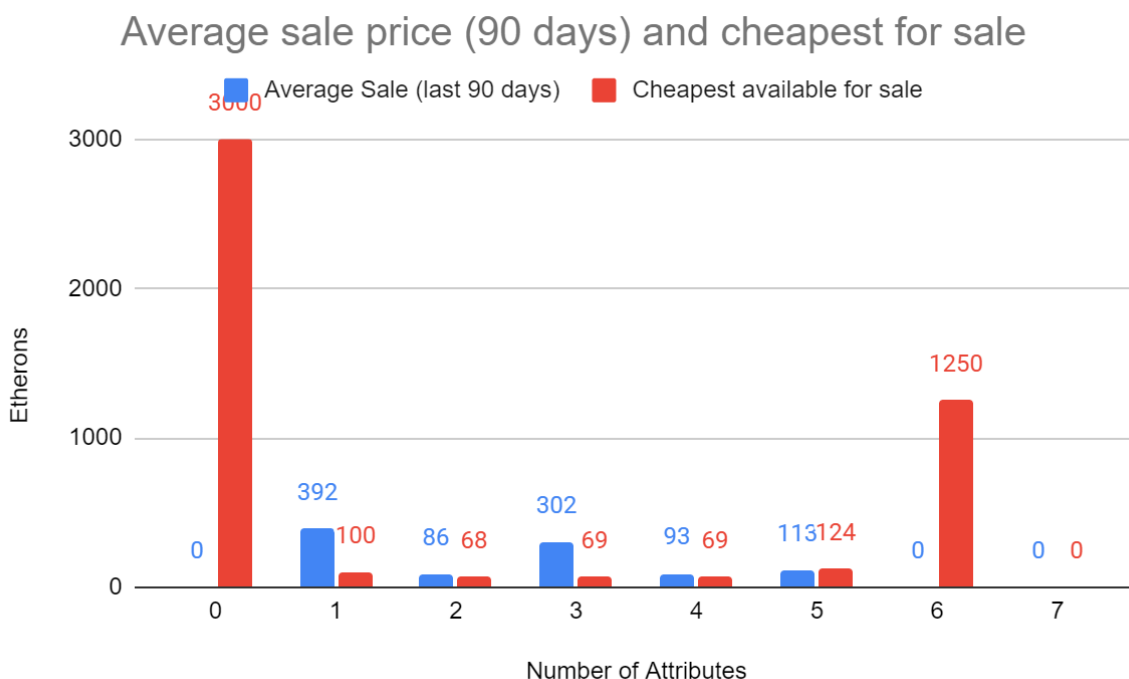


Figure 12. Histogram. CryptoPunk average sale price (90 days) by attributes.

The number of attributes could be an additional information to detect investment opportunities. There are CryptoPunks cheaper than the average sale price in the last 90 days, as we can see in Figure 12. For example the average sale for CryptoPunks with 3 attributes is much higher than the cheapest CryptoPunk available at the moment.

3.4 Average sale price by type and attribute, in USA Dollars

There are attributes that are specific of a type and others that are more common. This is why, for example, Beanie and Luxurious Beard have a high price and are found only in Male type.

On the other hand, attributes such as Bandana have a very high price in Alien but a much lower price in Male. This is due to the low number of Alien punks, which render them very valuable regardless if they have an attribute or another.

So the value of a CryptoPunk is a combination of the type of punk and certain attributes.

For more detailed information, see in Annex “Table 1. Average sale price by type and attribute, in USA Dollars” and “Table 2. Average sale price by type and attribute, in USA Dollars: Alien, Ape, Zombie, Female, Male”.

3.4 Sales statistics

3.4.1 Statistic Summary of sales

Table 3. Statistic Summary of sales

Number of sales	20.036
	USA Dollars
Mean of sale	98.258
Standard Deviation	206.359
Min.	1
25%	706
50%	36.165
75%	108.557
Max.	10.260.000

We have recorded more than 20.000 transactions with an average value of more than 98.000 USA Dollars. As commented before, we have not taken into account the sales of 0 dollars because they don't reflect the real market value and we don't know the reason for this kind of transactions.

The standard deviation is very high since it's a market with a high level of volatility. As we can see in Table 3, there are sales from one dollar to more than ten millions. The most frequent sale is about 36.000 dollars.

Table 4. Total sold by type

Type	USA Dollars
Alien	15.939.723,00
Ape	24.513.635,00
Female	642.535.304,00
Male	1.237.137.169,00
Zombie	48.574.956,00
Suma total	1.968.700.787,00

Although types such as Alien, Ape and Zombie have the most expensive punks, their scarcity and their collectable nature reduce the number and amount of total sales. On the contrary, types such as Male and Female, which make the brunt of punks, are the ones that register more transactions (Table 4).

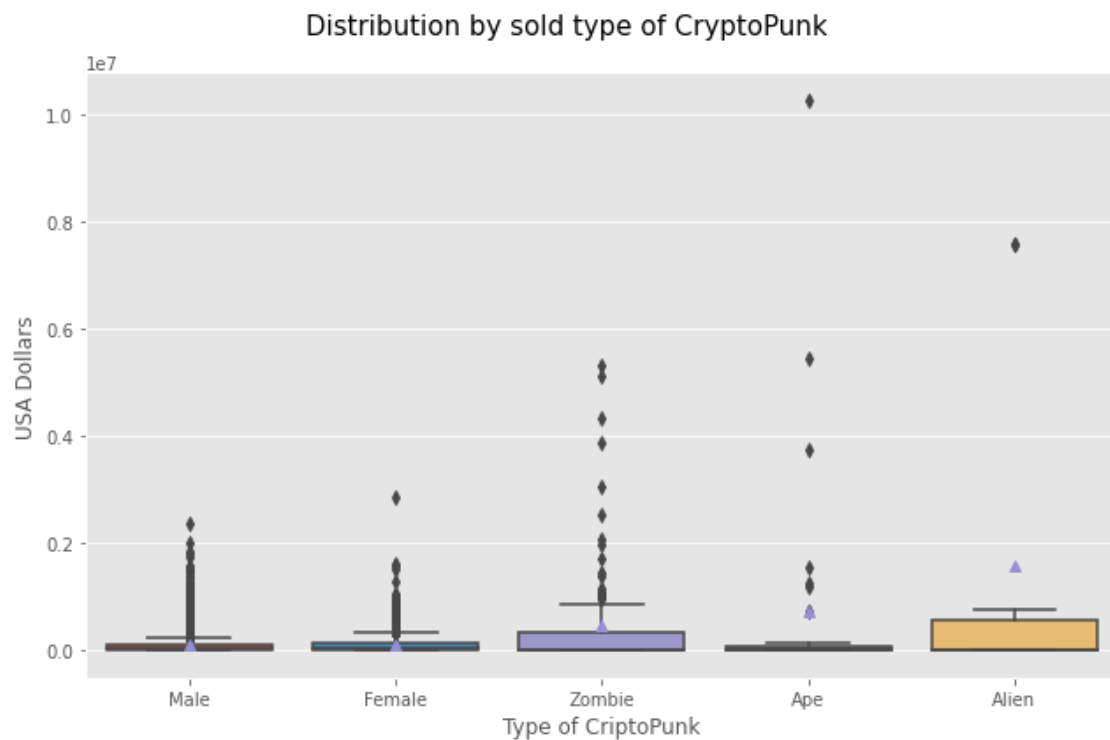


Figure 13. Distribution by sold type of CryptoPunk.

Zombie CryptoPunks have larger numbers of outliers, but in Ape and Alien these are more extreme due to their popularity.

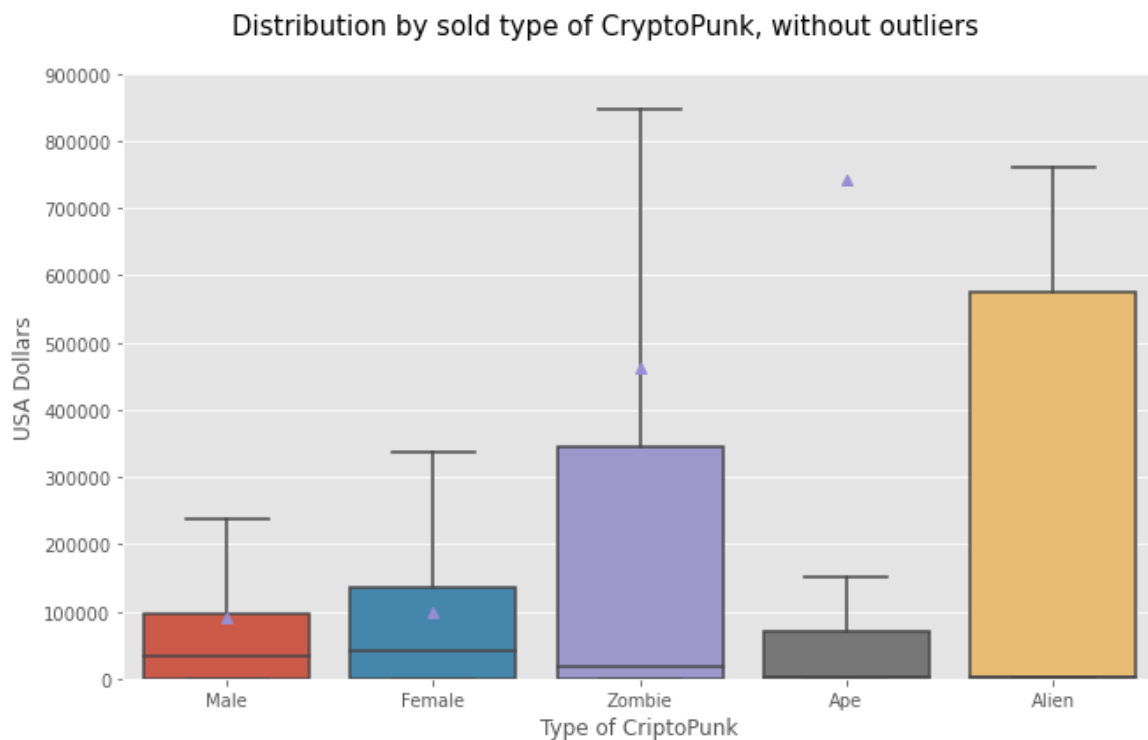


Figure 14. Distribution by sold type of CryptoPunk, without outliers.

The average sold punk (lila triangle in Figure 14) is higher in Alien, followed by Ape and Zombie, being similar for Female and Male.

The dispersion of prices (main box in Figure 14) between percentil 25% (prices equal to the 25% or inferior) and 75% in Alien and Zombie. The lowest is with Ape which has lesser variability in prices, though it has the largest outlier among other types with a CryptoPunk sold for 10,3 million dollars.

For more detailed information, see in Annex “Table 5. Statistic summary price by type of CryptoPunk, in USA Dollars: Alien, Ape, Zombie, Female, Male”.

3.4.2 Sales evolution by type

From november 2021 onwards the number of transactions and their value rocketed with some of the early owners reaping their benefits. Many, instead, choose to keep their ownership due to the collectable nature of these tokens or because they expect higher prices in the future.

The main reason for the increase of transactions is due to the fall of the exchange rate between Ethereum and dollar or euro. The investors have preferred to sell before the value of their CryptoPunks in hard currency falls even further, which is more clear in punks of Male and Female type.

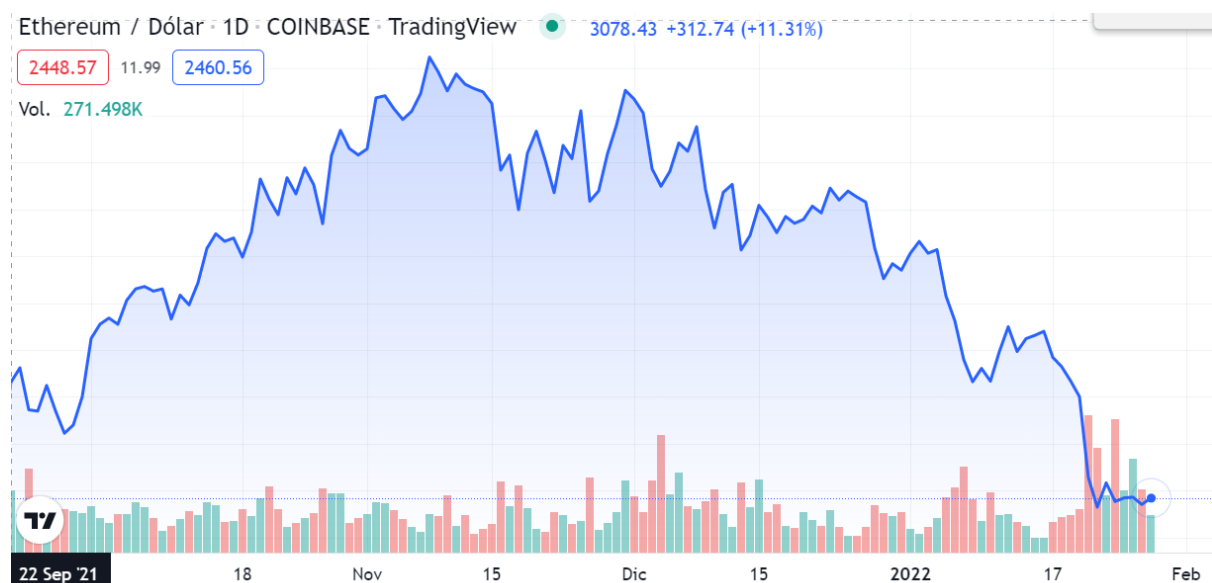


Figure 15. Ethereum/ Dollar trading [6].

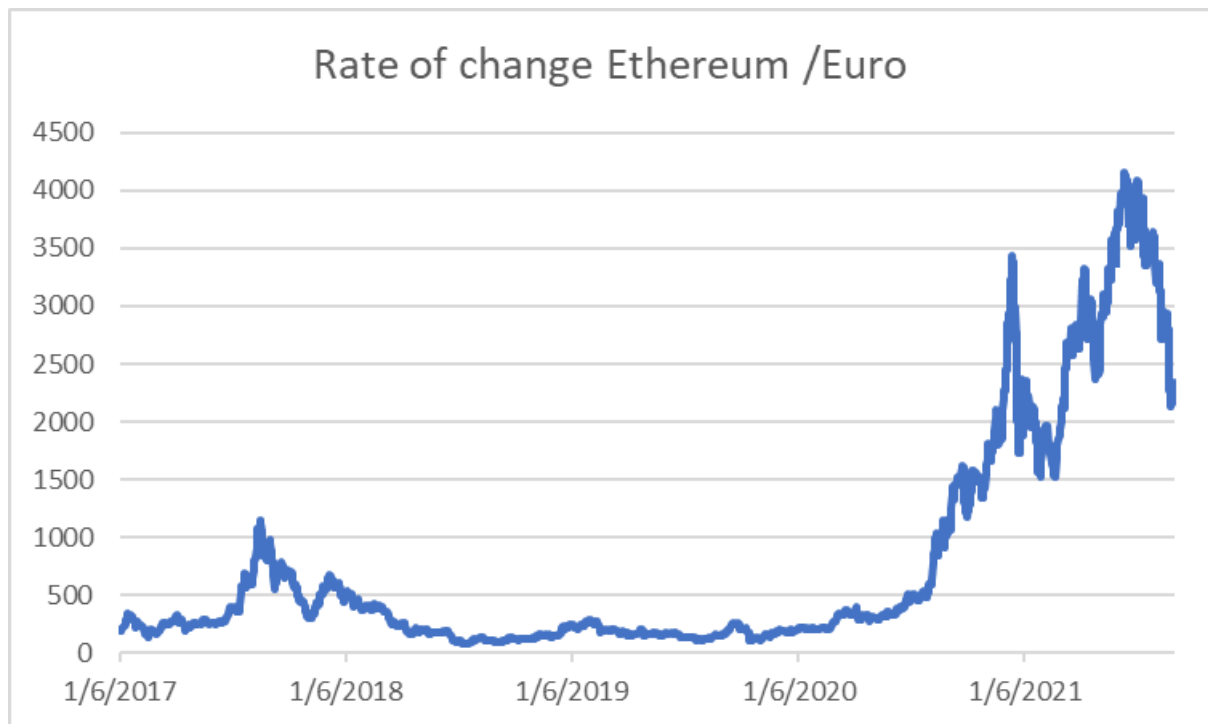


Figure 16. Ethereum/ Euro trading [5].

In Figure 17 we get an idea of the density of transactions per month, and also the values paid for punks. We enumerated the months, starting with 1 for January 2017. We see that transactions have increased a lot in the last 12 months, in the number of sales and in value in Ethers. August 2021 (month 56) was the busiest.

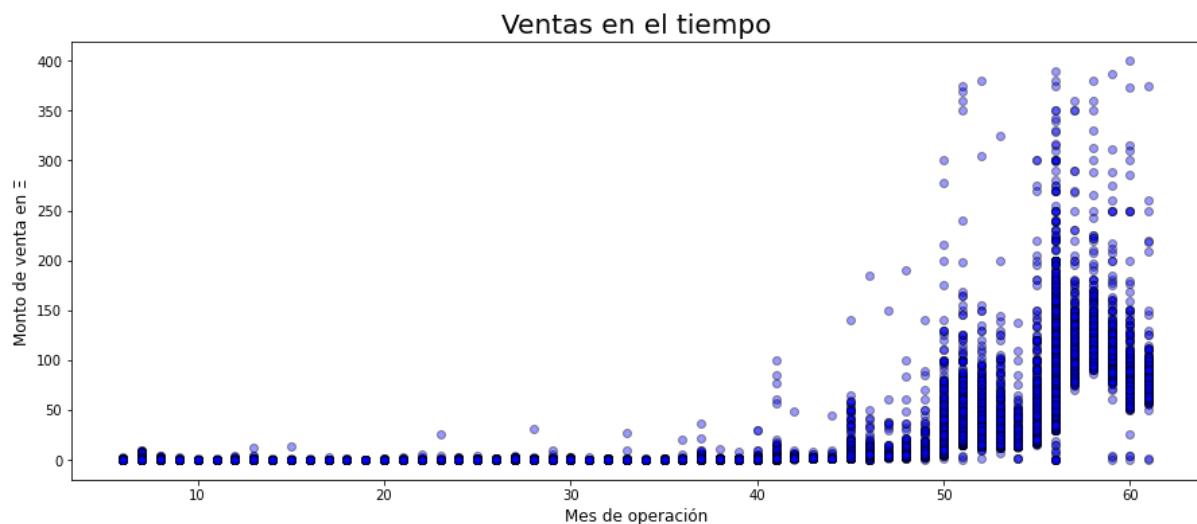


Figure 17. Sales amounts, in Ethers, per month

We can see that all types of CryptoPunks have increased the values in dollars for their sales in the last months.

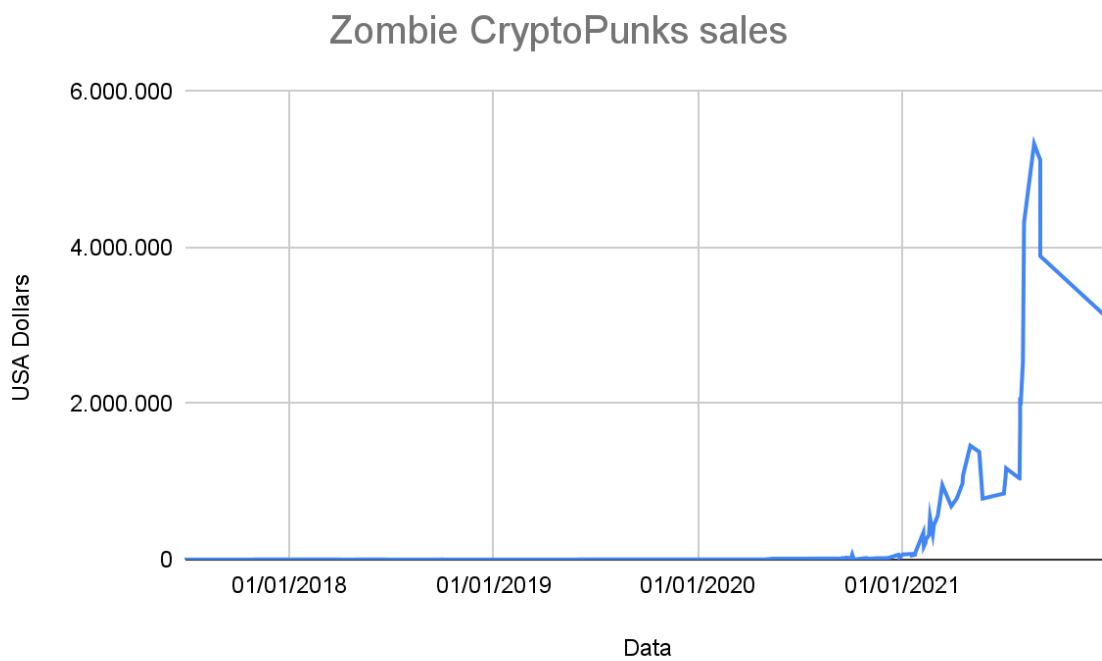


Figure 18. Zombie CryptoPunks sales.

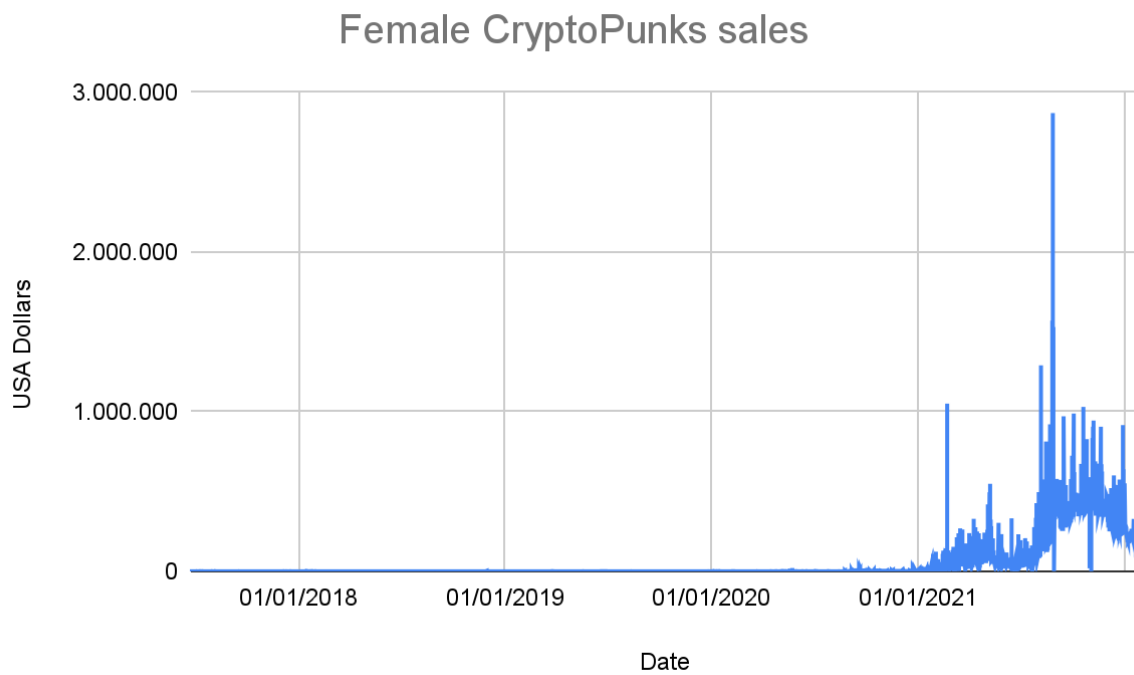


Figure 19. Female CryptoPunks sales.

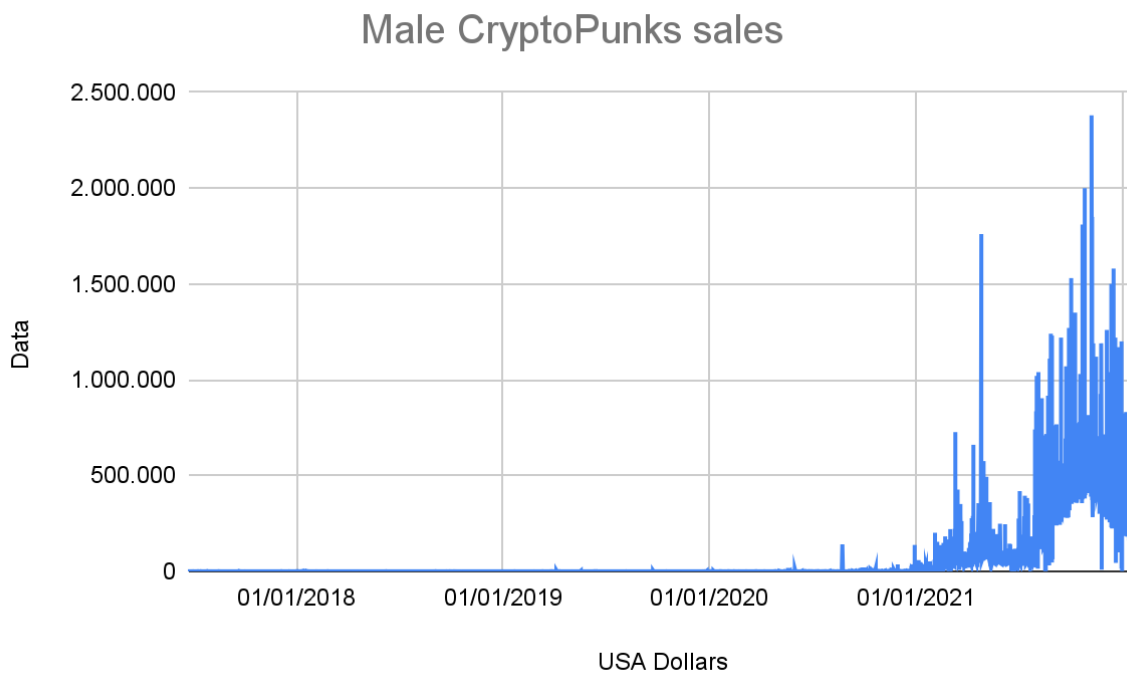


Figure 20. Male CryptoPunks sales.

For Alien and Ape sold CryptoPunks by date, see “Table 6. CryptoPunks sold by date, in USA Dollars: Alien and Ape”.

3.7 Possible investment opportunities

The difference of the average sale price in the last 90 days and the currently cheapest sale price could help to identify possible investment opportunities.

For example, there are 22 CryptoPunks with the Wild White Hair attribute. The last 90 days this attribute had an average sale price of 17880, but the lowest punk for sale costs 100. In this case, we should study the historical data of this attribute and the type of punks they belong to to consider them as a good investment.

For more detailed information, see in Annex “Table. 7 Possible investment opportunities by attribute (sample). Interactive table”.

3.8 Conclusions

The value of a CryptoPunk is a combination of the type of punk and certain attributes according to their rarity and fashionable features, since it is a form of art.

Types of punks such as Alien, Ape and Zombie have the most expensive punks due to their scarcity, and Male and Female, which make the brunt of punks, are the ones that register more transactions.

There are 87 different attributes which are not evenly distributed among different CryptoPunks. For example, the attribute Beany is only present in 44 of the punks, but Earring is in 2459 of them. The most frequent distribution is an attribute that is present in 250-300 punks.

There are attributes that are specific of a type and others that are more common. This is why, for example, Beanie and Luxurious Beard have a high price and are found only in Male type.

On the other hand, attributes such as Bandana have a very high price in Alien but a much lower price in Male. This is due to the low number of Alien punks, which render them very valuable regardless if they have an attribute or another.

We have recorded more than 20.000 transactions with an average value of more than 98.000 USA Dollars. The standard deviation is very high since it's a market with a high level of volatility by offer and demand and the exchange rate in dollars.

From november 2021 onwards the number of transactions rocketed, with some of the early owners reaping their benefits. Many, instead, choose to keep their ownership due to the collectable nature of these tokens or because they expect higher prices in the future.

The main reason for the increase of transactions is the fall of the exchange rate between Ethereum and dollar or euro. The investors have preferred to sell before the value of their CryptoPunks in hard currency falls even further, which is more clear in punks of Male and Female type.

4. Machine Learning method selection

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy[7].

We will apply different regression algorithms to our dataset to help us foresee which price could obtain each type of CryptoPunk, combined with clusters of types and attributes which could be a good investment in the near future.

We used dollar prices instead of Ethereum in order to measure the loss / benefit in a solid currency. In this way we don't have to take into account the variation in the Ethereum market.

4.1 CryptoPunks regression

We were looking for a good regression method to foresee the CryptoPunks price in the future, according to its accuracy and other parameters.

Table 8. Most suitable model with our dataset according to the PyCaret library.

	Model	MAE	MSE	RMSE	R2	RMSLE	MAPE	TT (Sec)
xgboost	Extreme Gradient Boosting	5.1458	68.6502	8.2714	0.9783	0.5870	0.4425	11.1140
rf	Random Forest Regressor	4.9474	72.6116	8.5029	0.9770	0.5841	0.4566	44.7530
et	Extra Trees Regressor	5.1060	73.7957	8.5867	0.9767	0.5829	0.5057	88.2100
lightgbm	Light Gradient Boosting Machine	5.2964	76.3472	8.7210	0.9759	0.6019	0.4447	0.7070
gbr	Gradient Boosting Regressor	6.0295	85.2174	9.2168	0.9730	0.6155	0.4698	11.7410
dt	Decision Tree Regressor	6.5101	134.9711	11.6095	0.9573	0.6317	0.7081	0.7410
lr	Linear Regression	9.4331	192.5478	13.8728	0.9391	0.5808	0.7460	1.1060
ridge	Ridge Regression	9.4331	192.5478	13.8728	0.9391	0.5808	0.7460	0.0660
lar	Least Angle Regression	9.4331	192.5478	13.8728	0.9391	0.5808	0.7460	0.0670
br	Bayesian Ridge	9.4326	192.5479	13.8728	0.9391	0.5804	0.7460	0.4120
lasso	Lasso Regression	9.4595	193.7020	13.9142	0.9387	0.5751	0.7518	0.1020
en	Elastic Net	9.4601	193.6965	13.9140	0.9387	0.5749	0.7514	0.1250
huber	Huber Regressor	9.3252	209.5210	14.4688	0.9337	0.5785	0.6971	5.0290
omp	Orthogonal Matching Pursuit	9.8029	213.8421	14.6176	0.9323	0.5799	0.7853	0.0690
knn	K Neighbors Regressor	9.4267	224.2485	14.9671	0.9291	0.6553	0.6075	1.9310

We have used the algorithm XGBoost [8] which has performed best in the PyCaret library [9] with our dataset. XGBoost is short for Extreme Gradient Boosting and is an efficient implementation of the stochastic gradient boosting machine learning algorithm.

After removing extreme outliers and performing other engineering transformations, we applied the algorithm to the dataset and predicted the price for transactions from 5-1-2022 to 27-1-2022. Then we compared the predicted price with the real price.

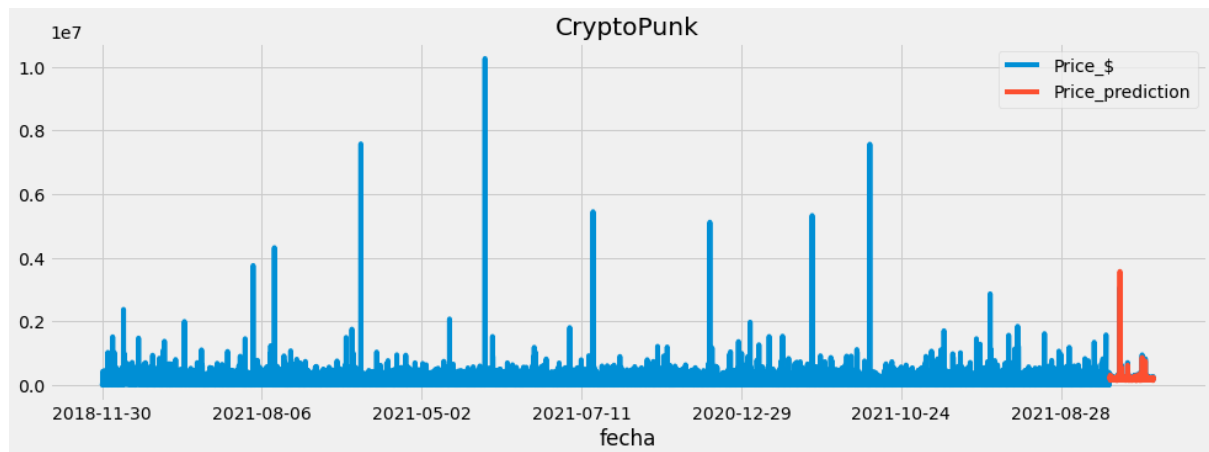


Figure 21. Price prediction after applying the model.

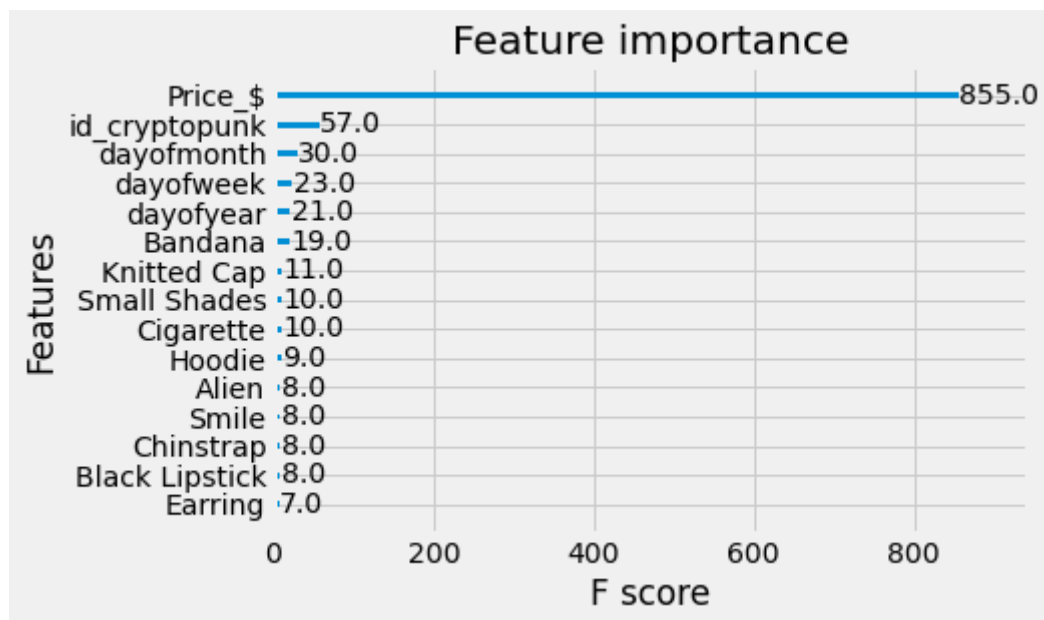


Figure 22. Feature importance (sample 15 firsts features) in our model.

Bandana, Knitted Cap, Small Shades, Cigarette, Hoodie, Smile, Chinstrap, Black Lipstick, Earring, are the 15th more relevant features of the dataset, according to the model.

Table 9. Sample of the results comparing real and predicate prices after applying (from January 6, 2022 to January 19, 2022, average per day)

dayofmonth	Price_	Price_prediction	error	abs_error
6	812084.800000	897859.937500	-85775.153125	115067.946875
7	216574.500000	198935.234375	17639.260937	17639.260937
8	294716.571429	269178.343750	25538.225446	25538.225446
9	286924.500000	262049.718750	24874.789062	24874.789062
10	256523.600000	235356.890625	21166.703125	21166.703125
11	237446.571429	219545.593750	17900.984375	17900.984375
12	246427.500000	226627.218750	19800.273438	19800.273438
14	224725.200000	208691.421875	16033.775000	16033.775000
15	223860.500000	205120.781250	18739.716146	18739.716146
16	224651.666667	205338.859375	19312.812500	19312.812500
17	287487.400000	263966.812500	23520.596875	23520.596875
18	307878.125000	279982.468750	27895.662109	27895.662109
19	211269.400000	194709.156250	16560.251563	16560.251563

The mean absolute error is 2.0115,88 dollars and mean absolute percentage error is 8.3, which are indicators that the model has a good performance.

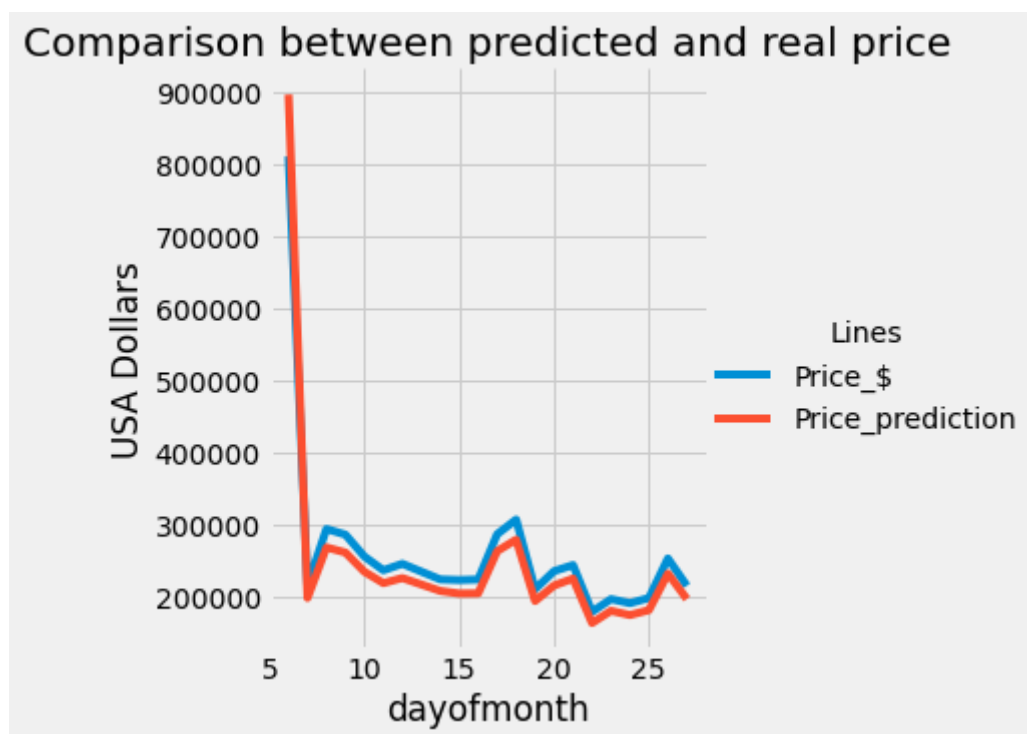


Figure 23. Comparison between predicted and real price.

After training the model with the historical data we run the model simulating that all the previous CryptoPunks sold in the past are sold again on May 1, 2022 to see if there were some differences. The result was as follow:

- Average historical price:162.992.25
- Average price 1-5-2022: 162.870.05

As expected, there was only a slight difference in price because we didn't include any additional information. To avoid this we could introduce some economic trends, like the evolution of the exchange rate Ethereum / Dollar, the evolution of other art tokens or add an opinion of the future evolution of the price in the data set, for example.

Due to the high volatility of the Ethereum / Dollar change rate, we think that this is the main factor to CryptoPunk evolution of prices, as the following table suggests.

Table 10. Ethereum Price Performance [6]

PERIOD	CHANGE	CHANGE (%)	HIGH	LOW
1h	\$-70.98	-2.55%	\$2,785.83	\$2,710.27
24h	\$-61.31	-2.21%	\$2,814.20	\$2,710.27
1w	\$68.17	2.58%	\$2,814.20	\$2,319.01
1m	\$-1,041.64	-27.75%	\$3,890.93	\$2,161.01
3m	\$-1,761.11	-39.37%	\$4,864.97	\$2,161.01
1y	\$1,191.19	78.29%	\$4,864.97	\$1,294.61
all	\$2,709.62	90,320.85%	\$4,864.97	\$0.420000

On the other hand, being CryptoPunks art tokens, there is a higher degree of uncertainty due to their collectable nature. Although there is price speculation, some punks are kept per se and not only as a form of investment, which makes it more difficult to predict the evolution.

4.2 CryptoPunks clustering

The aim of the clustering is to identify a group of CryptoPunks that we cannot see a priori and that could make a good investment. We are thinking of a conservative investor, that is, one who wants to obtain a benefit with low risk of losing money. We want to find CryptoPunks with certain types and attributes with a clean history of benefits. Our priority is to minimize loss.

Our first choice was to try K-Means Clustering. After some tuning of features, parameters and k numbers we got results we could use.

It was of great help to include a ranking of skin types provided in [10] (“CryptoPunks rankings | punk-ranks”, n.d.). This rank groups CryptoPunks by skin color and resulted in a big difference for the algorithm. Subtypes of skin color: Dark, Light, Mid y Albino were added to Male and Female types.

Apart from attributes, types, and skin subtypes, we feeded the algorithm with new values for each CryptoPunk:

- number of attributes
- number of sales (since the creation in 2017)
- accumulated benefits in sales
- indicator of sales with money loss
- amount in dollars of last sale

Apes, Aliens and Zombies are scarce, and we already saw in Figure 11 that their prices differ from Male and Female. We decided to analyze this last group, which is much bigger.

We cut out outliers, normalized the data and reduced the features with PCA. Then we run the K-Means model with types Male and Female several times, with different arguments. Although the search of parameters with GridSearch resulted in a value of k equal to 4, we got a better clustering with k equal to 10, or at least something we could read better. With 10 clusters we got groups of very different numbers of punks, as we see in Figure 24.

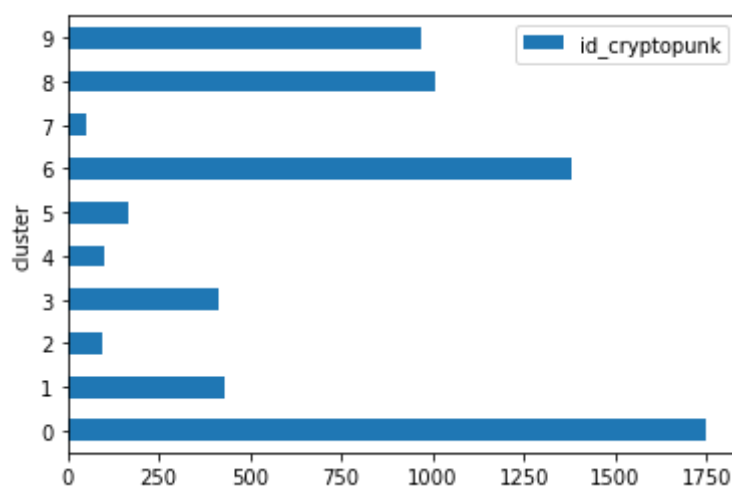


Figure 24 :Distribution of CryptoPunks in clusters

Cluster 7, for example, includes 50 CryptoPunks. In Figure 25 we can see the clusters, with the two most important variables in PCA.

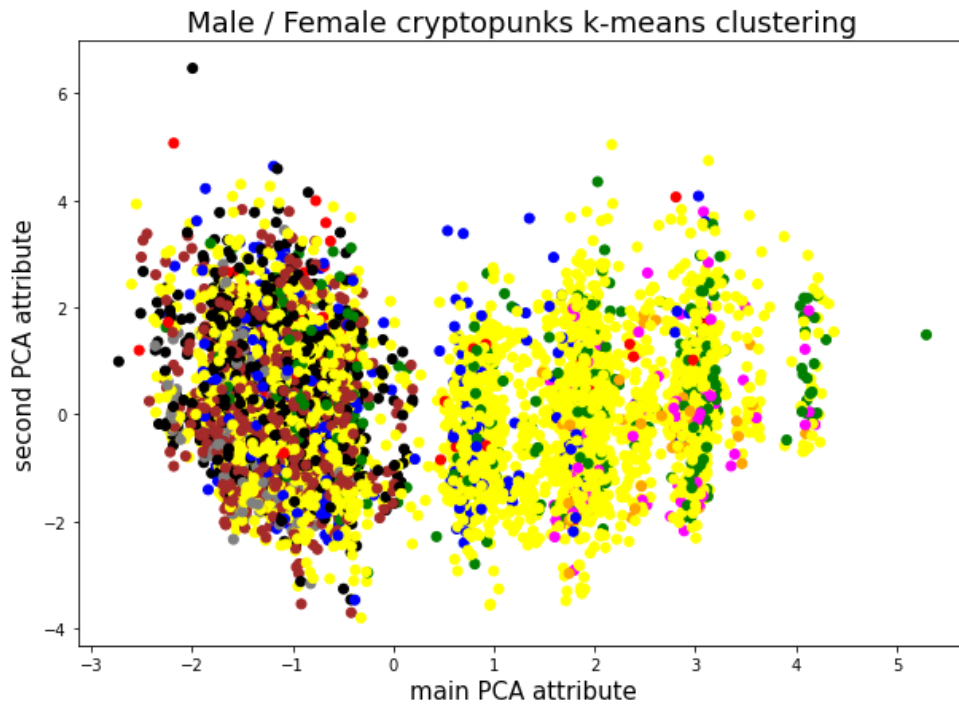


Figure 25: Clusters obtained by K-Means Clustering

We can not get clear ideas from Figure 25, but we went on making more plots. We got a better view in Figure 26, where we see the benefits given by the CryptoPunks in each cluster. Notice that the CryptoPunks in cluster 7 do not have benefits below 0, that is their sales don't imply money loss.

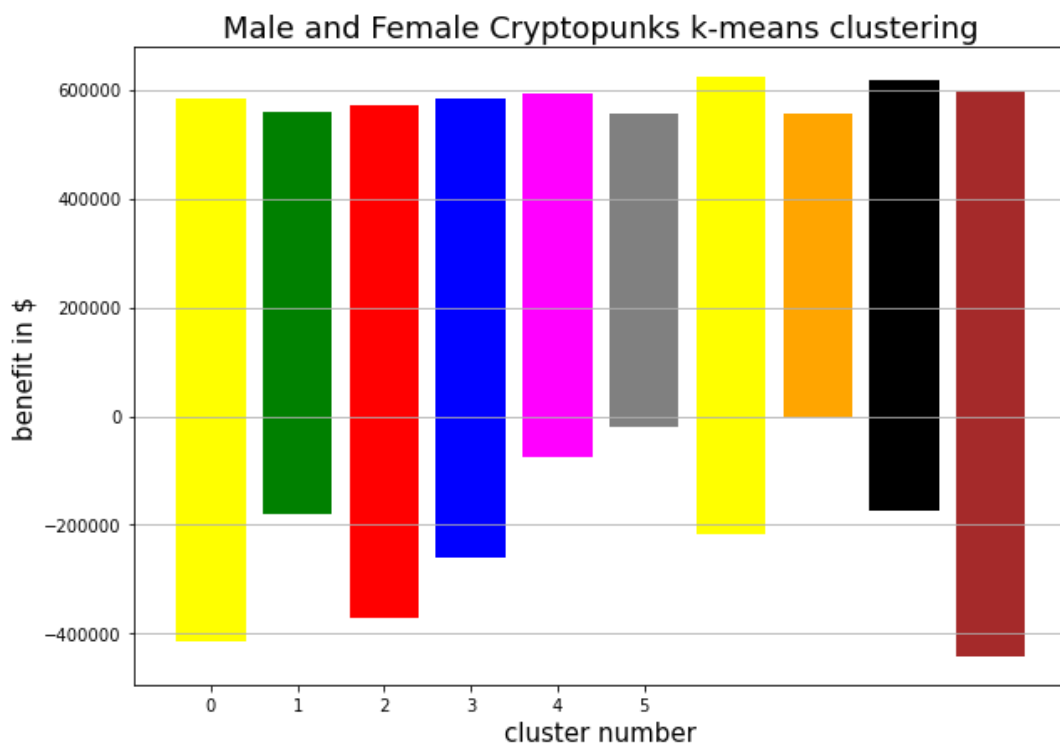


Figure 26: Male / Female clusters by benefit

Cluster number 7 has 50 CryptoPunks in all. They share this interesting facts:

- all of them had, at least, one sale (actually all of the punks in the input do)
- none of this sales implied loss of money
- all of the CryptoPunks have the 'Pink With Hat' attribute (see Table 11)
- these are no Male or Female CryptoPunks with this attribute in other clusters
- the maximum obtained benefit is similar to the one obtained by the rest of the clusters

Table 11: Attributes of the CryptoPunks in cluster 3 with # of appearances

3D Glasses 1	Hot Lipstick 8
Big Shades 2	Mole 3
Black Lipstick 8	Nerd Glasses 2
Blue Eye Shadow 8	Pink With Hat 50
Cigarette 2	Pipe 1
Classic Shades 2	Purple Eye Shadow 1
Clown Eyes Blue 7	Purple Lipstick 12
Clown Eyes Green 6	Regular Shades 3
Earring 13	Silver Chain 2
Eye Patch 1	Spots 1
Green Eye Shadow 1	VR 1
Horned Rim Glasses 3	Vape 2

So, this is a good group to think about when starting an investment in CryptoPunks. If we get them for a reasonable price we can expect to make a good investment. So, what is a reasonable price? A good ally for this clustering is the use of the regression in 4.1. If we take the CryptoPunks in cluster 7 and predict the sale value for them in a week, we can have an idea of the values in which we can make the purchase. Of course there are a number of factors outside the scope of this analysis that might influence the result of the investment. We already talked about the market volatility in this document.

After finding this particular attribute, we checked the algorithm with smaller groups of CryptoPunks, using k equal to 4, as advised in the GridSearch. For example por Mid-skin Male we got something similar.

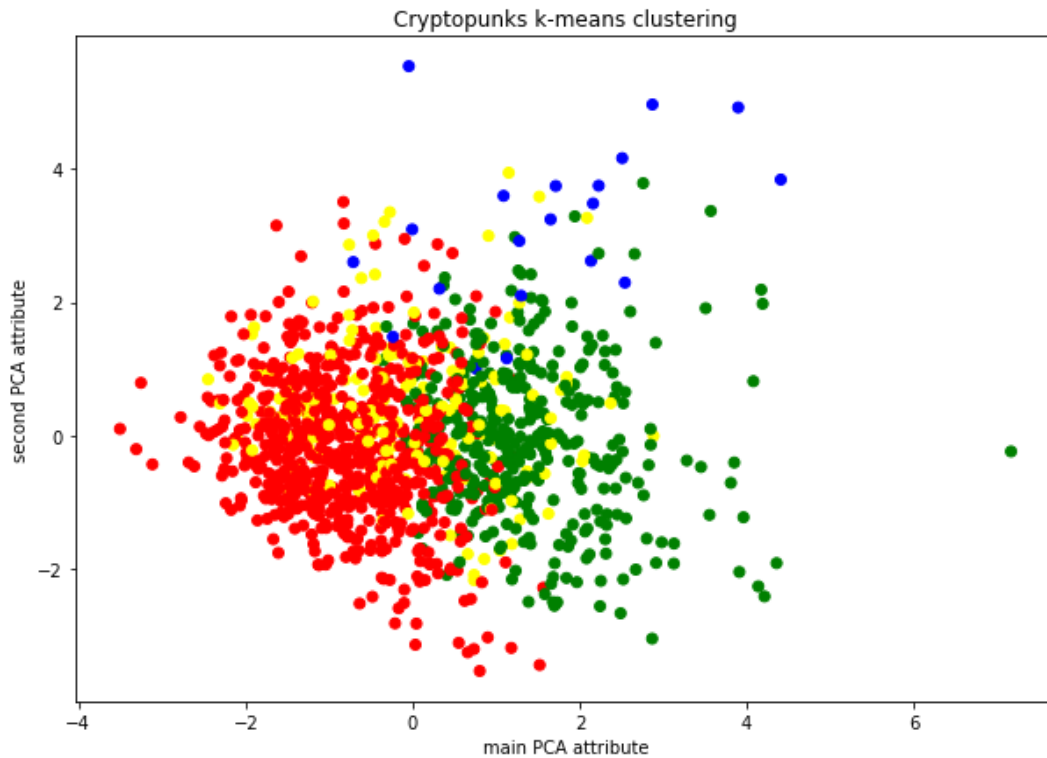


Figure 27 : Mid-skin Male CryptoPunks clusters by most important PCA variables

Not very impressive, but reviewing the amount of benefits, we get Figure 28, where we can already see that the CryptoPunks in cluster 3 (blue color) never lost money. The benefits are not so good but the investment seems less risky.

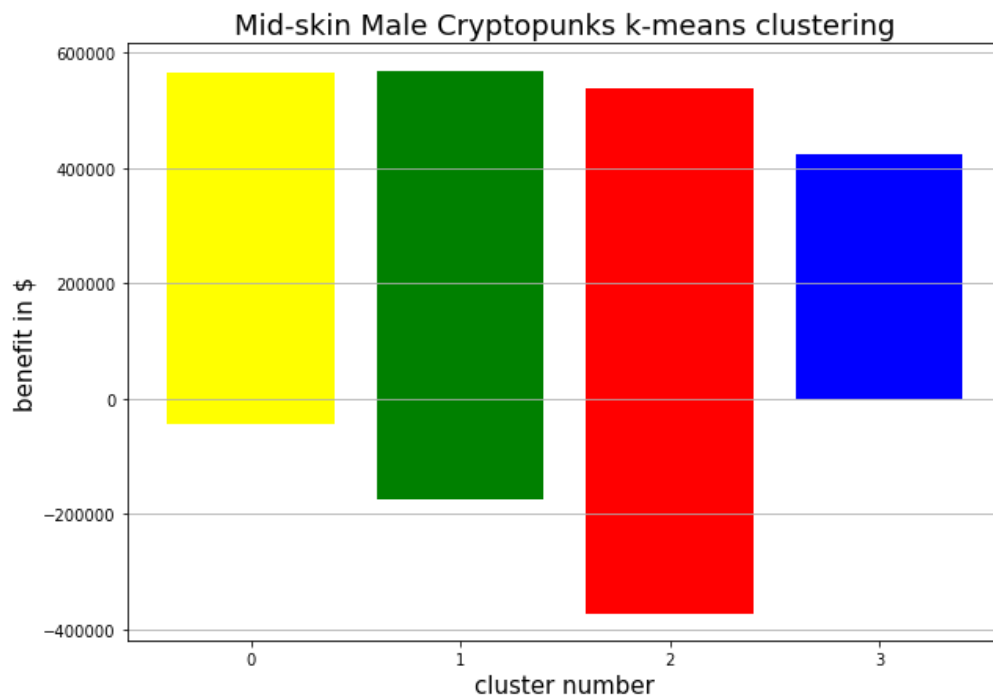


Figure 28: Mid-skin Male CryptoPunks benefits by clusters

Again, cluster number 3 has 20 CryptoPunks in all and share the previous facts:

- all of them had, at least, one sale
- none of this sales implied loss of money
- all of the CryptoPunks include the 'Rosy Cheeks' attribute
- these are the only Mid-skin Male CryptoPunks with this attribute

Apart from the subgroups of Mid-skin Male, we were able to identify other interesting clusters with similar properties, when running the other subtypes. We were not surprised to find a subgroup of Type/Subtype featuring the attribute 'Pink With Hat':

- Mid-skin Female with Medical Mask includes 12 CryptoPunks.
- Light-skin Male with Clown Nose includes 33 CryptoPunks, one of which had a loss of 24 dollars. We believe this loss is not big enough to discard the group.
- Albino-skin Male with Classic Shades includes 22 members. There is one cryptopunk in this group with a loss of 4 dollars. Probably due to exchange rates with Ethereum.

The total cluster in this case included 38 CryptoPunks, but we can easily identify the 22 with Classic Shades, having the desired characteristics. We were not able to find a pattern to include the other 16 (by attributes or number of attributes).

- Dark-skin Male with Big Beard includes 26 CryptoPunks.
- Light-skin Female with Pink With Hat includes 12 CryptoPunks (this came as no surprise)
- Albino-Skin Female with 3D Glasses includes 3 CryptoPunks

Finally, we can put all together in Table 12 and get a group of 166 CryptoPunks worth looking into for investment.

Table 12: Groups of CryptoPunks identified with no loss

Group / subgroup definition	Existing number
Male or Female with Pink With Hat	50
Mid-skin Male with Rosy Cheeks	20
Light-skin Male with Clown Nose	33
Albino-skin Male with Classic Shades	22
Dark-skin Male with Big Beard	26
Albino-Skin Female with 3D Glasses	3
Mid-skin Female with Medical Mask	12

Total:	166
---------------	------------

Throughout the process we were checking the number of attributes in each CryptoPunk. We do not see a relation towards loss of money in the clustering results.

4.3 CryptoPunks alternative analysis

To complement the information offered before, we have chosen some types and attributes in a statistical analysis that in the past have had higher benefits with no losses, thus lowering the risk for the investor. Needless to say that past benefits don't entail future benefits.

We have limited our analysis to Female and Male CryptoPunks because Alien, Ape and Zombie are more scarce and their prices have soared and many of them are not for sale.

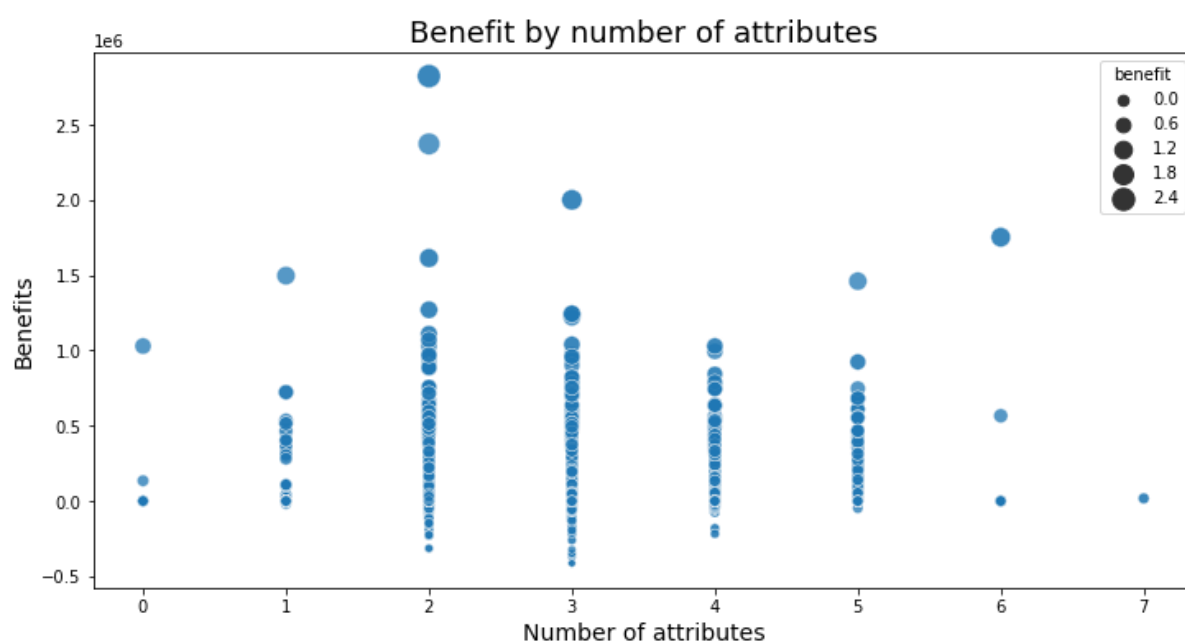


Figure 29. Benefits by number of attributes.

Our target should be CryptoPunks with two or three attributes because they are less scarce than 0, 1 or 7 attributes, which are more expensive. Although there are benefits in punks with other numbers of attributes, limiting the number of options will be easier to make a decision where to invest.

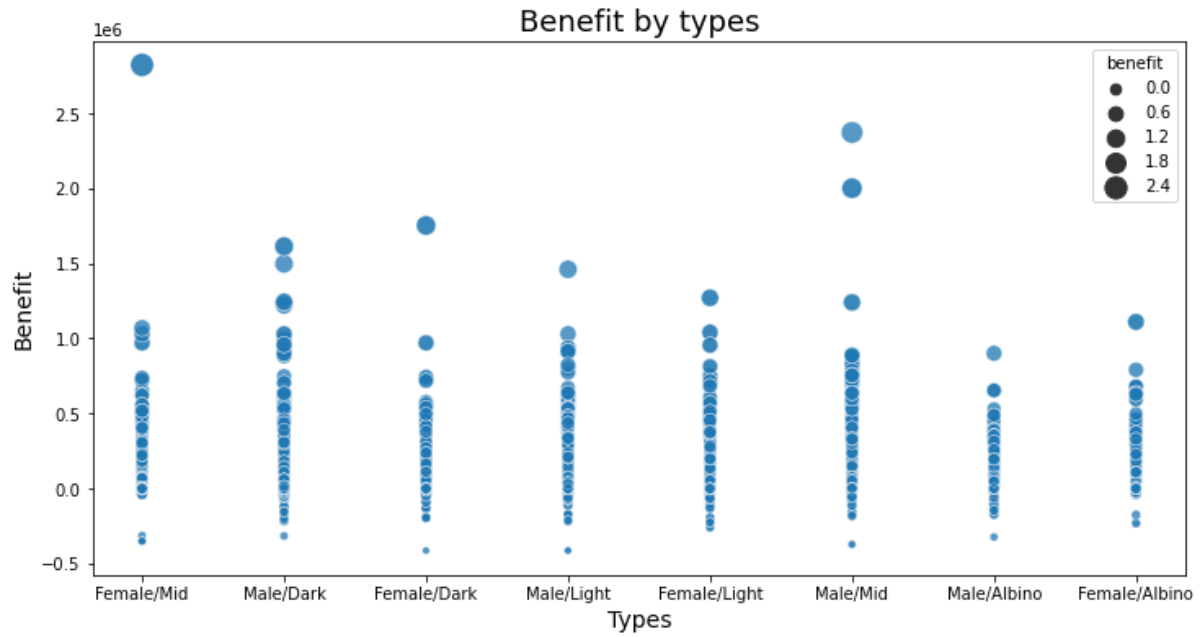


Figure 30. Benefits by type of attributes.

Types of CryptoPunks have been selected after considering the mean and percentile 95% of their benefits.

Table 13. Statistical analysis by type of CryptoPunk and their benefits.

types	benefit								
	count	mean	std	min	25%	50%	75%	95%	max
Female/Albino	590.0	80125.962712	170438.969142	-231298.0	0.0	0.0	79099.0	427300.0	1109904.0
Female/Dark	1886.0	66827.034464	150656.412724	-413487.0	0.0	0.0	54937.0	381897.0	1752157.0
Female/Light	1917.0	78012.687011	162253.689409	-259876.0	0.0	0.0	68441.0	422044.0	1269884.0
Female/Mid	2039.0	76779.959294	182186.041980	-350044.0	0.0	0.0	63355.0	402387.7	2821644.0
Male/Albino	1009.0	63020.019822	131469.848385	-322927.0	0.0	0.0	54604.0	360326.6	900840.0
Male/Dark	3329.0	76884.411835	165537.378921	-315990.0	0.0	0.0	66831.0	396672.0	1613174.0
Male/Light	3715.0	70818.711171	150579.941206	-413192.0	0.0	0.0	53175.0	419438.9	1459809.0
Male/Mid	3638.0	77282.729247	169921.986404	-371959.0	0.0	0.0	63477.0	417303.0	2371824.0
id_punk	3.0	36198.000000	0.000000	36198.0	36198.0	36198.0	36198.0	36198.0	36198.0

We have chosen Female/Albino, Female/Light and Male Mid as good investment options, again to ease the decision making process. From all the possible attributes by type of punk, we have chosen those with the highest benefits and no losses in their historical record of transactions.

Mean is the average of the benefits in USA Dollars, Std is the standard deviation of these benefits, and 95% percentile means that 95% of these attributes benefits were equal or less than the amount specified.

Table 14. Selected types of CryptoPunks and their attributes by benefits.

Female Albino				
	Number of punks	Mean	Std	95%
Frumpy Hair	8	147.640,13	389.462,86	744.212,80
Clown Eyes Blue	15	112.266,93	224.196,24	602.563,70
Spots	5	208.349,40	295.046,51	584.709,00
Cap	5	165.932,80	294.488,71	573.799,00
Tassle Hat	5	146.243,60	272.641,11	522.603,20
Pink With Hat	5	118.395,40	264.740,16	473.581,60
Blonde Bob	8	81.767,25	225.038,17	420.393,45
Stringy Hair	14	170.153,43	173.669,35	401.472,15
Crazy Hair	9	130.484,89	151.690,13	354.823,00
Mohawk Thin	11	92.692,91	136.231,73	345.874,50

Female Light				
	Number of punks	Mean	Std	95%
Blonde Short	16	78.048,94	199.256,18	580.264,50
Big Shades	25	84.429,40	169.173,65	444.996,80
Crazy Hair	25	112.733,68	210.449,56	440.538,00
Cap	15	97.434,00	155.735,51	432.985,50
Pigtails	18	126.435,44	165.037,73	404.453,00
Wild Hair	16	128.683,69	148.660,37	395.764,25
Pilot Helmet	13	96.212,00	155.821,35	383.035,00
Vape	26	90.831,00	143.353,43	348.969,25
Clown Hair Green	12	59.104,50	123.384,35	315.797,45
Medical Mask	9	56.692,89	145.780,92	290.126,80

Male Mid				
	Number of punks	Mean	Std	95%

Top Hat	28	168.011,50	472.838,92	723.138,50
Smile	52	143.224,83	300.319,56	450.368,55
Bandana	78	86.584,35	189.718,09	405.934,15
Police Cap	28	70.702,71	173.060,25	392.459,30
Clown Hair Green	15	56.374,40	138.544,50	347.434,80
Clown Nose	26	71.077,92	147.492,34	342.406,50
Front Beard	64	67.923,84	145.866,76	332.885,50
Peak Spike	65	62.546,15	132.846,18	302.912,20
Spots	13	57.477,31	109.788,73	300.604,00
Medical Mask	21	46.702,52	104.420,42	187.355,00

5. Final conclusions

Like all NFT's the value of CryptoPunks is very volatile due to its speculative nature. Since May 2021, this market has grown at an exponential rate, with unprecedented liquidity and, perhaps, unrealistic expectations and potential disappointments.

Up to now, the market has given benefits to its investors, but we can't predict when people will lose interest in NFTs. Too many factors influence the market price. Some we see clearly, such as the difference of exchange rate dollar / ethereum or the natural interest in the rare or scarce types / attributes . But other facts are impossible to simulate, take for example, the effect of the purchase of an NFT made by a pop star [11].

Despite the volatility of this market, we can make some recommendations to the investor willing to invest in CryptoPunks as a result of our analysis using Machine Learning methods and other statistical techniques, based on the historical data of transactions and the structure of the market.

First of all, the rarest the punk the higher its value. Many of these tokens are unavailable, their prices are too high and the investment is too risky. So, we don't recommend buying them. This includes all the Alien, Ape or Zombie types and punks with no attributes, one or 7.

Second. For a good investment is it advisable to avoid unnecessary risks by diversification of investments. Female and Male types of CryptoPunks are more frequent and have a large variety of attributes and prices. Some of the attributes are scarce or are fashionable, thus increasing the price, and others are more common and less valued.

To ease the decision-making process on investment, we provide information about some CryptoPunks groups of types and attributes that historical data of transactions show that have yielded high benefits and no losses at all. This information is the result of our analysis through Machine Learning methodologies and other statistical analysis. Needless to say that past benefits don't assure future gains.

We recommend investing in these types and attributes.

Group / subgroup definition	Existing number
Male or Female with Pink With Hat	50
Mid-skin Male with Rosy Cheeks	20
Light-skin Male with Clown Nose	33
Albino-skin Male with Classic Shades	22

Dark-skin Male with Big Beard	26
Albino-Skin Female with 3D Glasses	3
Mid-skin Female with Medical Mask	12
Total:	166

We also recommend investing in Female Albino, Female Light and Male Mid with 2 or 3 attributes of the list, which have yielded benefits in all their transactions. Mean is the average of the benefits in USA Dollars, Std is the standard deviation of these benefits and 95% percentile means that 95% of these attributes benefits were equal or less than the amount specified.

Female Albino				
	Number of punks	Mean	Std	95%
Frumpy Hair	8	147.640,13	389.462,86	744.212,80
Clown Eyes Blue	15	112.266,93	224.196,24	602.563,70
Spots	5	208.349,40	295.046,51	584.709,00
Cap	5	165.932,80	294.488,71	573.799,00
Tassle Hat	5	146.243,60	272.641,11	522.603,20
Pink With Hat	5	118.395,40	264.740,16	473.581,60
Blonde Bob	8	81.767,25	225.038,17	420.393,45
Stringy Hair	14	170.153,43	173.669,35	401.472,15
Crazy Hair	9	130.484,89	151.690,13	354.823,00
Mohawk Thin	11	92.692,91	136.231,73	345.874,50

Female Light				
	Number of punks	Mean	Std	95%
Blonde Short	16	78.048,94	199.256,18	580.264,50
Big Shades	25	84.429,40	169.173,65	444.996,80
Crazy Hair	25	112.733,68	210.449,56	440.538,00
Cap	15	97.434,00	155.735,51	432.985,50
Pigtails	18	126.435,44	165.037,73	404.453,00
Wild Hair	16	128.683,69	148.660,37	395.764,25
Pilot Helmet	13	96.212,00	155.821,35	383.035,00
Vape	26	90.831,00	143.353,43	348.969,25

Clown Hair Green	12	59.104,50	123.384,35	315.797,45
Medical Mask	9	56.692,89	145.780,92	290.126,80

Male Mid				
	Number of punks	Mean	Std	95%
Top Hat	28	168.011,50	472.838,92	723.138,50
Smile	52	143.224,83	300.319,56	450.368,55
Bandana	78	86.584,35	189.718,09	405.934,15
Police Cap	28	70.702,71	173.060,25	392.459,30
Clown Hair Green	15	56.374,40	138.544,50	347.434,80
Clown Nose	26	71.077,92	147.492,34	342.406,50
Front Beard	64	67.923,84	145.866,76	332.885,50
Peak Spike	65	62.546,15	132.846,18	302.912,20
Spots	13	57.477,31	109.788,73	300.604,00
Medical Mask	21	46.702,52	104.420,42	187.355,00

There are also other possible investments on an individual basis according to “Table. 7 Possible investment opportunities by attribute (sample). Interactive table”.

Our regression model based on historical data could provide better price estimators to individual CryptoPunks or types and attributes as a tool for the process of decision-making.

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7. Data Annex

Table 1. Average sale price by type and attribute, in USA Dollars.

AVERAGE USA attribute	Type					
	Alien	Ape	Female	Male	Zombie	Weighted average
Beanie				12.098.333		12.098.333
Bandana	122.965.000		13.790.697	1.281.276	39.060.000	10.033.012
Luxurious Beard				7.611.591		7.611.591
Hot Lipstick			5.081.456			5.081.456
Knitted Cap			635.516	5.508.112		4.599.662
Cigarette			6.137.754	1.433.524	39.060.000	3.768.417
Headband	111.160.000		832.118	820.746		3.170.084
Hoodie				3.091.180		3.091.180
Choker			2.524.228			2.524.228
Regular Shades	110.500.000		879.012	1.104.109	14.170.000	2.522.600
Pilot Helmet			2.482.841			2.482.841
Cowboy Hat		17.360.000		1.673.516		2.386.538
3D Glasses			2.906.413	2.035.072		2.319.592
Small Shades				2.008.018	3.240.000	2.032.658
VR			1.182.163	2.237.076		1.983.115
Dark Hair			1.978.190			1.978.190
Vampire Hair				1.906.170		1.906.170
Handlebars				875.015	39.060.000	1.879.883
Big Beard				1.848.838		1.848.838
Big Shades			3.141.328	1.367.519		1.798.986
Orange Side			1.731.792			1.731.792
Pipe			1.523.799	1.826.526		1.708.799
Normal Beard Black				1.699.149		1.699.149
Eye Mask		17.830.000	626.745	1.176.081		1.650.473

Cap Forward				1.626.759		1.626.759
Silver Chain			2.075.412	1.472.210		1.618.441
Classic Shades			1.939.829	1.300.299	5.450.000	1.598.977
Normal Beard				1.586.178		1.586.178
Pigtails			1.569.886			1.569.886
Do-rag		17.830.000		987.024		1.567.816
Medical Mask			2.093.855	887.275	5.450.000	1.540.445
Top Hat				1.534.438		1.534.438
Mohawk			1.455.452	1.563.978		1.522.979
Earring			1.189.237	1.518.335	39.060.000	1.512.104
Eye Patch			552.629	1.628.484		1.501.913
Buck Teeth				1.499.452		1.499.452
Mohawk Thin			2.627.959	974.364	3.240.000	1.478.279
Mole			1.912.000	1.159.352		1.455.035
Chinstrap				1.384.325		1.384.325
Blonde Bob			1.352.096			1.352.096
Crazy Hair			1.317.132	900.657	14.170.000	1.332.037
Shaved Head				1.327.500		1.327.500
Straight Hair Blonde			1.320.442			1.320.442
Half Shaved			1.293.315			1.293.315
Black Lipstick			1.278.997			1.278.997
Police Cap				1.262.978		1.262.978
Purple Eye Shadow			1.251.432			1.251.432
Clown Eyes Green			1.287.545	1.127.551		1.218.457
Shadow Beard				1.174.575	3.370.000	1.211.786
Straight Hair Dark			1.207.116			1.207.116
Frown				1.204.324		1.204.324
Vape		17.830.000	765.044	756.039		1.185.814
Wild Hair			1.249.984	994.279	5.450.000	1.168.707
Messy Hair			1.605.565	1.075.742		1.167.885

Front Beard Dark				1.164.597		1.164.597
Spots			849.775	1.282.421		1.158.808
Rosy Cheeks			1.439.845	488.448		1.122.713
Wild Blonde			1.120.197			1.120.197
Purple Lipstick			1.107.433			1.107.433
Stringy Hair			1.729.265	891.484		1.093.172
Clown Hair Green			1.280.181	909.826		1.071.856
Smile				1.056.268		1.056.268
Pink With Hat			1.053.923			1.053.923
Mohawk Dark			1.379.601	666.448	3.370.000	1.027.440
Welding Goggles			1.025.391			1.025.391
Cap			1.117.095	979.936		999.938
Gold Chain			1.086.652	941.402		974.200
Tiara			973.904			973.904
Muttonchops				946.870		946.870
Front Beard				944.158		944.158
Straight Hair			936.976			936.976
Blue Eye Shadow			918.555			918.555
Wild White Hair			910.126			910.126
Clown Eyes Blue			934.370	848.574		902.663
Goat				887.716		887.716
Peak Spike				880.026		880.026
Clown Nose			924.058	806.062		863.272
Nerd Glasses			655.568	937.562		838.864
Tassle Hat			812.515			812.515
Mustache				783.225		783.225
Frumpy Hair			949.335	681.356		782.593
Horned Rim Glasses			754.315	708.817		720.017
Green Eye Shadow			719.222			719.222

Blonde Short			695.644			695.644
Fedora				688.147		688.147
Purple Hair				676.589		676.589
Red Mohawk			601.758			601.758
Suma total	116.897.500	17.712.500	1.977.666	1.496.984	16.473.077	1.866.816

Table 2. Average sale price by type and attribute, in USA Dollars: Alien, Ape, Zombie, Female, Male.

	Type
Attribute	Alien
Bandana	122.965.000
Headband	111.160.000
Regular Shades	110.500.000
Suma total	116.897.500

	Type
Attribute	Ape
Vape	17.830.000
Eye Mask	17.830.000
Do-rag	17.830.000
Cowboy Hat	17.360.000
Suma total	17.712.500

	Type
Attribute	Zombie
Handlebars	39.060.000
Earring	39.060.000
Cigarette	39.060.000
Bandana	39.060.000
Regular Shades	14.170.000
Crazy Hair	14.170.000

Wild Hair	5.450.000
Medical Mask	5.450.000
Classic Shades	5.450.000
Shadow Beard	3.370.000
Mohawk Dark	3.370.000
Small Shades	3.240.000
Mohawk Thin	3.240.000
Suma total	16.473.077

	Type
Attribute	Female
Bandana	13.790.697
Cigarette	6.137.754
Hot Lipstick	5.081.456
Big Shades	3.141.328
3D Glasses	2.906.413
Mohawk Thin	2.627.959
Choker	2.524.228
Pilot Helmet	2.482.841
Medical Mask	2.093.855
Silver Chain	2.075.412
Dark Hair	1.978.190
Classic Shades	1.939.829
Mole	1.912.000
Orange Side	1.731.792
Stringy Hair	1.729.265
Messy Hair	1.605.565
Pigtails	1.569.886
Pipe	1.523.799
Mohawk	1.455.452
Rosy Cheeks	1.439.845
Mohawk Dark	1.379.601
Blonde Bob	1.352.096
Straight Hair Blonde	1.320.442
Crazy Hair	1.317.132
Half Shaved	1.293.315

Clown Eyes Green	1.287.545
Clown Hair Green	1.280.181
Black Lipstick	1.278.997
Purple Eye Shadow	1.251.432
Wild Hair	1.249.984
Straight Hair Dark	1.207.116
Earring	1.189.237
VR	1.182.163
Wild Blonde	1.120.197
Cap	1.117.095
Purple Lipstick	1.107.433
Gold Chain	1.086.652
Pink With Hat	1.053.923
Welding Goggles	1.025.391
Tiara	973.904
Frumpy Hair	949.335
Straight Hair	936.976
Clown Eyes Blue	934.370
Clown Nose	924.058
Blue Eye Shadow	918.555
Wild White Hair	910.126
Regular Shades	879.012
Spots	849.775
Headband	832.118
Tassle Hat	812.515
Vape	765.044
Horned Rim Glasses	754.315
Green Eye Shadow	719.222
Blonde Short	695.644
Nerd Glasses	655.568

Knitted Cap	635.516
Eye Mask	626.745
Red Mohawk	601.758
Eye Patch	552.629
Suma total	1.977.666

	Type
Attribute	Male
Beanie	12.098.333
Luxurious Beard	7.611.591
Knitted Cap	5.508.112
Hoodie	3.091.180
VR	2.237.076
3D Glasses	2.035.072
Small Shades	2.008.018
Vampire Hair	1.906.170
Big Beard	1.848.838
Pipe	1.826.526
Normal Beard Black	1.699.149
Cowboy Hat	1.673.516
Eye Patch	1.628.484
Cap Forward	1.626.759
Normal Beard	1.586.178
Mohawk	1.563.978
Top Hat	1.534.438
Earring	1.518.335
Buck Teeth	1.499.452
Silver Chain	1.472.210
Cigarette	1.433.524
Chinstrap	1.384.325
Big Shades	1.367.519
Shaved Head	1.327.500
Classic Shades	1.300.299
Spots	1.282.421

Bandana	1.281.276
Police Cap	1.262.978
Frown	1.204.324
Eye Mask	1.176.081
Shadow Beard	1.174.575
Front Beard Dark	1.164.597
Mole	1.159.352
Clown Eyes Green	1.127.551
Regular Shades	1.104.109
Messy Hair	1.075.742
Smile	1.056.268
Wild Hair	994.279
Do-rag	987.024
Cap	979.936
Mohawk Thin	974.364
Muttonchops	946.870
Front Beard	944.158
Gold Chain	941.402
Nerd Glasses	937.562
Clown Hair Green	909.826
Crazy Hair	900.657
Stringy Hair	891.484
Goat	887.716
Medical Mask	887.275
Peak Spike	880.026
Handlebars	875.015
Clown Eyes Blue	848.574
Headband	820.746
Clown Nose	806.062
Mustache	783.225
Vape	756.039
Horned Rim Glasses	708.817
Fedora	688.147

Frumpy Hair	681.356
Purple Hair	676.589
Mohawk Dark	666.448
Rosy Cheeks	488.448
Suma total	1.496.984

Table 5. Statistic summary price by type of CryptoPunk, in USA Dollars: Alien, Ape, Zombie, Female, Male.

Ape	
Number of sold punks	33
	USA Dollars
Mean of sale	742.837
Standard Deviation	2.067.539
Min.	64
25%	1.438
50%	2.447
75%	71.403
Max.	10.260.000

Alien	
Number of sold punks	10
	USA Dollars
Mean of sale	1.593.972
Standard Deviation	3.161.128
Min.	1.646
25%	2.127
50%	2.650

75%	575.164
Max.	7.580.000

Zombie	
Number of sold punks	105
	USA Dollars
Mean of sale	462.619
Standard Deviation	1.022.994
Min.	35
25%	600
50%	18.354
75%	343.933
Max.	5.330.000

Female	
Number of sold punks	6414
	USA Dollars
Mean of sale	100.177
Standard Deviation	148.337
Min.	1
25%	735
50%	42.124
75%	134.948
Max.	2.870.000

Male	
Number of sold punks	13.474

	USA Dollars
Mean of sale	91.817
Standard Deviation	155.526
Min.	3
25%	690
50%	33.053
75%	95.805
Max.	2.380.000

Table 6. CryptoPunks sold by date, in USA Dollars: Alien and Ape.

Alien CryptoPunks Sales

CryptoPunk	USA Dollars	Data
7804	7.570.000,00	11/03/2021
3100	7.580.000,00	11/03/2021
2890	761.889,00	23/01/2021
7804	14.988,00	10/01/2018
5822	1.646,00	10/07/2017
7523	1.646,00	10/07/2017
3100	2.127,00	06/07/2017
2890	2.127,00	06/07/2017
5905	2.690,00	04/07/2017
6089	2.610,00	01/07/2017

Ape CryptoPunks Sales

CryptoPunk	USA Dollars	Data
4156	10.260.000,00	09/12/2021
5217	5.450.000,00	30/07/2021
2140	3.760.000,00	30/07/2021
2140	1.180.000,00	02/03/2021

2140	731.604,00	22/02/2021
6965	1.540.000,00	19/02/2021
4156	1.250.000,00	18/02/2021
8219	150.275,00	06/01/2021
2924	71.403,00	13/11/2020
5314	54.978,00	17/09/2020
2386	15.313,00	21/05/2020
4178	5.914,00	26/04/2020
2386	5.914,00	26/04/2020
5314	6.305,00	17/01/2020
4156	645,00	17/09/2018
4156	64,00	12/08/2018
7191	2.046,00	15/01/2018
6145	2.174,00	15/01/2018
8498	5.424,00	14/01/2018
6965	3.025,00	01/01/2018
5217	1.884,00	26/12/2017
6915	2.447,00	13/12/2017
2386	826,00	19/07/2017
2924	1.438,00	13/07/2017
8498	953,00	11/07/2017
2924	953,00	11/07/2017
4178	1.928,00	07/07/2017
9280	1.816,00	04/07/2017
6965	2.125,00	04/07/2017
6965	1.106,00	03/07/2017
2711	276,00	03/07/2017
5795	2.212,00	03/07/2017
9265	587,00	01/07/2017

Table. 7 Possible investment opportunities by attribute (sample). Interactive table.

Nº	Attribute	Quantity	Availability for sale	Average sale price	Cheapest sale price	% Availability for sale over total	Cheap-Avg_sale
14	Wild White Hair	136	22	17880	100	16%	-17780
62	Clown Eyes Green	382	49	2430	70	13%	-2360
82	Black Lipstick	617	82	1620	68	13%	-1552
10	Top Hat	115	31	228	140	27%	-88
15	Cowboy Hat	142	22	204	145	15%	-59
47	3D Glasses	286	51	165	109	18%	-56
48	Luxurious Beard	286	46	122	78	16%	-44
37	Hoodie	259	32	276	245	12%	-31
34	Clown Nose	212	34	102	74	16%	-28
8	Pigtails	94	20	115	90	21%	-25
35	Smile	238	43	107	82	18%	-25
13	Blonde Short	129	18	95	71	14%	-24
80	Big Shades	535	74	92	69	14%	-23
26	Silver Chain	156	33	96	75	21%	-21
39	Frown	261	47	94	74	18%	-20
63	Clown Eyes Blue	384	54	89	69	14%	-20
11	Spots	124	20	89	70	16%	-19
41	Handlebars	263	40	93	75	15%	-18
59	VR	332	56	102	84	17%	-18
65	Crazy Hair	414	55	87	69	13%	-18
71	Wild Hair	447	56	93	75	13%	-18
21	Blonde Bob	147	24	86	69	16%	-17
40	Purple Eye Shadow	262	29	87	70	11%	-17
86	Cigarette	961	144	90	73	15%	-17
61	Small Shades	378	52	99	83	14%	-16
9	Pink With Hat	95	13	154	139	14%	-15
78	Regular Shades	527	86	87	72	16%	-15
43	Green Eye Shadow	271	37	84	70	14%	-14
51	Normal Beard	292	33	87	74	11%	-13

81	Nerd Glasses	572	61	90	77	11%	-13
31	Tassle Hat	178	23	85	73	13%	-12
36	Cap Forward	254	39	98	86	15%	-12
87	Earring	2459	338	81	69	14%	-12
58	Pipe	317	56	103	92	18%	-11
79	Horned Rim Glasses	535	72	83	72	13%	-11
84	Purple Lipstick	655	87	81	70	13%	-11
16	Wild Blonde	144	14	100	90	10%	-10
60	Cap	351	53	86	76	15%	-10
83	Mole	644	89	79	69	14%	-10
22	Vampire Hair	147	26	83	74	18%	-9
27	Dark Hair	157	22	94	85	14%	-9
46	Chinstrap	282	40	83	74	14%	-9
50	Normal Beard Black	289	42	99	90	15%	-9
76	Classic Shades	502	67	78	69	13%	-9
6	Buck Teeth	78	18	97	89	23%	-8
32	Fedora	186	32	93	85	17%	-8
72	Messy Hair	460	47	78	70	10%	-8
5	Orange Side	68	15	116	109	22%	-7
7	Welding Goggles	86	13	95	88	15%	-7
20	Half Shaved	147	16	95	88	11%	-7
70	Frumpy Hair	442	48	75	68	11%	-7
30	Medical Mask	175	31	97	91	18%	-6
53	Goat	295	47	82	76	16%	-6
19	Red Mohawk	147	14	78	73	10%	-5
33	Police Cap	203	28	88	83	14%	-5
64	Headband	406	46	82	77	11%	-5
66	Knitted Cap	419	62	83	78	15%	-5
18	Big Beard	146	29	84	80	20%	-4
52	Eye Mask	293	31	78	74	11%	-4
57	Peak Spike	303	42	78	74	14%	-4
24	Straight Hair Dark	148	15	74	71	10%	-3
44	Vape	272	38	85	82	14%	-3
45	Front Beard	273	43	77	74	16%	-3

73	Eye Patch	461	68	78	76	15%	-2
75	Bandana	481	73	74	72	15%	-2
77	Shadow Beard	526	63	92	90	12%	-2
56	Muttonchops	303	35	80	79	12%	-1
42	Blue Eye Shadow	266	34	70	70	13%	0
49	Mustache	288	38	73	73	13%	0
54	Do-rag	300	31	75	75	10%	0
1	Beanie	44	9	349	350	20%	1
69	Mohawk Thin	441	59	68	69	13%	1
25	Straight Hair	151	21	72	74	14%	2
28	Purple Hair	165	26	92	94	16%	2
68	Mohawk	441	53	66	69	12%	3
85	Hot Lipstick	696	89	66	69	13%	3
55	Shaved Head	300	40	70	74	13%	4
23	Clown Hair Green	148	31	83	88	21%	5
29	Gold Chain	169	31	95	100	18%	5
74	Stringy Hair	463	58	68	74	13%	6
67	Mohawk Dark	429	49	68	75	11%	7
38	Front Beard Dark	260	37	75	85	14%	10
17	Straight Hair Blonde	144	30	69	81	21%	12
12	Rosy Cheeks	128	15	69	83	12%	14
2	Choker	48	11	121	140	23%	19
4	Tiara	55	5	120	170	9%	50
3	Pilot Helmet	54	11	143	225	20%	82

