Introduction

Uniswap is an Ethereum based token swapper that trades pairs of ERC-20 tokens. It utilizes smart contracts and has a user-friendly interface. Most notably, it is decentralized and does not use order books to determine asset prices. In this paper we will discover the mechanisms and economics behind Uniswap's decentralized approach as well as explore traditional exchanges in comparison.

DeFi

Decentralized finance, also known as DeFi, aims to help strengthen the shortcomings of traditional financial services. DeFi creates an ecosystem with full transparency on the price of assets, history of transactions, and allows for more freedom in market activity. Without the meddling of middlemen, DeFi products and services aim to replace traditional financial services such as loans, insurance and exchanges to reach a wider market and expand access to capital to all people.

Decentralized exchanges are a new kind of DeFi instrument. They emerged as a novel approach to trading assets. Decentralized exchanges, or DEXs, allow for peer-to-peer transactions to take place on exchange platforms as a rival or crypto equivalent to trading stocks on a stock trading platform or application.

Automated market makers (AMMs) emerged as a type of decentralized exchange. Automated market makers rely on mathematical algorithms to conduct the conditions of smart contracts and act as price oracles for the assets on the exchange. They utilize smart contracts that allow anyone to create a liquidity pool. As participants lend their cryptocurrency to a liquidity pool, their assets are traded automatically in the pool and the lender, or liquidity provider (LP), is incentivized via exchange fees. The algorithms in AMMs allow traders to trade with the smart contracts instead of other traders. They also derive the value of assets in a pool from the specifics of the algorithm that is used.

Uniswap

Uniswap is one of the most prominent decentralized exchanges and automated market makers. It hosts 845 tokens for traders to trade against. There are over $2 billion worth of crypto assets held on Uniswap as of September 2020.

Uniswap utilizes the Constant Product Market Maker model which is an algorithm that uses logarithmic market scoring rules to determine the price of an asset.

The Constant Product Market Maker formula is **x*y = k.** In which, x and y are equivalent to the two different coin quantities available in any given liquidity pool. While, k is the constant.

This formula aims to determine the price of the assets in a liquidity pool where the price is determined by the ratio of x and y.

X and y are inverses of one another. When you increase your amount x, you can purchase more of y, therefore the amount of y decreases.

For example, Alice wants to purchase toilet paper with her USD.
Here, the USD is x and the toilet paper is y.

- There are a total of 10 rolls of toilet paper on the shelf.
- She can purchase 1 roll of toilet paper (y) for $5.
- If she wants to purchase more toilet paper (y), she will need to spend more USD (x).
- The more toilet paper she purchases (y), **the more money (x) she will spend** on it and **the less toilet paper that is left on the shelf (y).**

Or, on Uniswap that is to say, Alice would like to trade LTC for ETH.
Here, LTC is x and ETH is y.

- There is a total of 10,000 LTC (x) and 1,000 ETH (y) so, k = 10,000,000
- Alice wants to spend 300 LTC to purchase ETH.
- The **amount of LTC (x) in the pool is then increased** to 10,300 LTC.
    - It costs Alice 10 LTC to purchase 1 ETH (10,000/1,000 = 10)
- The **amount of ETH (y) is then decreased** to 970 ETH (10,000,000/10,300 = 970)
- The more ETH she purchases (y), **the more LTC (x) she will spend** on it and **the less ETH (y) is left in the pool**.

This equation shows us that the more a trader spends on an asset the less of that asset is available in the pool and that the trader is rewarded fairly for his investment. However, due to transaction fees (0.3% on Uniswap), the reward for investment does not move linearly. That is to say, after a certain amount of money invested, the return on investment will begin to decay. Traders can, however, refer to the features on DEXs to calculate their returns before investing, to see when more money invested is actually more harmful than good.

Mechanisms behind Uniswap's operations

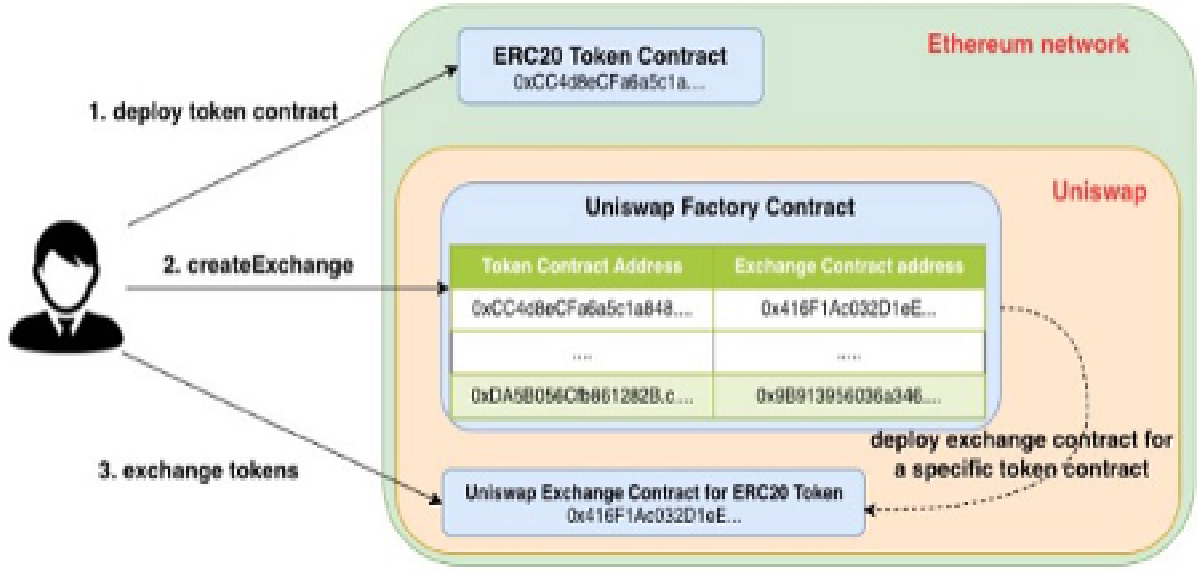
Unlike traditional exchanges, Uniswap does not use **order books.** Order books are a collection of all the prices where the market makers are willing to buy or sell a certain volume of an asset.

Instead, Uniswap utilizes smart contracts to pool tokens and allow traders to trade against these pools.

Uniswap's architecture works by deploying an ERC-20 token contract to the Ethereum network and then uses a **Factory contract** to create an **Exchange contract** for the ERC-20 token. Eventually it allows for a swap between the ERC-20 token with other tokens in the network by using the Exchange contract.

Exchange contracts hold a pool of specific tokens so that traders can trade said tokens against Ether. Token holders can only swap ERC-20 tokens with ETH. Uniswap uses ETH as an intermediary token to allow token holders to swap between all kinds of ERC-20 tokens, not only ETH. So, a token holder could sell DAI to a ETH holder and buy ATOM with their newly purchased ETH.

Factory contracts essentially manage and create these new Exchange contracts. They also manage a map of the token contract addresses and exchange contract addresses.



Source: Ocean Protocol, 2019

Another utilized mechanism by Uniswap is **price slippage.** This mechanism protects traders. Price slippage is essentially the difference between the expected price of a trade and actual price that the trade is executed at. Oftentimes, if there is volatility in the

market, price slippage can cause extreme damage to return on investment. Users can utilize the price slippage feature on Uniswap to protect their trade from a price change that they cannot tolerate.

Market participants & conditions

The main market participants on Uniswap are casual traders or users, arbitrageurs and liquidity providers.

Casual traders and users are those who connect to Uniswap using a decentralized wallet to swap token pairs against one another.

Arbitrageurs in decentralized exchanges act in much the same way that they do in traditional markets. They are market aggregators and take advantage of price movements. On Uniswap arbitrageurs are bots that buy and sell assets at the lowest prices across DEXs. Arbitrageurs take advantage of liquidity providers' pain, by profiting off of a liquidity provider's impermanent loss. However, they do provide some value to the exchange as they generally act as price oracles by providing price information to the exchange.

Liquidity providers (LPs) are important participants in DEXs as they provide the liquidity in pools. Liquidity providers can inject any amount of token pairs into a liquidity pool and are compensated through transaction fees. When liquidity providers inject liquidity into a pool, casual traders are able to swap tokens using the liquidity provided by LPs.

As the size of a liquidity pool grows, the LPs compensation from transaction fees decreases. This happens only when the number of LPs in said pool increases. So, a large liquidity pool with a large number of LPs decreases each LP's compensation. While, a large liquidity pool with a small number of LPs would increase each LP's compensation.

Another factor that helps to increase an LP's return is the trading volume in each pool. If there is a high volume of trades being executed in a pool and a small number of LPs in said pool, then the LP's compensation is high. On the other hand, if the trade volume in a pool is low then LP's will not have high compensation.

Impermanent loss affects an LP's return on investment as well. When an LP provides liquidity to the pool using tokens whose values have decreased since the time the liquidity was provided, the LP is at a loss.

Traditional Exchanges

A centralized market routes all sell and buy orders directly to a single, centralized exchange where the order is matched with an offsetting order and then fulfilled. Centralized exchanges publish the prices of securities and assets and are the only prices that an investor sees. These traditional exchanges act as middlemen between the buyer and seller to minimize the issuance of fraud and bad actors.

The world's first stocks were bought and sold in a coffeeshop in London, England in the 1700's. Stock exchanges began as a means to help merchants trade with one another across borders and to accumulate enough capital to help new and existing ventures raise capital. By providing new and existing ventures with capital, investors were rewarded with a stake in the business and hence became stockholders of that company. When paper shares were created, investors began to buy, sell and trade their stock in companies with other shareholders and investors. The concept of a centralized exchange went on to develop into what we now see as a sophisticated stock trading machine across the globe, such as the New York Stock Exchange.

While centralized exchanges are often thought of as traditional exchanges such (NYSE), most blockchain companies offer centralized exchanges as well. Blockchain companies offering exchange services control the transactions and flow of assets traded on the platform and users do not have access to their private keys. However, many of these companies are learning to leverage decentralization to realize a new type of fully decentralized exchange with DeFi and DEXs.

Centralized/Traditionl Exchange	Decentralized Exchange
Funds controlled by exchange	Funds controlled by user
Not anonymous	Anonymous
Requires KYC	No KYC
Hacks & system failures	No hacks (because nodes are distributed, less susceptible to attacks)
Operating hours are limited	Operates 24/7
High transaction fees	Low transaction fees
More functionality/features	Less functionality/features (no stop loss/limit order)

Uniswap's Advantages & Disadvantages

Uniswap is a novel and bold approach to trading assets. It has gained a lot of momentum and popularity since its launch in 2018. Like all advancements, Uniswap has both its advantages and disadvantages. Let's explore them.

Advantages:

- **Decentralized & Self-custodial:** Uniswap has no single, central authority and gives users the privilege of completely owning their assets.
- **Low trading fees:** Uniswap charges users a 0.3% fee for each transaction on the exchange.
- **No KYC:** This is advantageous because it includes the full population and gives anyone access to a trading platform. It also means, your personal information can never be hacked or stolen because it was never taken from you in the first place.
- **Access to new coin listings:** Uniswap allows any project to list their coin on their exchange, cutting the lengthy diligence process that is seen on other exchanges.
- **Open source:** This is advantageous because it gives everyone full transparency about the platform and the future of its services.

Disadvantages:

- **Transaction failures:** If users select a low gas fee for the transaction and the transaction doesn't go through within the time limit, there is a chance the transaction will fail.
- **Fake coins:** Because Uniswap allows any project to list their coin without conducting due diligence, bad actors will take advantage of the system by publishing their fake coins and trying to profit from them.
- **Cannot exercise limit orders:** Traders don't have the privilege of setting prices to buy and sell at, they are limited to the prices set by the constant product algorithm.
- **Set fee price:** 0.3% is a small fee, but in some cases it may be higher than necessary when liquidity is low.

Conclusion and parting thoughts

Uniswap has disrupted asset trading and given rise to a novel, more inclusive approach to trading. Building on DeFi protocols, the exchange has seen a flooding of assets and hefty trading volumes. Since its founding, Uniswap has spurred innovation across the industry and we've seen new projects and innovations get built and accelerated. Although Uniswap was not the first DEX to launch, it does own over 46% of DEX market share. Surely, we're just barely scratching the surface with this new way of

trading, but what we see for sure is that DEXs are positively impacting DeFi and making financial services stronger in the broken places.