As we begin to loosely explore and specify various types of Anoma applications or applications that may benefit explicitly from intent-centric architectures, prediction markets arise as one such example.

Note that this topic is exploratory and a collection of Notes mixed with some analysis that should serve as a foundation for future blog posts or writing. As such, I may not include all relevant information, thoughts or conjectures. The reader is encouraged to add or point out any gaps that are missed, or not addressed.

What are prediction markets?

Prediction markets are forums for trading contracts that yield payments based on the outcome of uncertain events. There is mounting evidence that such markets can help to produce forecasts of event outcomes with a lower prediction error than conventional forecasting methods.

-Arrow et al., The Promise of Prediction Markets

Onchain prediction markets

In a prediction market, individuals can speculate on the outcomes of future events; those who forecast the outcome correctly win money, and those who forecast incorrectly lose money . The price of a prediction market can serve as a precise and well-calibrated indicator of how likely an event is to occur.

– Peterson et al. Augur: a Decentralized Oracle & Prediction Market platform

Prediction Markets can act as trustless oracles. As a source ofinformation or as a real-time oracle

, prediction markets can be extremely useful.

The vision of a truly decentralize onchain oracle was first put forth by Augur. One key feature is that anyone can create a market based on any real world event.

There are four phases to an augur prediction market;

1. Creation
2. Trading
3. Reporting
4. Settlement

Note that further explanations of how augur works well be left for later discussions. Noted here for motivational context.

Introduction to prediction markets

This section contains notes on Robin Hanson's presentation An introduction to prediction Markets

- presentation

Consider an ordinary market where people trade money for some standard item like a bar of gold, for example. Prices in such markets tend to fluctuate. When trading and storing items is cheap, this attracts speculators, who attempt to guess if the price of the item will rise or fall. If the speculators can guess this correctly, they can make profitable trades; e.g., buy low, sell high. Speculators search long and hard to help them find information about future prices.

For example, If speculators think that prices of a particular item will rise on Tuesdays, then they may buy on Monday and sell on Wednesday. However, doing this will make prices rise less on Tuesday. In general, speculators who bet on information not currently reflected in market prices tend to push that information into the prices. Thus, in active markets, prices tend to embody a lot of information about future prices. In fact, it is usually very difficult to make money consistently betting in these markets. This is a mild version of the so-called "efficient markets hypothesis".

All of these work for markets in natural markets but also for markets in artificial markets. For example, one could buy a token that says, "Pays $1 if Bitcoin becomes the reserve currency of Argentina by June 1, 2024." The future price is set by the outcome of the event happening before June 1, 2024. If you can get enough people to trade in this market, then the current market price should become an accurate estimate of that future price; that is, that Argentina will adopt Bitcoin as their reserve currency by June 1, 2024.

Prediction Markets Beat Alternatives

While we have had speculative markets for many centuries, they were often created for other reasons and have only aggregated information as a side effect. However, in the last few decades, people have started to make prediction markets.

Prediction markets, which are speculative markets created to harness this information effect on topics of interest.

Thus far, there have been at least a dozen head-to-head comparisons where in both speculative markets and some other institution like polls or committees, estimated the same thing at the same time using comparable resources, resulting in speculative markets typically more accurate than traditional methods. For example, in [Prediction Market Accuracy in the Long Run

](https://www.biz.uiowa.edu/faculty/trietz/papers/long%20run%20accuracy.pdf) (Berg et al., 2008) out of 1000 comparisons between election polls and markets, the markets were closer to the truth about 75% of the time even though market participants were not representative of the electorate and markets moved less than polls did in response to debates.

Other papers which add evidence to the axiom “prediction markets are generally more accurate than traditional polling or committee-based methods” in predicting outcomes.

- Combinatorial Prediction Markets
- Searching for Positive Returns at the Track: A Multinomial Logic Model for Handicapping Horse Races
- Do asset prices reflect fundamentals? Freshly squeezed evidence from the OJ Market
- The Complexity of price discovery in an efficient market: the stock market reaction to the challenger crash
- Prediction Markets
- Markets as information Gathering tools

As a result many organizations create internal markets to answer questions of interest, such as weather they will make project deadlines or which new projects they should start.

Advantages

Prediction markets have many advantages over traditional or other ways people aggregate information into consensus estimates.

- Markets give numerically precise estimates
- When there are markets on many questions, markets tend to be consistent across all questions
- Price estimates are frequently updated if trading is frequent
- Prices are difficult to manipulate in contrast to other methods to create consensus estimates
- Markets are robust, in contrast to other mechanisms that can be sensitive to the quality of participants
- Markets are at least as accurate as alternative

Some have framed the issue as prediction markets revealing the wisdom of crowds, with crowds better than experts. This is not right. The idea is to entice participants who know something about a particular topic. The main argument in favor of speculative markets is empirical; when tested, they work. Speculative markets offer simple direct incentives for accuracy; incentives to trade or not trade. Traders have incentives to find and fix any biases or arbitrage opportunities they find in markets. Markets do not need individual traders to be rational.

Prediction markets are a simple powerful way to let a large diverse community collect information and merge the information into precise estimates that everyone can use to make their decisions.

Advanced market tricks

Prediction markets may look simple, but we can do much with them once we learn a few simple tricks

In the simplest prediction market, one trades $s for assets of the form pays $1 if A is some claim. The asset ratio in these trades is the market price, which can be treated as an estimate of the probability of A.

$1if A ⇔ p(A) $1

If we use a conjunct A & B where B is another claim instead of A, we can get a probability of that conjunct.

$1 if A+B ⇔ p(A+B) $1

And if users trade the A&B conjunct asset for the A asset, then that price should be the ratio of the two prices, which is the conditional probability of A & B.

$1if A+B ⇿ p(B|A) $1 if A

Thus, we can make markets in conditional probabilities. Instead of starting with an asset that pays $1 if some discrete event A, we can use an asset that pays proportionally some continuous variable x that is restricted to lie in the range of 0-1. In this case, prices can give us expected values for x and conditional expected values for x.

$x ⇿ E(x) $1

$x if A ⇿ E(x|A)*p(A)$1

$x if A ⇿ E(x|A) $1 if A

In an ordinary market traders must either post an offer and wait for someone to accept it or accept an offer that someone has posted. When traders are rare this can lead to long delays.

A solution is to create an automated market maker (AMM) who always has two posted offers - one to buy and one to sell with a small price difference between then and a simple rule for how price responds to trades. With an AMM any trader can make a trade fast when other traders are rare.

In an ordinary prediction market trades are zero sum. Whatever one side gains another side loses. Theory says that rational risk averse traders without insurance needs would not trade in such markets. However, humans do trade in such situations. There are a few ways to subsidize these markets to make sure that all traders can gain.

- Set the parameters of an AMM so it loses money on average as price moves towards its final resting price and set a limit on how much it will lose. This AMM could be funded by the parties who want the information that the market prices can reveal.
- Alternatively a subsidy can come from manipulative traders. Traders who are willing to lose some money in order to distort the consensus price that everyone will see. Not only do manipulative traders subsidize other traders, but on average their presence increases price accuracy.
- Imagine a simple prediction market on weather a particular project will make its deadline. We might worry that project personal will sabotage the project to win some bets. A simple fix is to start everyone who can harm the project with a positive stake in the project, and them prevent them from letting their stake go negative. Now traders can reveal information via their trades and have no incentives to sabotage.

User interfaces

By using AMMs we can create an edit based interface where users think in terms of editing a probability distribution instead of trading. For example, a user may see a distribution that they can grab from one point and drag to another point. There trading assets would change automatically. The next user would see this new curve and could reverse this new edit if desired. In addition, users could be allowed to edit a probability distribution over a large tree of possibilities. Specialists may dive deep and generalists would stick with higher level predictions. In a combinatorial prediction market, users can bet on any of a very large set of possible combinations of some basic set of questions.

A few years ago Robin Hanson and some colleagues created a conditional prediction market where all members were represented by a Bayesian network. Users could edit any number via radio buttons or by moving a slider. User changes would then be propagated through the bayesian network using Bayes rule to exactly update both ht probability shared by all the users and the representation of the user’s assets. The project made sure no one could ever make a change requiring a bet they could not pay for in all possible scenarios. Users were also afforded the ability to use a map to make changes to the network structure and edit marginal probabilities.

Conclusion

While most all real prediction markets today are simple, the field of prediction markets contains many possibilities.

Analysis

Now that we have a high level understanding of prediction markets lets briefly discuss a couple niche use cases. Prediction markets historically have been used and studied regarding high stakes political elections. There has also been work done in weather predictions, flight delays, etc. There really is no limit to what one could attempt to predict.The nice thing about prediction markets is also they give everyone who is a niche expert an opportunity to help arbitrage markets with expertise.

For example think of a market that accurately predicted the local weather in Berlin. If you live in Berlin and think the market is off you can bet it will rain say and if it rains you capture the upside. If it doesn’t rain then you don’t have to bare the cost of an umbrella or additional time in drying your wet clothes.

In the Anoma architecture, users will have intents to predict things. The beauty of this as I already mentioned, is you do not need to rely on “solvers” to provide oracle updates on many markets now because users will want to arbitrage them

constantly. So, in a sense, users are better positioned to capture prediction MEV (highly debatable) - more important it allows the solving market to stay decentralized if incentivized correctly.

Conditional predictions are another key unlock of prediction markets.

There is not much social value in having slightly more accurate predictions of who will be the next president. But there is

a lot of social value in having conditional predictions

: if we do A, what's the chance it will lead to some good thing X, and if we do B instead what are the chances then

? Conditional predictions are important because they do not just satisfy our curiosity; they can also help us make decisions.

– Vitalik, [Prediciton markets: tales from the elections

](https://vitalik.eth.limo/general/2021/02/18/election.html)

Given that we decide to use a promise graph system, will we ship Anoma faster than if we do not? Notice this question deviates from a simple question of When will we ship Anoma. The question informs the strategy based on a predicted outcome given the strategies implementation.

Additional Resources

Helpful Links & Resources

- The Promise of Prediction Markets
- Designing Markets for Prediction
- Decentralized Common Knowledge Oracles
- Prediction Markets: Tales from the Election
- SchellingCoin: A Minimal-Trust Universal Data Feed
- Prediction Markets: Does Money Matter?
- Augur: a Decentralized Oracle and Prediction Market Platform (v2.0)
- Robin Hanson: "Take the gold!" | Future of Prediction Markets speech (Manifest 2023)
- An experimental test of combinatorial information markets
- Shall We Vote on Values, But Bet on Beliefs?
- Idea Futures
- An Introduction to Futarchy
- Prediction Markets for content curation DAOs
- Trade-based Asset Model using Dynamic Junction Tree for Combinatorial Prediction Markets
- Combinatorial Information Market Design
- Combinatorial Prediction Markets for Fusing Information from Distributed Experts and Models
- Probability and Asset Updating using Bayesian Networks for Combinatorial Prediction Markets
- Hybrid forecasting method for wind power integrating spatial correlation and corrected numerical weather prediction
- Gaming Prediction Markets: Equilibrium Strategies with a Market Maker
- Dr Wei Sun wins prize in Climate Prediction Market competition
- Augur Docs
- Polymarket Docs
- Polymarket CTF-Exchange
- Airline Flight Delay Prediction Using Machine Learning Models

- Prediction Markets vs. Polls - an examination of accuracy for the 2008 and 2012 Elections