

FORWARD

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Abstract

In the Digital Age we have seen an increase in inactivity particularly sitting. Knowing the health risks this poses, we came up with a system to incentivize participants to incorporate more walking into their daily lives.

In our concept we use data provided by various applications and devices (e.g. smartphones) to measure the amount of activity a person exerts and reward this with tokens that can be used in a raffle. In the raffle, prizes are provided by external sponsors which gain from participating by generating publicity and are allowed to advertise their products or services in this regard.

On the technical side we implemented an ERC223 compliant token together with an app-interface and a smart contract with a simple data stream, representing the distance walked, to show the basic structure of obtaining tokens through activity.

In this report we also outline problems and issues we had while working on this project and provide an outlook on the features that a completed version should have.

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Introduction

Why walk? The purpose of our project is to increase incentives for being more active. Although health is mainly controlled by the individual, lack of exercise has multiple different effects on one's mental and physical health such as an increased risk for obesity. A high amount of leisure-time sitting enhances obesity risk regardless of one's other activities¹. Knowingly obesity leads to various other diseases. Hence, employers, insurances and the general public have an interest in keeping one's citizens healthy and active. With the help of tokens, which can be generated by physical activity, in this project mainly the walking motion, one creates an incentive for physical movement. The number of steps can be collected from different applications and devices and are standardized in order to provide weighted data for a smart contract on the Ethereum Blockchain.

On the one hand, companies can participate by being a sponsor and providing prizes that can be won as part of a regular raffle. This gives the tokens a value. Users can use their tokens as raffle tickets or donate them to other users.

On the other hand, companies can get access to tools allowing them to make sense of the data stored on the blockchain.

By being more active one not only reduces stress and various health risks. Moreover, by replacing bus rides or car trips with a walk, or in a more general application with a bike ride, one's ecological footprint will be smaller.

Challenge

Digital age has brought many advantages. Communicating face-to-face can be done across the world, as long as one has Internet access. Over a century ago machines have replaced the ordinary factory workers and helped farmers out to produce more crops. More and more moves the working force from the second to the third sector in an economy. In a first world country like Switzerland only a fraction of its labor force works in the agriculture sector. About a fifth works in the industrial sector and the rest in the service sector². A large part of the labour force in the third sector spend their working time sitting at a desk. Even students sit a long time every day, listening to lectures or studying. Furthermore, for one's convenience many use a car to commute to work, which is neither good for the individual's health nor good for their ecological footprint.

¹ Chau Josephine Y. et al. (2012).

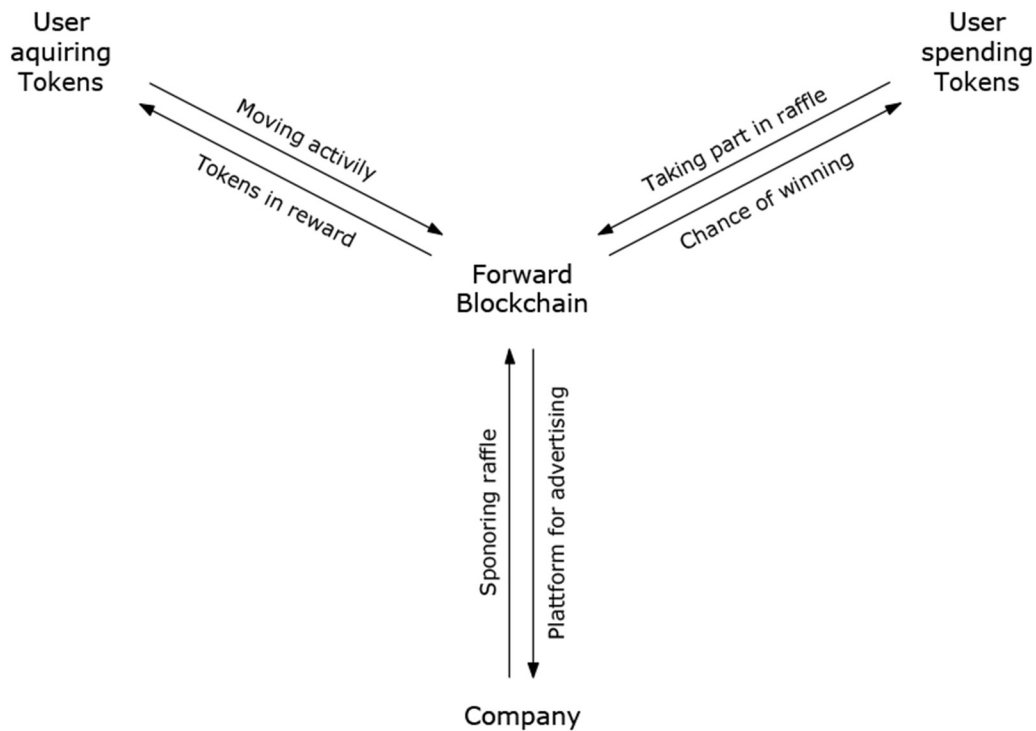
² Statista, 15.02.2018.

The main challenge in this project is to increase people's physical activity and therefore decrease various health risks. Exercise not only benefits physically but also helps to reduce stress. Not only should each individual be keen on preserving one's personal health but also the government, insurances, employers and the community as a whole.

By combining a reward system for users and the possibility to either receive information or advertise, one can build a platform where its users are remunerated with tokens for their physical movement.

Conceptual solution model

Overview



The graphic above shows a simplified model of the whole system.

The main players in this project's concept are the FORWARD company, the users and the external companies, divided into sponsors and companies interested in the user data. The FORWARD company's main goals are building and maintaining of the entire platform, as well as bringing users and external companies together. FORWARD's influence will diminish over time.

The basic idea lies in measuring a user's movement and then credit an according amount of coins to his account. To incentivize the need to obtain tokens, it was decided to implement an internal and external bounty system besides the attainment of tokens. The internal bounty system is based on sponsorships which provide possible prizes for the raffle and the external one on interest of companies, e.g. employers, who want their employees to be healthy and hence more eager to work. Employers can create their own incentives such as challenges among the workers or an event after a certain number of tokens is reached.

To prevent a user from hoarding tokens and an ever-increasing amount of tokens, these tokens lose value over time and the lost tokens are returned to the administrator. For users who do not want to take part in the raffle there is an option to donate their tokens to someone else.

Conceptual challenges lie in how to measure movement and how to actually incentivize the participant to collect these tokens.

Measurement of activity

This part addresses the first difficulty mentioned above. Measuring participants movement can be done in several ways. Almost every modern smartphone is capable of measuring how many steps one takes during the day. This information is often retrievable via an application on the smartphone or a dedicated browser interface (e.g. STRAVA).

Therefore, creating a new smartphone application might not be necessary. Companies that are collecting movement data of their users already exist. If those companies are eager to be part of the *FORWARD* ecosystem, they have to make slight changes to their front- and backends of their applications in order to ensure the collection of valid data. These changes vary in each case and reduce fraudulent behavior of certain users.

Data accessing

The following sections contain the information about what the smart contract is used for. However, not everything described below is, due to complexity, implemented in the actual smart contract (code) yet.

To access the data, there is a co-working with already existing applications. Every new motivated walker willing to use *FORWARD* has to register - enter an email address and the information needed to access the external applications server (e.g. access data for STRAVA) - and thereby create an account on a private and secure *FORWARD* server. By creating an account, the user is provided a blockchain address, which is then stored on the server as well. For every newly created account *FORWARD* executes the smart contract and from there on the system works automatically.

Approximately once a day the contract gets the number of steps each user has taken from an external server via an API using the Oraclize interface. The number of steps is then converted to coins, which are assigned to the user's blockchain address, as a reward for walking (this procedure is described in the "coins distribution" chapter). The user can then check his coin balance on the company's website.

Coins distribution

How many steps do people walk in a day

There are different opinions about the minimum number of steps a person should take each day. A widely accepted number used as a benchmark are the magical 10'000 steps a day. There is still a lot of discussion going on whether the 10'000 steps actually match a healthy lifestyle. The National Center for Biotechnical Information suggests the following connection between daily steps and activity³:

Number of steps	< 5'000	< 7'500	< 10'000	< 12'500	> 12'500
State of activity	Sedentary lifestyle index	Low activity	Somewhat active	active	Highly active

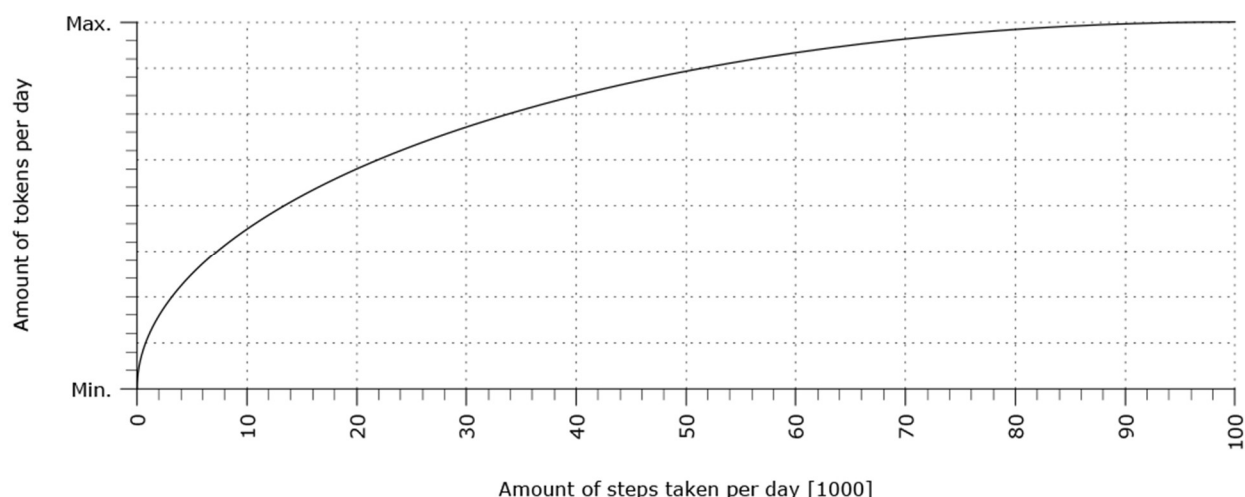
In what order does the smart contract credit coins to a user's account

Approximately once a day, the contract evaluates the number of steps a user has taken during the last time period. This number is then mapped via a distribution function to another value - the so-called fitness score. It represents the average amount of steps the user has taken per minute.

In a first step the fitness score is only implemented as a representation for the steps taken, but it could also be used for many other concepts, such as different activity measurements.

Since the primary goal is to motivate people to simply increase their daily movement e.g. generally walking more, and not to reward people for doing an extreme amount of sports, the mapping function converting steps to coins is not linear. Multiple algorithms are used to compute the amount of coins a user receives. These algorithms must first be tested and fine-tuned during test programs to ensure that every user is treated fairly, and the number of motivated users is maximized.

³ Tudor-Locke (2004).

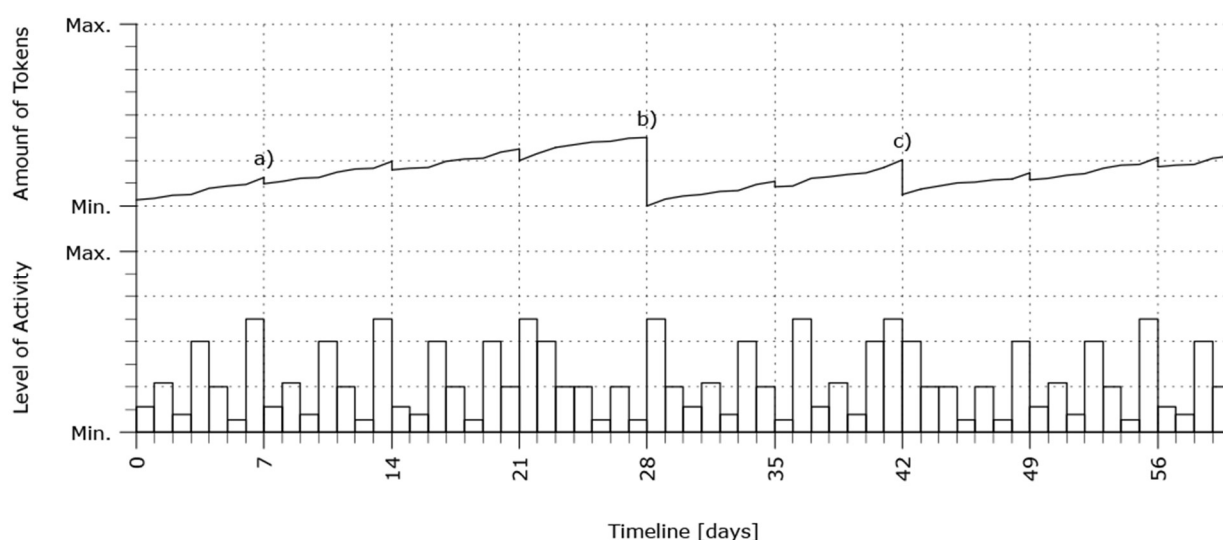


There are different sectors (e.g. below 1'000 steps, between 3'000 and 6'000 steps, 6'000 to 9'000 steps and so on). Each sector has its corresponding computing method, which is designed in such a way, that it gets more difficult to obtain additional tokens, the higher the user's fitness score is.

Lifespan of a token

The coins on a user's blockchain wallet can be used in several ways, which are presented in the "incentivizes to obtain tokens" chapter below.

In addition to obtaining tokens, there is a way for losing them as well - by keeping them for too long in your account. Tokens lose value over time. In particular, tokens are degraded by 10 percent each week (a). This encourages users to use their tokens either in the raffle (b) or donate them to another user (c). This should prevent users from hoarding the tokens, and thereby limiting new users' chances to ever obtain an equal amount of coins as a user already participating for a longer time period.



Incentives for obtaining tokens

There are two main incentives for a user to participate in the *FORWARD* ecosystem: First, he can use his tokens in a weekly raffle where he has a chance of winning a reward. This reward can be either a physical object, service or monetary benefit. The rewards are sponsored by companies not related to *FORWARD*.

The second benefit for a user is the verified proof of his physical activity on the blockchain. It might be beneficial for a user to share this information with other companies.

Sponsorship

Each year more than 60 billion U.S. dollars (2016) are spent on sponsoring worldwide⁴. By far the largest sponsoring market is the sports sector. This is mainly because of the high number of participants and fans one can reach by sponsoring an event, team or single athlete.

For such enterprises willing to promote their brands, this project offers a platform to reach a wide target audience. Official sponsors sign a contract limited to a one-week lifespan. *FORWARD* provides space on its website and social media platforms for advertisement dedicated to the weekly sponsor. Multiple smaller companies might team up and combine their resources to be able to contribute the demanded value to the *FORWARD* ecosystems.

In return the weekly sponsor pays a small fee to cover parts of the running costs generated by user interactions on the network - such as transaction fees and costs to store the data. They also provide the rewards for the weekly winners.

Raffles - Internal bounty system

One token can be seen as one entry ticket for our weekly raffle. A user can choose how many tokens he wants to put into the pot each week. The tokens he did not assign to a pot will be taken to the next week except ten percent of those tokens, which, as mentioned above, are subtracted approximately every week.

With each token put into the pot the chance of winning rises. Therefore, the logic is simple: The more you walk, the more tokens you receive and the more tokens you put into the weekly pot, the higher your chance of winning.

The winner is drawn by a smart contract with no human interventions. The winners will be notified via email.

The number of participants, a user's probability of winning and other useful statistics concerning the ongoing raffle is shown in a user's account once logged in.

⁴ ESP Sponsorship report (2016).

Donations

FORWARD does not only aim at encouraging people to be more active, but even further at incentivizing social thinking. Therefore, it is possible to donate one's coin to another user. By doing so, users can support their companions, family and friends.

Supplementary to support good companionship, the donating systems does have another virtue. If trading tokens was a possibility within the system, wealthy users could be tempted to buy instead of earning their coins. By not giving a financial incentive to donors, we hope to dissuade such behavior.

Companies - External bounty system

Employers or insurance companies (later referred to as employers) have an interest at keeping their employees, respectively their customers, healthy. Through this platform they can implement various internal campaigns and an own reward system. Employers have the ability to register on *FORWARD*'s website as employers, giving their company's name, an email address and the number of participants or users, whose data they wish to receive. Depending on the number of participants they have to pay a monthly fee, which, as well as the sponsors, contributes to cover the finances.

On the user's website users are able to create IDs which can be forwarded to their employers. This means every user has to explicitly express the will to share his activity data. Otherwise the company, or any other interested party, cannot get hold of any data, so that a user's individual need for privacy can be met. Those IDs are independent from the wallet address on the blockchain and can be deactivated anytime. With this external bounty system, the user has an additional incentive to move, respectively walk more.

Coding Part

Smart Contract

As a part of the project, we have also implemented an ERC223 compatible token and a smart contract built upon that idea. ERC223 is a standard which makes the token compatible with various things. The language we used for this is Solidity and the IDE used for this was Remix and Oraclize Dev Center.

The code for the ERC223 compatible token was used from the GitHub user Dexaran⁵ and edited slightly by adding small features for our purposes.

The smart contract works the following way. There is an administrator, who gets all the tokens in the beginning. The administrator can add participants, in which process they get some newly created tokens. The participants have some fitness data, in the implemented version the number of steps. With these data, a fitness score is developed according to a formula. The administrator collects the fitness data of the participants and calculates their fitness score. Depending on that, the participants receive some tokens, which is implemented in a progressive way: if the fitness score is higher than a minimal value, then for the higher value they get less. This is especially to motivate people who do not exercise that regularly. There is also a simple system how they can use their tokens: they can bet their tokens each week, and the one who bets the most wins the prize. Each week, when the administrator collects the data, he also calculates the winner. To motivate participants to invest, each week they also lose 10 percent of their tokens. Currently, the fitness data are some dummy values in the basic version, in the second, more advanced version, we access an external url to receive the data which is implemented with Oraclize. Using Oraclize, we can store the data on our data center offline and the administration only needs to access the data each week to check all the participants' fitness scores as shown above.

There were various difficulties which arose during the implementation. First of all, Solidity is a relatively new programming language because of which some features cannot be implemented well and finding out how one could do something is also more challenging than with a programming language like Java, where there is a lot of material on the Internet. We also used this language for the first time this week, which did not make it easier. We had, for example, difficulties building on additional smart contract which forces the administrator to give tokens and reveal the winners each week but have added the theoretical ideas to the code as comments,

⁵ Dexaran, Github.

so currently it is only implemented that the administrator can only do this once every seven days.

As a result, we could not implement many ideas within two days, but we added in the comments how we could further improve the code with various iterations. Most features, e.g. the calculation of the fitness score are done in a general way such that it can easily be edited. The main goal would be to implement the ideas developed above in this document, but because of implementation and time issues, this smart contract is a much simpler, and partly even differs significantly from the developed concept.

Our main goal for this part was to create a basic version which runs and works the way we want it to and to be able to iterate through that systematically. Our code can be found on GitHub.

App - Interface

Concurrently to the theoretical approach we decided to also produce a small but functioning prototype of a mobile application enabling interactions with the smart contract deployed on the blockchain. The app was written using the Java-API web3j available on Github and Android Studio as an IDE.

Our original goal was to implement interactions with our main smart contract. But after experiencing unexpected problems with basic wallet creation as well as utilization and missing documentation of the web3j API we decided to create a simpler version of the smart contract with tokens. This was then able to interact with the app as a proof-of-concept for a more advanced version. In the finished prototype the user is supplied with a unique identifier and is able to request tokens of a randomized amount. After experiencing problems with Oraclize to receive the random values from an external website used to simulate actual data from a provided server, we settled on simple block height values as a random number. After requesting tokens, the user can check his balance as well as sending tokens to other users using their ID. To achieve the desired actions the app issues a transaction to the Rinkeby-Testnet using the webj API which is a lightweight Java API for web3 interaction. The basic functionality works as we wanted. The Android Studio Project can be found on GitHub.

Evaluation

Evaluation on Concept

Centralized vs. decentralized version of the smart contract

Currently *FORWARD* is storing the participants data and has to actively interfere in several ways, such as executing the contract and store the user's data. So, it is not yet an entirely decentralized solution. In an upgraded version, *FORWARD* would ideally not be needed that much or even at all, once the system is set in motion. A possible solution to achieve that, would require an updated version of the contract.

One hypothetical scenario to create a smart contract that meets the requirement of decentralization better shall be described as follows.

As long as the contract automatically checks the steps and allocates the tokens, the users access data for the external server need to be stored in a place, where the contract can always access them. This means a *FORWARD* company server seems indispensable. If, however, the user himself and not *FORWARD* would execute the contract, some issues could be solved. At the current state the company does three main things: Executing the contract, storing the user's access data and gathering financial support for keeping the platform operational.

In an updated version, where *FORWARD* does not store any user data and does not set the contract in motion, the user interface must be adapted. A button, for updating the account's balance and an option for adding or changing personal user data, must be integrated.

By doing so the balance would not be checked automatically once every day, but only when the user wishes to do so. There will be a maximum number of requests a user can send during one week to limit unnecessary transaction costs. Since the smart contract cannot collect the data without the user's access permission, the contract would have to ask for it via the web or app interface. The user then types in the login details every time he wishes to update the token balance. This might make things more complicated for the user, but it also brings the possibility of keeping one's login details private and not having to share them with a third party.

Is sharing your data save?

Sharing data is always a give and take. Depending on the importance of data, sharing might be helpful to society. Furthermore, most people are quite careless with their information and sharing habits on the Internet. Even though the account balances are public on the Ethereum blockchain, it will be very hard to link those accounts to a real-world profile. Even with an

activated ID, which is just pointing on a specific account on the blockchain, one does not know which person is the owner.

In future implementations statistics and rankings could be implemented. Hence, receiving tokens becomes more competitive and users are encouraged to walk more. This will of course all be optional for the user, as it might make it easier to link him with his account.

Fraud protection

Imagine the following scenario: A user opens multiple accounts on different mobile devices. He then uses a harness to attach the devices to his two dogs (the example also works with other animals or moving objects such as a cars) The dogs are walking around and accumulate steps on the accounts configured on each device. The owner then collects the tokens in the end of the week by donating them to his own account or using the tokens in the weekly raffle directly from the “dog-accounts”.

How can we stop such people from misusing the system? In the following section we are briefly listing ideas limiting fraudulent behavior:

To unlock an app which is part of the *FORWARD* network one has to provide their fingerprint. This helps to ensure that the moving object is the valid account user.

By using AI technology individual walking patterns can be learned and be used to report unusual behavior. After reaching a threshold of unusual behavior the user could be asked to unlock the app with their fingerprint again.

Individual walking patterns can be compared to patterns contributed by other users. Different moving objects such as dogs or cars have different motion patterns and can be detected by the system.

Devices within a certain radius (for example 10 meters) must have a different movement pattern to ensure that one person is not carrying multiple devices.

By fixing the number of tokens an account can receive via donations each day or week, the process of moving tokens will be more time consuming - cheating will be less attractive.

Individual accounts could be block entirely or for a certain period if the system finds strong and repetitively fraudulent behavior.

There will always be people trying to game the system. There will be people that succeed in doing so. *FORWARD* must improve their countermeasures constantly to ensure a fair system for all participants.

Token trading

Even though trading of tokens is not directly implemented into the system one might still be able to trade them on a crypto marketplace provided by a third party. Even though this is against our initial goal of a sustainable user - user interaction via donations - such behavior is almost impossible to prevent. Bought tokens will have the same properties as tokens received via a donation. They can be used to participate in a raffle but will not be seen as honestly “earned”.

There are various factors defining the market value of one token.

The total number of tokens in circulation: This number might directly depend on weather conditions and the popularity of rewards donated by our sponsors. Because the weather is not the same on the entire globe this effect should even out. Changes in weather should still be considered a non-neglectable factor as the number of active users in summer and winter might be different.

Total value of rewards: Depending on the total value of rewards and number of participants it won't be economically viable to buy tokens on a marketplace. It might be cheaper to buy the desired product directly in a shop, without the risk of losing your stake with no return.

Compensations for different age groups?

Currently the entire concept is based on the fact that walking or moving requires the same amount of effort for everyone. As a first step towards more equality, the system takes differences in age to account. Health risks and problems increase with increased age. Therefore, it takes more effort to move and live a healthy lifestyle as an elderly person. To include the elderly in the target group of the *FORWARD* project, an age compensation can be implemented. For healthy senior citizens, 50 years and older, the recommended amount of steps is usually about 1,000 to 5,000. This is significantly less than the recommended 10'000 for an adult between 20 and 50 in age⁶. To simplify the step count to fitness score conversion, one could divide the users in age groups. Users in different age groups benefit from a scaled fitness score. This could imply an up to 80% scaled fitness score for the oldest participants.

This additional feature needs more information from the user's side. In particular his birthday or year of birth. However, this feature could be voluntary and not necessary during the initial registration process.

⁶ Tudor-Lock (2004)(Cited by: Walkabout.)

Using data of multiple different apps

A possible future extension would be a feature to take the data from different apps and thus have a larger audience. However, one should not forget, that varying apps use different algorithms and might not end up with the same step count. Some apps might take advantage of this platform and manipulate the data. Therefore, a fair way to evaluate the right amount of steps needs to be found. This can be done by real life experiments, such as using multiple apps on the same device and then compare the data, or by taking averages and comparing them.

Nonetheless, *FORWARD* must find a way to verify the user's birthday to minimize cheating attempts.

Including more activities

A further application to be considered is the expansion to other activities such as riding a bike, swimming, working out in the gym and other physical activities. *FORWARD*'s goal is to generally incentivize movement and a healthier lifestyle. A reliable tracking tool for these activities is needed to embed various physical activities. There are already a few apps on the market which track biking or swimming (e.g. STRAVA). This means these two activities could easily be implemented into the application. Additionally, one would have to figure out a way to calculate the fitness score fairly because e.g. swimming takes more effort than biking for the same distance. One way could be the use of a conversion factor.

Allowing additional movement patterns will make it more difficult to detect fraudulent behavior but will at the same time allow more people to be part of the system.

Code evaluation

To evaluate the smart contract, one should first click the button "create a new participant" to create a new participant, the administration, who is the message sender. Then we can see the initial status of all the added participants using the participant button, including steps, etc. After one minute (for testing), the administration is then able to access the steps of all participants and calculate the corresponding fitness scores of them calling the test fitness score function. After that, the transfer function defined in ERC223 protocol would be invoked to transfer money according to our formula. Then each participant would feel free to put their tokens to the bet pool and the get winner function would show who should be the winner.

While for the oraclize part, we simply read data using oraclize query function with a url and get the data in json format. After receiving the data, we can parse the strings and get the

corresponding address and steps of participants. Therefore, the participants mapping would be updated using the received data.

Conclusion

Ultimately, the goal of our project is to get people to live a healthier lifestyle with the side benefit of achieving a smaller ecological footprint. By using the peer-to-peer processes of a smart contract we are able to share and distribute tokens and thus provide motivation to incorporate exercise into the daily routine.

The implemented prototype already showcases this important functionality and the ERC223 token provides a good basis for further development. Subsequently the implementation can be improved by incrementally developing the features outlined in the concept.

Furthermore, our project is a good example of the potential decentralized applications and smart contracts can have in the future. Especially with the use of smart contracts on the Ethereum blockchain and the documentation and ease of use of Solidity even small teams with little experience can develop and deploy their projects quickly without the need to cater to an established enterprise to fund and publish their applications.

This provides great opportunities especially for community driven projects where many small actions by unrelated participants can be joined together to fulfill a bigger goal. With this 'grassroot' approach issues can be tackled quicker and with more input from the groups that are affected the most.

Taking a step forward to improve the living conditions for all people involved.

Statements

The software code which is part of this report is open source and available at <https://github.com/ETHBiots2018/FORWARD>.

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