

SAMPLE POSTERS



An Advanced Parking Navigation System for Downtown Parking A Practical Implementation

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Abstract

Private vehicle penetration rate in urban area is rising at a higher rate than ever. Consequently, finding parking space has become drivers' daily headache. This research aims to mitigate the problem through establishing a real-time and intelligent navigation system between drivers and parking spaces. Adopting a two-sided matching algorithm, the system matches the drivers to their most appropriate parking spaces based on their real-time locations and parking preference, and thus preventing multiple drivers from being guided to the same parking space. This research will first build a fully functional, performance optimized backend to implement the two-sided matching algorithm and then develop a native APP on iOS mobile platforms. The APP will guide drivers to parking spaces according to their preference by considering their real-time position and traffic condition information. For demonstration, parking space occupancy will be simulated through a randomized algorithm since real-life parking data fetching requires sensor installation and serial communication, which is beyond the scope of this research.

Significance

Finding parking space is becoming a nightmare for drivers in urban area. For instance, drivers in some major cities may have to wait up to 14 min to find an available parking space (see Shoup 2006). As Caliskan (2006) pointed out, 44% of the traffic is searching for parking spaces in the district of Schwabing in Munich, which causes 20 million Euros in waste every year. To reduce drivers' cruising time, this research implements an advanced parking navigation system that can guide drivers to open parking spaces and substantially reduce their cruising time for parking.

Though many studies have focused on developing an advanced parking navigation system, most of the existing systems are not ready for practical implementation.

Problems of current solutions

1. Expensive computation
2. Strong assumption
3. Disclosing drivers' private information

Methods

The Two-Sided Match

We consider a downtown area where there is a finite number of parking spaces. Let $V = \{v_1, v_2, \dots, v_m\}$ and $S = \{s_1, s_2, \dots, s_n\}$ denote the set of drivers cruising for parking spaces and the set of open spaces at time t . Based on the current location, final destination and other personal favors (e.g., parking price, safety, etc.), open spaces are ranked based on each driver's preference. On the other hand, each open space has a preference ranking for cruising drivers, which is measured by the travel time for drivers to arrive at the space. That is, a space would prefer a driver who is closer to the one who is farther away.

Algorithm 1 The driver-oriented deferred acceptance algorithm
Step 1: Each driver requests her most preferred space.
Repeat
Step 2: Each space keeps its most preferred application (if any) and rejects the rest (if any).
Step 3: Each driver who was rejected at the previous step requests her next acceptable space (if any).
until no driver requests in the last step.

Distributed Stable Match

Although the classic driver-optimal deferred acceptance procedure in Algorithm 1 can be easily deployed centrally, it is not desirable, as it needs to disclose drivers' private information (i.e., preferences regarding spaces and final matched spaces). Accordingly, we present a distributed stable matching procedure (Brito and Meseguer 2005) to minimize the centralized coordination.

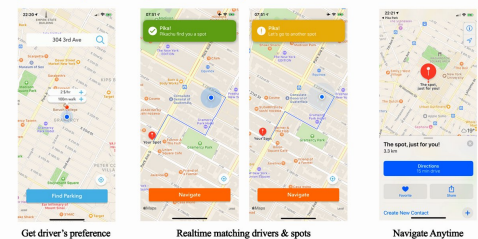
Specifically, it consists of two procedures, including driver and space procedures (see Algorithm 2 and Algorithm 3), and they are executed iteratively and asynchronously. It is closer to the one who is farther away.

Algorithm 2 Driver procedure
 $v \leftarrow \text{unmatched};$
 $\text{terminal} \leftarrow \text{false};$
while $\neg \text{terminal}$ **do**
 if $v = \text{unmatched}$ and $P(v) \neq \emptyset$ **then**
 $s \leftarrow \text{first}(P(v));$
 $v \leftarrow \text{dis}(v, s);$
 $s \leftarrow s;$
 $\text{msg} \leftarrow \text{getMsg}(s);$
 switch msg.type
 $\text{accept: do nothing;}$
 $\text{reject: } P(v) \leftarrow P(v) - \text{msg.sender};$
 $v \leftarrow \text{unmatched};$
 $\text{stop} \leftarrow \text{terminal} = \text{true};$

Algorithm 3 Space procedure
 $s \leftarrow \text{unmatched};$
 $\text{terminal} \leftarrow \text{false};$
 $\text{dis} \leftarrow \emptyset;$
while $\neg \text{terminal}$ **do**
 $\text{msg} \leftarrow \text{getMsg}(s);$
 switch msg.type
 $\text{request: } v \leftarrow \text{msg.sender};$
 if $v \leftarrow \text{dis}$ **then**
 $\text{sendMsg}(v, s, \text{reject});$
 $\text{dis} \leftarrow v;$
 if $s = \text{unmatched}$ **then**
 $\text{sendMsg}(v, s, \text{accept});$
 $s \leftarrow v;$
 $\text{dis} \leftarrow \text{dis};$
 $\text{stop} \leftarrow \text{terminal} = \text{true};$

Implementation

The two-sided matching algorithm ensures the user gets the most appropriate spot by real-time matching drivers with parking spots. If the newly-added user is closer to a parking spot that is already assigned to a further driver, the system will rematch the drivers and spots because the parking spot prefers a closer driver. This mechanism not only serves the parking spot's preference but also prevents the further driver finding his spot has already been taken by the closer driver by the time he arrives.



Get driver's preference

Realtime matching drivers & spots

Navigate Anytime

System Performance

Based on our simulation system which simulates a realistic environment including app-users and normal non-app users, the app decreases the average cruising time by 59%, and both the parking space utilization and the percentage of successful trips improve greatly.

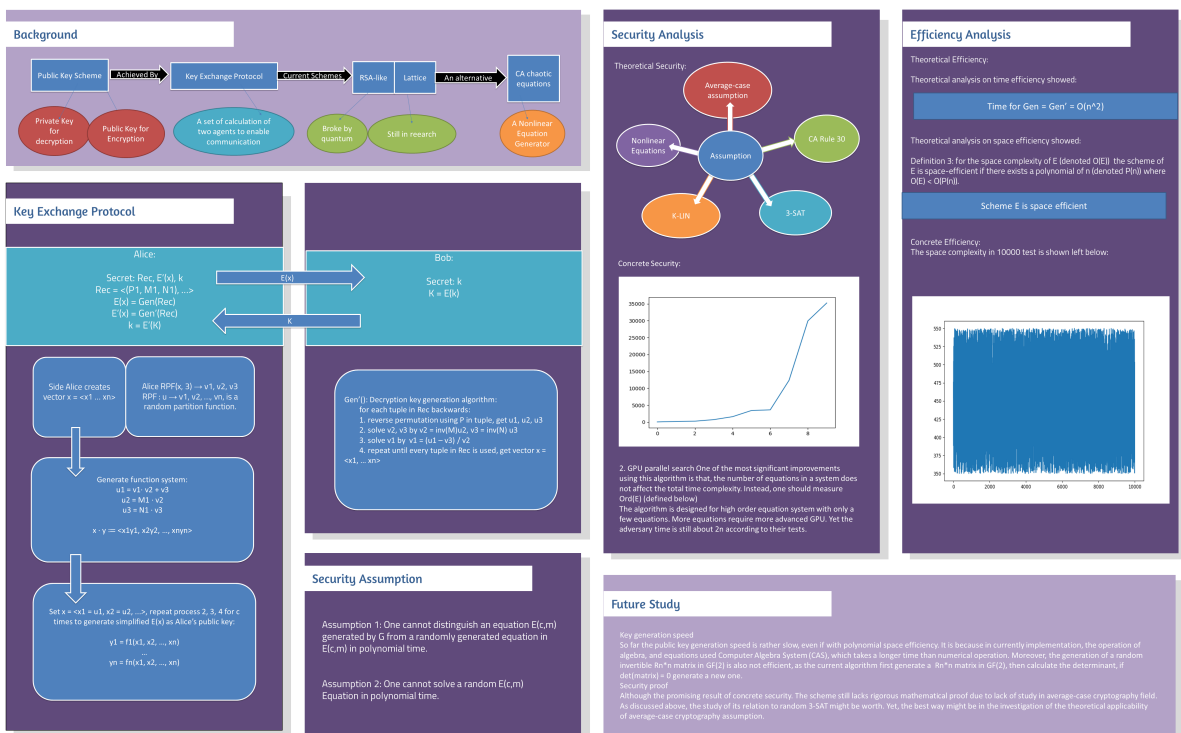
Project Title: Pika Park - Intelligent Parking Navigation System Zheng Zhang & Fangqing He



Public Key Cryptosystem Based on CA Nonlinear System

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Project Title: A New Public Cryptography Design Based on CA Chaotic System Name: Gengyu Chen