Parkalot: Extended Edition

Using parking apps like traditional meters

using license plate validation loopholes

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Cackalackycon 2023

Disclaimer

- I talked to people from both Passport Parking and the City of Raleigh, and what I am about to discuss is **not** an application flaw in Passport's app nor any municipal system.

Relevant background

- I am a Security Engineer by trade
- I live in Raleigh, NC
  Population: ~467,000
- Raleigh uses Passport Parking to handle metered parking downtown
- NC allows special characters in personalized license plates
- Mine has a '$' in it
- In 2018 I got a parking ticket in Scotland the first time I parked the rental car
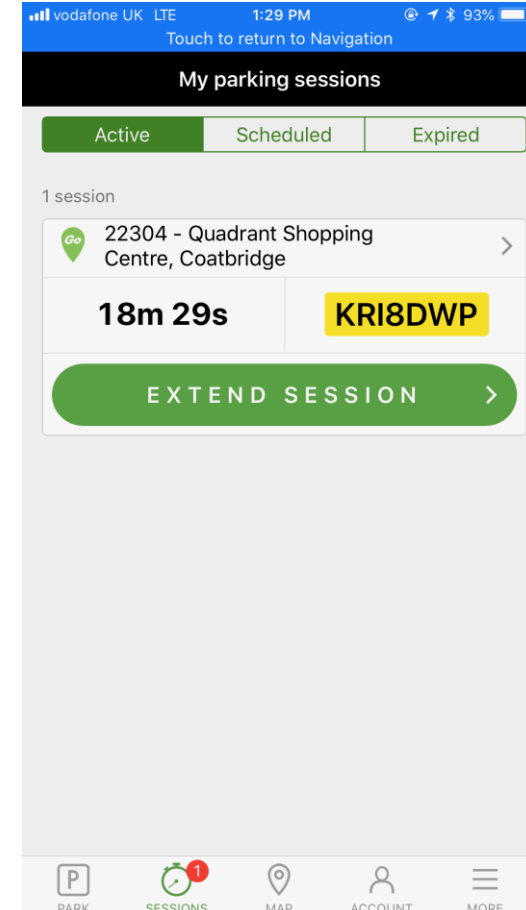
Scenario – Present day

- I drove to city hall for a meeting

- I'm parking in a 1-hour metered parking zone directly across from the building

- The meeting starts at 1:30 and I may need to be there longer than an hour

- Raleigh has Passport parking so the app will notify me and I can top off the session… right?

1. I buy an hour of parking, it expires
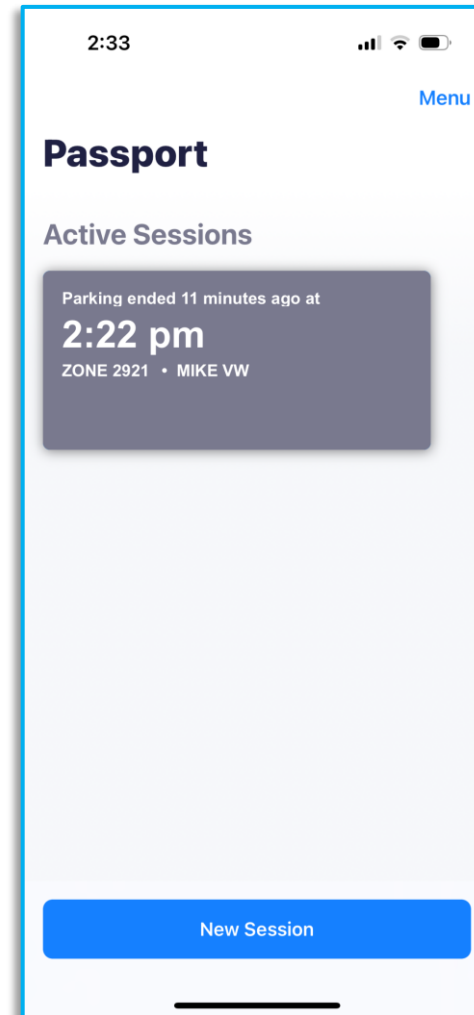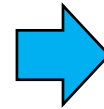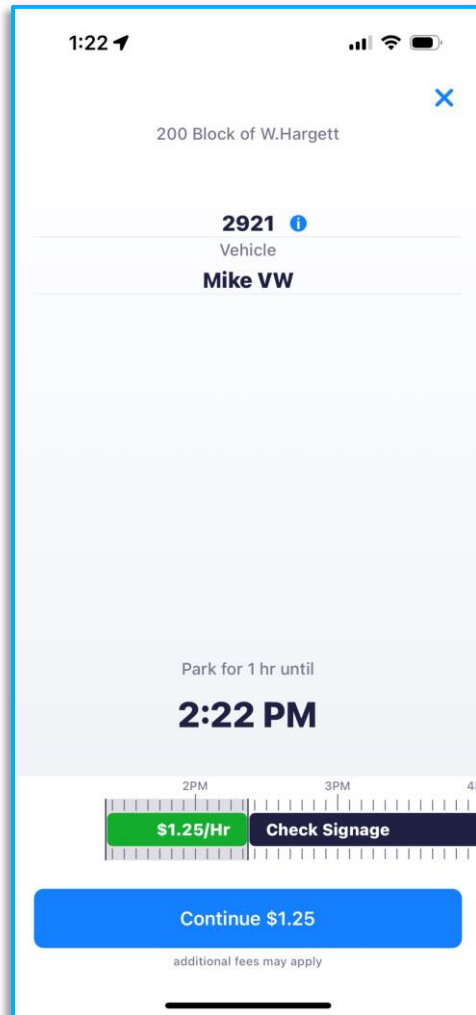
2. I attempt to renew, and am blocked
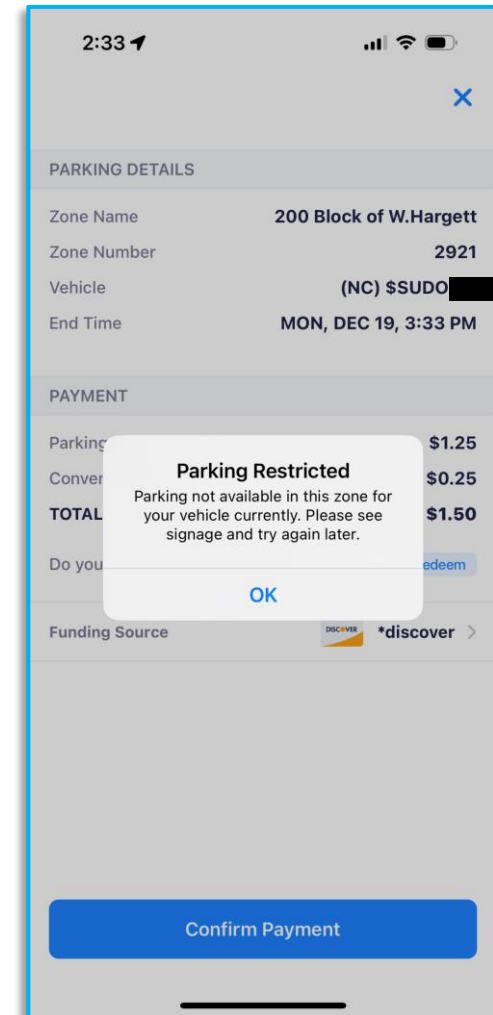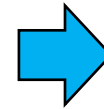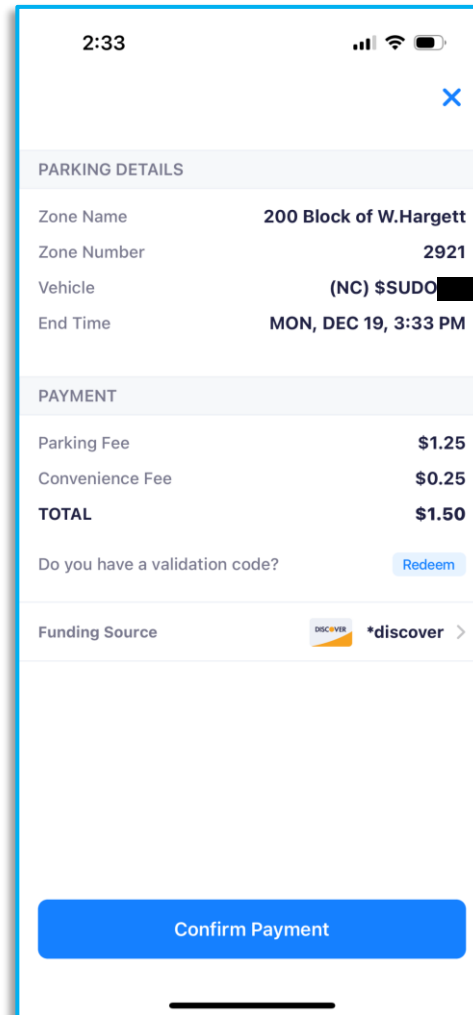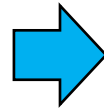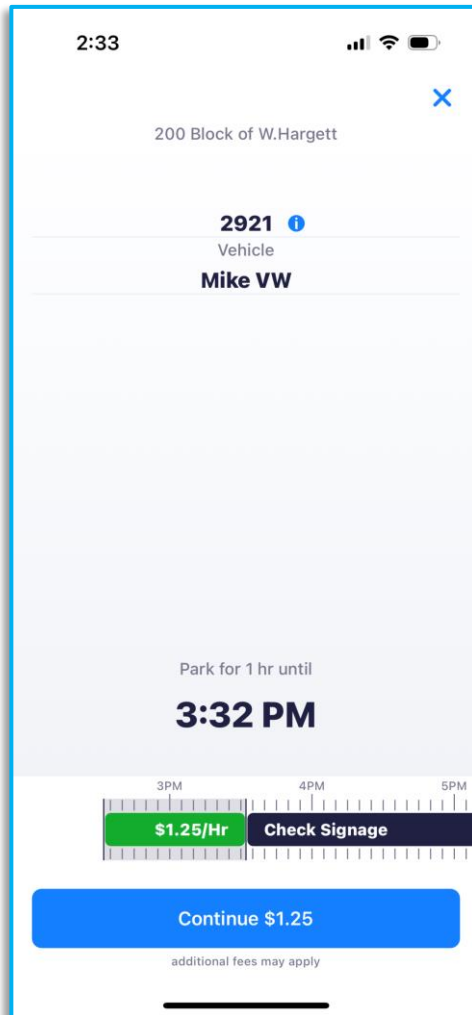
Let's go back in time

What would we have done prior to Passport implementation in 2019?

- Put some more quarters in the meter

- Move the car a few spaces over

- Rub a chalk line off your tire

Hacking around the limitations

Starting with a deep dive into NC License Plate syntax

Isn't it time you made a name for yourself?

First In Flight
CHOOSE8!
NORTH CAROLINA

May 20, 1775 — April 12, 1776
FIRST IN FREEDOM
CHOOSE8!
NORTH CAROLINA

IN GOD WE TRUST
CHOOSE8!
To Be Rather Than to Seem
NORTH CAROLINA

APPLICATION FOR PERSONALIZED LICENSE PLATES
Personalized plate fee $30 in addition to annual renewal fee. Please remit $30 check with application.

Vehicle type: ○ automobile ○ private truck ○ commercial vehicle ○ trailer ○ motorcycle (7 digit limit) ○ moped (7 digit limit)

Plate type: ○ First in Flight* ○ First in Freedom* ○ National/State Motto*

Owner's Name _____ Last _____ First _____ Middle (Full)

Mailing Address _____

City _____ State _____ Zip Code _____

Phone (8 a.m. to 5 p.m.) _____

Current Plate # _____ Expiration Date _____

Title # _____

Vehicle Identification # _____

Owner's Signature _____ Date _____

DMV Use Only

ISN'T IT TIME YOU MADE A NAME FOR YOURSELF?
Now's your chance to join thousands of North Carolinians and show the world what you think, who you are or almost anything else. Be original, be creative! Use up to eight characters to design your own license plate.

By investing in a personalized license plate, you are supporting the following important programs.

The Clean Water Management Trust Fund
The Roadside Wildflower Planting Program
N.C. Travel and Tourism Promotion
Handicapped Access Guide to N.C.

Characters that count as 1 space:
Ampersand (&), Number Sign (#), Single Quotes ('), Plus Sign (+), Dollar Sign ($), Slant Line (/), Equal Sign (=), Asterisk (*), Question Mark (?), At Sign (@)

Characters that count as 1/2 space:
Apostrophe ('), Dash (-), Comma (,), Exclamation Point (!), Colon (:), Period (.)
No 1/2 spaces are allowed on motorcycle plates.

Characters that count as 2 spaces:
Double Quotes ("")

First Choice
Second Choice
Third Choice

*Available for a private passenger and a private hauler vehicle licensed for 6,000 pounds or less.

There are no ½ space characters for motorcycle license plates.

DMV
North Carolina Division of Motor Vehicles

Source: NC DMV

Side note: 0s and Os are the same character in North Carolina

DMV Personalized Plates Special Characters Guide

The below list indicates which special characters are allowed. The amount of space a character occupies is subtracted from the number of characters allowed on the plate. Personalized Plates require at least one letter or one number. There are no ½ space characters allowed for motorcycle license plates.

First In Flight
CHOOSE8!
NORTH CAROLINA

Description	Character	Amount of Space
Ampersand	&	1.0
Number Sign	#	1.0
Question Mark	?	1.0
Dollar Sign	$	1.0
Forward Slant	/	1.0
Equal Sign	=	1.0
Asterisk	*	1.0
Plus Sign	+	1.0
At Sign	@	1.0
Empty Space		1.0
Exclamation Point	!	0.5
Colon	:	0.5
Period	.	0.5
Dash	-	0.5
Comma	,	0.5
Apostrophe	'	0.5
Double Quotes	"	1.0
Ampersand	&	1.0
Number Sign	#	1.0
Question Mark	?	1.0
Dollar Sign	$	1.0
Forward Slant	/	1.0
Equal Sign	=	1.0
Asterisk	*	1.0
Plus Sign	+	1.0
At Sign	@	1.0
Empty Space		1.0
Double Quotes	"	1.0

Note: Special characters will not be considered when determining whether the plate text is available. For example, plate A&3@C is the same as A3C.

**Note:** Special characters will not be considered when determining whether the plate text is available. For example, plate A&3@C is the same as A3C.

Source: NC DMV

Key takeaways

1. A special character is the same as a space, and a space is the same as nothing at all

2. Every license plate number with a special character in it can be expressed 3 different ways

Let's try the same plate another way (no '$')
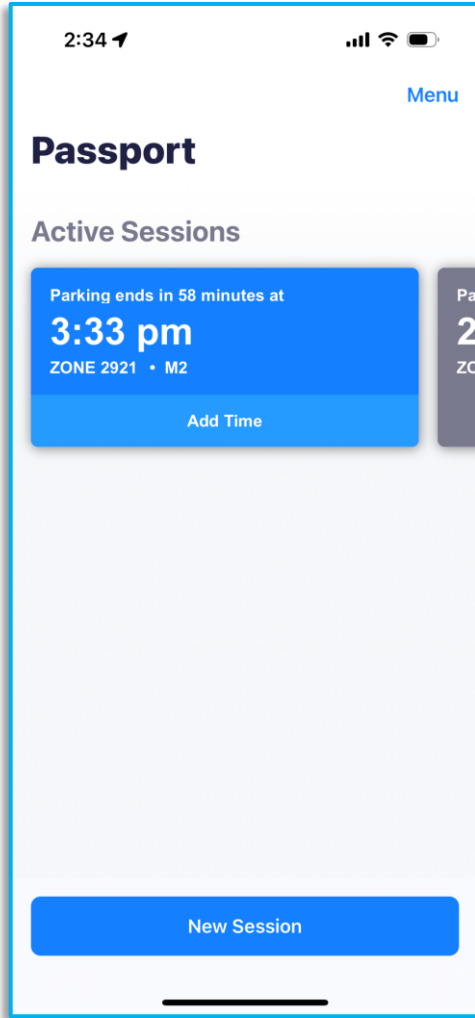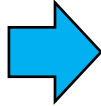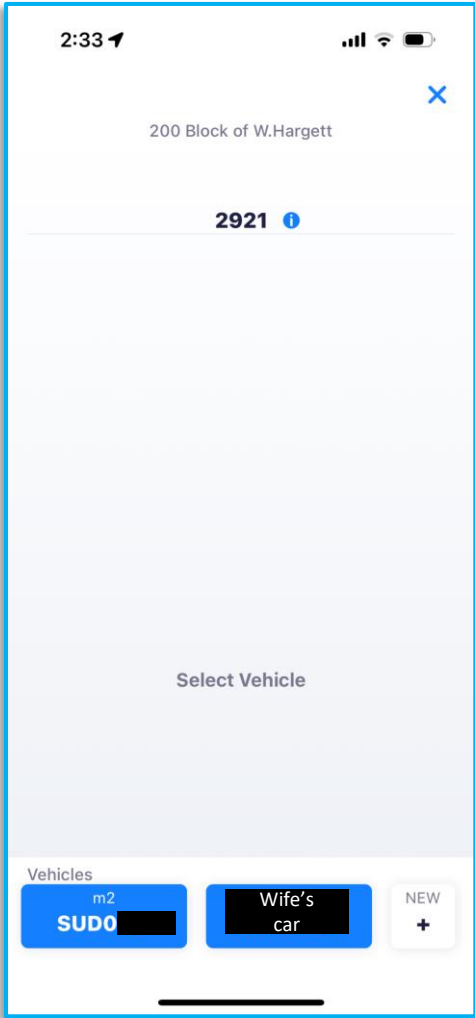
It works! ☑

Thinking and going beyond

- Every non-personalized, non-specialty plate in North Carolina has a hyphen in the middle
- This means every standard issue NC plate can be expressed as 3 valid numbers
- Not every parking system can handle all the characters, so you need to know the other forms of your plate number

Other considerations

- Os and 0s are the same in North Carolina
- Specialty plates have their own formats

Prepare for unforeseen consequences

What happens if parking enforcement comes around?

- If:
  The detected plate exactly matches a paid plate, you're good
- If else:
  The parking staff does a manual check
- Else:
  You get a ticket
- Raleigh writes <5% of people parking each year a citation (~1.5 million transactions, 40-60k citations)

Workaround: The appeals process

- Sometimes people pay the zone next to the one they're parked in, but it's an easy mistake
- Don't want to ticket Purple Heart veterans for missing the little "PH" on their plate
- 60% of appeals are accepted

Taking an economic view

- In many cities, parking falls under the police department
- Police enforce rules against people who break rules
- Levying parking fines increases revenue and creates a feedback loop
- Raleigh's goal: treat parking as part of the transportation network
- Parking fees do not feed into law enforcement funds

Systems architecture and design

- Everything is an economic lever that can be adjusted

- Parking spaces, lots, and garages are nodes within the system

- Garages incentivize longer-term parking than street parking "at the door"

Looking forward – The Customer Journey

- Your goal within the transportation network is to get to your destination
- You want to do your shopping, eat dinner, and go home
- In the future, can your navigation take you to the best spot for your goal?
- Can your car drive you to the best parking spot, or drop you off and find it itself?

Bonus content

Not specific to Raleigh

Fun new developments

- California approved digital license plates in October 2022
- A company called Reviver is currently approved

Visual Personalization

Switch between light or dark mode. Personalize your banner message.

In-App Registration Renewal

Complete your vehicle registration renewal with a few clicks on your smartphone.
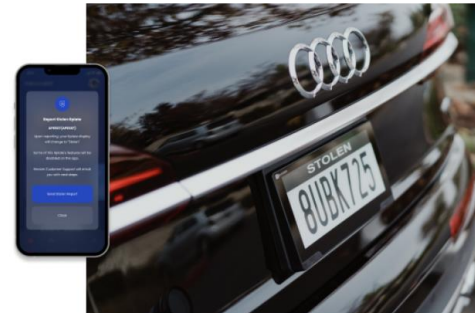
Safety and Telematics

Receive instant alerts if your vehicle moves and report it stolen through your mobile app.

Easy Install and Maintenance

Limited lifetime warranty and replacement insurance. Simple installation. 7/365 customer support.

But did you hear the onions are coming back

What if there were emojis?

"There are no real guidelines for how to report symbols," **Marty Greenstein**, a DMV spokesman up in Sacramento, told Honk in an email. "One suggestion would be to use parentheses, for example I(heart)RADIO, IAM(hand)Y, etc., but there is no 'right' way to do it."

Honk scratched his chin for a bit and then called the California Highway Patrol. What agency could possibly be more dependent on the accuracy of license-plate numbers than the CHP, such as when its officers are pursuing a speeding bank robber or nailing one of us for going a tad too fast?

"The symbol doesn't play a factor in running a plate," said **Officer Duane Graham**, a CHP spokesman out of the agency's Westminster HQ. "It's on your plate, but it's not part of your plate number."

Case Study: Maryland Pay-by-Plate

I do not have an *E-ZPass* or Pay-By-Plate account and have not received a notice in the mail.

Save up to 15% (up to $5 total discount) if you pay online or in person now before Notices of Toll Due (NOTDs) are mailed.

Find My Tolls

License Plate State

North Carolina ▾

License Plate Number *

abc-123

Please enter a valid plate.
Plate Type *

ABN - Military/82nd Airborne ▾

Zip Code *

Search

Customers are encouraged to check all license plates for all current and past zip codes.

I do not have an *E-ZPass* or Pay-By-Plate account and have not received a notice in the mail.

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License Plate State

North Carolina ▾

License Plate Number *

abc123

Plate Type *

ABN - Military/82nd Airborne ▾

Zip Code *

Search

Customers are encouraged to check all license plates for all current and past zip codes.

Case Study: Maryland Pay-by-Plate

1. You figure out the right syntax to enter your license plate number

2. Now you pick which "Plate Type" you have

License Plate State
North Carolina

License Plate Number *
abc123

Plate Type *
ABN - Military/82nd Airborne

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Save up to 15% (up to $5 total discount) if you pay online or in person now before Notices of Toll Due (NOTDs) are mailed.

Find My Tolls

License Plate State
North Carolina

ABN - Military/82nd Airborne

ABU - Collegiate/University of Alabama, Auburn University

AFR - Military/Air Force Reserve

AFV - Military/Afghanistan Veteran

AKA - Special Interest/Alpha Kappa Alpha Sorority

Search

Customers are encouraged to check all license plates for all current and past zip codes.

View Source

- Right Click > Inspect Element

- There are 300 options in this list

- Which one is "normal car"?

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Find My Tolls

License Plate State
North Carolina ▾

License Plate Number *
abc123

Plate Type *

PDV - Military/Partially Disabled Veteran
PEM - PERMANENT MOTORCYCLE
PER - PERMANENT VEHICLE
PFT - Permanent, For-Hire
PHA - Civic Club/Prince Hall Shrine

- Napkin math:
  - 5 options visible at a time
  - ~300 options once NC is selected
  - = 60 unique sets of 5 to check
  - = 3+ minutes of scrolling and reading in a tiny selector box
- This still assumes you know that Maryland calls our "normal car" license plates "PER - PERMANENT VEHICLE"

- What happens for other states?
- The state with the highest number of vanity plates*:
    1. Virginia

- Virginia has over 250 styles of plate to pick from

I do not have an *E-ZPass* or Pay-By-Plate account and have not received a notice in the mail.

Save up to 15% (up to $5 total discount) if you pay online or in person now before Notices of Toll Due (NOTDs) are mailed.

Find My Tolls

License Plate State

Virginia

License Plate Number *

ABC123

Plate Type *

STANDARD - For non-numeric plates

AA - Alzheimer's Association

AB - 173rd Airborne

ABHP - 173rd Airborne Handicapped and Alzheimer's Association Handicapped

AE - Aviation Enthusiasts

Final thoughts

A lot of security concepts carry over into parking management:

- Entitlements – by space (old way) vs. by car (new way)

- Automated detection and handling false negatives

- Rules-based enforcement that can be hard to apply consistently across different vendors and tools

- Input validation and sanitization

- End-user awareness and training

- Regulatory requirements

That's all, folks

Special thanks to
- The City of Raleigh
- Passport Parking

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