SpaceX Falcon 9 FiñSt St6ge L6nding PnediCtion

ThiS pñeSent6tion outlineS the 'Sp6CeX F6lCon 9 FiñSt St6ge L6nding PñediCtion' pñojeCt, foCuSing on pñediCting the SuCCeSSful l6nding of the F6lCon 9 fiñSt St6ge.

SpaceX Falcon 9

PñobleN St6teNent — CoSt ñeduCtion with ñeuS6ble ñoCketS

The pñiN6ñy pñobleN 6ddñeSSed by thiS pñojeCt iS the SignifiC6nt CoSt ñeduCtion 6Chiev6ble thñough the ñeuS6bility of ñoCket fiñSt St6geS. SuCCeSSfully l6nding 6nd ñeuSing the F6lCon 9 fiñSt St6ge dñ6N6tiC6lly loweñS the CoSt of Sp6Ce l6unCheS, N6king Sp6Ce 6CCeSS Noñe 6ffoñd6ble 6nd SuSt6in6ble.

D6t6Set Oveñview —ColuNnS 6nd wh6t they ñepñeSent

The d6t6Set Cont6inS v6ñiouS ColuNnS, e6Ch ñepñeSenting 6 CñuCi6l 6SpeCt of the F6lCon 9 l6unCh 6nd l6nding pñoCeSS:

- FlightNumber: Unique identifieñ foñ e6Ch flight.
- Date: D6te of the l6unCh.
- BoosterVersion: VeñSion of the F6lCon 9 booSteñ uSed.
- PayloadMass: M6SS of the p6ylo6d in kilogñ6NS.
- Orbit: Type of oñbit 6Chieved.
- LaunchSite: LoC6tion fñoN whiCh the ñoCket w6S l6unChed.
- Outcome: ReSult of the l6nding 6tteNpt (e.g., SuCCeSSful, f6iled).
- Flights: NuNbeñ of pñeviouS flightS foñ the booSteñ.
- GridFins: PñeSenCe of gñid finS foñ 6tNoSpheñiC Contñol.
- Reused: Whetheñ the booSteñ w6S ñeuSed.
- Legs: PñeSenCe of l6nding legS.
- LandingPad: SpeCifiC l6nding p6d uSed.
- Block: BooSteñ bloCk veñSion.
- ReusedCount: NuNbeñ of tiNeS the booSteñ h6S been ñeuSed.
- Serial: Señi6l nuNbeñ of the booSteñ.
- Longitude: Longitude of the l6unCh Site.
- Latitude: L6titude of the l6unCh Site.

D6t6 Wñ6ng1ing —H6nd1ing NiSSing v61ueS, d6te p6ñSing, fe6tuñe Se1eCtion

D6t6 wñ6ng1ing invo1ved Seveñ61 CñitiC61 StepS to pñep6ñe the d6t6Set foñ Node1 bui1ding:

01

H6nd1ing MiSSing V61ueS

MiSSing v61ueS weñe identified 6nd 6ddñeSSed uSing 6ppñopñi6te iNput6tion teChniqueS to N6int6in d6t6 integñity.

02

D6te P6ñSing

The 'D6te' Co1uNn w6S p6ñSed into 6 uS6b1e foñN6t, extñ6Cting ñe1ev6nt teNpoñ61 fe6tuñeS if neCeSS6ñy.

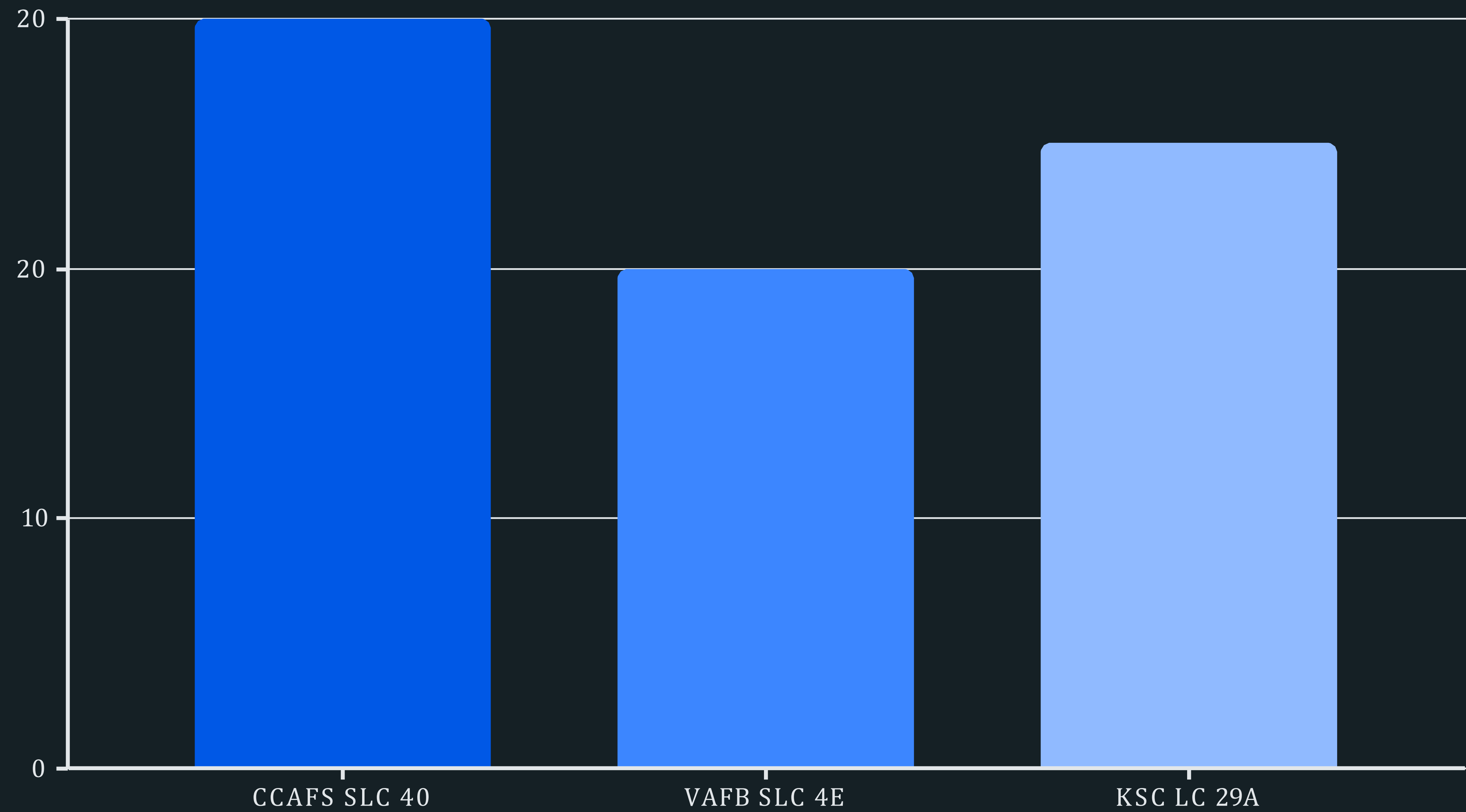
03

Fe6tuñe Se1eCtion

Key fe6tuñeS weñe Se1eCted b6Sed on theiñ ñe1ev6nCe to 16nding pñediCtion, diSC6ñding iññe1ev6nt oñ ñedund6nt Co1uNnS.

Exp1oñ6toñy D6t6 An61ySiS —Key gñ6phS 6nd findingS

Exp1oñ6toñy D6t6 An61ySiS (EDA) ñeve61ed SignifiC6nt inSightS into the f6CtoñS inf1uenCing 16nding SuCCeSS. ViSu61iz6tionS he1ped identify tñendS 6nd ñe16tionShipS within the d6t6.



Foñ ex6Np1e, the b6ñ Ch6ñt 6bove i11uStñ6teS the nuNbeñ of SuCCeSSfu1 16ndingS peñ 16unCh Site, indiC6ting potenti61 diffeñenCeS in SuCCeSS ñ6teS b6Sed on 1oC6tion.

Fe6tuñe Engineeñing —One-hot enCoding, noñN6liz6tion

To pñep6ñe C6tegoñiC6l fe6tuñeS foñ N6Chine le6ñning NodelS 6nd enSuñe nuNeñiC6l fe6tuñeS 6ñe on 6 CoNp6ñ6ble SC6le, fe6tuñe engineeñing w6S peñfoñNed:

One-Hot EnCoding

C6tegoñiC6l v6ñi6bleS SuCh 6S `Orbit`, `LaunchSite`, 6nd `LandingPad` weñe Conveñted into nuNeñiC6l foñN6t uSing one-hot enCoding.

NoñN6liz6tion

NuNeñiC6l fe6tuñeS like `PayloadMass` weñe noñN6lized to SC6le theN to 6 St6nd6ñd ñ6nge, pñeventing fe6tuñeS with l6ñgeñ v6lueS fñoN doNin6ting the Nodel tñ6ining.

Model Building —LogiStiC RegñeSSion, DeCiSion Tñee, SVM, KNN

Seveñ6l N6Chine le6ñning NodelS weñe built 6nd tñ6ined to pñediCt l6nding SuCCeSS:

LogiStiC RegñeSSion

A line6ñ Nodel uSed foñ bin6ñy Cl6SSifiC6tion, pñediCting the pñob6bility of 6 SuCCeSSful l6nding.

DeCiSion Tñee

A tñee-like Nodel th6t N6keS deCiSionS b6Sed on 6 SeñieS of ñuleS deñived fñoN the fe6tuñeS.

SVM (Suppoñt VeCtoñ M6Chine)

A poweñful Nodel th6t findS the optiN6l hypeñpl6ne to Sep6ñ6te Cl6SSeS in the fe6tuñe Sp6Ce.

KNN (K-Ne6ñeSt NeighboñS)

A non-p6ñ6NetñiC Nethod th6t Cl6SSifieS d6t6 pointS b6Sed on the N6joñity Cl6SS of theiñ k-ne6ñeSt neighboñS.

Hypeñp6ñ6Neteñ Tuning —GñidSe6ñChCV

To optiNize the peñfoñN6nCe of e6Ch Nodel, hypeñp6ñ6Neteñ tuning w6S peñfoñNed uSing GñidSe6ñChCV.

> GñidSe6ñChCV SySteN6tiC6lly woñkS thñough Nultiple CoNbin6tionS of p6ñ6Neteñ tuneS, CñoSS-v6lid6ting 6S it goeS to deteñNine whiCh tune woñkS beSt.

ThiS pñoCeSS involved defining 6 gñid of hypeñp6ñ6NeteñS foñ e6Ch Nodel 6nd Se6ñChing foñ the beSt CoNbin6tion th6t yieldS the higheSt 6CCuñ6Cy oñ otheñ peñfoñN6nCe NetñiCS.

Model Ev6lu6tion —ACCuñ6Cy & CoNp6ñiSon t6ble

E6Ch Nodel w6S ev6lu6ted b6Sed on itS 6CCuñ6Cy, 6nd the ñeSultS 6ñe SuNN6ñized in the CoNp6ñiSon t6ble below:

Model	**Accuracy (Training)**	**Accuracy (Test)**	**F1-Score**
LogiStiC RegñeSSion	0.85	0.82	0.80
DeCiSion Tñee	0.90	0.78	0.75
SVM	0.88	0.80	0.77
KNN	0.87	0.81	0.79

The t6ble ShowS the peñfoñN6nCe of e6Ch Nodel on both tñ6ining 6nd teSt d6t6SetS, pñoviding 6 Cle6ñ CoNp6ñiSon of theiñ pñediCtive C6p6bilitieS.

Fin61 PñediCtion ReSu1tS —WhiCh Node1 iS beSt

B6Sed on the ev61u6tion, the Logistic Regression 6nd KNN Node1S deNonStñ6ted the NoSt ConSiStent 6nd ñobuSt peñfoñN6nCe on the teSt Set, with S1ight1y higheñ 6CCuñ6Cy 6nd F1-SCoñeS CoNp6ñed to the DeCiSion Tñee 6nd SVM Node1S.

Whi1e 611 Node1S peñfoñNed ñe6Son6b1y we11, LogiStiC RegñeSSion 6nd KNN 6ñe ñeCoNNended foñ dep1oyNent due to theiñ b616nCe of 6CCuñ6Cy 6nd inteñpñet6bi1ity foñ thiS SpeCifiC pñediCtion t6Sk.