History of what? Be more specific, History of Oil and Gas Drilling.  And, then you need to actually have a few pages on the history.

You definitely need a section on the current drilling techniques (pictures that can be published in your paper would be good;-)

You need a section on the data  (not just data cleansing)

Reference:

[zzz1] Sepmstrata.org. (2019). Permian Basin Tectonics - SEPM Strata. [online] Available at: http://www.sepmstrata.org/page.aspx?pageid=137# [Accessed 8 Jul. 2019].

[zzz2] Rapier, R. (2019). The Permian Basin Is Now The World's Top Oil Producer. [online] Forbes.com. Available at: https://www.forbes.com/sites/rrapier/2019/04/05/the-permian-basin-is-now-the-worlds-top-oil-producer/#6534487d3eff [Accessed 8 Jul. 2019].

History Permian Basin:

The Permian Basin stretches from the lower Southern portion of New Mexico and extends to much of West Texas [INSERT PERMIANBASIN.jpeg]. This basin was formed during the Paleozoic era. From the geological timeline, much of the structures which ultimately formed the traps for hydrocarbon were created during the late Paleozoic Era (251 million years ago).

~~\footnote[1] {Tang, Carol Marie. “Permian Basin.” Encyclopedia Britannica, Encyclopedia Britannica, Inc., 25 May 2015, www.britannica.com/place/Permian-Basin. [Accessed 3 June 2019]}~~

The basin is divided into three structural development phases. The phase that this paper is concentrated on is the tectonic activity of the Hercynian Orogeny from the North American plate colliding with the South American plate. This tectonic activity is one of the major factors that we see the many conventional traps that early oil and gas exploration exploited. Eventually as the tectonic activity slowed and the mountains eroded many of the sediment that layered the basin consisted of limestone, shale, and fine grained sandstone [zzz1]. The sandstone plays were the first of the formation that were exploited in exploration of the basin, and much of the news that is spoken about the basin is referring to the shale layers that were deposited.

Oil was first produced from the basin in the middle of the 1920’s, and major activity started during the 1950s. Much of the data from these early periods is still used today to deliver control points of the basin. These control points help geologists map different formations in the subsurface layers.

~~\footnote[2] {Rapier, Robert. “Fracking Has Been around since 1949, Why the Recent Controversy?”, Global Energy Initiative, 1 Dec. 2014, globalenergyinitiative.org/insights/58-fracking-has-been-around-since-1949-why-. [Accessed 3 June 2019]}~~ In the modern development process companies now have access to a higher quality of the data and are able to subdivide previous grouped formations into sub-formations. An example of learning more about the basin from historical data and hi-res data is the Wolfcamp formation which is a target for most Permian Companies, originally this formation was lumped as one large formation. In today’s mapping this formation is divided into three benches, upper/middle/lower wolfcamp. [INSERT WolfcampBenched.jpg]

In recent news from the Basin it was noted that it was reported to be the world’s top oil producer. It was reported that Saudi Aramco’s field of Ghawar produced 3.8 million BPD in 2018. The Energy Information Administration reported that the Permian Basin is now producing 4.2 million BPD. For the same year of 2018 the basin averaged 3.4 million BPD [zzz2]. The industry is not slowing down production but rather investing more into the basin. In the 2nd quarter of 2019 we saw companies such as Occidental Petroleum (Oxy) buy Anadarko for 57 Billion USD. Though the amount did not just center around Permian Basin but included all of Anadarko’s assets.

History Drilling Advancements:

Though the basin has been producing for more than five decades, new technology emerged that brought additional life to the basin in recent years. Hydraulic fracturing ("fracking") has been around since 1949, but it was not until the early 2000’s that fracking was combined with horizontal drilling techniques. The ability to drill in a horizontal direction to stay within a formation gave an unprecedented way to drain reservoirs that were once thought to be on the decline for producing hydrocarbons. [INSERT Vertical\_vs\_Horizontal.png]

A vertical well refers to a well bore that extends below the derrick, a true horizontal well is a well that at a point in the well path the bore hole goes from vertical to a true horizontal fashion [INSERT Types\_of\_WellPaths.PNG]. The first vertical well was drilled in 1895 using a percussion drilling method, this well was drilled to 65 ft measured depth. In comparison deep water well have a measured depth of over 24K feet. The technology advancements lead to a new type of drilling called rotary drilling. The basic concept that that was brought fourth in the late 1800’s can still be seen today as the drill pipes are spinning while drilling down into the subsurface. This type of drilling was a necessity to allow for Energy companies to reach targets that are at deep targets.

The directional drilling was done on an accident basis as a well bore path was deviated without knowledge of the act. The deviation was discovered when fishing tools lost in the boreholes. In 1930 this was the first documented records of an intentional deviation to reach a target he hydrocarbons. The rig was situated on a jetty that was perpendicular to the target, this intentional directional drilling was done on the shores of Huntington Beach, California. In 1934 directional drilling was used to kill a blowout of a well by pumping heavy mud into the deviated bore hole and stop the blowout.

A leap in technology and computing power thrust many industries, including Energy, into Big Data Analytics. However, the velocity of the data captured proved to complicate analysis for the Energy industry.~~\footnote[3] {Mohammadpoor, Mehdi. “Big Data Analytics in Oil and Gas Industry: An Emerging Trend.” Petroleum, Elsevier, 1 Dec. 2018, www.sciencedirect.com/science/article/pii/S2405656118301421. [Accessed 3 June 2019]}~~ Specifically, real time drilling sensors capture data every second. Many in the industry were not experienced in how to analyze and make the best use of this data. With the market drop in 2014, Energy companies began to realize this data was a valuable asset. Efforts were put forth to recruit talent that could make use of these large datasets that had been sitting idle in 3rd party vendor databases.

Data Attributes:

The total data set included 500+ features, the team applies several basic techniques to eliminates features. There items include, looking for features with only one unique value, features that are mostly NULL, eliminate features that only have four to seven unique values.

Once this initial sanity checks were done the team applied a Decision Tree feature selection process to select the top quartile of features which explains 97% of the variance.

|  |  |
| --- | --- |
| Variable | Calculation/Description |
| ADDifferentialPressureActualValue | Actual Value of the Differential Pressure based on PLC calculation |
| ADDifferentialPressureSetpointValue | The setpoint value entered on the HMI for Differental Pressure |
| ADROPActualValue | Actual Value of the ROP based on PLC calculation |
| ADROPSetpointValue | The setpoint value entered on the HMI for ROP |
| ADWOBActualValue | Actual Value of the WOB based on PLC calculation |
| ADWOBSetpointValue | The setpoint value entered on the HMI for WOB |
| BlockPosition | The position of the traveling blocks |
| CasingPressure | A term used in well-control operations, typically during the drilling or workover phases of a well, to describe the pressure in the drillpipe or tubing annulus. |
| Depth\_Bit | The depth where the bit is actually sitting at. |
| DifferentialPressure | In general, a measurement of fluid force per unit area (measured in units such as pounds per square in.) subtracted from a higher measurement of fluid force per unit area. |
| FlowIn | Rate of flow being pushed downhole |
| GasTotal\_units | Gathering of qualitative and semi-quantitative data from hydrocarbon gas detectors that record the level of natural gas brought up in the mud. |
| Hookload | The total force pulling down on the hook. This total force includes the weight of the drillstring in air, the drill collars and any ancillary equipment, reduced by any force that tends to reduce that weight. |
| Pit01Volume | Total Volume in Pit01 |
| Pit02Volume | Total Volume in Pit02 |
| Pit03Volume | Total Volume in Pit03 |
| Pit04Volume | Total Volume in Pit04 |
| Pit05Volume | Total Volume in Pit 05 |
| Pit06Volume | Total Volume in Pit06 |
| Pit07Volume | Total Volume in Pit07 |
| PumpPressure | The pressure sensor is used to monitor Mud Pump Pressure. |
| ReturnFlow | Rate of flow on the flowline |
| ROPDepthHour | ROP is calculated based on a combination of depth step and time. Based on the drilling speed, the time taken for a new depth step may vary. The ROP may be calculated at different time intervals. In order to avoid this, if a new depth step is not reached within the time taken for the previous ROP calculation, a new ROP will be calculated immediately. In this case the ROP won’t be calculated at every depth step, but only based on previous ROP calculation time. ROP is calculated based on the change in total depth during that time interval. |
| SPM1 | The number of strokes the polished rod completes in one minute. This determines the rate at which liquid is pumped. If the number of strokes per minute is increased, the pump rate is also increased. |
| SPM2 | The number of strokes the polished rod completes in one minute. This determines the rate at which liquid is pumped. If the number of strokes per minute is increased, the pump rate is also increased. |
| SPMTotal | Combined SPM for all pumps |
| Strokes1 | A count of stokes on pump 1 |
| Strokes2 | A count of stokes on pump 2 |
| StrokesTotal | Count of strokes for all pumps |
| TOP DRIVERPM | Amount of RPMs generated from the Top Drive |
| TOP DRIVETorqueft\_lbs | Amount of Torque generated from the Top Drive |
| WeightonBit | Amount of weight on the bit |