AI+VR: The future of data analytics

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VIRTUALITICS[™] immerse yourself in your data

NVIDIA GTC Conference March, 18th 2019

Virtualitics fast facts

- Software company merging AI and VR to provide a novel way to find insights in data
- Founded in August 2016, based on 10+ years of research at Caltech and NASA/JPL in machine learning and immersive visualization
- Significant customer traction with DOD and Fortune 500 companies



Immersive analytics in VIP - Virtualitics Immersive PlatformTM



Technology trends - 2019



Trend No. 2: Augmented analytics

Data scientists now have increasing amounts of data to prepare, analyze and group - and from which to draw conclusions. Given the amount of data, exploring all possibilities becomes impossible. This means businesses can >> too much data, even for miss key insights from hypotheses the data scientists don't have the capacity to explore.

data scientist!

Trend No. 3: Al-driven development

Al-driven development looks at tools, technologies and best practices for development process.

Trend No. 6: Immersive technologies

a new immersive experience. AR, MR and VR show potential for increased user's position and MR enabling people to view and interact with their world.

Technology trends - 2019



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Trend No. 6: Immersive technologies

Through 2028, conversational platforms, which change how users interact with the world, and technologies such as augmented reality (AR), mixed reality (MR) and virtual reality (VR), which change how users perceive the world, will lead to a new immersive experience. AR, MR and VR show potential for increased productivity, with the next generation of VR able to sense shapes and track >> VR is here to stay! user's position and MR enabling people to view and interest

The importance of data visualization



"If I can't picture it, I can't understand it"

- Key in understanding data
- Visual access to huge amount of data
- Helps understand not only the data but also how it was collected
- Humans have an incredible pattern recognition system, but don't scale!



KDD: visualization crucial at every step



Knowledge Discovery in Databases

KDD: visualization crucial at every step



Knowledge Discovery in Databases

Visualization-centric view:

visualization and interaction essential at every step.

Data has evolved, BI tools haven't

Evolution of data

- Complex: Hundreds of metrics for each sample
- From static to dynamic, from centralized to distribute resources, from data sets to data streams
- From "next day" analysis to real-time

Not easy to find insights with standard tools

"Big Data is not a revolution, but an evolution"

Evolution of data visualization

From Van Langren

- Standard visualization tools not enough anymore
- We need to re-imagine the way we represent and interact with data to get key insights
- Clever interaction makes it easier to look for patterns
- Virtual Assistants and AI-driven visualization





From 2D to 3D and... beyond!

- Traditional 2D data visualization may hide crucial information
- Beyond 3D: new ways to encode, visualize and understand more dimensions



Dimensions Encoded in VIP

Position (X, Y, Z) Colors, Opacity Shape, Texture Size, Halo, Vectors Pulsation, Sounds Spinning, Glow, Sounds

New class of "3D" problems

Standard 2D plots may hide crucial information visible only at the intersection of many dimensions



High-dimensional visualization

Clusters are clearly visible in 3D; on a "flat screen" still difficult to understand relative size and position...



Immersive visualization

- Overcome limits of 3D on a "flat screen"
- Users can easily interact with their data and with each other in a familiar environment
- Easier and more effective collaboration across teams in different geographic locations
- Powerful tool for data analysis storytelling



Virtual environments offer new ways to visualize and interact with data

Case study: Mars map drawing - task





Problem: terrain on Earth is available for geologists to walk through. Scientists studying Mars cannot do that. **Goal:** investigate whether the immersive environment provided scientists a more intuitive understanding of the terrain.

Experiment settings: map drawing task; six landmarks; scientists divided in 2 groups: one given a panorama image, one put in an immersive environment; compute angle and distance errors in map-making task (sum across all landmarks).



Experiments conducted at Caltech and NASA/JPL (Norris, Davidoff and Luo) showed that users commit less errors when immersed in a 3D environment.

Donalek C., et al., "Immersive and Collaborative Data Visualization Using Virtual Reality Platforms", IEEE Big Data

Case study: Mars map drawing - results

Results: when relying on their natural perceptual capabilities in 3D, scientists are able to understand better their environment using immersive VR, as compared to a traditional, flat 2D image.





Points drawn by participants in the immersive VR group are more compact and closer to the correct location than the panorama group.

Understanding complex relationships

Ongoing study: Preliminary results

- Task: look at complex dataset with both traditional tools and VR
- Users in VR can understand relative size, position, more effectively
- Find answers more easily (e.g. outliers detection, trends)
- More effective collaboration



VR/AR: Skeptics and Natives







VR/AR: been around for 60 years...







Sensorama by Morton Helig (1962): first immersive, multisensory machine, still working today! Ivan Sutherland & Bob Sproull (1968): the first augmented reality head-mounted display, suspended from a ceiling. Virtual Boy Nintendo (**1995**). 32 bit, table-top, video game console. Advertises as the "*first portable console capable of displaying true 3D graphics*". Lasted 6 months on the market.

Nowadays: Major players involved



AR/VR industry landscape

THE VR FUND H1 2018 VR INDUSTRY LANDSCAPE

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THE VR FUND H1 2018 AR INDUSTRY LANDSCAPE



VR is here to stay!

• Advances in computing and graphics: GPU era

 "By 2022, 70% of enterprises will be experimenting with immersive technologies for consumer and enterprise use, and 25% will have deployed to production" - Gartner report on 2019 technology trends



GPU techniques in VIP

- Direct Compute: VIP uses Compute Shaders to optimize Force Atlas computation for Network Graph Visualizations
- Tessellation: VIP uses Tessellation Shader techniques to generate surfaces to visualize complex data in real-time
- Geometry shaders: Using point-topology meshes, VIP can render millions of data points while letting the GPU do the heavy lifting for creating complex 3D mesh detail for compelling visualization in VR



Case Study: large logistics company

KUEHNE+NAGEL

- Objective: need to make sense of massive supply chain data
- AI+VR to accelerate understanding of what processes are related to each other
- Collaborative environment
- Digital twin



Supply Chain Situation Room (concept developed in collaboration with Dr. Alban Quillaud -Head of Innovation and Analytics, Kuehne+Nagel)

Case Study: photogrammetry

- High-end graphics cards are essential when developing content like photogrammetry
- Idea of endless screens to be immersed in data
- Vibrant colors to help aid users to focus on data
- Machine learning results superimposed on the map



So far so good, but...

What can slow down VR adoption

- Generational gap
- VR companies not delivering strong user experience
- Interaction
- Setup





All-in-one devices and inside-out technology are making VR adoption easier

Al adoption: pain points

- Data scientists demand will increase ~30% by 2020 and there are not enough of them (source: IBM "The Quant Crunch" study)
- Businesses will look at "citizen data scientists" as a way to enable and scale data science capabilities: need AI-driven tools
- Difficult to convey the results to decision makers: AI seen as a black box



Solution: Democratizing machine learning

- Empower non-data scientists through easy-to-use, embedded ML routines
- Provide insights in natural language
- AI+VR makes data insights more broadly shareable across the business, including analysts and decision makers



Smart Mapping: proprietary Virtualitics routine, drag-and-drop functionality to find key insights using AI and high-dimensional visualization

How to explain complex ML models



Al-explainability: Use immersive visualization to describe complex Machine Learning models.

Convey information to upper management, bridge the gap between data scientists and decision makers.

Case study: large financial company

AI + VR pipeline: Prediction and Visualization + Collaboration between teams across the country



Modern data science

- Involve complex tech stacks with moving parts
- Highly iterative optimize one step at a time
- Need to be explained to business stakeholders



Virtualitics API - pyVIP

- Designed for use with industry leadings tools
- Immersive and interactive way to analyze results from leading packages and proprietary tools
- Faster and improved iterations in data science workflow
- Explainable results on-the-fly ready for collaboration





VIP's AI based Insights

Specifically lets find insights about our top quartile of spenders!

data['SlowBulkShoppers'] = vip.get_visible_points()

[]: data["ExpressShoppers"] = vip.get_visible_points()



Influence from the energy sector

[6]: data = pd.read_csv("D:/Demo Datasets/commodities.csv") vip.load_data(data, "Energy Sector")

[7]: vip.line(color="series_name", x="Date", y="Value", y_normalization="log10", x_scale=2.0)

Using TF-IDF to Vectorize the tweet text

We are going to turn the tweet text into a vector by using Tfidf vectorizer with a certain vocabulary. This will allow us to visualize the content of the tweets. First we will start with a generic vocabulary of 100 words with a lot of meaning.

from sklearn.feature_extraction.text import TfidfVectorizer [241: import numpy as np

> vocab = pd.read_csv('GOT-Twitter/mostUsefulWords.csv').values # The csv stores words using a numbering scheme like this: # 1. word1

2. word2



Connect VIP with NVIDIA HPC Clusters



HPC Cloud Cluster

- 1. Launch Jupyter on HPCC
- 2. Import pyVIP and specify host/port
- 3. Setup SSH Tunneling

Virtualitics API uses WebSockets to connect with VIP. The Virtualitics API can be used on any Python ready platform!





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	Load data for the ETL part 2 with 11x speedup	
In [54]:	%%time # read data on gpu step = 'load data part2'	

	<pre>start = time.time() ts_cols = ['object_id', 'mjd', 'passband', 'flux', 'flux_err', 'detected'] ts_dtypes = ['int32', 'float32', 'int32', 'float32', 'float32', 'int32']</pre>
	<pre># test_gd = gd.read_csv(`%s/test_set.csv`%PATH,</pre>
	<pre>cols = ['object_id', 'ra', 'decl', 'gal_l', 'gal_b', 'ddf',</pre>
	<pre>train_meta_gd = gd.read_csv('%s/training_set_metadata.csv'%PATH,</pre>
	<pre># test_meta_gd = gd.read_csv('%s/test_set_metadata.csv'%PATH, # names=cols,dtype=dtypes,skiprows=1)</pre>
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In [27]: vip.pca(num_components=5, exclude=["object_id"])
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Network graphs

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Join us for a demo!

- AI+VR = Augmented Analytics
- Al can guide users through their data and unlock key insights
- VR provide immersive visualization of insights and also contribute to unique collaborative environment



