A computer programmer takes on his Parkinson disease...

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"Little Bits of Big Data for Parkinson Disease and Co-morbidities"

Background

On my being diagnosed with Parkinson disease (PD) on April 22, 2010, I was shocked by the gravity of the diagnosis, and upset with how long it had taken to get it. I had been asking various doctors, including neurologists, about various symptoms for more than three years prior to my actual diagnosis. This motivated me to go to work to learn and do as much as I could to reduce its impact on my life. I learned a lot. Among many other things I learned is that there are significant benefits from high intensity aerobic exercise.

An example of such high intensity exercise is bicycle riding. Human experiments had shown high cadence (> 80 crank revolutions per minute) biking to be successful at reducing symptoms. Animal model experiments had suggested intense aerobic exercise to be neuroprotective, i.e. stop or slow disease progress (note that the US FDA has not approved any medications to be labeled as neuroprotective). I conjectured that bicycling, especially high cadence bicycling, COULD be neuroprotective. Further, I also conjectured that better effects, both symptomatic and neuroprotective, could come from even higher cadences than had been used in experiments to date. (One big caveat is that at high cadences the risk of injury is greater and one has to be careful.)

Application #1: Find equipment to maximize cadence.

I continue to find better ways to ride. I nearly always use a stationary bike, either my street bicycle on a stand at home, a Spinning (TM) bike at my gym, or a newly purchased stationary bike for using at home.

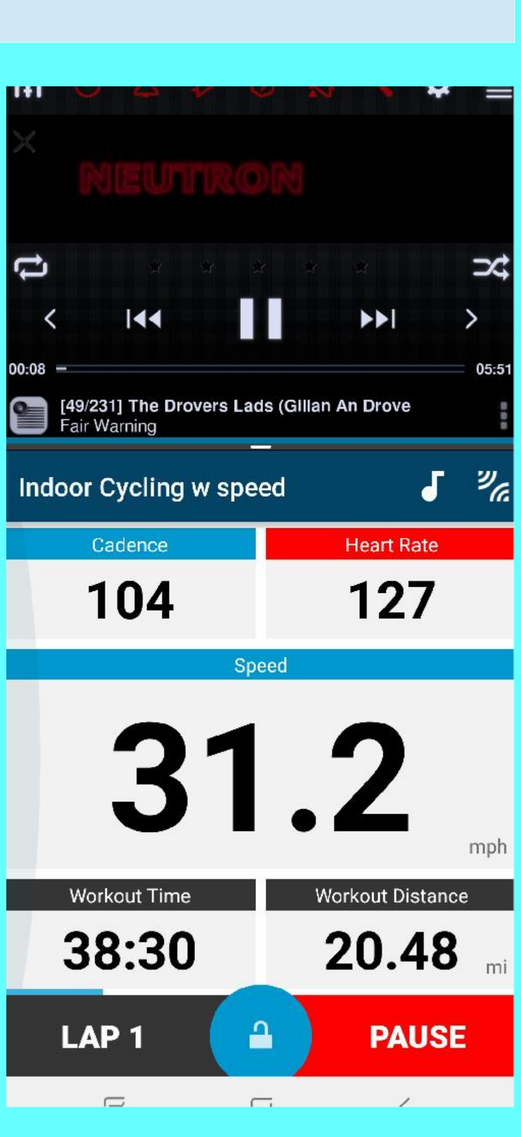
I try to optimize benefit by maximizing cadence (in crank revolutions per minute). The research with which I am familiar shows benefits accrue to a 80-90 RPM cadence, and no measurable benefits accrue to a 50-60 RPM cadence. I am unaware of any research showing benefits or lack thereof to a cadence above the 80-90 RPM level, so I conjecture that there are indeed such benefits increasing above 90 RPM, as I cannot think of a reason why benefits would start above 60 RPM and stop at 90 RPM. Maybe there is. But I don't want to wait for someone else to research the matter and confirm it while I go without such benefits. Cadence is my **"figure of merit!"**

I use wearable Bluetooth measurement devices to get cadence and heart rate, and another device attached to my bike at home to get "speed." All are supplied by a maker who also provides a smart phone app to accept Bluetooth transmissions that enable me to get the data into a database. (Some other wearable device manufacturers do not provide data in non-proprietary comma separated value [.csv] format. I want to be the one deciding what to do with my data, and I don't want to pay extra to get it into a usable format – some other device manufacturers charge. I can take the .csv formatted data directly into a spreadsheet [such as Excel or OpenOffice4 Calc] or into a program that I write myself to enter the measurement values into the database.)

So, I use my database to get average cadences at the varying locations and varying equipment configurations. I use a Structured Query Language (SQL) query to get a result table that will compare average cadence (avcad) rates (not warm up or cool down) for different locations and equipment combinations. It also can show me how many sessions and how many data-points are used to derive the answers. I compare home and gym, type of bike, and type of shoes to see which get better RPMs. I get my best results with the Spinning (TM) bikes at the gym.

Playing music and collecting data both use off-the-shelf apps.

I can control my music selection using an off-the-shelf mp3 player.



The lower part of this split screen shows results from the wearable or mountable devices that record heart rate, speed (only on a street bicycle [usually on a stand]), and cadence.

Information Can Inform Action.
1. use spin bike,
2. don't take a useless med,
3. inform med timing.

Application #1 Table

```
select format(avg(cadence),2)+0 average_cadence, count(distinct s.sessionid)
as num_sessions, loc location, equipment, shoes from BikeCad c join Sessions
s on s.sessionid=c.sessionid where loc in ('home','gym') and s.sessionid <
'201810' and Timestamp between (s.min_attachment_datetime)+15*60000 and
(s.min_attachment_datetime)+30*60000  group by 3,4,5 order by average_cadence
desc;

Exercise optimization table / shows where and with what I got best cadences.

+-----------------+--------------+----------+-------------------+----------+
| average_cadence | num_sessions | location | equipment         | shoes    |
+-----------------+--------------+----------+-------------------+----------+
|          113.85 |           99 | gym      | Spinning(TM)      | cleated  |
|          108.81 |           38 | gym      | Spinning(TM)      | ordinary |
|          104.99 |          115 | home     | bike on stand     | cleated  |
|          101.99 |          141 | gym      | stationary cycle  | ordinary |
|           95.95 |          194 | home     | bike on stand     | ordinary |
|           89.69 |            2 | gym      | Expresso VR       | ordinary |
+-----------------+--------------+----------+-------------------+----------+
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Application #2: Address a co-morbidity (something else besides PD that is wrong with me).

As anyone in any exercise program should do, I consult my physicians about it. While exercising, on occasion, I experience a dull but definite pain in my chest. My cardiologist has examined me very carefully using a number of tools including a cardiac catheterization and a nuclear stress test to ensure I was not at risk for a heart attack. He prescribed a nitroglycerin sub-lingual spray for me to take, if and when the pain occurs, to alleviate the pain. It works.

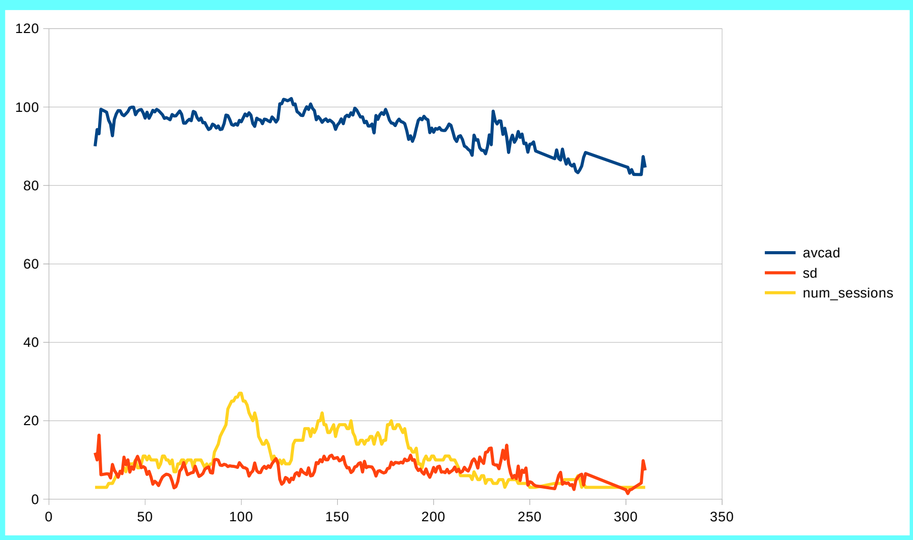
After we determined that the sub-lingual nitroglycerin spray was useful, he advised me of another drug available to be taken in tablet form by mouth daily (or more) so that the pain would hopefully not arise at all. I carefully logged on which days I had to use the sub-lingual spray for pain and logged those on which I did not. I further logged whether I was taking the daily drug tablets and when I was not.

With this information I could see whether the daily drug tablets could replace the sub-lingual spray, and hopefully avoid the chest pain entirely.

The numbers said that the new drug did not help. I wrote the following to my cardiologist: "I looked at my database information and found that for my exercise sessions since May of 2016 [to the date of this letter], there were 184 days when I was taking [the daily tablets] and 254 days when not. 28.2% of the days I was taking [the tablets] I also had to use my nitroglycerin; but in 24.0% of the days I was NOT taking [the tablets] I had to use my nitroglycerin. So it looks like I need the nitroglycerin about 24% of the time when not taking [the tablets]. If taking [the tablets] the odds are actually and counter-intuitively nearly the same as not that I will need the nitroglycerin."

He agreed with me that the new drug was not helping me. We discontinued it. I use nitroglycerin in the minority of exercise sessions when I need to address chest pain.

Application #3 Graph



avcad (blue at top) is the average cadence for the minutes' buckets, sd (red at bottom) is the standard deviation of the cadences in the buckets, num_sessions (yellow) is the number of sessions whose data is in each minute's bucket.

Application #3: Measure medication effects.

My movement disorder specialist wanted to know how long my body stayed "on" after I took my medication. I had cadence rates, the exact times at which they were measured, and the times I took my medication; all in the database.

Cadence is higher when I am "on" than when I am "off". So I used cadence as a proxy for medication effectiveness.

Data is collected from an accelerometer (commercially sold) worn on a holder on my left ankle which transmits cadence nearly every second via the Bluetooth protocol to an Android device (Samsung Galaxy Android phone using a proprietary app*) which bundles the cadence data, along with my pulse rate in heart-beats per minute (from a device from the same source), every second, and accepts additional session level data which I personally enter including time medication was administered, ambient temperature, ambient humidity, etc. When the session is complete and all data entered I email these metrics to a computer on which I reformat the data into a relational database.

Structured Query Language (SQL) is used to further process the data to be passed to a spreadsheet calculator, which then is used to create a spreadsheet showing average cadence for each one-minute interval (data is collected in virtual buckets) following medication administration, for each session being studied, and then to draw the graph that is shown.

The X-axis shows minutes since medication administration.
The Y-axis blue line shows cadence in RPMs.
The Y-axis red line shows the standard deviation, a measure of dispersion.
The Y-axis yellow line shows the number of sessions involved in the calculation.

So we see a little irregularity to this with a few outlier data points, but in general we see that my carbidopa/levodopa could fade in its effect from ~180 to ~240 minutes or (3 to 4 hours) after ingestion.

* The app's functionality to perform this process has been discontinued and I am trying to find a replacement.

Conclusions

We have seen some practical applications of computer relational database technology in the measurement of exercise for Parkinson disease and compilation of that measurement into database form for analysis. We have found that I can maximize my cadence on an exercise cycle with a weighted flywheel and a fixed gear drive such as a Spinning (TM) bike. We have found that a medication for chest pains was not helping (and will continue to analyze the data to see if other things might help). And we have seen an effectiveness curve for carbidopa/levodopa in my system.