Predictive analytics and wearables in insurance

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Transforming Healthcare
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Trends transforming the insurance industry

- Explosion of data volume
- Significant improvements of sensing and analytical capabilities
- Substantial increase in computational power
- Rapid change in consumer behaviour
- Proliferation of digital platforms/market places
- Emergence of agile digital native primary attackers

Technological shift and behavioural shift
Technology with three major implications for the insurance industry

Technological advancements
(e.g. internet of things, cognitive computing, blockchain)

Implications for the industry
1. **Change in risk pools**
   (e.g. new risks)
2. **Transformation of value chain**
   (e.g. automation)
3. **Disruption of industry structure**
   (e.g. changing roles, new ecosystems)

Catalysts / Inhibitors
(e.g. technological diffusion, regulation, consumer, competitors)
Impact falls into two main categories

**Evolutionary – Leaner, Better, Faster**
Existing business processes can be better supported and automation levels of «mechanical» tasks can be increased, using...

- Text Analytics & Data Capture
- Advanced Search
- Robotics Automation
- Predictive Modelling
- Handwriting Recognition
- ...

**Transformational – Disruptive**
Emerging technologies and capabilities enable new ways to do business:

- Wearables / IoP (Internet of People)
- IoT (Internet of Things – ecosystems based on sensor data)
- Blockchain (transactional, smart contracts, medical data)
- Cognitive Technology
- ...

Setting the scene
Smart Analytics
@ Swiss Re

Evolution and revolution in the digital world
Predictive Analytics and Machine Learning is extensively used at Swiss Re in various areas – P&C, Life & Health and Special Lines

Applications

### Global Motor Risk Map

Use **Predictive Modelling** to predict accident level (frequency and severity) on a regional level for motor insurance to enable insights into new and currently untapped markets.

### High Medical Claims Forecasting

Enable **better underwriting and reserving decision** for our Employee Stop Loss portfolio by leveraging predictive modelling techniques on massive data set of US medical claims.

### Lapse Modelling/ Customer Behavior

Understand what are the **drivers that impact lapse rate** of certain life insurance products to enable more accurate projections of lapse rate in the future.

### Other applications

Use **Machine Learning** and **Predictive Modelling** to enable **dynamic pricing** for insurance products to enable better differentiation in the market.
Accident & Health Cost Claims Forecasting
Informing underwriting and reserving decisions with descriptive and predictive analytics using big set of medical treatment data

Opportunity
The profitability of the ESL portfolio is increasingly threatened by medical inflation and rising frequency of catastrophic claims.

To set appropriate deductibles and maintain adequate reserves, we wanted a better understanding of the disease conditions and treatments that are driving the rise in medical claims.

Approach
• Acquisition of five years medical claims (40m insured) containing full medical track.
• Exploration of various underwriting relevant questions by applying advanced modelling and machine-learning techniques.
• A descriptive analytics dashboard was created in order to allow intuitive and interactive exploration of the data, which eventually can support underwriting decisions.

Benefit
The solution allows underwriting and reserving decisions based on more accurate understanding of the evolution o medical conditions and treatment costs.

For example, we can predict with 67% accuracy the chances of an individual patient exceeding their deductible by a given amount.

1.7 billion
drug payment records are included in the data set used for descriptive and predictive analytics.
A Case of Big Data Analytics
Context

**Corso A&H ESL Portfolio**
- Corso Accident & Health (A&H) provides employer stop-loss (ESL) solutions in the US
- This product is designed to protect employers from catastrophic medical claims on each individual covered by the plans (employees and employees families)
- Practically, a deductible is set for each individual during the underwriting process, ranging usually from USD 50,000 to USD 1,000,000

**Medical market in the US**
- Strong medical inflation
- In particular, increase in the frequency of catastrophic claims (> USD 1 mio per person)
  - In 2009, the upper 2% of the enrolees represented 30% of the total claim amount. In 2013, they represented 38% of the total claim amount
- Among the usual suspects, the treatment costs of cancers, renal disease, and in particular specialty drugs that can reach USD 10mio per year per individual

- ESL market is under pressure due to rapidly increase very large claims
- Catastrophic claims can easily put the profitability of SR A&H ESL portfolio at risk
A Case of Big Data Analytics
Large External Claims Database to Support the Analysis

5,000,000,000 external consultations
1,700,000,000 drug payments
40,000,000 insureds
5 years of data
2 TB

BIG DATA

Physician consultations
Drug prescriptions
Hospital admissions
Demographics and employment data
A Case of Big Data Analytics
From a Large Dataset to Business Answers

Data Preparation
- What is the optimal IT setup to achieve the technical challenges?
- How to sample the population?
- Is the population representative of the Corso A&H portfolio?

Descriptive Analytics
- What is the medical inflation for the different demographics?
- What are high claims made of? What is their dynamicity?
- How much does a given treatment cost, e.g., lung cancer?

Predictive Analytics
- Which key features have the highest forecasting power?
- What will the medical inflations be next year?
- How to get early warnings on new high cost treatments?

Massive data set of 2 terabytes

Practical answers for business
Descriptive Analytics
Underwriting Support Solutions

How does the medical expenses evolve over time? What is the dynamicity in medical inflation?

➢ Various inflation measurements to validate UW assumptions

➢ Tail-based inflation to concentrate on the actual faced inflation and leveraging effects

How to underwrite safely new portfolio accounting for known medical conditions?

➢ Severity curve over time for different medical conditions (lasering)

➢ Identification of the diagnoses & drugs characterizing high claims
Trends Analysis
Treatments Inflation: Low/Mid/High Cost comparison

- Clear positive relationship between the 2009 mean treatment cost and the mean inflation observed from 2009 to 2013

- High cost treatments do not have the same inflation as low or middle cost treatments.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Average 2009 Cost [USD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for prophylactic vaccination and inoculation against influenza</td>
<td>38</td>
</tr>
<tr>
<td>Acute sinusitis, unspecified</td>
<td>116</td>
</tr>
<tr>
<td>Acute appendicitis without mention of peritonitis</td>
<td>7.5k</td>
</tr>
<tr>
<td>Encounter for antineoplastic chemotherapy</td>
<td>24k</td>
</tr>
<tr>
<td>End stage renal disease</td>
<td>68k</td>
</tr>
</tbody>
</table>
Descriptive Analytics
Understanding the Medical Risk

What are the critical medical complications that can lead to very large claims?

- A **network-based analysis** is used to understand the dependencies between diagnoses and drugs, and the **co-morbidities** of the very high claims patients

- **Forward looking analysis** of the critical illness and complications leading to high claims

What are the medical characteristics of a given subpopulation?

- Practical visualisation of the main disease for different cohorts (age, gender, state)

- Disease prevalence per cohort

*High cost (>USD 50k per year) diabetic patients are characterized by a high-level of co-morbidities, including skin and cardio-vascular diagnoses.*
Predictive Analytics: 50% Notifications

Definition

- A notification is sent by the prime insurer/employer to Corso whenever the total claims have reached **half of the deductible for a given individual** (a.k.a. *census point*).

- This notification is embedded in a form containing:
  - **Demographic** information
  - **Claim** information
  - **Medical** information

Conditional on a given 50% notification, can we forecast the final cost reached at the end of the year?

What are the key forward looking medical drivers that will impact the cost forecasts?
Predictive Analytics: 50% Notifications

Problem Formulation

- The 50% notification is translated into a machine-learning problem, where the features match the information of the 50% notification form.

- The time window considered is assumed to be the 12 months preceding the notification.

- Note that we make a pure ex-ante analysis: we look for factors known at the time of notification that can lead to a very large claims (as opposed to factors revealed between the notification time and the end of the policy window).
Predictive Analytics: 50% Notifications Forecasting Results

- **Achieved results**
  - Precision: 66%
  - Recall: 67%
  - F-score: 0.67

- **Results interpretation:**
  - Out of all the 50% notifications coming in, **we can successfully flag 67% of all those that will end up exceeding USD 125k** at the end of the policy year.
  - Out of all the notifications that we forecast as exceeding USD 125k at the end of the year, 66% of them actually exceed this threshold.
  - The history of **hospital admissions** (day length and count) is key to discriminate the cost.*
  - On a medical side, cancers and kidney disease (incl. the dialysis procedure) are the leading indicators indicating a forthcoming very large claim.

*Statistically speaking, lengthy and repeated admissions are strongly **auto-correlated** in time, so they indicate forthcoming hospital stays/admissions.*
The Evolution of Health Tech – Wearables
Wearable Devices - Examples

Omron’s wristband Project Zero is a clinically accurate blood pressure monitor (BPM) that provides real-time blood pressure readings. Its purpose is to help patients with chronic illness better record and manage their health data. The wristband also collects data like steps, calories burned, and sleep quality.

Resound builds smart hearing aids and accessories for people with mild to severe hearing loss. The ReSound LINX2, is its second-gen aid that enables wearers to control their hearing via an iPhone app. Users can adjust volume, treble, and bass, and create specific programs of settings they can access when they're outside or in a restaurant.

Hexoskin has gone beyond fitness bands to create smart clothing. Its biometric shirts have sensors woven into the fabric for measuring your heart rate, pace, breathing rate and volume, steps taken, calories burned, and sleep. Recorded data is transmitted to a mobile app (iOS and Android), or users can access their health information via an online dashboard.

Zhor has built smart footwear. Its DigitSole shoes, which come in various fashion styles, can be adjusted to foot size. It measures steps taken and calories burned. It charges wirelessly, and submit data via Bluetooth to a compatible mobile.

Google has developed smart contact lenses for people who suffer from diabetes and those who simply wear glasses. Google has partnered with pharma Novartis. The technology takes the tears in a person’s eye and measure the glucose levels that are present. For people who wear glasses, the lens would be engineered to what the companies say is ‘to restore the eye’s natural autofocus’.
We distinguish two basic types of wearables

**Fitness-Grade**

**Medical-Grade**
Nice, but - what for? Why should we be interested?

**Biomedical data in the insurance chain**

**Underwriting**
- Easier (pre) selection
- Preferred classes possible
- Selection effect (cf. no claim bonus profiles)
- Could offer current “non insurables” cover with better management, compliance

**In Force**
- Ongoing underwriting, shifting of class
- Keep policyholders healthier
- Manage disease
- Increased persistency (when combined with other programs)

**Claims**
- Reduce claims for Life and Illness claims (DI, CI)
- Reduce hospitalisation frequency, duration, and re-admission for medical insurance
- Potential faster claims process – could we know before the client?
- Earlier intervention, quicker recovery, better rehabilitation
**e-Health**: Swiss Re is pursuing wearable opportunities through partnerships with clients and providers

**Biovotion**

Swiss Re’s **engagement**: Investment

**Innovation**: Medical grade wearable

**GOQii**

Swiss Re’s **engagement**: Partnership

**Innovation**: Fitness system of engagement

**MLC – On Track**

Swiss Re’s **engagement**: Client & Partnership

**Innovation**: Wearable incentivised health product
The Cases: MLC On-Track – Engaging Customers
The Cases: Biovotion – Medical-Grade Data

Product pipeline

<table>
<thead>
<tr>
<th>Year</th>
<th>VSM1*</th>
<th>VSM2</th>
<th>VSM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Heart rate, Blood oxygenation, Skin temperature, Skin blood perfusion, Steps/Motion, Respiratory rate</td>
<td>Cutaneous water</td>
<td>Blood glucose</td>
</tr>
<tr>
<td>2017</td>
<td>Heart rate variability, Stress, Sleep, Blood pressure wave, Energy expenditure, Sweat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multisensor data

- Heart rate
- Blood oxygenation
- Skin temperature
- Skin blood perfusion
- Steps/Motion
- Respiratory rate
- Heart rate variability
- Stress
- Sleep
- Blood pressure wave
- Energy expenditure
- Sweat

* To be added step by step
** Limited motion tolerance

A Quiet Sunday
A Working Day
A Day with Challenges

Sophisticated, easy to use, wearable, accurate, motion tolerant, secured

Multiple vital signs
Medical grade accuracy
Highly motion tolerant
Relatively low cost
Ergonomic/aesthetic
Data mgmt. ecosystem
Social media connectivity

Predictive Analytics & Wearables | D. Thyssen, E. Qeli | Transforming Healthcare
The Cases: GoQii – Your Personal Health Coach

GOQii Ecosystem

- Comprehensiveness: all key elements for permanent lifestyle change
- Integrated: platform adoptive to other wearable’s and apps
- Scalability: scalable platform, scalable coaching
- Affordability: fraction of a single training session

- Band: Measure activities and sleep
- Application: Track nutrition, hydration, activities. Chat with coaches
- Coach: Personal guide to healthier living and goal reinforcement
- Experts: passionate minds designing GoQii Life
- Karma: live healthy, earn karma points, donate
The e2e View – It’s Not Just About Data Analytics

Challenges and Opportunities

- Engagement
- Glucose
- Ethics
- The Markets
- The Products
- The Data
- The Models

Insurer/Reinsurer

Smart Analytics

- Prescriptive,
- Predictive,
- Clustering

Data-driven business

The Data

The Markets

The Models

The Products

Ethics

Glucose
Pitfalls

• Basis Peak device overheating
• Pickup rate @ MOT
• “useless data” without personal parameters
• Regulatory change sets GoQii project back by 6m

Successes

• Everbest Challenge: Wearables-based Behavioural Engineering in 2013 at Swiss Re
• Pickup rates @ MLC going up following revised engagement model
  → Behavioural Economics based learning
• Biovotion Everion device ready for pilot
• NGIC and Wearables Conferences at CGD in 2016 meet with high client interest and confirm Swiss Re is a leader in the field
Vision

- **Biovotion**: 19 sensor signals including blood glucose by 2018
  - manage diabetes
  - predict / prevent heart attacks

- **Fluidless Underwriting**
  - close protection gaps

- **Predictive** models based on standard fitness data

- **Prescriptive** ... → insurance becomes lifestyle (and oh, we pay your claims, too)

- **Super-simple** buying of insurance thanks to fitness data + IoT + circumstantial data

- High consumer engagement with frequent touch points

- “myHealthVault” managed through **Blockchain**

- Wearables & Motor Telematics & Smart Home
  - integrated engagement, ecosystem + product offering

*Swiss Re leads the way*
Appendix
The Technology Clusters are elements of broader Technology Themes

<table>
<thead>
<tr>
<th>Technology Cluster</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement Space &amp; Data Exchange</td>
<td>Partner driven / external exchange</td>
</tr>
<tr>
<td>Portal / Client Services</td>
<td>SR driven / internal exchange</td>
</tr>
<tr>
<td>Platforms &amp; Clouds</td>
<td>SR driven / internal base</td>
</tr>
<tr>
<td>Wearables</td>
<td>Data Producer</td>
</tr>
<tr>
<td>Analytics</td>
<td>Data Mining</td>
</tr>
<tr>
<td>Data Set Management</td>
<td>Internal storage</td>
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<tr>
<td>Self Data</td>
<td>External storage</td>
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<tr>
<td>Robotic Process Automation</td>
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<tr>
<td>Cognitive &amp; NLP</td>
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<tr>
<td>Text Analytics</td>
<td></td>
</tr>
<tr>
<td>Robo Advisor / Digital Assistant</td>
<td></td>
</tr>
<tr>
<td>Blockchain</td>
<td>PoC at this stage</td>
</tr>
</tbody>
</table>
Challenges and Opportunities Described (1/2)

**Engagement:**
One of the key success factors is getting and keeping individuals interested in interacting with their insurance provider on a regular basis. This is an art of its own and heavily draws on Behavioural Economics. As a reinsurer, this is probably the biggest learning area for us.

**Glucose:**
Stands, as an example, for the new possibilities emerging technologies offer. Medical/insurance experts agree that being able to accurately measure blood glucose 24/7 in a non-invasive way would be a huge door opener for better disease management as well as new business models.

**The Data:**
These new sources and high volumes of sensor data need to be transported, managed, stored, protected and linked with data from other sources. Then we need to apply the right analytical approaches and algorithms to make sense of the ocean of data.

**The Models:**
One of our key value propositions is to build top-quality risk models. We are a world leader in doing that based on data from more traditional sources. Now we need to learn how to build the top-notch next-generation models with new kinds of data, such as vital signs from wearables.
Challenges and Opportunities Described (2/2)

The Products:
This is what we bring to the market – translating our risk models into something that is of value to the primary insurers and end customers and can be bought and sold.

The Markets:
We need to understand the markets we move in – geopolitically, socio-economically, age stratification, etc. etc. – to be able to offer the right products in the right space at the right time.

Ethics:
The more detailed data we gather about individuals, the more we need to ensure we have and enforce proper ethical guidelines governing what we will and what we won't do with that data. Ultimately, we think that we, the insurance industry, should work more closely with regulators and other key stakeholders (like medical doctors' associations) to create a fair, level playing field that protects the interests of the individual end customer while offering clear rules for commercial enterprises like ourselves to operate under.
Biovotion VSM-1 Pilot: Circadian Spirals (1/2)

A Quiet Sunday

A Working Day

A Day with Challenges

what happened here?

heavy lunch

and here?

a stressful pre-concert practice
9th November 2016

An Active Saturday

What the ... ??

news on the US elections

the concert

peaceful sleep

a good practice session

post-run dehydration + caffeine

drank >1L of water
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