

Analytics in Action

Timothy Chan, Islay Wright Justin Boutilier, Swapneel Mehta University of Toronto

NSF Enhancement Initiative – Analytics Ottawa, March 23, 2016

Agenda

- 10:00 10:45 Introduction and a Game
- 10:45 11:30 Analytics in Sport
- 11:30 11:45 *Coffee Break*
- 11:45 12:30 NSF Analytics Brainstorming; Basketball Tool
- 12:30 1:15 Lunch
- 1:15 2:15 Demographic and Tennis Tools

Looking Ahead

- 2:15 2:30 Coffee Break
 - NSF Analytics Brainstorming
- 3:45 4:00

2:30 - 3:45

Who are we?





Timothy Chan

- Associate Professor and Director of the Centre for Healthcare Engineering, University of Toronto
- Canada Research Chair in Novel
 Optimization and Analytics in Health
- 1st Place 2013 MIT Sloan Sports Analytics Conference Research Paper Competition



Justin Boutilier

- Third year PhD candidate in operations research from the University of Toronto
- Focus on health and humanitarian applications of operations research and machine learning
- Former captain of the Acadia University varsity men's basketball team



Islay Wright

- First year Masters of Applied Sciences candidate in operations research from the University of Toronto
- Focus on applying mathematics to social issues, particularly those based in Canada
- Marathon runner and Special Olympics coach



Swapneel Mehta

- Strategic consultant with experience in the Telecommunications, Pharmaceutical, Sports and Entertainment Industries
- Director of Analytics, SportTesting Inc., Strategy Specialist, Bell Canada
- 10 years volunteering with Tennis Canada

What is analytics?

Analytics is about using models and data to make better decisions

















The analytics approach



Disciplined common sense meets ingenuity



Clearly define your question Gather reliable data

Build an appropriate solution

Know the limitations

Derive actionable recommendations

mplement and measure

Review and revise

A big part of analytics is about making decisions in the face of <u>uncertainty</u>

Let's get the analytics (and competitive) juices flowing with this first exercise.

INTERACTIVE: Deal or No Deal (mini)

Rules

- Suppose there are 6 briefcases
 - Amounts are \$0, \$1K, \$10K, \$100K, \$500K, \$1M
- Pick a briefcase for yourself
- Open another briefcase (that \$ amount is eliminated from play)
- I make you a \$ offer
 - If you accept, you get that \$ and the game ends
 - If you reject, open another briefcase
- Game ends when you accept an offer, or when all briefcases are open, in which case you get the \$ amount in your briefcase.



INTERACTIVE: Deal or No Deal (mini)

Strategy

- Suppose you hold one briefcase and there are two others remaining. The amounts in play are \$0, \$100K, \$500K.
- Suppose I make you an offer of \$200K.
 - Do you accept?
 - If you reject, what is the probability that you will get a better offer next time? Are you making any assumptions about my offer?
- What if the offer is \$150K? 250K?
- Is there an optimal strategy for playing this game?



Let's Play!

- 26 briefcases each with a dollar value between \$0.01 and \$1M
- You choose a briefcase, then start opening the other briefcases one at a time
- What is revealed is obviously not in your briefcase
- At certain points, the banker will make you an offer to buy your briefcase
 - Accept: Game ends and you win what's offered
 - Reject: Continue opening briefcases until next offer
- If you open all briefcases, you receive whatever is in yours





Play game here...

Discussion

- The culmination of everything we do in analytics is to improve decision-making
- Uncertainty is a part of all (hard) decisions
- Sometimes we optimize for "expected" outcome, other times for "worst-case"
- Whether it is a...
 - tactical move ("should I break from the pack now")
 - operational move ("in which five locations should I run camps to maximize turnout"), or
- strategic move ("should I invest resources in a few or many top athletes")
 ...analytics can help you make informed, data-driven decisions



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3:45 - 4:00	Looking Ahead

The Rise of (Sports) Analytics



The Rise of (Sports) Analytics



Forbes / SportsMone	EY The Little Black Book of Billionaire Secrets		
AUG 18, 2015 @ 03:08 PM 16,089 VIEWS			
CHANGING T	HE GAME: The Rise of Sports		
Analytics	IBM Watson Teams With Toron Driven Talent Analysis Posted Feb 10, 2016 by Ron Miller (@ron_miller)	to Raptor	s On Data-
NHLTRAVIS YOSTFor the teams padd real value	Feb 9 Daying attention, analytics continue to	MAN	
Map New hires CBC Sports	De Leafs creating analytics de to include head of ExtraSkater.com blog Posted: Aug 19, 2014 2:08 PM ET Last Updated: Aug 19, 2014 3:56 PM ET	partment	: report

Sports Analytics Timeline





Technology, Data & the Future of Sport



Technology

- In game player tracking
- Wearables
- Electronic assessments
 - Auto-umpire
 - Scouting Combines





Data

- More data, more power, more value!
- Cloud based storage and analysis
- Don't be left behind

80%

\$1.6M

of enterprises have or plan to deploy big data projects - Forbes

Average SMB spend on data initiatives over the next year - Forbes

People

- Demand is high but supply is short
- Sporting organizations are improving their capabilities

1.5M

Shortage of analysts / managers with a data analysis skillset - McKinsey

The geeks, they're here to stay

Technology, Data & the Future of Sport





Technology, Data & the Future of Sport



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The geeks, they're here to stay

MIT Sloan Sports Analytics Conference



2015



MARCH 11 - 12, 2016 BOSTON CONVENTION AND EXHIBITION CENTER

2007

- 175 attendees
- Single-day event in MIT classrooms
- 2 Keynote speakers:
 - JP Ricciardi GM of the Toronto Blue Jays
 - Jaimie McCourt CEO of the LA Dodgers

- 3200 attendees, 100+ professional teams, 300+ sport organizations
- Multi-day event at Boston Convention and Exhibition Center
- 29 panel discussions featuring:
 - League commissioners
 - Owners and presidents
 - General managers
 - Players

Gregg Popovich

– San Antonio Spurs head coach and president



Charles Barkley – 11x All-Star and NBA Hall of Famer



Theo Epstein

– Chicago Cubs president



Brian Burke

- Calgary Flames president



Shane Battier

– 2x NBA Champion



Drew Doughty – 2x NHL Champion





The Lovers

"Sometimes, they prove what you were thinking ahead of time. Now and then, there might be something you look at because there's something happening you maybe didn't notice." – Gregg Popovich (San Antonio Spurs head coach and president)

"The currency of the draft is information. Scouting information, statistical information, makeup information, medical information. In each of those buckets, we have to drill deeper if we want to have an advantage." – Theo Epstein (Chicago Cubs president)

"And so guarding a guy like Kobe Bryant, understanding exactly who he is, what his weakness is, made me a much better defender and allowed me to stick around the NBA for 13 years." – Shane Battier (2-time NBA champion)

The Haters

"Analytics don't work at all. It's just some crap that people who were really smart made up to try to get in the game because they had no talent." – Charles Barkley (NBA Hall of Famer)

"The thought that you can sit behind a computer and find an athlete is bullshit." – Brian Burke (Calgary Flames president)

"I think that Corsi thing is a bunch of crap, personally." – Drew Doughty (2-time NHL champion)

Embracing analytics





9 combined championships since 2007



3 combined championships since 2007





Examples of analytics in Sports





Fan Enhancement in Broadcasting

Artificial Snow Optimization

Hawkeye: Electronic Line Calling in Tennis





Can you beat Hawkeye?

Source: http://www.hawkeyeinnovations.co.uk/sports/tennis

Hawkeye: Electronic Line Calling in Tennis





Fan Enhancement in Sports Broadcasting



Descriptive IBM SlamTracker

australian <mark>A</mark> lopen	N. DJOKOVIC MEN'S SINGLES - F	V R. NADAL ROD LAVER ARENA	ANALYTICS & INSIGHT BY IBM		
	Rod Laver Arena -	Men's Singles - Finals			
	N. DJOKOVIC	✓ <u>5</u> 6 6 6 ⁵ 7			
	R. NADAL	7 4 2 77 5			
	TOTAL P	OINTS WON			
	193 MON	IENTUM			
SHOW LIVE MATCHES					
KEYS TO THE MATCH	MOMENTUM	MATCH STATISTICS	COMMENTARY		
Keys to the the match for Novak I 1. Win more than 48% of 3 to 8 shot rallies. 48% 2. Win more than 46% of points on second serve 46% 3. Win more than 29% of first serve return point 29%	Djokovic KEY STRENGTH e. S. S. C. C. C. C. C. C. C. C. C. C. C. C. C.	Keys to the the match for F 1. Win more than 51% of 3 to 8 shot railie 51% 2. Have an Aggressive Ratio of more than 3. Win more than 68% of points on first se	Rafael Nadal KEY S. 1.4. erve. Sos		
SET 1	SET 2 SI	ET 3 SET 4	SET 5		
			мрн кмн		

MLB StatCast



Slamtracker's "Keys to the Match" feature, built on IBM's predictive analytics technology (SPSS), mines over **8 years of Grand Slam Tennis data (~41 million data points)** to determine patterns and styles for players when they win – Wimbeldon.org Instead of just looking at the leaders in Triple Crown categories or even advanced sabermetrics, fans will now be able to seek out players with the fastest average speeds on the basepaths, the best route efficiencies over the course of a season or the strongest throws from each position – MLB.com

Source: http://www.wimbledon.com/en_GB/slamtracker/ Source: http://m.mlb.com/news/article/119234412/statcast-primer-baseball-will-never-be-the-same

Predicting Talent in Youth Hockey

Predictive

Do physical maturity and birth date predict talent in male youth ice hockey players?

LAUREN B. SHERAR, ADAM D. G. BAXTER-JONES, ROBERT A. FAULKNER, & KEITH W. RUSSELL

College of Kinesiology, University of Saskatchewan, Saskatoon, Canada

(Accepted 4 July 2006)

Abstract

The aim of this study was to examine the relationships among biological maturity, physical size, relative age (i.e. birth date), and selection into a male Canadian provincial age-banded ice hockey team. In 2003, 619 male ice hockey players aged 14-15 years attended Saskatchewan provincial team selection camps, 281 of whom participated in the present study. Data from 93 age-matched controls were obtained from the Saskatchewan Pediatric Bone Mineral Accrual Study (1991–1997). During the initial selection camps, birth dates, heights, sitting heights, and body masses were recorded. Age at peak height velocity, an indicator of biological maturity, was determined in the controls and predicted in the ice hockey players. Data were analysed using one-way analysis of variance, logistic regression, and a Kolmogorov-Smirnov test. The ice hockey players selected for the final team were taller, heavier, and more mature (P < 0.05) being selected at the first and second selection camps. The birth dates of those players selected for the team were positively skewed, with the majority of those selected being born in the months January to June. In conclusion, team selectors appear to preferentially select early maturing male ice hockey players who have birth dates early in the selection year.

Snow Height Prediction

Predictive

Artificial Snow Optimization in Winter Sport Destinations Using a Multi-agent Simulation

M. Revilloud, J.-C. Loubier, M. Doctor, M. Kanevski, V. Timonin, and M. Schumacher

Abstract. This paper presents the Juste-Neige system for predicting the snow height on the ski runs of a resort using a multi-agent simulation software. Its aim is to facilitate snow cover management in order to i) reduce the production cost of artificial snow and to improve the profit margin for the companies managing the ski resorts; and ii) to reduce the water and energy consumption, and thus to reduce the environmental impact, by producing only the snow needed for a good skiing experience. The software provides maps with the predicted snow heights for up to 13 days. On these maps, the areas most exposed to snow erosion are highlighted. The software proceeds in three steps: i) interpolation of snow height measurements with a neural network; ii) local meteorological forecasts for every ski resort; iii) simulation of the impact caused by skiers using a multi-agent system. The software has been evaluated in the Swiss ski resort of Verbier and provides useful predictions.

Decathlon Training Optimization

Prescriptive

OPERATIONS RESEARCH Vol. 57, No. 4, July–August 2009, pp. 812–822 ISSN 0030-364X | EISSN 1526-5463 | 09 | 5704 | 0812



DOI 10.1287/opre.1080.0616 © 2009 INFORMS



Training Optimization for the Decathlon

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Decathlon coaches usually spend days or even weeks on designing training schedules for their athletes. A major complication is the fact that the athlete has only limited time for an extensive range of training exercises, whereas the effects of exercises on the athlete's performance in the various events are interrelated. This paper presents a mathematical model for optimizing the use of the total available training time by assigning time to training exercises. The data used in this time capacity planning model concerns a decathlete preparing for the Olympic Games.

Subject classifications: recreation and sports; applications; nonlinear programming; decision-support systems; information systems.

Area of review: OR Practice.

History: Received April 2007; revisions received August 2007, January 2008; accepted January 2008. Published online in Articles in Advance March 24, 2009.

Gearbox Ratio Optimization

Prescriptive

Interfaces Vol. 42, No. 2, March–April 2012, pp. 191–198 ISSN 0092-2102 (print) | ISSN 1526-551X (online)



http://dx.doi.org/10.1287/inte.1110.0580 © 2012 INFORMS

TEAM ASPAR Uses Binary Optimization to Obtain Optimal Gearbox Ratios in Motorcycle Racing

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Oscar Reinoso Departamento de Ingeniería de Sistemas Industriales, Universidad Miguel Hernández, 03202 Elche (Alicante), Spain, o.reinoso@umh.es

In this paper, we present a binary integer linear program for obtaining the optimal combination of gears to install on a competitive racing motorcycle. Our objective is to meet the requirements of both the rider and track at a set of points on the racing circuit. This requires determining the best transmission (gearbox) for each circuit and rider. We discuss a solution for a rider in the World Motorcycling Racing Championship.

Key words: integer programming; gearbox. *History*: This paper was refereed. Published online in *Articles in Advance* December 21, 2011.



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Sports analytics is everywhere





Next Best Action



Season Ticket Prediction

Fraud Prevention
Sprint (US) – Next Best Action

Idea	Use info acti	rmation about yo ions should be ta	our customers to ken to meet their	predict what r needs
Collect customer level data (e.g. customer used up monthly minutes)	Map data to appropriate action (e.g. customers who use up minutes tend to require an upgraded voice plan)	Measure data on customers in real time (e.g. identify customers who have used up monthly minutes)	Determine most likely solution based on data (e.g. outbound call customers with voice plan upgrade promo)	Measure if successful or not and add to collection of data (e.g. measure close rate on outbound sales)
	Co	ntinuous Improveme	ent	
Impacts				
Decreased Churn	d Ind	creased Sales	Improved Satisfaction	\$500M in Added Revenue

Source: Next Best Action using SAS Customer Intelligence: http://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/next-best-action-using-sas-customer-intelligence-104445.pdf ³⁷

Orlando Magic – Season Ticket Prediction



Idea	Use ticket holder data to identify and save customers at risk of not renewing their season tickets		
Current Season Ticketholders	 Tenure: How long the customer had been a ticket holder? Ticket Use: Did the customer actually attend the games? Secondary Market: Were unused tickets sold on secondary sites? 	Segment customers by risk of leaving	Target fence-sitters for retention tactics
Impacts			
Season t	ricket base of 75% growth	in ticket 90%	% season ticket

revenue over the last 3

years

Source: The magic behind the Magic: http://www.sas.com/en_us/customers/orlando-magic.html

14,200 (out of 18,500)

renewal rate (highest

rate in 5 years)

HSBC – Fraud Detection System



Source: Reduce losses from fraudulent transactions: https://www.sas.com/en_us/customers/HSBC.html

- Write down three challenges or problems facing your sport/NSF that you think analytics may help you solve
 - These could range from blue sky ideas to very concrete tasks that you are planning to do anyway in the short term
- We will return to these later in the day

Basketball Tool - Intro



The Tall Player Project

- A tall player is above 206cm or 6'9"
- Tall players are a limited resource
- Many tall players are inadequately developed

Basketball Tool - Methods

- Obtain the number of males in each age cohort from 8 to 19 (Statistics Canada)
- Obtain the average height for each age cohort (WHO & Dieticians of Canada)
- Use statistical methods to determine the number of players at or above a given height
- Limited by lack of height data based on province

Basketball Tool - Results

Age	Available players between 193- 206cm (6'4"-6'9")	Available players above 206cm (6'9"+)	Active Canadian players above 206cm (6'9"+)	_
8	0	0	0	·
9	1	0	0	Meeting or
10	1	0	0	exceeding
11	1	0	0	expectations
12	1	1	0	CAPCOlations:
13	2	1	2	
14	48	1	0	
15	390	1	0	
16	1720	3	3	

Basketball Tool – Interactive

Demonstration...

Basketball Tool – Impact

- Worked with Michael Meeks from the Men's Youth Development Program at Canada Basketball
- Ballpark the number of available tall players
- Verify if Canada Basketball is attracting a large proportion of tall players

Basketball Tool – Next steps

- Want to know province-specific height data
- Focus on younger ages
- Collecting height & location data across Canada through:
 - Steve Nash Youth Basketball
 - Targeted Athlete Strategy Program





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3:45 - 4:00	Looking Ahead
11:45 - 12:30 $12:30 - 1:15$ $1:15 - 2:15$ $2:15 - 2:30$ $2:30 - 3:45$ $3:45 - 4:00$	NSF Analytics Brainstorming; Basketball Too Lunch Demographic and Tennis Tools <i>Coffee Break</i> NSF Analytics Brainstorming Looking Ahead

Demographic Tools



Question

Can we expand on the basketball tool so that it can be used by any sport to examine factors beyond height?

Two related tools to examine demographic characteristics

Tool A

Finds areas that have people similar to a **target person**

Tool B

Finds areas that have people similar to a **target area**

Canadian Census Data (2011)



Census Profile

- Population
- Gender
- Age
- Marital Status
- Language

National Household Survey

- Immigration Status
- Religion
- Education
- Occupation
- Industry
- Income

Known at Forward Sortation Area (FSA) level

Demographic Tool A

• What are the characteristics of people you're interested in?



• Where in Canada are there high proportions of people with these characteristics?

How Tool A works



Let's take a look at how this tool works

Demographic Tool B

- What are the areas in Canada you're interested in?
 - For example, are a lot of people who play your sport in a certain area?



• Where else in Canada are there similar people?

How Tool B works





Let's take a look at how this tool works

Takeaways



What can we use the tools for?

- Are there people living in nonmountainous areas with similar characteristics to alpine skiers?
- Are there a lot of skiers in Northwest Calgary? Where are there nonmountainous areas with similar people?

Further work

- Can do further study on what characteristics certain athletes have
- Use this information as input for the tool

Tennis Tool



Goal

To build a complete picture of what makes a tennis player and identify mismatches of tennis supply and demand in Canada Identify characteristics of Canadian tennis players

Determine where in Canada there are people with these characteristics

Examine the number of tennis courts in the areas where there are typical tennis players

Tennis Survey Data

What data did we use?

2015 Canadian Tennis Brand Health Study

Ages 12-17 answered for themselves Ages 18+ answered for the household 3005 survey respondents 7372 answers including household members

Tennis Survey Data



Demographic Features

Gender

Age

Province / Postal Code

Ethnicity

Whether they were born in Canada

Language spoken at home

Education

Occupation

Household Income

Tennis & Sport Related Features

If they played tennis last season & how often

Interest-level in various sports

Professional tennis players they follow

Likelihood of playing tennis next year

Factors that would encourage them to start playing

Reason they began playing tennis

Knowledge of Canadian sports organizations

Where they buy their sports equipment

Attendance of sports venues in Canada

Raw Data Processing

In building our model we:

- Only used respondents who directly answered survey
- Removed respondents from data set with responses "prefer not to say" and unknown responses

Number of respondents we used was n = 2275

What does the raw data look like?

Raw Data Findings

Overall: 276/2275 (12%) respondents play tennis at least once a season

Gender	148/994 (15%) men play tennis	
	128/1281 (10%) women play tennis	

Age	96/446 (22%) 30 to 40 year olds play tennis	
	90/580 (16%) 40 to 50 year olds play tennis	

Occupation	60/155 (39%) executives/managers play tennis		
	89/438 (20%) professionals play tennis		
	34/226 (15%) skilled workers play tennis		





From this model we learned how certain characteristics increase (or decrease) the probability that a given person plays tennis

Results



	More likely to play	Less likely to play	No real effect
Gender	Male	Female	
Age	Younger	Older	
Province	PE,NB,QC,ON	NL,MB,SK,AB	NS,BC
Ethnicity	Chinese, Korean, Latin American, South Asian	Black, Japanese	Aboriginal, Arab/West Asian, Filipino, SE Asian, White, Mixed ethnicity, other
Birthplace	Canada	Other	
Language		Non-official language	English, French
Highest Education	Graduated university/college	Some high school, graduate high school	Some university/college, post graduate courses
Occupation	Professional, Business owner, Executive/Manager, Clerical, Skilled	Unskilled, Homemaker, Retired, Unemployed, Student	Sales
Income	Higher	Lower	

Results



Change in characteristics	Probability of playing tennis
Value of age increasing by 1 year	decreases by 5%
Difference between occupation in sales vs. in management	increases nearly 4 times
Difference between income of \$85K and \$95K	increases by 3.5%
Difference between high school degree and university degree	increases by 45%

Example



By understanding the athlete's pathway, NSFs can tailor their marketing efforts based on the circumstances of the athlete.

Tennis Tool

- One example of typical tennis player profile is: young, male, high income, executive
- Using Tool A, we can find areas in Canada where there are high proportions of these people



Next steps: Supply and demand





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- After reviewing all the ideas, we've tried to group them into common themes
 - Training / Health
 - Performance / Tactics
 - Development / Evaluation
 - Sales / Marketing
 - Business Operations
 - General Strategy



Training / Health

- How do we track injuries and their severity?
- What is ideal training plan / environment for synchro swimmers?

– Performance / Tactics –

- How to integrate technology in the measurement of synchro performance in a judged sport that currently uses zero technological application
- How to select team members, order of team members, playing time?

Development / Evaluation

- Can we find the best pool of water polo players in Canada?
- How to develop elite athletes that can grow our national team pool, particularly at younger ages?
- What is the impact of programming modifications on athlete skill development? (Skating)



Sales / Marketing

- How to generate revenue and attract donors?
- How can we increase sport awareness/participation at a community level?
- How to create / convert recommendations to new participants
- Where are paralympic atheletes located and how can we be smarter at finding them
- What is the impact of gate sales vs. weather?
- Ticket purchase habits

- Business Operations

- What are key indicators for success in games delivery?
- How do we better track, measure, and repeat results
- Is it feasible to split disciplines and run two national events? (costs, schedule, etc.)
- Analysis of the junior nationals discipline type, venue type, how to organize?
- Regionalization of score posting data

General Strategy

- Is there any better way of targeting sports to increase # of medals?
- How to train a second analyst to ensure continuity and succession planning?
- Investigate ways to use analytics at the operational level?
- How can we continue to improve our analytics package?
- Can we develop a hosting strategy for the national championships?

- Next, we want you to form small groups of 2-3 people and pick two of the ideas to build on further (could be your own or even off the board)
- For each idea,
 - Elaborate on the main question or challenge
 - Brainstorm possible solutions
 - Identify data sources and data readiness
 - Identify sports that be interested in this problem
 - Etc.

Serve and turf



Idea	Challenge	Solution
We want to get more kids playing tennis	Many kids don't have courts nearby; hard to find courts in winter	Use indoor artificia turf stadiums for tennis camps (like hockey does)

How can analytics help?

- Gather data on turf stadium locations
- Estimate where demand is
- Optimize locations for camps based on budget and demand
- Optimize scheduling

• Each group presents...


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Keeping the Momentum

- Go back to your organization and engage people on analytics
- Tell them about the ideas and examples we discussed today, maybe they have other ideas
- We would love to hear about new ideas and will gladly aggregate and share among all participants
- We are happy to help and consult on an ongoing basis
 - If you want to engage in a formal project, we can work together to apply for funding

Final Thoughts

- Really appreciate your time today
- Hope you have learned something new, and have a better appreciation of what analytics is and what it can do for your organization
- Keep us in the loop
 - We always like hearing about successful analytics stories
 - Let us know how we can contribute to your success