

Design of an Anterior Cruciate Ligament (ACL) Injury Repression System

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Context

- Gap
 - 13% of NCAA athletes participating in dynamic sports tear their ACL in non-contact injuries and only 33% of coached implement repression training and nobody is accountable.
- Factors creating the gap
 - 70% of ACL tears are from non-contact injuries.
 - Non-contact injuries are primarily caused by bad form and neuromuscular deficiencies.
 - Coaches believe that repression programs take away from their coaching time and do not help the athlete.
- Main Stakeholders
 - Insurance Companies – Pay for surgery. No way to implement.
 - NCAA – Make rules for players. No incentive to make rule.
 - Coaches – Train players. Little incentive to implement program.
 - Team Physician – Clear players for sport. No incentive to withhold player.
 - Player – participates in sports. Little knowledge of programs.

Need Statement & Alternative Con-Ops

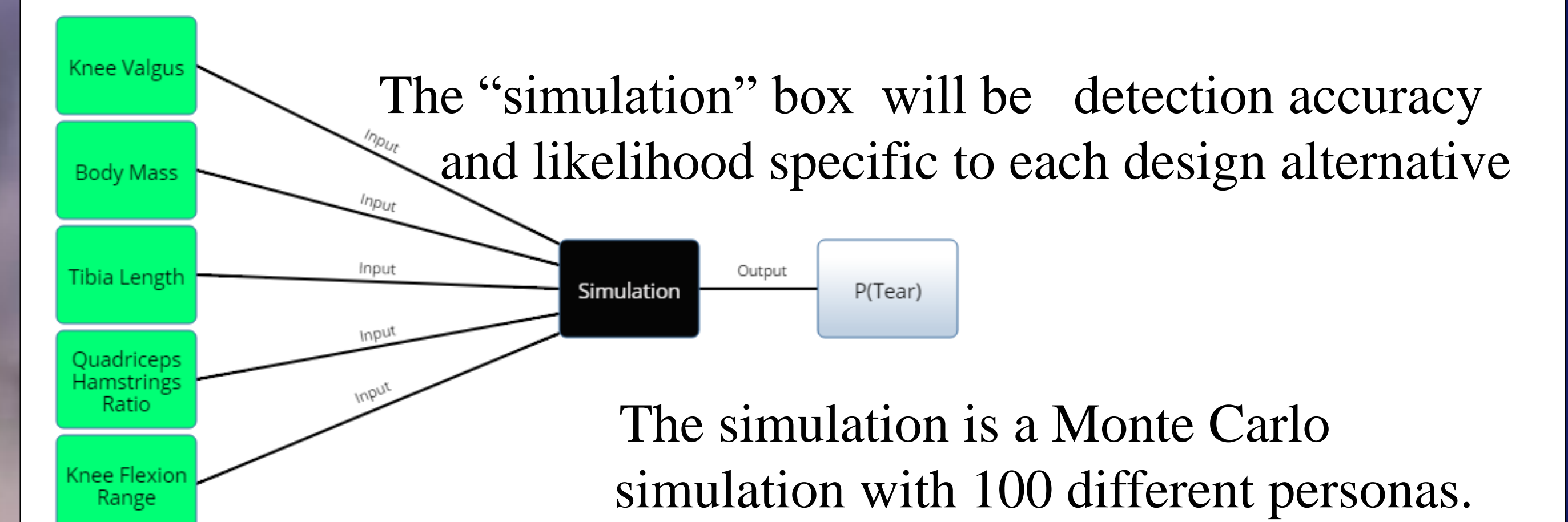
- There needs to be a precise system that quantifies the risk of a tear, lowers the probability of a tear resulting from non-contact athletic moves by XX%, and a way to implement and enforce the system to all athletes throughout their college career.
- The best way to accomplish this is through an identify, mitigate, and warn system.
- Identify – detects the probability of an ACL tear.
- Mitigate – reduces the likelihood of a tear.
- Warn – alerts when probability of tear increases due to fatigue

Number	Requirement
MR.1	The system shall reduce the probability of ACLI in collegiate athletes by XX%.
MR.2	The system shall work with individual athlete's ranges of motion specific to the sport.
MR.3	The system shall cost no more than 80% the profit of the insurance company.
MR.4	The system shall cover an athlete through their entire NCAA career.
MR.5	The system shall not detract from a coach's coaching time.
MR.6	The system shall be maintained throughout an athlete's NCAA career.
MR.7	The system shall have an identify component with XX% accuracy.
MR. 8	The system shall have a mitigation component with XX% accuracy.
MR. 9	The system shall have a warn component with XX% accuracy.

Method of Analysis

Our equation has 5 inputs:

$$P(\text{tear}) = \text{Knee Valgus Motion} + \text{Body Mass} + \text{Quadriceps Hamstring Ratio} + \text{Tibia Length} - \text{Knee Flexion Angle}$$



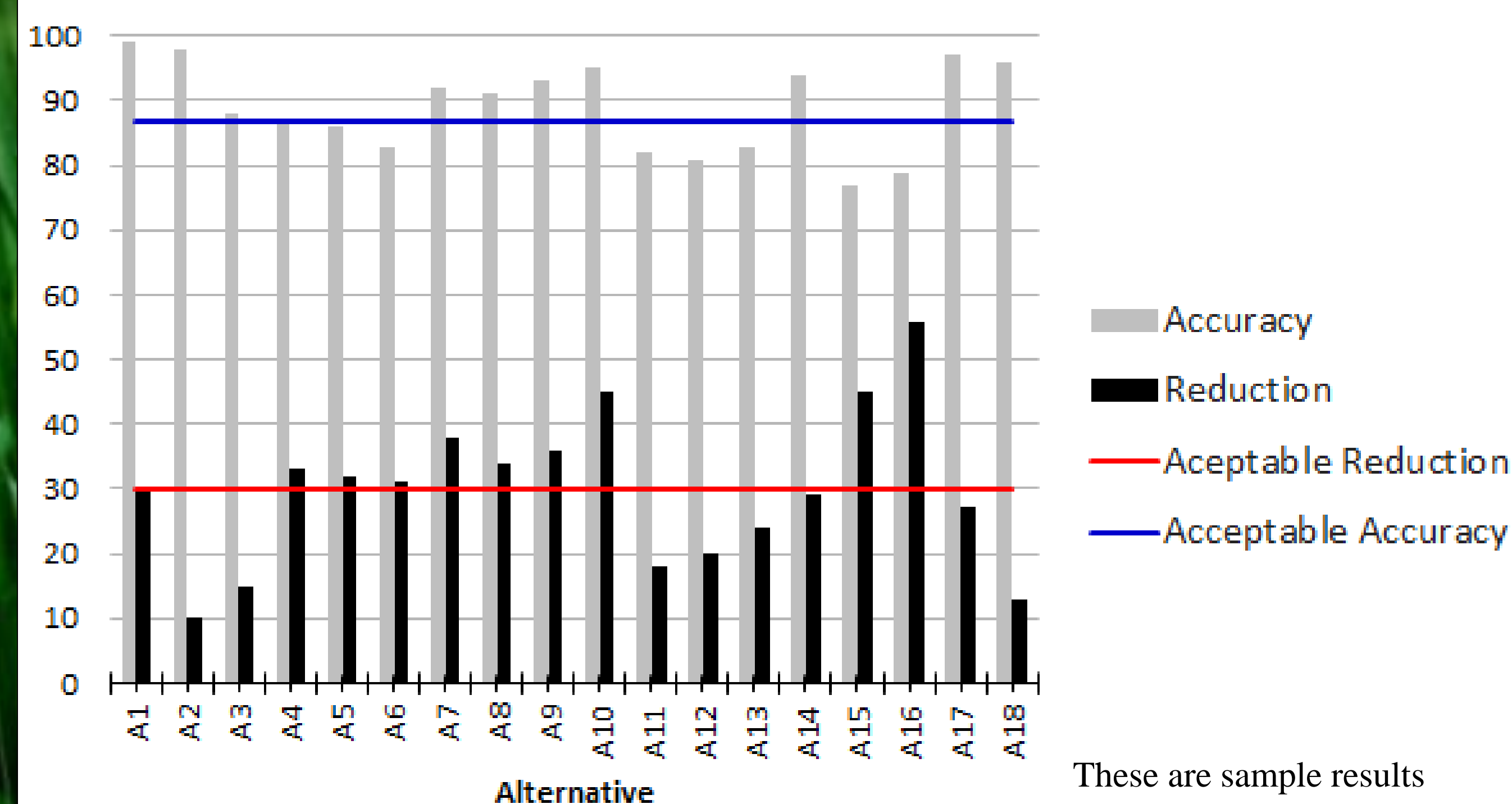
Persona	Input						Effectiveness Output		
	Tibia Length (cm)	Mass (kgs)	Quad Ham Ratio (%)	Knee Flexion Angle (deg)	Knee Valgus Motion (cm)	Identify Error Rate (%)	Mitigation Error Rate (%)	Warn Error Rate (%)	P(Tear)
1	26	70	59	4	12	20	10	2	0.76
2	50	55	75	22	7	25	13	5	0.45
3	48	60	55	45	11	5	12	3	0.66
4	35	100	60	80	5	10	9	7	0.88
...
100	41	40	66	97	3	15	7	4	0.48

Results

Alternative	Description	Alternative	Description	Alternative	Description
A1	Visual, DJO, Polar	A7	Clinical, DJO, Polar	A13	Lab, DJO, Polar
A2	Visual, Sleeve, Polar	A8	Clinical, Sleeve, Polar	A14	Lab, Sleeve, Polar
A3	Visual, KT, Polar	A9	Clinical, KT, Polar	A15	Lab, KT, Polar
A4	Visual, DJO, Smart	A10	Clinical, DJO, Smart	A16	Lab, DJO, Smart
A5	Visual, Sleeve, Smart	A11	Clinical, Sleeve, Smart	A17	Lab, Sleeve, Smart
A6	Visual, KT, Smart	A12	Clinical, KT, Smart	A18	Lab, KT, Smart

Bold - In the acceptable range

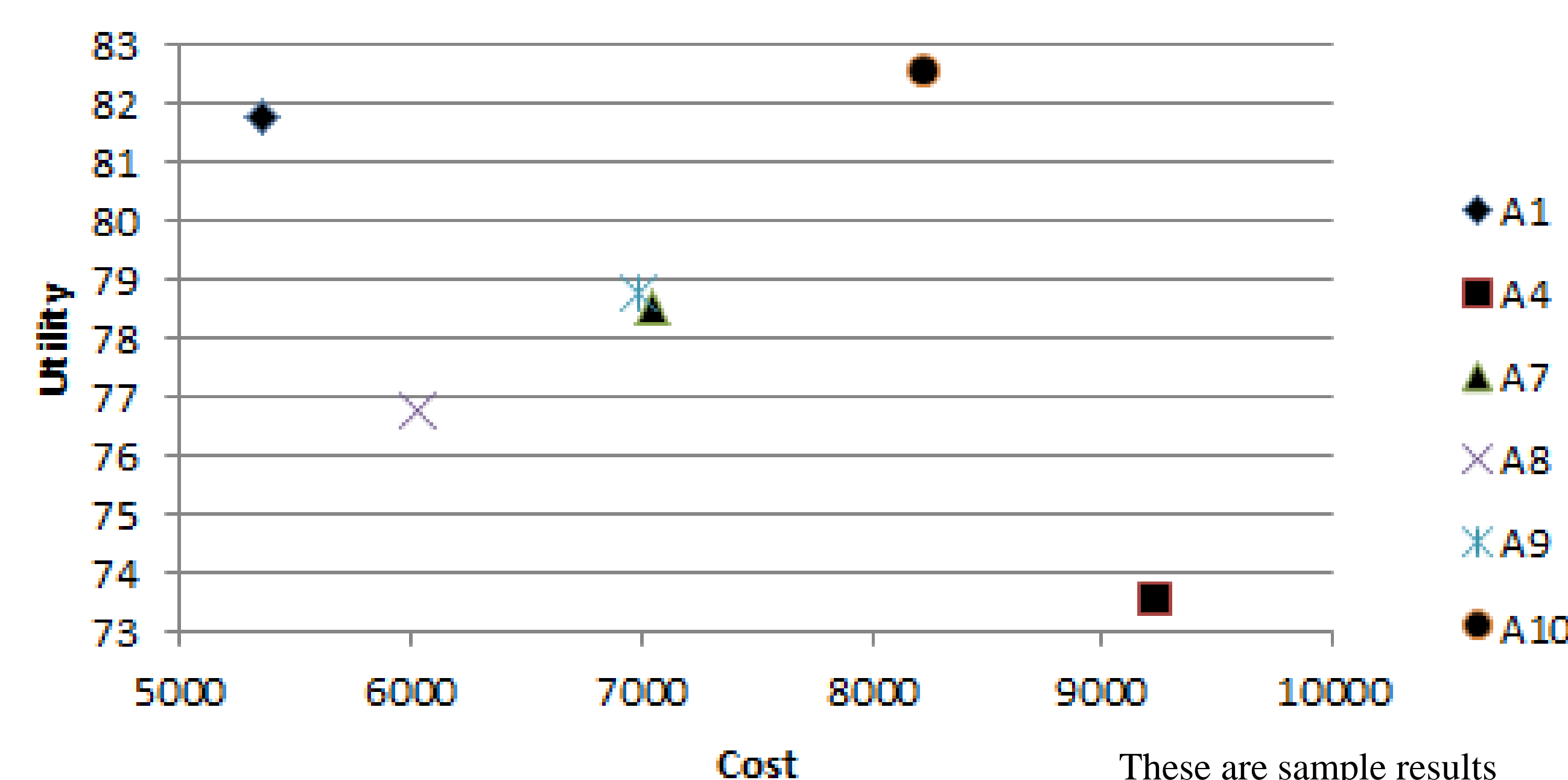
Accuracy and ACLI Reduction



Results

Alternative 1 (Visual, DJO, Polar) and 10 (Clinical, DJO, Smart) provide the two highest points. All other points will never be picked because they are lower than the first two.

Utility Vs. Cost



Conclusions

With a decreased occurrence of ACL tears by xx%, the insurance company stands to profit by yy%. The insurance companies would pay for a study with the NCAA to facilitate regulation changes and would pay to implement the system. When pitching the idea to the insurance companies we should suggest alternative combination X, Identify alternative I, Mitigate alternative M, and Warn alternative W. This offers AA% accuracy with a RR% reduction in ACL tears. The NCAA and insurance companies will team up to implement a regulation requiring athletes to receive a visual analysis every 6 weeks and a regulation saying athletes with high-tear syndrome should be removed from play. If an athlete needs to mitigate the probability of tear to get below the HTS threshold, they will use the mitigate alternative M. During games they will wear a warn alternative W to watch for high fatigue levels that would increase their probability of tear above the high tear syndrome levels.

This closes the gap by quantifying the risk of a tear, lowering the probability of a tear resulting from non-contact athletic moves, and enforcing it through the use of the NCAA and insurance companies, creating a win-win scenario.