POLITECNICO DI MILANO

The 2011 Simulated Car Racing Championship @ CIG-2011

Daniele Loiacono, Luigi Cardamone,

Martin V. Butz, and Pier Luca Lanzi

2011 Simulated Car Racing Championship
9 races during 3 conferences

Develop a driver for TORCS
(hand-coded, learned, evolved, …)

Drivers will be awarded based on their score
in each conference competition

At the end, the team with highest overall score
wins the championship

Roadmap of the 2011 Championship

1. **EVO***-2011, Torino (Italy)
   April 27-29, 2011

2. ACM **GECCO**-2011, Dublin (Ireland)
   July 12-16, 2011

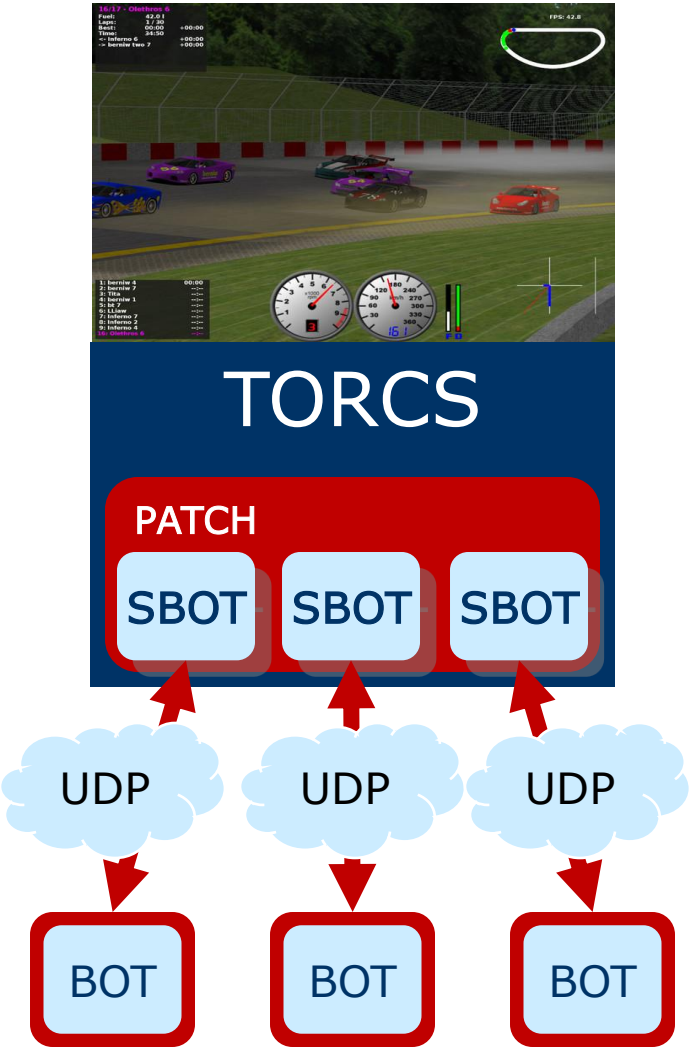
3. IEEE **CIG**-2011, Seoul (South Korea)
   August 31 September 3, 2011

Motivations

- Proposing a **relevant** game-based competition
  - more representative of commercial games AI
  - more similar to a real-world problem
- Proposing a **funny** and **exciting** competition
  - you can see and play with the entries of this competition
  - human players can interact with AI
  - a lot of programmed AI available for comparison
- Proposing a **challenging** competition
  - computationally expensive
  - real-time
  - on-line learning
  - noisy sensors

The Open Racing Car Simulator

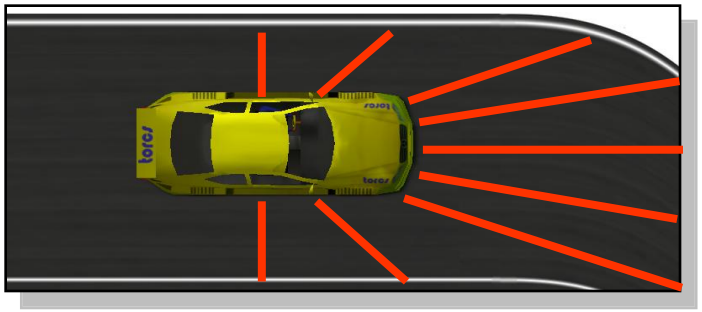
The Open Racing Car Simulator & the Competition Software

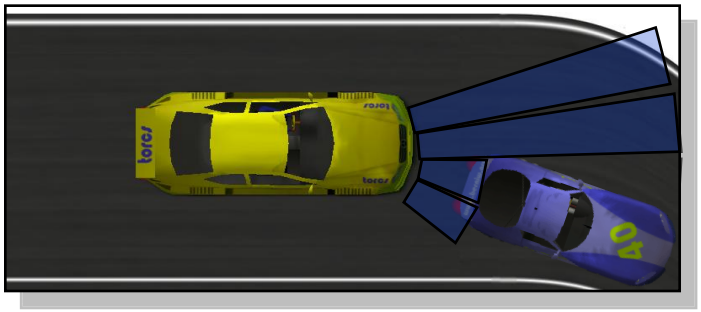


- The competition server
  - Separates the bots from TORCS
  - Build a well-defined sensor model
  - Works in real-time

Sensors and actuators

- Rangefinders for edges on the track and opponents (with noise)
- Speed, RPM, fuel, damage, angle with track, distance race, position on track, etc.





- Six effectors: steering wheel [-1,+1], gas pedal [0, +1], brake pedal [0,+1], gearbox {-1,0,1,2,3,4,5,6}, clutch [0,+1], focus direction

What is the structure of a race?

Three stages: warm up, qualifiers, actual race

During warm-up, each driver can explore the track and learn something useful

During qualifiers, each driver races alone against the clock (the best 8 drivers move to the race)

During the race all the drivers race together

Competitors

The competitors

- Four entries in the first leg:
  - Mr. Racer, TU Dortmund
  - Mariscal & Fernández, Málaga University
  - Ready2Win, Slovak University of Technology - FIIT
  - Powaah, Blekinge Institute of Technology
- Two more entries in the second leg:
  - Ho Duc Thang, University of Nottingham
  - CRABCAR, Norwegian University of Science and Technology (NTNU)
- One entry in the third leg
  - BFB3 - Sejong Univ, Korea
- Three reference entries from the past championship:
  - AUTOPIA, Madrid and Granada
  - COBOSTAR (Lönneker & Butz, University of Würzburg)
  - POLIMI (Cardamone, Politecnico di Milano)

Mr Racer

Jan Quadflieg, Tim Delbruegger and Mike Preuss
TU Dortmund

Mr. Racer 2011

- 13 Variables learned offline with the CMA-ES
- Warmup used to learn a model of the track
- Noise Handling:
  - Low pass filter on sensor values
  - 2 Regression polynoms are fitted to each side
  - Resample the polygons
- Overtaking
  - Computes on the fly a recommended speed and an overtaking line
  - Recommendation are provided to a planing module

Mariscal - Fernández

A controller for the Simulated Car Racing Championship

David Mariscal Fernández
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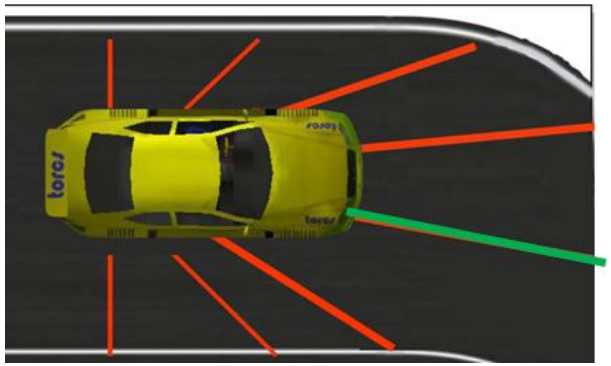
Dpto. Lenguajes y Ciencias de la Computación
ETSI Informática, Málaga University,
Málaga, Spain

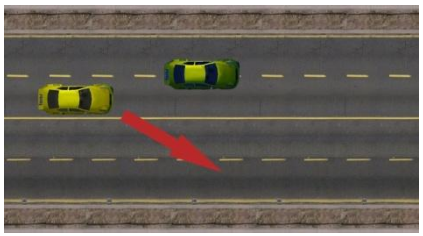
Mariscal & Fernández

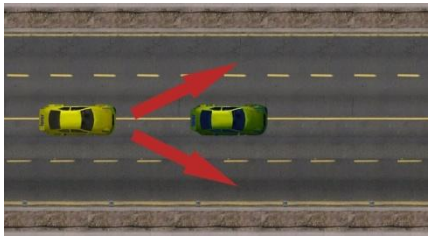
- General approach: expert systems improved by multi-objectives evolutionary computation techniques
  - Maximize distance.
  - Minimize damage

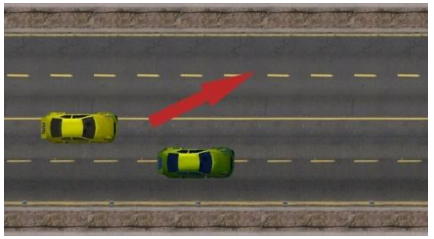


- Steering based on a simple rule follow the track sensor with biggest distance.

- Overtaking based on simple rules and expert systems







STU
FIIT

Faculty of informatics and information technology

READY2win

Torcs Championship

Supervisor:

Peter Vilhan

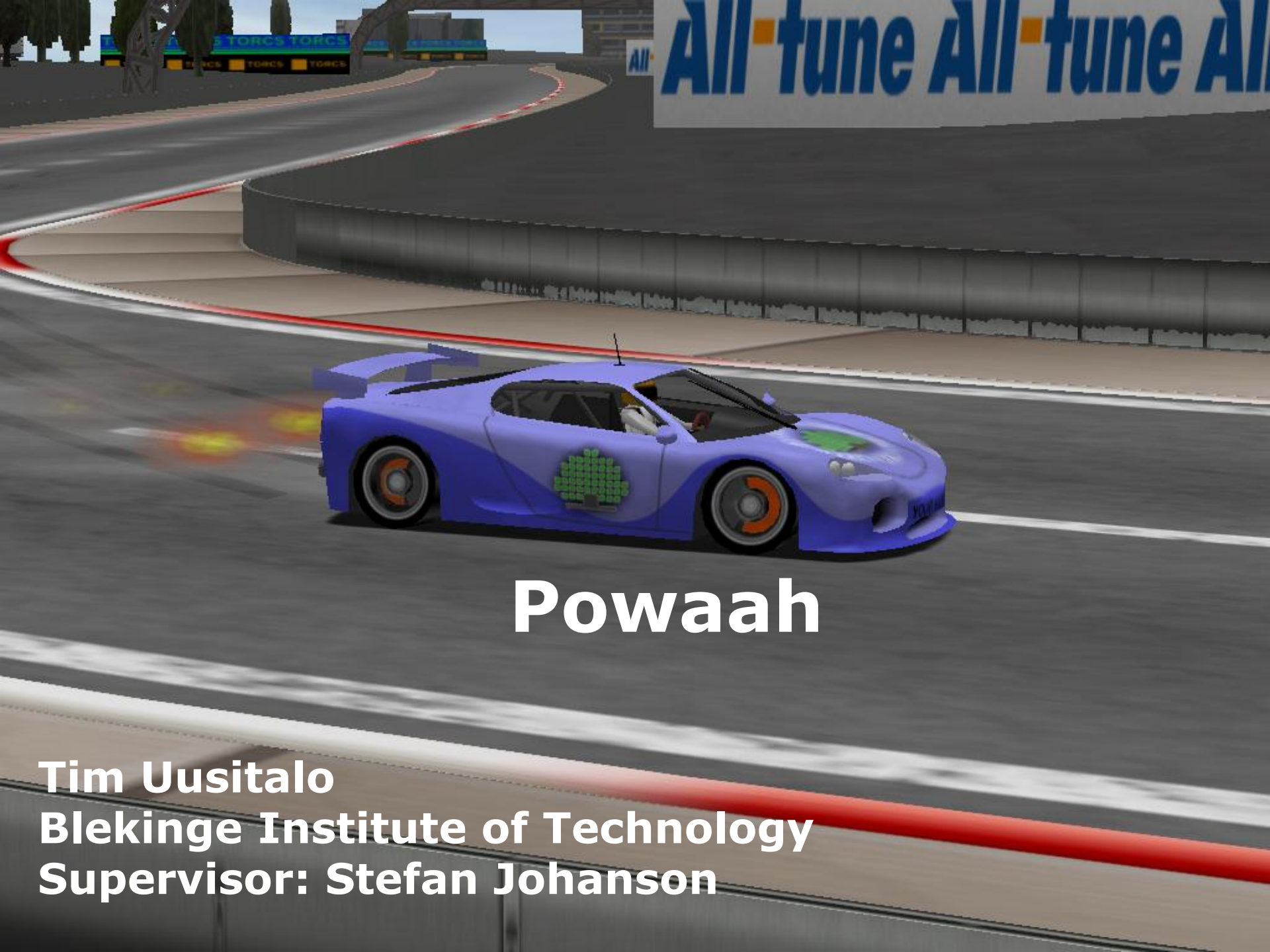
Ready2Win team :

Maroš Bednár
Adam Brček
Marek Briš
Marián Florek
Vojtech Juhász
Juraj Kosmeľ
Ivan Valenčík

Ready2Win

- Modular architecture:
  - Driving module:
    - The speed is computed using the maximum braking distance
  - Overtaking module
  - Recovery module
  - ABS module

- Track learning during the warm-up:
  - First lap, driven slow, to identify turns (start, end, entry position, curvature) and learn the track model
  - Other laps, speed adaptation:
    - Increasing according to lateral speed
    - Reducing when the car goes off-road



Powaah

Tim Uusitalo
Blekinge Institute of Technology
Supervisor: Stefan Johanson

Powaah

- Based on Artificial Potential Field
- Every sensor in the span (-40, +40) has a charge
- The charge is determined by how far the sensor measures the track
- Coulomb's law is used to calculate potentials in the field

  $Pot = (C_1 * C_2) / d^2$
- The sensor with the highest potential is used for computing how much steering is needed

Ho Duc Thang
University of Nottingham

Ho Duc Thang

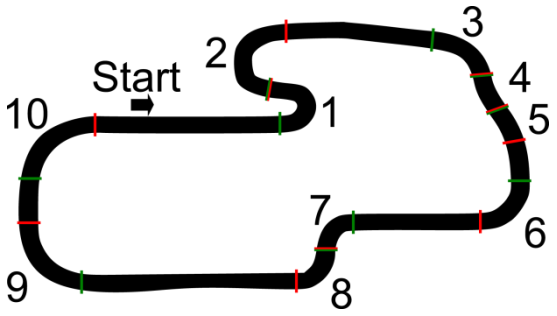
- Hybrid fuzzy controller with a module to learn the model track as the car drives, a module to perform some simple plannings based on the modelled segments of the track and a fuzzy controller which actually drives the car.
- All the modelling, planning and driving are done during the race, the warm-up stage is not exploited
- No opponent handling

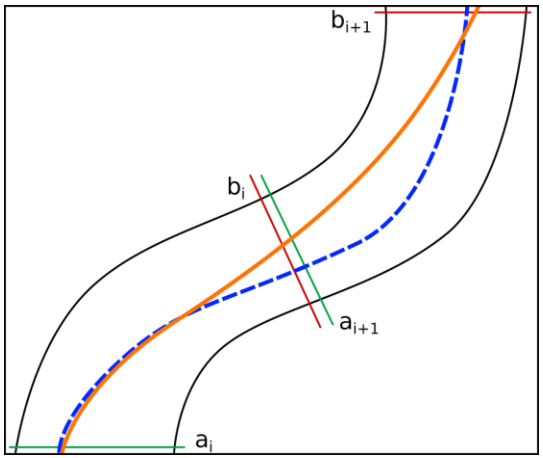
CRABCAR

By Snorre Corneliussen and Magnus Westergaard, NTNU

CRABCAR

- Turns classification based on sensors during warmup and saved in the track model
- Different evolved strategies to go through the turns
- Strategies are re-evaluated during stages, adjusted and save in the track model
- Simple opponent avoidance based on keeping safe distance





BFB3

Kyung-Joong Kim
Jun-ho Seo
Tae-seong Kim
Sejong Univ, Korea

BFB3

- Scripted approach
  - Simple approach for steering and accelerating
- Jump Detection
  - When the Z-Sensor is more than 0.4
  - While the car is jumping and landing(few times, 10 tick count), the steer of car is fixed to forward
- Opponent avoidance:
  - Just brake if the opponent is approached on a straight
  - Modify the normal steering when the opponent is approached in a bend

AUTOPIA

Industrial Computer Science Department.
Centro de Automática y Robótica
Consejo Superior de Investigaciones Científicas
Madrid, Spain
Contact:E. Onieva (enrique.onieva@car.upm-csic.es)

AUTOPIA

- Fuzzy Architecture based on three basic modules for gear, steering and speed control
  - optimized with a genetic algorithm

- Learning in the warm-up stage:
  - Maintain a vector with as many real values as tracklength in meters.
  - Vector initialized to 1.0
  - If the vehicle goes out of the track or suffers damage then multiply vector positions from 250 meters before the current position by 0.95.

- During the race the vector is multiplied by F to make the driver more cautious in function of the damage:
  - F=1-0.02*round(damage/1000)

Thies Lönneker and Martin V. Butz
University of Würzburg

http://www.coboslab.psychologie.uni-wuerzburg.de

COBOSTAR

- One of the best controller of the 2009 Championship
- Parameterized controller optimized with CMA-ES
- Dynamically saves crash points

Cardamone

Luigi Cardamone
Politecnico di Milano

Luigi Cardamone

- Winner of the CIG-2008 Car Simulated Competition
- The controller is based on a neural network evolved with NEAT
- Very simple policy for overtaking

Qualifying

Scoring process: Warm-up & Qualifying

- Scoring process involves three tracks:
  - Promontory
  - Ushite
  - Ustka
- The tracks are not distributed with TORCS:
  - Generated through interactive evolutionary computation
  - The competitors cannot know the tracks
- Each controller raced for 100000 game ticks in the warm-up stage and then its performance is computed in the qualifying stage as the distance covered within 10000 game ticks

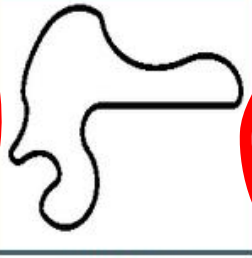
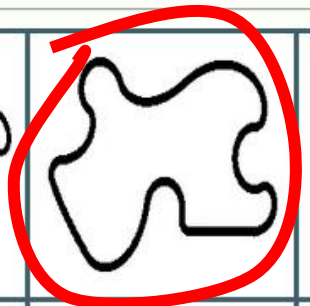
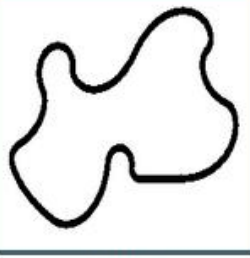
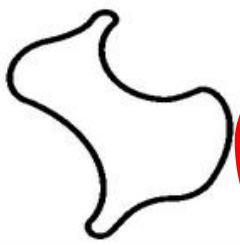
ack Generator

trackgen.pierlucalanzi.net

TORCS Track Generator

Hall of Fame

Here, it is possible to find the best tracks evolved so far.

				
Promontory score: 10 views: 120	Ledzokuku score: 8 views: 118	Ushite score: 6 views: 41	Relau score: 6 views: 70	Kreki score: 6 views: 110
				
Gorszewice score: 6 views: 66	Leeuwarden score: 6 views: 78	Cultra score: 6 views: 79	Ustka score: 4 views: 42	Tonnoy score: 4 views: 55

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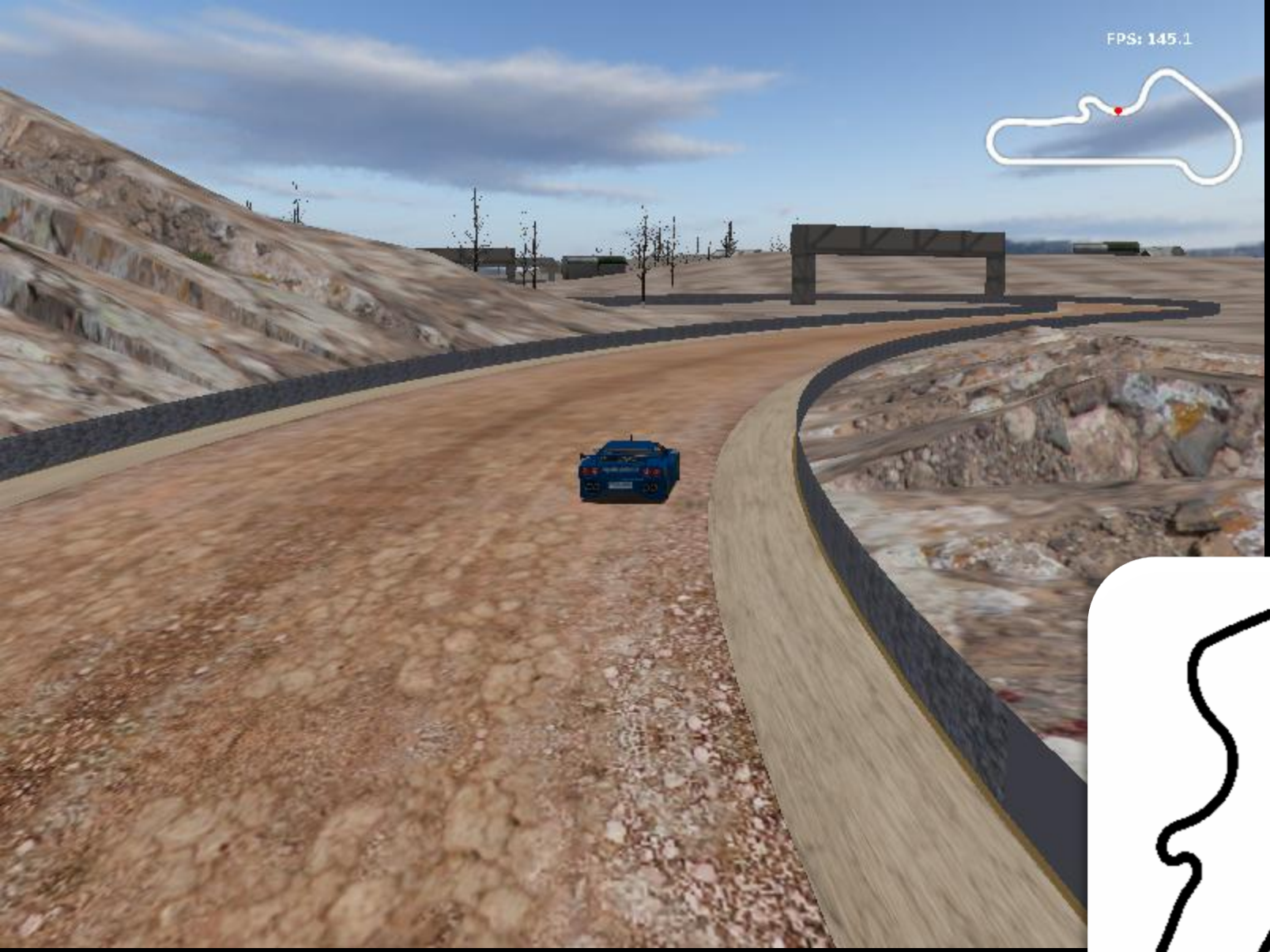
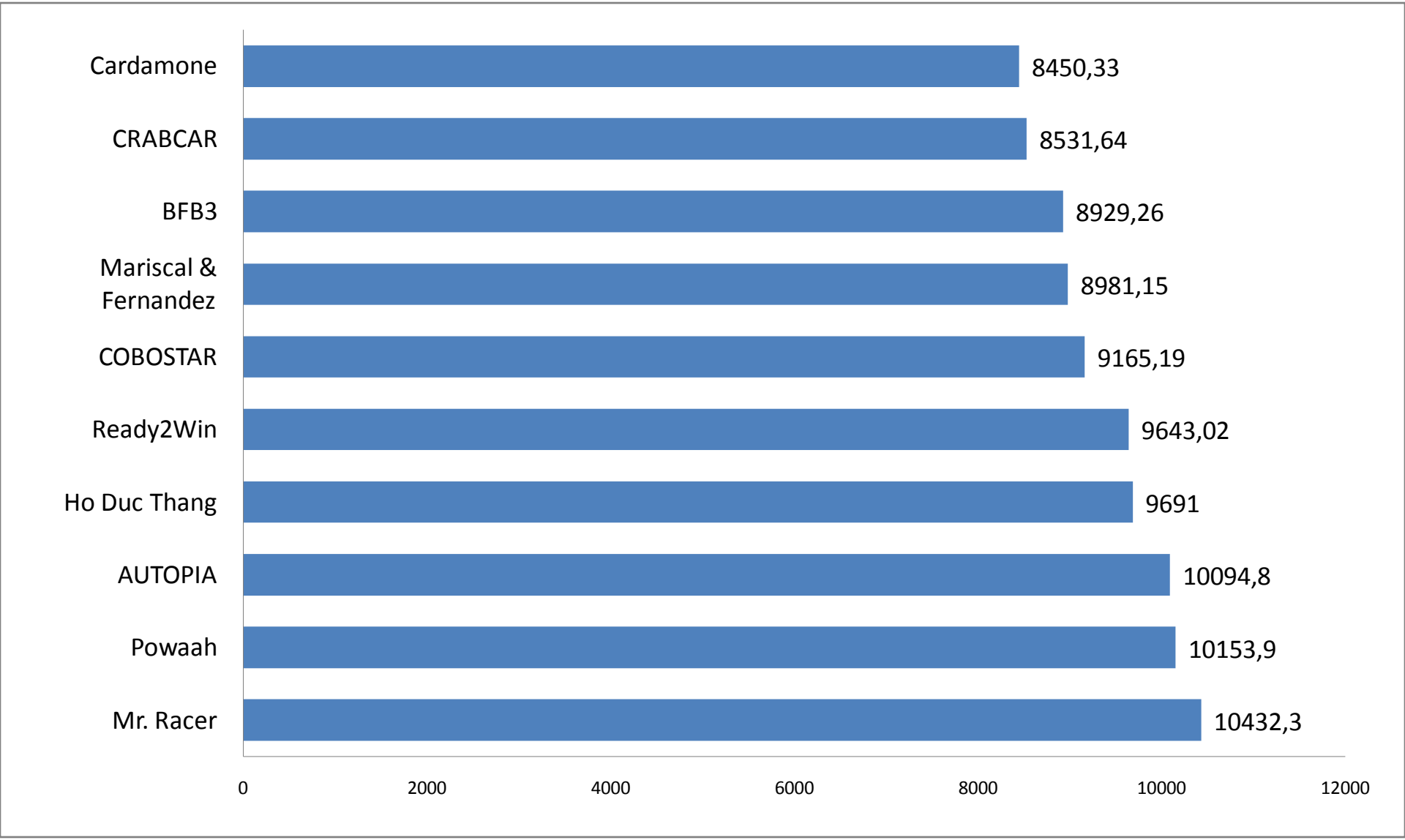
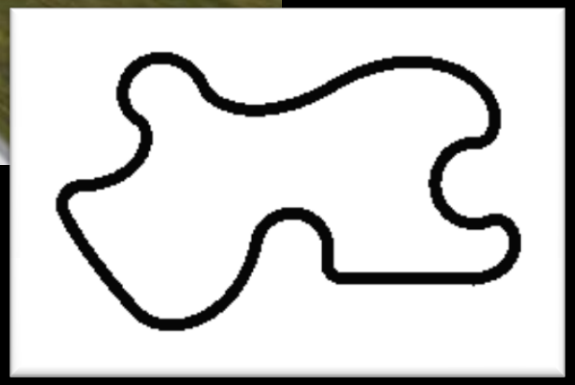


Promontory

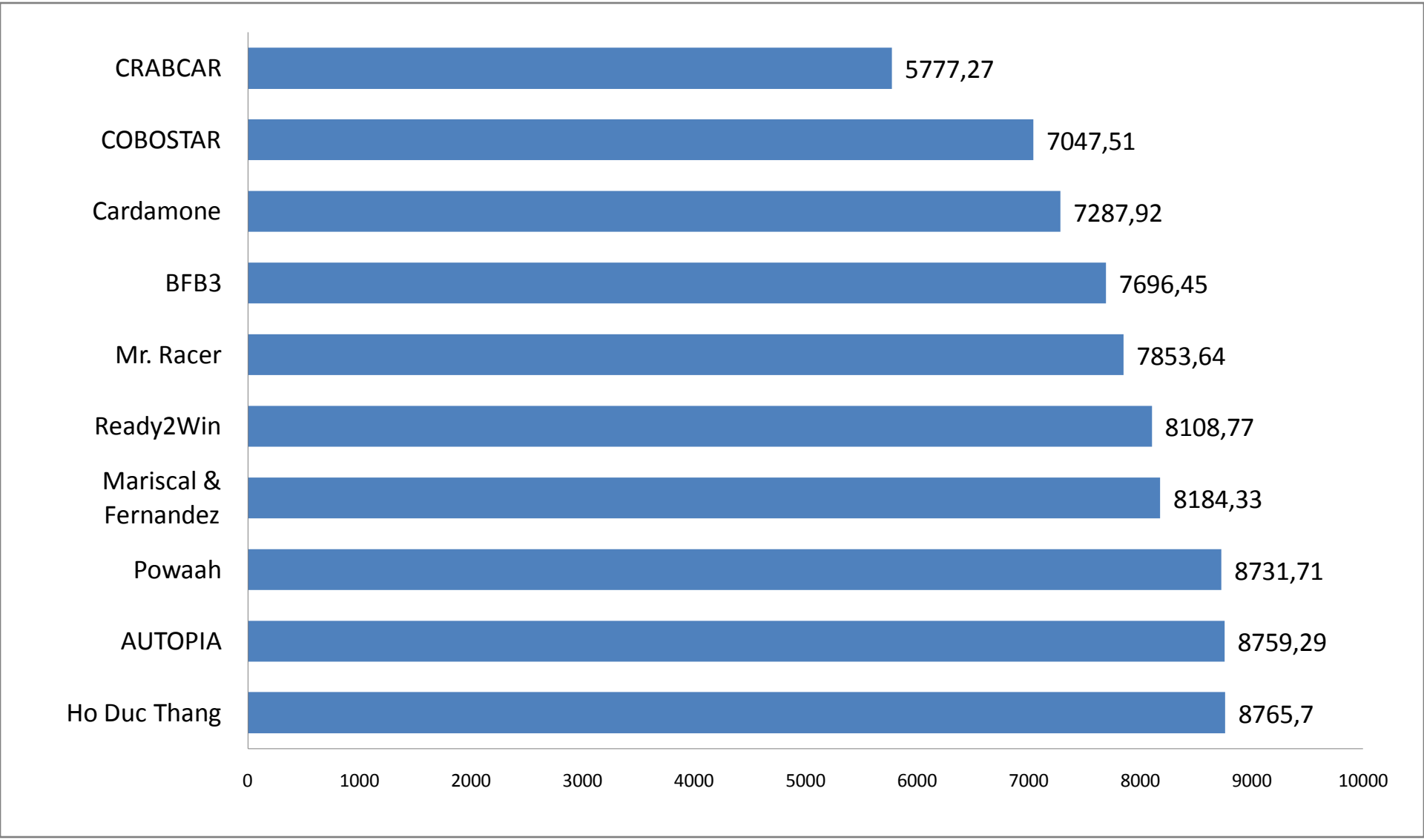
Qualifying: Promontory

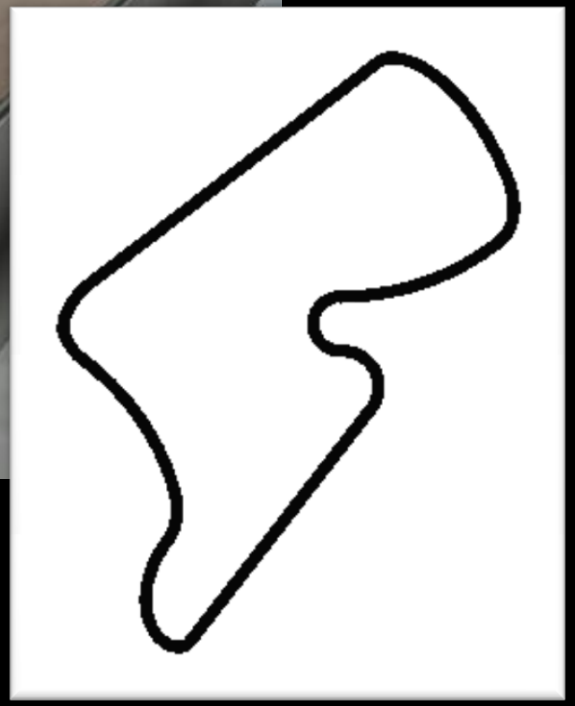




Ushite

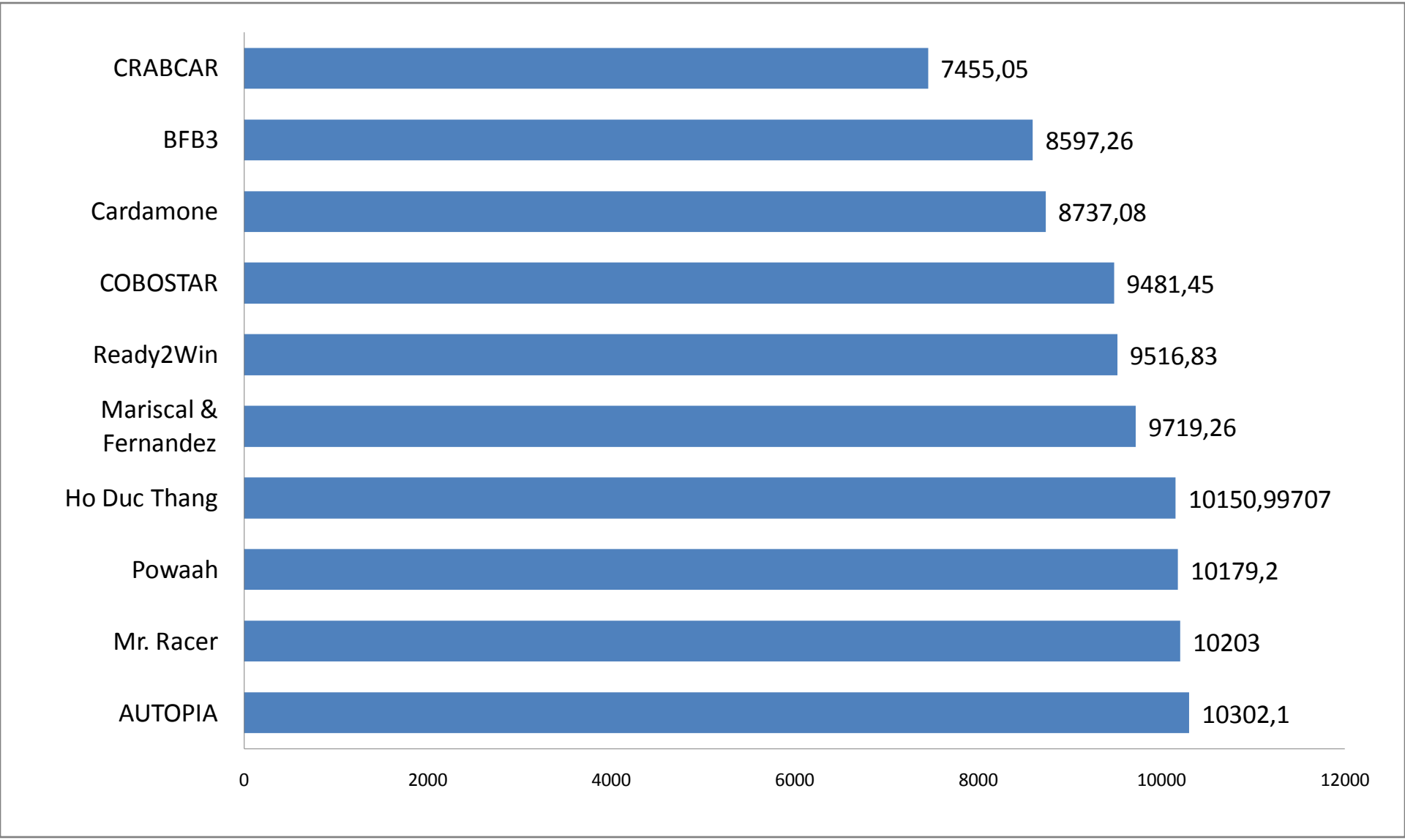
Qualifying: Ushite





Ustka

Qualifying: Ustka



Qualifying summary

Driver	Promontory	Ushite	Ustka	Total
AUTOPIA	6	8	10	24
Mr. Racer	10	3	8	21
Powaah	8	6	6	20
Ho Duc Thang	5	10	5	20
Ready2Win	4	4	3	11
Mariscal & Fernandez	2	5	4	11
COBOSTAR	3	0	2	5
BFB3	1	2	0	3
Cardamone	0	1	1	2
CRABCAR	0	0	0	0

Races

Three Tracks

For each track we run 8 races
with random starting grids

Each race is scored using the F1 point system
(10 to first, 8 to second, 6 to third, …)

Two points to the controller with lesser damage

Two points for the fastest lap of the race

Some videos of the races

Race Results

Competitor	Promontory	Ushite	Ustka	Total
Autopia	10	11	11	32
Mr. Racer	7,5	4	7	18,5
Powahh	4	7	6	17
Ready2Win	6	5,5	5	16,5
Mariscal&Fernandez	3	3	5	11
BFB3	3,5	4,5	2,5	10,5
COBOSTAR	4,5	3	2,5	10
Ho	3	2,5	2,5	8

MR. RACER

WINNER OF CIG-2011 SIMULATED CAR RACING COMPETITION

What about the race results?

Race Start is crucial!

AUTOPIA still the best controller…

Qualifying and final results very similar (with few exceptions)

Championship’s Final Standings

2011 Championship Standings

Competitor	EVO*	GECCO	CIG	Total
Autopia	34	34	32	**100**
Mr. Racer	22	21	18,5	**61,5**
Ready2Win	10	19	16,5	**45,5**
Mariscal&Fernandez	20	14,5	11	**45,5**
COBOSTAR	17	10,5	10	**37,5**
Powahh	10	5,5	17	**32,5**
Ho	-	14	8	**22**
Cardamone	12	-	-	**12**
BFB3	-	-	10,5	**10,5**
Crabcar	-	7	-	**7**

MR. RACER

WINNER OF 2011 SIMULATED CAR RACING CHAMPIONSHIP

Thank you!

Questions?