

# **RoboCup:** the Robot Soccer World Cup



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## RoboCup

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By 2050, build a team of fully  
autonomous humanoid which  
win against human world  
champion under the official  
regulation of FIFA



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### RoboCup goals

- Soccer
- Rescue + Home + Work
- Junior/Education

Roma, 2017

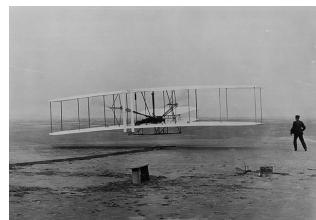
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## Can we accomplish the goal?

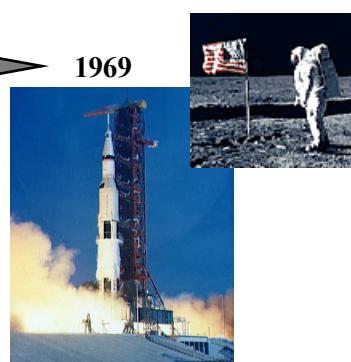


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1903



1969



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Roma, 2017

© NASA

3

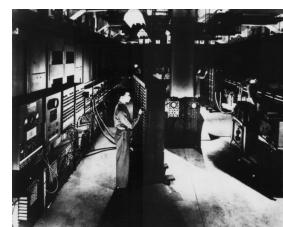
## Computer Chess

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ENIAC  
1946



Deep Blue  
1997



Deep Blue  
This 1.4 ton  
8-year-old super  
computer plays a mean  
game of chess

© IBM

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4

	1997 Nagoya
	1998 Paris
	1999 Stockholm
	2000 Melbourne
	2001 Seattle
	2002 Fukuoka
	2003 Padua
	2004 Lisbon
	2005 Osaka
	2006 Bremen
	2007 Atlanta
	2008 Suzhou
	2009 Graz
	2010 Singapore
	2011 Istanbul
	2012 Mexico City

**RoboCups**

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5

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**RoboCup-97 Nagoya**



35 teams from 12 countries

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**RoboCUP**  
LEIPZIG 2016  
GERMANY  
30 JUNE to 3 JULY COMPETITIONS  
4 JULY SYMPOSIUM



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**Robotic football (soccer)**

NO MULTI-ROBOT GAME: why?

Cooperative Multi Robot Systems  
require *autonomy*

In RoboCup players in a *team* must  
cooperate to play football

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## Soccer Simulation

- Teamwork, scale-up
- Strategic decision making
- Prepare the way

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2D/3D



## Middle size

Own-built large wheeled robots

Information on the game acquired through on board sensors

All computation Onboard

Communication (but unreliable)

Distributed system

- Omnidirectional Perception
- Cooperative localization
- Task assignment (dynamic)



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## Small-size

Small and fast own built robots

Global vision system

Controlled by a remote host

Centralized system

- Perception and action
- Coordinated action
- Teamwork
- Learning the opponent model



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## Standard Platform League

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Focus on software

initially  
4 legged  
Sony AIBO



## Standard Platform League

Information on the game acquired through on board sensors

All computation Onboard

Communication

- Articulated Motion
- Robust perception
- Localization
- Teamwork

**Focus on software**  
**biped Aldebaran NAO**



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## Humanoid Robots

Teen size (60 cm)

Kid size (120 cm)

Adult size

Own built and commercial (Darwin)

Additional challenges

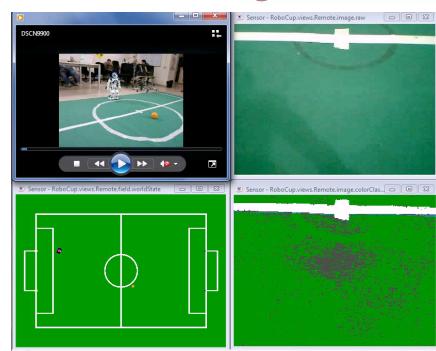
- Mechanical design
- Biped walking
- Kicking-Ball throwing

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## Vision



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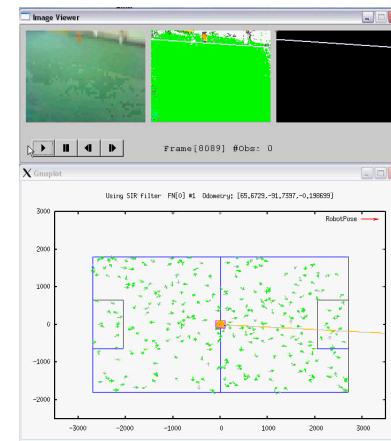
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## Localization



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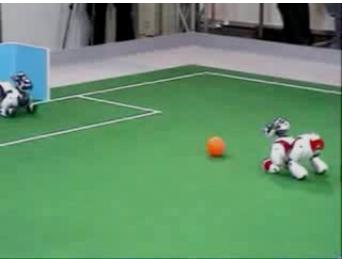


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## Motion Control

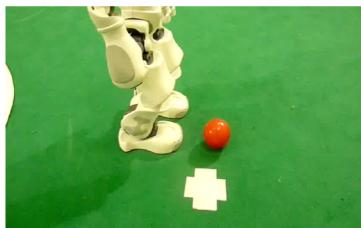


Penalty kicks  
(S.P.Q.R.) 2005

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Back-kick  
(SPQR-UChile) 2010

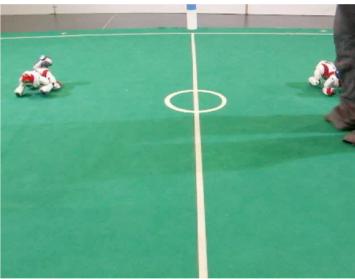


17

## Teamwork



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## Soccer challenge: overview



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## Soccer challenge

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The complexity comes from the dynamics of the environment (opponent):

- Complex perception-action
- Learning
- Cooperation/coordination
- Planning and game strategy

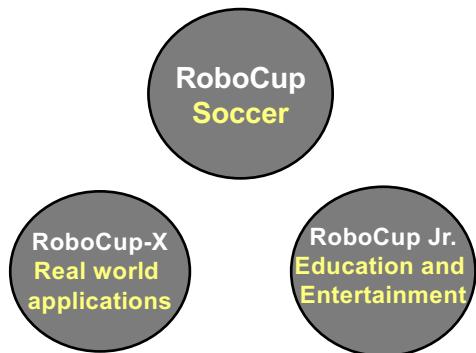
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## RoboCup long-term perspective

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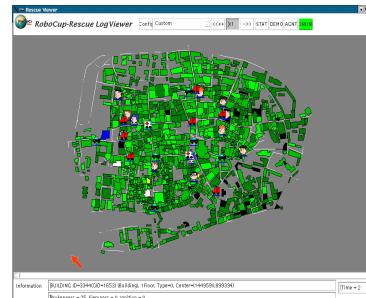
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21

## RoboCup Rescue Simulation

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- Multi Agent Modeling (Foligno)
- Simulation of operation procedures



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- Multi Robot Modeling
- System test& development

## RoboCup Rescue: Robots

Goal: find victims in a disaster scenario



Rescue arenas from NIST



Two categories of robots

- Autonomy
- Tele-operated

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## Rescue Arenas & Field Exercises

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- unknown
- unstructured
- dangerous

NIST

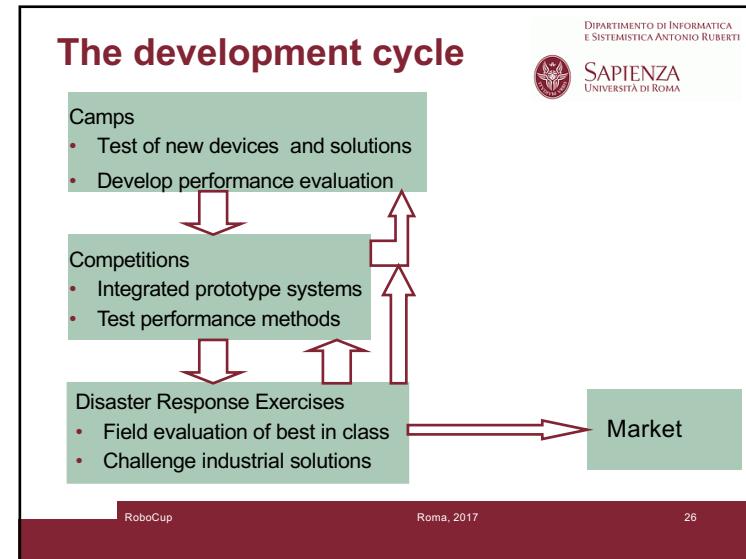


**Rescue Robotics Camps**

Italy, Roma 2004-2007  
+ IEEE SSRR 2007  
+ Thailand 2009 -2011  
+ Turkey 2012

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**RoboCup@Home**

RoboCup@Home focuses on *real-world applications* and *human-machine interaction* with *autonomous robots*.

- Aim:** foster the development of useful robotic applications that can assist humans in everyday life.
- Challenges:** Fast Follow, Fetch & Carry, Who's Who, Lost&Found, Partybot, Supermarket, Cleaning up, Cooking ...

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**Robocup@home Robots**

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Cosmo

**Current focus of RoboCup@Home**

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**Technical objectives:**

- Ease of use
- Fast calibration and setup
- Attractiveness and ergonomics of the robot
- Natural and multi-modal interaction (natural programming)
- Adaptivity and general intelligence
- Robustness
- General applicability

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**RoboCup@work**

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RoboCup@Work tackles open research challenges in **autonomous industrial robotics**:

- Indoor navigation
- Mobile manipulation
- Industrial object recognition, pickup and delivery
- Multirobot coordination
- Multirobot cooperation

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**RoboCup@Work**

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**RoboCup Junior**

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- Soccer
- Dance
- Rescue

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**RoboCup** **Impact on research**

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- Symposium
- Publications
- PhD
- Standard problems: Keepaway, ...
- Standard solutions: CMU Vision, ...
- Standard test methods: Rescue Arena, ...
- New platforms: NAO, Darwin, ...

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**RoboCup** **Impact on education**

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Beyond conventional curricula: complex, integrated system design, teamwork, competitiveness

- Courses: multi-agents, multi-robot, software development, perception
- Master theses
- Camps
- + Junior

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**RoboCup** **Citizens' awareness**

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- Simple and appealing message
- Outreach (promoted by cities as science events for the general public)
- High interest of media

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**RoboCup** Success stories

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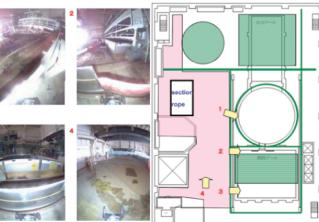
Boat-speeding: Argos is operational in Venice since 2006



Logistics: SSL hosted the genesis of KIVA Systems



Rescue: Robot in Fukushima designed for RoboCup



Education: NAO is a RoboCup robot, now a product



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**European Robotics Leagues**

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- **ERL Professional Services (RoboCup@Work)**  
Innovative robot applications in industry (*towards modern factories where networked robot systems interact naturally and work together with human workers performing industrial tasks*)
- **ERL Consumer Services (RoboCup@Home)**  
Domestic Service robots (*towards having homes populated by networked robot systems that interact naturally with humans to assist them*)
- **ERL Emergency (RoboCup Rescue)**  
Emergency robots (*air, water and land*)

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EUROPEAN ROBOTICS LEAGUE  
Brought to You by SPARC

**ERL in the Smart Cities**

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**SciRoc**

1. Competition event (Milton Keynes) Sept. 2019

2. New challenges (in a shopping mall)

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Next ...

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- Sydney, Australia, July 2019
- + Several Regional EVENTS ((German), Dutch, Mediterranean, Asian, Iranian, China, Japan, Thailand, US, South America, ...)

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