

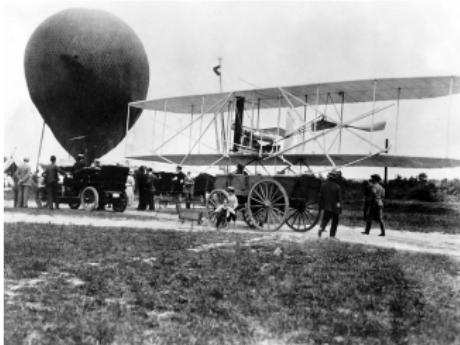
Algebra, Geometry and Robots

The two-way relationship between mathematics and robotics, with a focus on modern algebra and geometry.

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University of Sydney

The Story of Humanity



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ChatGPT



What day of the week is it?

Today is Thursday.



Humanity's Next Tool: Robots



KUKA - Robotic Arms



Waymo -
Self-Driving Cars



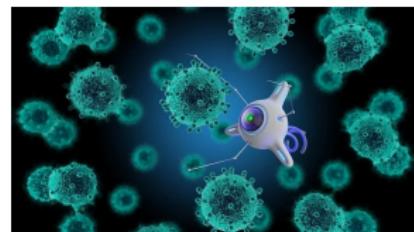
NASA - Martian Rovers



BMW -
Humanoid Robots



Boston Dynamics -
Dog Robots



Nanorobots

What is Robotics?

Common Definition of Robotics

$R(t)$ = Robotics at time t

$A(t)$:= What's Theoretically Possible at time t

$P(t)$:= What's Already Possible at time t

$$R(t) := A(t) - P(t)$$

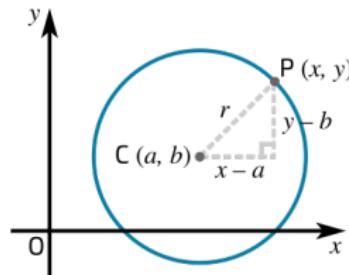
Goal of Robotics

$$\lim_{t \rightarrow \infty} R(t) = 0$$

The Story of Mathematics

$$1 + 2 = 3$$

$$ax^2 + bx + c = 0$$



$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$

$$\mathrm{GL}_n(\mathbb{R})$$

 $\mathrm{Grp} \rightarrow \mathrm{Set}$

The Story of Mathematics: Today's Mathematics

Algebra

Analysis

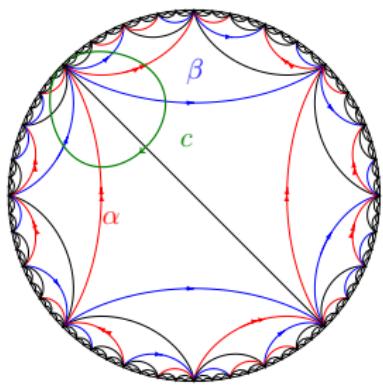
Topology

Geometry

Overview

- 1 Humanity
- 2 Mathematics
- 3 Who am I?
- 4 Kempe's Universality Theorem
- 5 Gröbner Basis
- 6 Lie Theory
- 7 Other Applications

Who am I?



Recent Master's in
Mathematics (Geometric
Topology)



Started PhD with ACFR and
CSIRO's Robotic Perception
and Autonomy Group

Linkages - Steam Engines



Alfred Kempe
1849-1922

Steam Engine

Linkages - Tracing Curves

<https://www.youtube.com/watch?v=b7NABUkyGok>



Gröbner Basis

Lie Theory

Other Applications of Mathematics