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GPS Aproximation Tracks

Vigo - Spain
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Dissertation submitted to the Department of Statistics and Operative Research University of Vigo, to obtain the title of Master of Statistics and Operative Research in the area of Nonparametric Regression Models.

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tive Research.

An intelligent person that at a given moment knew all the forces that animate nature and positions of the beings who are, and that was huge enough to be able to analyze such data, could condense into a single formula the movement of the largest objects in the universe and the lightest atoms: for that nothing would be uncertain, and both the future and the past would be present in front of their eyes.

Laplace

Acknowledgments

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Resumen

El Sistema de Posicionamiento Global (GPS) es un sistema de navegación por radio desarrollado por el Departamento de Defensa de los Estados Unidos, con el objetivo de ser el medio principal de navegación del ejército. Pero pronto el mercado civil verificó que este sistema podría ser un buen negocio. Actualmente este sistema se compone de varias partes: los satélites, la estación central de control, las antenas de transmisión de datos a los satélites, las estaciones de control y el receptor.

Los datos facilitados por los receptores GPS no siempre son los más correctos. Estos errores pueden variar de un país a otro, también varían si estás en una ciudad o en otros lugares más remotos. Por otro lado, dependen de las condiciones atmosféricas (condiciones de tormenta pueden interferir y provocar una mala comunicación entre el satélite y el receptor). Por ejemplo, la nube de ceniza del volcán Eyjafjallajokullda de Islandia ha interferido en gran escala en los sistemas de navegación de la mayor parte de Europa.

Estos errores se pueden evitar? Sí pueden, ya que el receptor GPS está compuesto por hardware (equipos) y software (mapas, sistemas de búsqueda y control de posición), y por lo tanto las actualizaciones de las mismas provoca una mejora del sistema. El uso de métodos estadísticos, es esencial para el control y reducción de los posibles errores. En este trabajo se desarrollarán algunos métodos estadísticos para tratar de mejorar la ruta de acceso proporcionada por el receptor. Para ilustrar estas metodologías ha sido utilizado una ruta entre dos localizaciones de la ciudad de Vigo en España. Como Vigo es una ciudad grande de España, perteneciente a la Comunidad Europea, que es un aliado de los Estados Unidos los datos obtenidos presentan un error pequeño, y el camino elegido, no muestra desviaciones importantes de la ruta original.

A lo largo del trabajo se utilizan métodos de regresión no paramétricos y el mecanismo de remuestreo bootstrap para la construcción de intervalos de confianza. Se utilizarán datos

simulados para verificar el buen comportamiento de los métodos propuestos, y finalmente se aplicarán a la reconstrucción de un camino basada en datos reales.

Abstract

The Global Positioning System is a radio navigation system developed by the US Department of Defense, at beginning is to use only in the US Army. But soon the civilian market saw in this system a good business objective. Currently this system is composed of various stakeholders, such as: satellites, central control station, antennas for transmitting data to satellites, monitoring stations and receiver.

Data provided by the GPS receivers are not always the most correct. This can also vary from country to country, also vary if you're in a city or in more remote locations. On the other hand, also depending on atmospheric conditions (storm conditions interfere with good communication between the satellite and receiver), now the cloud of ash from the volcano Eyjafjallajokullda are interfering in large scale in navigation systems at most of Europe.

These errors can be avoided? Yes they can, because as the GPS receiver is composed of hardware (equipment) and software (maps, search engines and position control) and as in all communication systems can be improved using a software with upgrades. By the use of statistical methods, that becomes necessary to control and errors and their removal. Hence throughout this work will be tested a few methods to try to improve the path given by the receiver. To illustrate these methodologies has been a useful route between two locations of city of Vigo in Spain. As Vigo is a large city in Spain, belonging to the European community, which is an ally of the United States, the data show a small error, and the path chosen does not show a large deviations from the original track.

Throughout this project we use methods based on nonparametric regression and bootstrap methodology for building confidence intervals. They are also used simulated data to verify the good behavior of the proposed methods and finally apply the reconstruction of track based on real data.