The following is a list of suggested problems. For each problem we have given the corresponding section in the book where further details and the answer to the problem may be found. Please note: the list of problems is being updated all the time.

CHAPTER 1

1.1 Define multi-sensor data fusion and its motivation (Sect. 1.1-1.2).
1.2 In Sect. 1.2 we explained how multi-sensor fusion improves the quality of information in four ways (representation, certainty, accuracy and completeness). Use this framework to analyze the multi-sensor data fusion system for the multi-modal biometric system in Ex. 1.1 (Sect 1.2).
1.3 Repeat Quest. 1.1 for the multiple camera surveillance system in Ex. 1.2 (Sect 1.2).
1.4 Three multi-sensor data fusion classification schemes are Boudjemaa-Forbes, Durrant-Whyte and Dasarathy). Use these schemes to analyze the multi-sensor data fusion flood forecasting system in Ex. 1.4 (Sect. 1.3).
1.5 Repeat Quest. 1.3 for the triangulation algorithm in Ex. 1.5 (Sect. 1.3).
1.6 Only some input-output combinations are allowed in the Dasarathy classification scheme. Suggest reasons why this should be the case (Sect. 1.3.3).
1.7 The fusion cell introduced in Sect. 1.4 has three inputs: input data, auxiliary data and external knowledge. (a) Explain the difference between these inputs. (b) Describe the triangulation algorithm in Ex. 1.5 using the fusion cell and identify the corresponding input data, auxiliary data and external knowledge (Sect. 1.4).
1.8 Explain why catastrophic fusion occurs (Sect. 1.5).
1.9 Explain how the auxiliary sensors C_A and C_V in the multi-sensor data fusion audio-visual automatic speech recognition system in Ex. 1.7 prevent catastrophic fusion (Sect 1.5).
1.10 In Ex. 1.7 the sensors C_A and C_V are regarded as sources of auxiliary data and not input data. (a) Could they have been classified as sources of input data? (b) Is there any difference between classifying C_A and C_V as sources of auxiliary data or input data? (Sect. 1.5).

CHAPTER 2

2.1 Use the concept of an interface file system (IFS) to explain the action of a brake pedal in an automobile (Ex. 2.1).
2.2 Compare and contrast the Real-time Service interface, the Diagnostic and management interface and the Configuration and Planning interface (Sect. 2.4.1).
2.3 Measurement uncertainty may be broadly divided into random errors, systematic errors and spurious readings. Explain and define these errors (Sect.2.5.1).
2.3 The following are all systematic errors: calibration errors, loading errors, environmental errors and common representational errors. Compare and contrast these errors. Give examples of each type of error (Sect. 2.5.1).

CHAPTER 3

3.1 Explain the concept of replication transparency in a decentralized multi-sensor data fusion network (Sect. 3.1).
3.2 Explain the concept of failure transparency in a decentralized multi-sensor data fusion network. Compare and contrast it to replication transparency.
3.3 List the relative advantages and disadvantages of the centralized, decentralized and hierarchical architectures (Sect. 3.4).
3.4 Give an example of a multi-sensor data fusion system which uses a parallel network (Sect. 3.3.2). What are its advantages and its disadvantages?
3.5 Give an example of a multi-sensor data fusion system which uses a serial network (Sect. 3.3.3). What are its advantages and its disadvantages?
3.6 Give an example of a multi-sensor data fusion system which uses an iterative network (Sect. 3.3.4).
3.7 Define data incest. Explain why it does not affect multi-sensor data fusion systems employing centralized architectures (Sect. 3.4.2).
3.8 Define the method of covariance intersection. Explain how it "solves" the method of data incest. What are is its disadvantages? (Sect. 3.4.2).
3.9 Suggest an alternative approach to prevent data incest (Sect. 3.4.2).

CHAPTER 4

4.1 Develop the algorithm for triangulation in the Bayesian framework (Ex. 4.2).
4.2 What is Kriging? Compare and contrast the methods of simple, ordinary, universal, indicator and disjunctive Kriging, co-Kriging and Kriging with an external drift (Sect. 4.3).
4.3 How should estimate how many sample points N to use in the ordinary Kriging equations (Sect. 4.3)?
4.4 In Sect. 4.4 we considered the conversion of range-bearing measurements to Cartesian coordinates. Show the conventional conversion equations, $x=r\cos(\theta)$, $y=r\sin(\theta)$, give biased estimates. Use a simple example to show the coordinates $x_{DB}=r\cos(\theta)/\lambda$, $y_{DB}=r\sin(\theta)/\lambda$ are less biased (Ex. 4.7).
4.5 Describe the main characteristics of the linear subspace techniques PCA, LDA, ICA, NMF and CCA (Sect. 4.5).
4.6 Explain the main differences between bagging, wagging, boosting and multi-boosting (Sect. 4.6).

CHAPTER 5

5.1 Define mutual information and explain the different approaches to measuring it (Sect. 5.2.1).
5.2 Explain why mutual information is useful for aligning sensors of different modalities. Suggest alternative approaches which may also be used (Sect. 5.2).
5.3 Resampling in an important step in spatial alignment. Explain what resampling is and why it is necessary (Sect. 5.3).
5.4 Describe the multi-sensor data fusion of a panochromatic sensor and multi-spectral sensors using co-Kriging (Sect. 5.5).

5.5 Describe the multi-sensor data fusion of PET and MRI images using fuzzy logic (Sect. 5.5).

CHAPTER 6

6.1 Describe the process of dynamic time warping. Explain the role the boundary conditions and the constraints of continuity and monoticity play in the algorithm (Sect. 6.3).
6.2 Describe the derivative DTW algorithm. Suggest when DDTW should be used instead of DTW (Sect. 6.3.1).
6.3 Describe the continuous DTW algorithm (Sect. 6.3.2).
6.4 Show how we may use the framework of DTW to explain video compression (Sect. 6.4).

CHAPTER 7

7.1 What is Virtual screening? List some of the similarity coefficients which are used in virtual screening (Sect. 7.1).
7.2 Define binarization. Develop the method of image thresholding using Kriging (Ex. 7.5).
7.3 Describe fuzzy normalization (Sect. 7.4).
7.4 Explain the advantages of using ranking as a normalization procedure (Sect. 7.5).
7.5 Compare and contrast the following methods for converting measurements to probabilities: Platt calibration, binning, kernels, isotonic regression (Sect. 7.6).
7.6 Explain Platt calibration. How may we reduce the impact of overfitting on Platt calibration (Sect. 7.6.1).
7.7 Describe the process of isotonic regression (Sect 7.6.4).

CHAPTER 8

8.1 Define the main premise of Bayesian inference. What are its relative advantages and disadvantages? (Sect 8.1).
8.2 Comapre and contrast fuzzy logic and Bayesian inference as a framework for multi-sensor data fusion (Sect. 8.1).
8.2 Write down Bayes' formula and explain how we may use it to find the a posteriori pdf (Sect 8.4).
8.3 What are conjugate priors? Give some examples (Sect 8.4.2).
8.4 What are non-informative priors? Give some examples (Sect. 8.4.3).
8.5 Explain the EM algorithm. Write down the main steps in the EM algorithm for modeling a given function as a mixture of Gaussians (Ex. 8.5).
8.6 Describe the use of the EM algorithm for PCA (Ex. 8.6).
8.6 Explain the process of Bayesian model selection (Sect. 8.5).
8.7 Describe Bayesian model averaging? Compare and contrast it with other model selection procedures (Sect. 8.5).

CHAPTER 9

9.1 Describe how we may use Bayesian analysis to find a finite length straight-line segment to a set of noisy points (Sect 9.3).
9.2 Define the method of maximum likelihood. When should it reduce to MAP (maximum a posteriori)? (Sect. 9.4).
9.3 Describe Kriging with an External Trend (Ex. 9.4).
9.4 Define the method of least squares. When does it reduce to MAP? (Sect 9.5).
9.5 Define the linear Gaussian model. Describe straight-line regression using the linear Gaussian model (Sect. 9.6).
9.6 Describe the detection of a single step in a piece-wise constant time using the linear Gaussian model (Sect. 9.6).
9.7 Describe the probabilistic PCA (Sect. 9.6).

CHAPTER 10

10.1 Define robust statistics. Give an example showing the importance of using robust statistics (Sect. 10.1).
10.2 Gating is often used in target tracking to eliminate outliers. What is gating? What are the relative advantages and disadvantages of gating? (Ex. 10.2).
10.3 Apart from eliminating outliers, robust techniques work by reducing the influence of outliers. Explain how employing student-t function reduces the influence of outliers (Sect. 10.3.1).
10.4 Write down the "Good-and-Bad" likelihood function. Given N independent measurements $(y_i,s_i),i \in \{1,2,..,N\}$ of a parameter θ show how we calculate the a posteriori pdf of the parameter θ (Sect. 10.3.2).
10.5 Derive the uncertain error bar likelihood function (Eq. 10.5). Explain the reasoning behind this likelihood function (Sect. 10.3.4).
10.6 Describe the Hough transform and its use in tracking initialization (Sect. 10.6).
10.7 Describe the method of RANSAC (Sect. 10.6).

CHAPTER 11

11.1 Define sequential Bayesian inference. Differentiate between smoothing, filtering and forecasting (Sect. 11.1).
11.2 The Kalman filter assumes a linear Gaussian process and measurement model. Explain what these models are (Sect. 11.3).
11.3 Describe the Kalman filter equations (Sect. 11.3).
11.4 Describe some maneuver models (Sect. 11.3).
11.5 Compare and contrast the Robust, Kriged, Augmented, Extended, Unscented and Switching Kalman filters (Sect. 11.4).
11.6 Compare and contrast measurement and track-to-track fusion (Sect. 11.6).
11.7 Define the data association problem. Compare and contrast the following data association algorithms: nearest neighbour, strongest neighbour, covariance union and probabilistic data association (Sect. 11.3).

CHAPTER 12

12.1 What is the curse of dimensionality? (Sect. 12.2).
12.2 Define the naïve Bayes' classifier. Explain why it is called naïve (Sect. 12.2).
12.3 In the naïve Bayes' the likelihood function is written as a product of individual features. Justify this approximation and suggest alternative approximation which could bee used (Sect. 12.3).
12.4 In the context of the naïve Bayes' classifier compare and contrast feature selection, feature extraction and feature joining (Sect. 12.4).
12.5 Explain the mRMR feature selection algorithm (Ex. 12.6).
12.6 Define wrapper feature selection. What are its advantages and disadvantages (Sect. 12.4).
12.7 Compare and contrast tree augmented naïve Bayes (TAN), adjusted probability model (APM) and homologous naïve Bayes' classifiers (Sect 12.4.2).

CHPATER 13

13.1 Describe the basic idea of ensemble learning (Sect. 13.1).
13.2 Describe the Bayesian framework for ensemble learning (Sect. 13.2).
13.3 Compare and contrast the empirical and Bayesian frameworks for ensemble learning (Sect. 13.3).
13.4 Compare and contrast two methods for constructing an ensemble of diverse training sets (Sect. 13.4).
13.5 Compare and contrast the following diversity measures: Yule statistic, correlation coefficient, disagreement measure, double fault measure, entropy, Kohavi-Wolpart variance and measure of difficulty.
13.6 Compare and contrast the following combination strategies: mean vote, Borda count, majority vote, mixture of experts (Sect. 13.7).
13.7 Describe the BKS (behaviour-Knowledge space) combiner (Ex. 13.9).
13.8 Describe the method of boosting (Sect. 13.8).

CHAPTER 14

14.1 Sensor management is often described as a hierarchy of three levels: sensor control, sensor scheduling and resource planning. Compare and contrast these three hierarchical levels of sensor management (Sect. 14.2).
14.2 Compare and contrast the information-theoretic and Bayesian decision-making methods for sensor management (Sect. 14.3).